Exploring and Explaining Impulsivity

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Abstract

The research reported in this dissertation supports a conceptualisation of impulsivity as a fundamental trait which is not subsumed by other traits in large scale models of personality, whether of three five or more factors. It argues for this by showing that a measure of impulsivity demonstrates incremental validity over and above the validity of two measures of the Big Five personality traits in the prediction of a variety of behaviours which previous research has linked to individual differences in impulsivity. The research also demonstrates that while impulsivity is a coherent trait, it nevertheless subsumes at least two and perhaps three correlated lower order traits; in the first instance this is demonstrated through an analysis of the factor structure of the BIS-11 which replicates the factor structure proposed by Patton et al (1996). Research reviewed in the first three chapters suggests a conceptual overlap between the multi-faceted trait of impulsivity and the dual factor model of inattentive and impulsive behaviours which constitutes the syndrome of ADHD. Two studies explore this overlap by first establishing that ADHD behaviours may be considered as two highly correlated traits and then exploring the correlations and conceptual overlap between these ADHD traits and the impulsivity facets measured by the BIS-11. The results suggest that while the correspondence between the variables across the two questionnaires and domains is not simple, it does justify further exploration. The final study explores the relationships between self-report measures of inattention and impulsivity and laboratory tasks selected to tap into behavioural and cognitive inhibition. The significant correlation between the cognitive inhibition tasks and the variance shared by the inattention and impulsivity scales supports the hypothesised role of cognitive variables in affecting individual differences in a unitary construct of impulsivity/inattention.
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A.1 Principal Axis Factor analysis. Loadings of 5 tasks (excluding SART) upon derived factors and the correlations between factors and the self report measures of impulsivity and inattention.
Summary

Introductory chapters 1-3

Chapter 1 aims at a delineation of the construct of impulsivity which lies at the core of most discussions of impulsivity. This occurs through establishing a coherent definition of impulsivity which is differentiated from phenotypically similar constructs; in particular, the relationship with the trait of sensation seeking, as defined by Zuckerman, is clarified. Next the construct of impulsivity as operationalised in a number of impulsivity scales is explored and the considerable overlap in variance between these scales is discussed; reflecting their overall agreement on the core construct of impulsivity while acknowledging the possibility of a model of impulsivity comprising correlated facets.

The second section discusses the positioning of impulsivity within hierarchically structured models of personality, noting the general agreement which exists on situating impulsivity within a broader higher-order trait of conscientiousness as it occurs in five factor models of personality or within largely similar constructs in other models (e.g. constraint for Tellegen, psychoticism for Eysenck and impulsive-sensation seeking for Zuckerman). There is some discussion of the different flavours/connotations given to impulsivity within these different models.
The third section explores the conceptualisation of impulsivity within research and theory in developmental psychopathology; a conceptualisation which argues for a conceptual and empirical link between behavioural disinhibition and regulation of attention. Both Rothbart and Eisenberg employ a construct of effortful control which involves the control of both attentional processes and behaviour while ADHD theorists give equal weight to problems of behavioural inhibition and attention regulation as facets of the ADHD syndrome.

Chapters 2 & 3 are concerned with the exploration and explanation of impulsivity. In Chapter 2 the contribution of the research into personality traits is assessed and its limitations discussed; in particular the neglect of the development of causal frameworks in structural models of personality and the tendency to treat personality traits only as independent variables. The relationship of impulsivity to conscientiousness is given special attention.

Chapter 2 also explores the way in which the behaviours which co-vary with impulsivity contribute to an explanation of its nature; in particular the relationship with various aspects of psychopathology in adults. The co-variation of impulsivity with a wide though delimited selection of psychopathological behaviours suggests to some theorists that these behaviours are typical sequelae of, and indeed caused by, impulsivity.

Chapter 3 explores a structured model of the causes and nature of impulsivity, building upon genetic, biochemical, neurological and cognitive research on both impulsivity and ADHD, which discusses hypothetical causal chains from the most
distal elements – genetics- to the most proximal – behavioural traits, social relationships and educational/occupational career.

**Empirical chapters**

Chapter 4 involves an exploration of the BIS-11 which confirms its structure as three correlated traits with conceptually coherent relationships to other Big Five traits. A short form of the BIS-11 is developed to reflect the three facets as well as the higher order construct of impulsivity. The construct validity of the various scales is demonstrated through their correlations with measures of personality traits and self report measures of aggressive behaviour, alcohol consumption and driving behaviour.

Chapter 5 reports two studies which demonstrate that impulsivity adds incremental validity to the Big Five, with the aim of exploring the relationship between impulsivity and the Big Five. The first of these studies finds that impulsivity adds incremental validity in the prediction of academic performance while the second study demonstrates incremental validity in the prediction of alcohol consumption and driving behaviour among students.

Chapter 6 explores an alternative model of impulsivity to that explored in the previous chapter; a model which deliberately embeds impulsivity within the Big Five framework while aiming to deconstruct the construct of impulsivity as a single coherent variable. The data from the study in this chapter confirms the three factor structure of the scales adapted from the Whiteside and Lynam (2001) UPPS
impulsivity questionnaire but argues against these authors’ reduction of impulsivity traits to nothing more than facets of the Big Five.

Chapter 7 develops the theoretical argument in chapter 2 relating impulsivity to ADHD behaviour considered as a trait. In the first study of this chapter the data provide evidence for the validity of ADHD as a trait and demonstrate that this trait cannot be reduced to some combination of Big Five traits. The second study in this chapter explores the relationships between the two ADHD subtraits and the three facets of the BIS-11; an exploratory factor analysis of the items of both scales identifies three different though related facets of impulsivity.

Chapter 8 explored the relationship between self report measures of two of the facets of impulsivity identified in the earlier chapters, behavioural impulsivity and inattention, and laboratory studies sustained of attention regulation, and of response inhibition; with the aim of exploring whether these two highly correlated traits have different cognitive underpinnings. The fact that both self report traits correlated with measures of attention regulation is consistent with much research from ADHD domain which does not differentiate between the two sub-traits in terms of cognitive or neuropsychological variables. The results also support the argument that impulsivity be conceived of as involving both attentional and behavioural inhibition.

Chapter 9 discusses the implications of the findings.
Summary of research methods and analysis

Two methods of research and analysis are used throughout the studies reported in this thesis; the first is exploratory factor analysis (EFA) and the second is multiple regression. According to Fabrigar, Wegener, MacCallum and Strahan (1999) “EFA is used when a researcher wishes to identify a set of latent constructs underlying a battery of measured variables.” In a number of studies exploratory factor analysis is used to identify the number of latent variables underlying the responses to the items in a questionnaire. In chapter four the BIS-11 is factor analysed to replicate the factor structure of that questionnaire proposed by Patton et al (1996). In that analysis, and others which employ exploratory factor analysis, three of the issues raised by Fabrigar et al. (1999) were tackled in a consistent way.

The first issue relates to the use of factor analysis rather than principal components analysis; as Fabrigar et al. (1999) point out factor analysis, as opposed to principal components analysis, aims to identify the common factors (or latent variables) which account for the correlations between items and in doing so ignores unique or error variance. Since, as mentioned above, the aim in this thesis is to identify latent variables then factor analysis (promax) is used throughout.

The second issue relates to the criterion for deciding on the number of factors to extract. In this thesis the scree test was used to estimate the number of factors which
best characterised the data sets analysed rather than the ‘eigen value greater than one’ is generally considered to lead to over factoring. While the scree test involves an element of subjectivity in judgements as to where the substantial drop in value (or ‘elbow’) occurs more formal decision rules, such as parallel analysis, were judged unnecessary since the aim was not to discover the correct number of factors; rather in most cases inspection of the scree plot serves to support the extraction of the number of factors as stipulated by previous research. Thus analysis of the scree plots produced in the factor analysis of the Whiteside and Lynam (2001) scales in chapter six and the analysis of the ADHD scales in chapter seven justified the extraction of three and two factors respectively as described by previous research which is discussed in the relevant chapters.

The third issue relates to the use of orthogonal or oblique methods of factor rotation; in this thesis oblique rotation was used throughout. As Fabrigar et al. (1999) point out, while orthogonal rotation constrains factors to be uncorrelated, oblique rotation allows factors to be correlated when they are in reality correlated. In the case of the questionnaires employed in this thesis substantial correlations were to be expected since not only do most personality traits correlate to some extent but many impulsivity questionnaires embody models of impulsivity comprising correlated facets. According to Fabrigar et al (1999) observation of substantial correlations between factors supports the hypothesis of higher order factors and thus serves the aim of this thesis in arguing for a higher order factor of impulsivity which subsumes traits such as acting without thinking, inattention, distractibility and premature responding. In the case of the BIS-11 and the ADHD questionnaires the use of oblique rotation allowed the examination of correlations between factors in order to
replicate previous research. In the analysis of the Whiteside and Lynam (2001) questionnaires the correlations between the factors were utilised to argue, against those authors, for the existence of a latent trait influencing the various manifestations of impulsivity.

The second major research strategy was the use correlation coefficients and regression analysis to demonstrate the validity of measures of impulsivity traits in the prediction of behaviours which were taken as indicators of impulsivity. While the first step was to demonstrate the validity of the measures of impulsivity through their correlation with indicators of behaviour which previous research had demonstrated to be manifestations of impulsivity. The second step was to demonstrate the incremental validity of impulsivity traits over measures of the Big Five personality traits.

Previous research has associated impulsivity with maladaptive behaviours such as poor academic performance and driving misdemeanours; research in the domain of psychopathology has associated impulsivity with more serious behaviours such as excessive alcohol consumption, impulsive aggression, and emotional disregulation. Research on the correlates of ADHD has similarly identified driving behaviour and alcohol misuse as the sequelae of ADHD symptoms in adults. Consequently measures of these behaviours are used throughout the studies in chapter four to seven.

The second step was the use of regression analysis to illustrate the incremental validity of impulsivity traits in the prediction of these behaviours; in most cases the concern was to illustrate the incremental validity over the Big Five traits. In chapters four and five a measure of impulsivity derived from the BIS-11 was shown to predict
significant variance in a number of variables over and above the variance predicted by the Big Five; similarly in chapter 7 the ADHD traits were shown to have incremental validity over the Big Five in the prediction of both self and peer reports of behaviour. This same strategy was employed in chapter six to support the argument that the impulsivity traits identified by Whiteside and Lynam (2001) should not, contrary to their conceptualisation of impulsivity, be simply identified as aspects of the Big five traits of conscientiousness.
Chapter 1

The conceptualisation and operationalisation of impulsivity

The concept of impulsivity figures in a number of different domains of Psychology.

1. It is a significant element in most structural models of personality where it is usually considered a lower order trait; a facet of a higher order trait such as Psychoticism (Eysenck's PEN model) or Conscientiousness (as in most five factor models).

2. It is a core symptom of the syndrome of Attention Deficit Hyperactivity Disorder (ADHD) wherein it serves to define, together with hyperactivity, one of the major subtypes of the disorder.

3. It is an important symptom in many psychiatric diagnoses; from Kleptomania through to Bulimia. In these contexts it is typically considered as a type of behaviour caused by the underlying pathology (as in borderline personality disorder), though in some diagnoses - fire setting and compulsive gambling - it may be play a more causal role.

4. In the study of a variety of behaviour disorders, drug and alcohol abuse or anti-social behaviour and delinquency it is granted a more clearly causal role; e.g. as a mediating variable between parental discipline and delinquency.
Defining and delineating impulsivity

It has become commonplace to comment upon the fact that “...there exists little consensus in the literature about what constitutes Impulsivity...” and that “...the lack of conceptual clarity in the impulsivity construct has become a source of widespread confusion in the literature on this topic.” (Parker & Bagby 1997 p.142). Thus Solanto, Abikoff, Sonuga-Barke, Schachar, Logan, Wigal, Hechtman, Hinshaw, & Turkel, (2001) point out that beyond broad definitions “there is little consensus with respect to specific criteria for, or conceptual modelling of, this behavioural construct” (p. 215). In particular there is disagreement, or at least a lack of clarity, as to the relationship of impulsivity to other traits: Depue & Collins (1999) note that impulsivity has been used to refer to a wide and heterogeneous variety of traits including “impulsivity, sensation seeking, risk-taking, novelty seeking, boldness, adventuresomeness, boredom susceptibility, unreliability and unorderliness” (p. 495). To this list one might add distractibility and lack of persistence from the developmental literature (Barkley, 1997) as well as explosive aggression and irritability from the clinical domain (Moeller, Barratt, Dougherty, Schmitz, & Swann. 2001)

It is the contention of the present chapter that there is substantial agreement among many researchers, using self report questionnaires as well as laboratory tasks, in delineating a narrow and relatively well defined concept of impulsivity.
• Solanto et al (2001) propose a broad definition of impulsivity — “An impulsive response may be defined as one that is executed with insufficient forethought, planning or control and is therefore inaccurate or maladaptive.”

• Moeller et al. (2001) refer to a “Tendency to act with less forethought than most individuals of equal ability and knowledge.”

• Cherek, D., Moeller, Dougherty, and Rhoades (1997) define impulsivity as “… an inability to inhibit one’s behaviour when such inhibition is required by the particular context.” (Cherek et al. 1997, p. 52).

These definitions capture the common and essential elements of impulsivity as expressed by numerous researchers. Thus impulsivity refers to behaviour which ...

.... occurs before a proper, normative, amount of consideration of consequences,

.... involves some degree of lack of control by the subject

.... is maladaptive from the perspective of both the actor and their society.

Implicit in this formulation are the assumptions that

• the impulsive behaviour is not due to lack of knowledge of the consequences, though it may involve a lack of attention to or a forgetting of, the situational consequences

• that the inability to inhibit behaviour is not due to a general cognitive deficit,

• nor that the actor does not care about the consequences
Delineating impulsivity

Differences between researchers in their conceptualisation of impulsivity tend to lie not
in their disagreement with the above description of impulsivity but rather in the range of
other traits which are included in their use of the construct. An illustrative example is
Hollander and Evers (2001) who offer the following definition: “Impulsivity (…) is the
failure to resist an impulse, drive or temptation that is harmful to oneself or others (…)manifesting as impatience, carelessness, risk-taking, sensation seeking and pleasure
seeking, an underestimated sense of harm, and extroversion.” This is an extraordinarily
wide definition which, furthermore, emphasises the harmful and maladaptive behaviours
which figure in psychopathology. The authors go on to list the psychiatric diagnoses
which include impulsive behaviour; these too range widely – from antisocial and
borderline personality disorders to Trichotillomania. However, the definition provided by
Hollander and Evers (2001) provides a useful focus for discussing at this point some of
the traits which the present thesis differentiates from impulsivity; though these issues will
be discussed again later in the context of models of personality and impulsivity.

Like Barkley (1997) the core of their model is the failure to resist an impulse, i.e. a failure
of inhibition; the rest of the constructs which they list are referred to as manifestations of
this core disinhibition. Using a similar logic Buss and Plomin (1975) suggest that
inhibitory control is the core of impulsivity, though other characteristics such as
inattention, distractibility, persistence and boredom are often included in the concept.
Both of these approaches agree with the model underlying the present thesis.
It is useful to take issue with the details of the conceptualisation proposed by Hollander and Evers (2001). Their suggestion that both extraversion and pleasure seeking might be a manifestation of impulsivity is disputed by theorists such as Eysenck, Tellegen and Depue and Collins; this issue will be discussed below in the sections of Eysenck, Gray and Tellegen. Their use of the terms ‘risk taking’ and ‘sensation seeking’ refers to the trait, or trait complex of sensation seeking; Zuckerman includes impulsivity and sensation seeking as two facets of the super-ordinate trait which he terms ‘impulsive unsocialised sensation seeking (Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993), a trait which he considers to be a close approximation to Eysenck’s trait of psychoticism. While the traits of impulsivity and sensation seeking are frequently conflated, a number of theorists suggest that they should be considered as separate traits. Eysenck, himself distinguishes between impulsivity, which he relates to psychoticism, and venturesomeness, which he considers to be an element of extraversion. Similarly, in their model of impulsivity Whiteside and Lynam (2001) situate their construct of sensation seeking (which they explicitly identify with Eysenck’s venturesomeness and Zuckerman’s sensation seeking scales) within the higher order personality domain of extraversion, while situating impulsivity within the domain of conscientiousness. Thus these authors each imply a distinction between the constructs of impulsivity and sensation seeking in terms of underlying latent variables while acknowledging their co-variance in terms of behaviour. Nevertheless the frequency of that conflation and the undoubted covariance of impulsivity and sensation seeking requires more detailed discussion.
Impulsivity and sensation seeking

Zuckerman's construct of sensation seeking comprises four lower order traits or facets; thrill and adventure seeking, excitement seeking, disinhibition and boredom susceptibility; however the coherence of this construct is questionable. Quilty and Oakman (2003) found the correlations between the facets to range from .11 to .46; particularly low were the correlations between boredom susceptibility and thrill and adventure seeking and excitement seeking ($r = .11$ and .22 respectively). Quilty and Oakman (2003) also provided data on the relationship between sensation seeking facets and the facet scales of the Barratt Impulsiveness Scale (BIS-11, Patton, Stanford, & Barratt, 1995). Correlations between the BIS-11 facet scales and the thrill and adventure and excitement scales ranged from .11 to .24, while the correlations between the BIS-11 facet scales and the dis-inhibition and boredom susceptibility scales ranged from .23 to .33.

Flory, Harvey, Mitropoulou, New, Silverman and Siever (2006) analysed data from a number of impulsivity and sensation seeking scales which were administered to 350 subjects. They administered the Barratt Impulsiveness Scale- version 10 (BIS-10 a precursor of the BIS-11 discussed below) as a single factor measure of impulsivity, and the Zuckerman four facet scales of sensation seeking from the SSS-V5. They also utilised the three novelty seeking scales of the Tridimensional Personality Questionnaire (TPQ: Cloninger 1987); these assess exploratory excitability versus stoical rigidity, impulsiveness versus reflection and extravagance versus reserve. Examination of scree
plot and eigen values led them to extract three factors. The first of these was identified by the sensation seeking scales of thrill and adventure seeking and excitement seeking as well as the exploratory excitability scale of the TPQ. The second factor was identified by the BIS-10 total score and two scales from the TPQ — extravagance versus reserve and impulsiveness versus reflection. The third was defined by the dis-inhibition scale and the boredom susceptibility scale from the SSS-V5.

When the three component scores were correlated with the Big Five personality traits the impulsivity component correlated predominantly with conscientiousness and secondarily with neuroticism (-.61 and .30 respectively) figures similar to those reported below in chapter 2. The thrill seeking component correlated with extraversion and openness (.33 and .61 respectively) and the disinhibited behaviour component correlated moderately with openness, agreeableness and conscientiousness (.27, -.31,.24 respectively). Once again this pattern of correlations suggests a distinction between impulsivity and sensation seeking; in particular the correlations between the ‘impulsivity’ variables and the Big Five suggest that while thrill and adventure seeking is a relatively benign and even admirable trait, both impulsivity and disinhibition are maladaptive — characterised by negative affect and low conscientiousness. Correlations between BIS-10 scores and the scales of the SSS-v5 are also revealing; the BIS-10 correlated .27 and .23 with boredom susceptibility and dis-inhibition respectively and .15 and .10 with excitement seeking and thrill and adventure respectively (Flory, 2007. personal communication). While all but the last of these was significant, given the sample size of 351, the pattern of correlations is reminiscent of the results of Quilty and Oakman (2003) discussed above where
impulsivity correlates more substantially with the maladaptive aspects of sensation seeking.

Studies utilising other measures of sensation seeking traits find a similar pattern. Thus Dahlén, Martin, Regan and Kuhlman (2005) correlated the total BIS-11 scores with scores on the Arnett inventory of sensation seeking (Arnett 1994) and the Boredom Proneness scale (Rupp & Vodanovich 1997). The sensation seeking and boredom scales, reflecting aspects of Zuckerman’s construct did not correlate significantly (r = .11); furthermore the BIS-11 correlated more highly significantly with the boredom proneness scale than with the sensation seeking scale (r = .50 and .28 respectively, both p<.01) reflecting the results of Quilty and Oakman (2003). These results question the coherence of the sensation seeking construct and its relationship to impulsivity.

Miller, Joseph and Tudway (2004) factor analysed data from the Dickman functional and dysfunctional scales (Dickman, 1990), the Eysenck impulsivity and venturesomeness scales (Eysenck, Pearson, Easting, & Allsopp, 1985), the BIS-11 facet scales (Patton, Stanford, & Barratt, 1995) and the BIS/BAS scales of Carver and White (1994). The three BIS-11 scales the Eysenck impulsivity scale and the Dickman dis-functional impulsivity scale loaded on the first factor; the second factor was defined by the Eysenck venturesome and the Dickman functional impulsivity scales, with substantial secondary loadings from the fun and drive scales of the BAS; the third factor was defined by the fun, drive and reward responsiveness scales of the BAS. These results indicate a clear
differentiation between impulsivity and sensation seeking and an affinity between the latter and positive affectivity, or extraversion.

The data considered above suggest that one should differentiate between two distinct senses of sensation seeking; the first of these is independent of impulsivity and involves a desire for strong stimulation, excitement and variety, for sky diving, cocaine; a deliberate and controlled exposure to risks—a desire which often involves planning and which co-exists with a generally well-regulated life style. The second involves impulsivity and dis-regulation, boredom susceptibility, distractibility, lack of forethought and is found in conjunction with personality and conduct disorders. What Eysenck, Dickman and Whiteside and Lynam mean by venturesomeness, functional impulsivity and sensation seeking respectively may be the first of these senses of sensation seeking; a non-impulsive sensation seeking. Interestingly, Zuckerman (1993) makes passing reference to this point when he remarks that mountain climbers are characterised by high scores on a sensation seeking scale yet their mountain climbing is characterised by careful planning. Gilchrist, Povey, Dickinson and Povey (1995) compared the Zuckerman sensation seeking scores of a sample of people who had recently been on an adventure holiday to a demographically similar control group. While the two groups differed significantly on thrill and adventure seeking and experience seeking subscales there were no significant differences on either the disinhibition or boredom susceptibility scales. The thrill and adventure scale correlated moderately with the excitement seeking scale \(r = .47\) and the boredom susceptibility and disinhibition scales correlated .42 while the other scale inter-correlations ranged from .11 to .28.
If this hypothesis is correct it suggests that the sensation seeking construct is a prime example of taking superficial description to indicate the nature of latent or causal variables. Thus it appears that at least some, if not all, of "...the lack of conceptual clarity in the impulsivity construct ......a source of widespread confusion in the literature on this topic." (Parker & Bagby, 1997, p.142) may be susceptible to clarification.

**Psychometric approaches to impulsivity**

In the field of individual differences impulsivity is considered as a personality trait and is most often measured by self-report questionnaire. The individual differences, psychometric tradition aims to establish a nomological network within which the validity of a trait such as impulsivity is established. Such research tends to view the trait as an independent variable and explores its relationship with other variables; this may well be driven by the pragmatic requirement of testing in applied psychology where predictive validity is prioritised (Caprara & Cervone, 1999). Where the nature of the trait is explored it is in a superficial way - refining descriptions, drawing finer distinctions. This is explanation at the simplest level, mapping out the surface structure [phenotype] of behaviour; though the demonstrable consistency of the behaviour across time and situations adds a further layer of explanation. Trait psychology does not however simply explore single traits, it also considers the relationship between different traits; of particular importance is the exploration of structural/hierarchical models of personality, such as the Big Five of Costa & McCrae (1992) where co-varying lower level traits...
produce higher level traits which subsume the lower level traits; the higher level traits being assumed to be independent or orthogonal.

The last few decades has seen the rise of structural models of personality which aim to encompass the major aspects of personality within a hierarchical trait model; the most prominent of these being the Five Factor Model (FFM). (John & Srivastava, 1999). Such models tend to concur in identifying five traits at the highest level of the hierarchy - the acronym OCEAN serves as a useful mnemonic for Openness to experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism. At a lower level more narrow, or primary, traits such as deliberation and self-discipline are identified as facets of, for example, conscientiousness; while at the lowest level are situated narrowly defined behaviours such as tidiness and orderliness at home.

Many omnibus personality questionnaires, and not only those operationalising the FFM, include measures of impulsivity. Impulsivity scales within such personality inventories include the self-control scale of the California Personality Inventory (CPI) and the Control/Impulsiveness scale of the Multidimensional Personality Questionnaire (MPQ); in each case the Impulsivity scale is conceptualised as a primary trait which is then situated within a higher order factor; e.g. within Constraint in the three factor model of the MPQ. In the following sections approaches to impulsivity considered as a relatively independent trait will be discussed, whether the scales are independent stand alone scales or whether they are part of an omnibus personality questionnaire. Approaches to
impulsivity where impulsivity is conceptualised as an integral part of a structural model of personality will be discussed in chapter 2.

A number of theorists have studied impulsivity as an independent trait often developing stand alone measures of trait, among the best known are the Barratt impulsiveness scale (BIS-11), Dickman’s scale of functional and dysfunctional impulsivity and the Eysenck scale of impulsivity and venturesomness, the I7. For each of these, there is considerable evidence for their internal and external validity. The BIS scales have been utilised in a considerable number of clinical studies, demonstrating their validity in differentiating between impulse disorders, such as borderline personality disorders, and non-impulse disorders such as depression (Solof et al., 2000). The Eysenck Impulsiveness scale, the I7 has also been developed over a number of years with numerous studies attesting to its validity, finding it to significantly predict problem gambling (Vitaro, Arsenault & Tremblay, 1999) and antisocial behaviour (Luengo, Carrillo-De-La-Peña & Otero, 1994) in adolescents. These impulsivity scales share considerable variance; The I7 and Dickman’s disfunctional impulsivity scale have been found to correlate 0.73 (Dickman, 1990; Claes et al., 2000), while correlations between the I7 and the BIS11 have been reported to be between .7 and .8 (Luengo et al., 1991). Miller et al. (2004) administered the Dickman, Eysenck and BIS-11 scales to a sample of 245 adults (mean age 42.7, 44% male). The correlation between the Dickman dysfunctional impulsivity and the Eysenck impulsivity scales was .78 while the correlation between these two scales and the BIS-11 facet scales ranged from .45 to .63.
A number of omnibus personality questionnaires contain scales to measure impulsivity. The Multidimensional Personality Questionnaire (MPQ: Tellegen, 1982) contains a Control/Impulsiveness scale which refers to impulsiveness, carelessness and recklessness; the Personality Research Form (PRF Jackson 1984) contains an ‘Impulse’ scale which refers to acting on the spur of the moment and without appropriate forethought; while the Guilford-Zimmerman Temperament Survey (GTZS; Guilford, Zimmerman & Guilford, 1976) contains a scale assessing the ‘happy-go-lucky, carefree, impulsive individual’. Once again these scales show considerable overlap in variance amongst themselves and with the single trait scales discussed above. Parker & Bagby (1997) report correlations ranging from 0.78 to 0.89 between the PRF, MPQ and GTZS scales of Impulsivity, while Dickman (1990) finds the PRF impulsivity scale to correlate .83 with Eysenck’s 17 impulsivity scale, and .67 with his own dysfunctional impulsivity scale but only .14 with the FI scale. This shared variance and the evidence for the validity of individual scales argues for the validity of their common concept/construct of impulsivity.

Impulsivity as a multi-dimensional construct

While acknowledging the distinction between impulsivity and other traits one may nevertheless explore the faceted nature of impulsivity; this is legitimate even if one eventually incorporates impulsivity into an hierarchical model – traits at all levels may be further subdivided. Note that there is a general problem of deciding to what extent multi-factorial models are carving the body of impulsivity into equivalent facets; it is not
enough to simply compare labels. It is necessary to compare the various subscales – at least one of the studies below attempts to do this – or to establish equivalent validity by relating them to common behavioural indicators.

Parker, Bagby and Webster (1993), explored the dimensionality of three impulsivity scales which were factors within well known personality questionnaires, using data from a sample of 252 adults and 230 undergraduate students. Exploratory and confirmatory factor analysis of the twelve item impulsivity scale from the Personality Research Form (PRF-form e; Jackson, 1984) supported a single factor solution in both samples. A similar analysis of the 24 item control scale from Tellegen’s MPQ suggested two factors which the authors labelled cautious/spontaneous and methodical/disorganised dimensions. The two subscales constructed upon this analysis correlated .60 and .63 across the two samples; both of the scales correlated substantially with the PRF scale, .83 and .61 respectively.

A similar analysis of the Guilford-Zimmerman temperament survey (GZTS) suggested a solution of three factor which they labelled carefree, serious minded and spontaneous respectively. Correlations between the constructed subscales varied from .35 to .43 across the two samples. Their spontaneous scale correlated substantially with the PRF and the cautious scale of the MPQ (.74 and .72 respectively), however the correlations between the carefree and serious minded scales and the PRF and MPQ scales were only modest (.31 to .50). It is worth noting at this point that the inspection of the GZTS items illustrates the vagaries in the conceptualisation of impulsivity in different models. The
analysis of Parker et al. (1993) of the GZTS items produces a carefree dimension characterised by liking to have a good time and lively parties, being carefree and happy go lucky as well as craving excitement and liking wild enthusiasm. This item content suggests positive affect and perhaps an element of sensation seeking; a trait which was considered above as not being a core aspect of 'narrow' impulsivity.

The authors subjected the 6 separate thus identified sub-sub scales to an exploratory factor analysis and concluded that the results suggested a two factor solution which they describe as entailing a cautious-spontaneous dimension and a methodical-disorganised dimension, though that analysis of the first sample produced eigen values for the first two factors of 3.59 and 1.03 and a confirmatory factor analysis of their second sample produced a parameter estimate for the relationship between the two factors of .72. Though such a correlation might suggest that the two traits share only 50% of their variance, the correlation is similar to that typically obtained between different measures of the same trait. Parker and Bagby (1997) in revisiting that data report correlations between 0.78 and 0.89 between the PRF, MPQ and GZTS scales of Impulsivity. The results of their analysis thus support a model of impulsivity as a single coherent higher order trait consisting of two highly correlated lower order traits.

The authors conclude that their data concurs with other research suggesting a multidimensional construct of impulsivity; citing the models developed by Barratt and his colleagues (discussed below), Dickman (1990) and Eysenck et al. (1985). With regard to the latter two examples, one sees once again a lack of clarity caused by relying upon
nomenclature. While the research of Eysenck and colleagues (Eysenck, Pearson, Easting & Allsop, 1985) is indeed often described as supporting a multi-faceted model of impulsivity consisting of impulsivity and venturesomeness, the data suggests that these two traits are different and only superficially related, aligning impulsivity with psychoticism and venturesomeness with extraversion, the two super-ordinate factors being independent and orthogonal within the Eysenck framework. Somewhat similarly, Dickman’s model of impulsivity is described as involving two types of impulsivity — functional and dysfunctional — however Dickman himself describes these as ‘two distinct forms of impulsivity that are independent of each other’ (Dickman, 2000. p.567).

Dickman himself (Dickman 1990) identifies functional impulsivity with extraversion and dis-functional impulsivity with Eysenck’s construct of core impulsivity. A recent study by Smillie and Jackson (2006) suggests that functional impulsivity should be renamed as reward reactivity as a contribution to clarifying the confusion around the variety of ‘impulsivity’ traits. There is a frequent tendency to blur conceptual distinctions by not distinguishing between superficial similarities and underlying variables or between similar labels and different behaviours. This issue of when and whether observed (behavioural) co-variance is attributable to a common latent variable will be discussed further below when considering the model of impulsivity proposed by Whiteside and Lynam (2001).

The most prominent multi-faceted model of impulsivity is that associated with the work of Barratt and his associates who have carried out a program of research into impulsivity which involves a variety of strategies including the development and frequent revision of
a self-report scale, the latest version being the BIS-11 (Patton, Stanford, & Barratt 1996). While the authors claimed that the overall item pool was consistent in being an homogenous measure of impulsiveness - overall alpha was .8 - they argued that the data also supported three secondary factors: motor impulsiveness, cognitive impulsiveness and non-planning impulsiveness; the correlations between these ranging from .46 to .53. These will be discussed further in Chapter 4.

The BIS-11 has been used extensively in the domain of clinical psychology; the accumulated data provides evidence of the validity of the scale as well as providing insights into the role of impulsivity in various disorders. While the validity of the total scale is well established, research does not unequivocally demonstrate the value of differentiating between the facets of the BIS-11; where differential validity is demonstrated the results are inconsistent across studies, while other studies find the facets to correlate equally with criterion variables.

Nevertheless, the BIS-11 is valuable in providing a multi-faceted model of impulsivity which allows further exploration of the nature and structure of impulsivity. Of particular interest in the context of the present thesis is the recognition of the importance of attentional impulsivity; operationalised in terms of reports of failures of attention and concentration, distractibility and the occurrence of extraneous and distracting thoughts. Whiteside and Lynam (2001) too identify a trait which they label perseverance which they operationalise in terms of giving up and failing to complete tasks and difficulties in
concentration. They distinguish between lack of perseverance and lack of premeditation which they identify in terms of the acting and thinking without due consideration, perhaps the most common conceptualization of impulsivity, though in fact the two traits correlate 0.45.

Developmental models of impulsivity

Goldsmith, Lemery and Essex (2004) illustrate the way in which developmental psychology has enriched the theorising of impulsivity. They identify a regulatory domain of temperament involving the ability to inhibit behaviour when required, the ability to deploy attention effectively and finally the ability to dampen negative affect. All three of these occur in the model of impulsivity as effortful control developed by Derryberry and colleagues, and in the syndrome of ADHD as described by Barkley (1997).

Derryberry and Rothbart (1997) employ the trait construct of effortful control, defined as the ability to inhibit a dominant response to perform a subdominant response; which involves the effortful control of both attentional processes and behaviour and is used to modulate emotional experience and expression. Eisenberg, Spinrad, Fabes, Reiser, Cumberland, Shepard, Valiente, Losoya, Guthrie and Thompson (2004) describe a similar model which includes reactive control as well as effortful control; by reactive control they refer to inhibition of behaviour which occurs as a consequence of fear, anxiety and stress and which is often involuntary. They refer to the negative pole of this dimension - reactive under-control - as impulsivity; this seems to mean behaviour
unconstrained by fearful inhibition. Marking this distinction between two types of control is important; effortful control is similar to the construct of narrow impulsivity delineated at the beginning of this chapter and is an affectively 'cool' process while reactive control is affectively 'hot' since it is a function of negative affect.

Both the research programs of Rothbart and of Eisenberg suggest an interaction between effortful control and emotional reactivity such that low effortful control and high negative affect lead to maladjustment. Both research programs find a correlation between low effortful control and negative affect, suggesting that the interaction between them begins in early childhood. The simplest possibility is that low levels of effortful control interfere with the development of strategies for emotion regulation so that the child’s latent negative affectivity develops as neurotic behaviour. It may also be the case that high levels of negative affect (NA) may interfere either with the development of executive control strategies or in a stressful situation would interfere with the execution either behavioural or attentional control. Both of these lines of research suggest that the variable of effortful control entails the inhibition or control of both behaviour and attentional processes and which is essentially independent of affectivity though it may interact with both positive and negative affect to produce adjustment problems.

Rothbart, Ahadi and Evans (2000) point out the similarities between some of their temperamental variables and the Big Five personality traits; nevertheless they also suggest that temperamental models are more likely to lead to the exploration of the interaction of organism and environment (and I would add, between temperamental
traits). They suggest that descriptive models of personality tend to reinforce a simple trait based model of personality without either dynamic or developmental elements. Five factor models rarely consider either the causal mechanisms which lead to either the covariance of behaviours which constitute a trait such as neuroticism or the reasons behind individual differences of such a trait. Interestingly the exceptions to this rule are the theories of Eysenck and Zuckerman which begin from a causal perspective. Similarly five factor models of personality rarely consider the interaction between traits, considering them to be orthogonal and to have independent/additive effects upon behaviour. An example of this is the attempt to reduce personality disorder syndromes to Big Five trait descriptions; a strategy which risks losing sight of the dynamic aspects of personality disorders such as narcissism. This will be discussed further in Chapter 2.

This recognition of a dimension of attentional as well as behavioural impulsivity is paralleled by the structure of the syndrome of ADHD as defined by DSM. Barkley (2006 p.79) points out that “Two dimensions of behaviour are almost universally found when the symptoms of ADHD as rated by parents and teachers are factor analysed.” These clusters of symptoms form the basis of the Diagnostic and Statistical Manual of Mental Disorders (2000 4th ed.; DSM-IV; American Psychiatric Association) description of the ADHD syndrome which divides the symptoms of Attention Deficit/Hyperactivity Disorder into three subtypes: inattentive, hyperactive/impulsivity and combined type. The inattention cluster is reflected in parent and teacher ratings of lack of concentration, distractibility, forgetfulness and lack of organisation as well as in direct observation of
off-task behaviour. The hyperactive/impulsive cluster includes lack of inhibition and hyperactivity.

In considering the syndrome of ADHD, though impulsivity may seem rather a minor element in terms of the number of symptoms in which it is implicated, 3 out of 18, its import in terms of explanations of ADHD is more central. Olsen (2002) points out that according to a number of theorists (Barkley 1997; Quay 1997; Schachar et al., 2000) deficiencies in impulse control are conceptualised as central deficits in ADHD, with problems of attentional and activity regulation viewed as secondary manifestations.

The relevance of ADHD to the understanding of impulsivity is highlighted by the increasing recognition that while the conceptualisation of ADHD as a diagnostic category may have value clinical practice, the underlying variable or variables may well be dimensional; three lines of evidence support this argument. Firstly, studies of the latent structure of ADHD symptoms do not support the view that a latent category underlies ADHD (Haslam, Williams, Pior, Haslam, Graertz & Sawyer 2006); secondly, behavioural genetic research finds that heritability estimates do not vary according to severity of ADHD nor to where thresholds for caseness are set (Levy, Hay, McStephen, Wood & Waldeman, 1997); and thirdly, experimental studies indicate that the laboratory tasks which are utilised to tap into the cognitive basis of impulsivity (continuous performance task, go/no-go tasks and matching familiar figures) are also tasks which significantly differentiate ADHD cases from non-cases. It has, furthermore, become clear in recent
years that ADHD problems do not fade with the passing of childhood but that the symptoms or sequelae of ADHD persist into adulthood. Adults with a history of childhood ADHD evince higher rates of driving accidents and of drug abuse and the problems seen in school are reflected in the adults' problems with employment stability and effective work habits.
Chapter 2

Explaining impulsivity; the trait approach

The present chapter argues that approaches to explaining impulsivity correspond to Cronbach’s (1957) distinction between two disciplines of psychology: the correlational and the experimental. This distinction was utilised by Eysenck (1997) to characterise two different approaches to the study of personality. Eysenck argued that the correlational approach per se lacked any explanatory power and indeed lacked any particular commitment to the explanation of personality; he identified the Big Five approach to personality as just such a purely correlational approach and thus lacking in explanatory power. He further argued that an explanatory theory would need to establish relationships between the trait constructs and other variables which were not themselves from the same domain of psychology; i.e. not other traits. This is similar to the argument of Caprara and Cervone (2000) who argue that explanations must utilise constructs of a different type to the constructs to be explained. Caprara and Cervone (2000) also suggest that the lack of interest in explanation is attributable to the intimate link between personality assessment and applied fields of psychology, particularly organisational and occupational psychology where prediction – especially of job performance - has been an overriding aim.

An adequate explanatory scheme would derive from studies of the genetic, neurological and cognitive precursors of personality traits as well tracing the influences of these traits upon large scale behaviours such as sexual behaviour or criminality. In the following
discussion it will be argued that the approach to impulsivity within the trait approach to personality consists largely of the correlational approach with an emphasis upon description rather than explanation and that one needs to move outside of this approach in order to reach an explanatory theory. It will be argued in the next chapter that the study of ADHD provides a model for research and theory on impulsivity.

The trait approach to impulsivity

There are a number of ways in which to begin to explain impulsivity within the correlational or trait approach. One may begin by a careful delineation of impulsivity, as was done in Chapter 1, to distinguish impulsivity from sensation seeking. Similarly one might carefully distinguish between affect related inhibition which arises from anxiety and fearfulness (a construct elaborated by Gray and Kagan) and an affect free inhibition as espoused by Depue and Collins as well as Eysenck. Equally valuable is the work of Smillie, Jackson and Dalgleish (2006) in identifying a trait complex involving reward sensitivity and functional impulsivity which they relate to Gray’s behavioural activation system and which they distance from the more ‘narrow’ construct of impulsivity described by Eysenck and defended by the present thesis.

A second strategy is to examine the correlates of impulsivity; both the other traits with which it co-varies and the particular behaviours with which it is associated. The lack of association with affective traits discussed above is particularly informative since it argues against the possibility that impulsivity is a neurotic disorder. Impulsivity would seem not
to be a defining characteristic of axis I disorders as defined by the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; American Psychiatric Association 1994), and this again concurs with the above conceptualisation of impulsivity as an essentially affect free trait. Nevertheless, the presence of impulsive behaviours in some Axis II syndromes of psychopathology – personality disorder and bulimia are examples – is challenging and awaits future exploration; here the constructs of emotional dysregulation and the construct of urgency identified by Whiteside & Lynam (2001) are likely to prove fruitful.

Within the trait approach to impulsivity certain issues, or questions tend to predominate; this chapter shall concern itself with two of these issues, the tendency either to seek to situate impulsivity within a structural model of personality or to identify correlations of impulsivity with criterion variables of interest. In each of these cases the tendency is treat impulsivity as an independent variable.

Recent decades have seen the rise of structural models of personality which aim to encompass the major aspects of personality within a hierarchical trait model; the most prominent of these being the Five Factor Model (FFM: John & Srivastava, 1999). Such models tend to concur in identifying five traits at the highest level of the hierarchy - the acronym OCEAN serves as a useful mnemonic for openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. At a lower level more narrow, or primary, traits such as deliberation and self-discipline are identified as facets
of, for example, conscientiousness; while at the lowest level are situated narrowly defined
behaviours such as tidiness and orderliness at home.

Within such a hierarchical model we enquire as to the behaviours which co-vary to give
rise to the construct: rising into the higher levels of the hierarchy one asks for the traits
which co-vary with impulsivity to form higher order traits. The answers given to these
questions are essentially descriptive rather than explanatory. An interesting effect of this
is that different models of personality are compared in terms of psychometric criteria
applied to the data obtained, typically by self report, not in terms of the theoretical
models which they may imply, nor even in relation to other forms of data. For example
propose a six factor model of personality; their sixth factor being an honesty and
humility factor. There is however no discussion of what it means from a theoretical point
of view to detach honesty/humility from agreeableness. A further interesting aspect of
their model is that they identify irritability as a facet of agreeableness, unlike the model
of Costa and McCrae (1992) which subsumes it into neuroticism. Though Ashton et al.
(2004) present this as a consequence of an alternative rotation of factors it also raises
important theoretical questions as to the causal relationships between anxiety, irritability,
interpersonal hostility and agreeableness. While it may be argued that until we can agree
upon the correct model it is fruitless to look for theoretical explanations of personality
structure, Eysenck (1997) argues that without a causal model "...different ways of
distributing the variance (as in factor analysis) cannot be discriminated as being better or
worse.” In this instance conducting more studies with more trait adjectives and different analytical methods is unlikely to prove fruitful.

Within the trait approach to personality there is a relative neglect of two fundamental questions to do with causation and explanation. The first asks why it is that certain behaviours rather than others co-vary. This applies at any level of the hierarchy; so that we may ask why impulsivity comprises certain behaviours rather than others as well as asking why impulsivity should co-vary with some traits rather than others. The second question asks why it is that individuals differ in the level which they manifest of a particular trait and what the underlying mechanisms or processes may be. Traits tend to be almost always treated as independent variables, though even then they are treated merely as predictors rather than causes of the behaviour with which they are found to correlate.

Explaining the covariance of certain traits rather than others is rarely addressed; the exceptions are in theoretical models which are explicitly based upon physiological mechanisms; models such as Eysenck and recent attempts to identify the core aspects of extraversion to be considered below. Not only is the covariance between traits rarely addressed, the possibility that the covariance is, at least to some extent, an artefact of semantic similarity or overlap is neglected.

In concrete terms, it is clear that there is a significant amount of semantic overlap in the meanings of the terms which often cluster together to form factors or traits. One sees the
problem at its worst in narrowly focused trait scales where the items are often virtually synonymous; while such item repetition may by useful in establishing the reliability of the scale (asking the same question twice does not always produce the same answer so that repeating questions can produce an interesting microscopic level test–retest reliability) it tells us little about the nature of the trait.

An instructive recent example can be seen in the research of Roberts, Bogg, Walton, Chernyshenko and Stark (2004) who factor analysed responses to a long list of adjectives relating to conscientiousness; in this way they identified clusters of items to identify and differentiate the facets of conscientiousness. Scrutiny of their results shows many of these facets consist of near synonyms and antonyms; e.g. the first factor which they label reliable was identified by the items reliable, unreliable, dependable and undependable. Leaving aside the problem of antonyms, it is instructive to ask what information is afforded by the fact that someone who describes themselves as reliable also describes themselves as dependable. More interesting perhaps is to ask what we would infer if someone described themselves as reliable but undependable, or dependable but unreliable; would we not be more likely to question their understanding of the terms rather than infer conflicting aspects of personality?

This problem may be particularly acute when dealing with adjectives rather than statements or descriptions of behaviour; though even in the latter case it is difficult to avoid this problem. Consider the following two items from the UPPS scales of impulsivity – 'I usually think carefully before doing anything' and 'I like to stop and
think things over before I do them’ (Whiteside & Lynam, 2001). However a further pair of items from the same scales illustrates the possibility of sampling from different forms or manifestations of the trait behaviour, or of the behaviour in different contexts and the way in which one might use similar items to access consistency across situations; - ‘When I feel rejected I will often say things that I later regret’ and ‘In the heat of an argument I will often say things that I will later regret’.

Kline (2000) points out the possibility that in some cases a factor structure may reflect the nature of the items rather than the nature of the psychological constructs when he points out that “… a factor can be little more than a bloated specific or a tautologous factor. A set of items which are little more than paraphrases of each other will load a factor.” (Kline, 2000. p. 171). This is another instance of Eysenck’s (1997) argument that without a causal model, or at least conceptual reasoning, the results of purely factor analytical approaches can be misleading.

Impulsivity and conscientiousness

Most structural models of personality identify impulsivity as a facet, or lower order trait, of a higher order trait, or domain and most research finds a strong correlation between impulsivity and conscientiousness. Nevertheless there are interesting differences between these models in the identification of the facets which co-vary with impulsivity within the higher order domain. Thus Eysenck situates impulsivity within the domain of psychoticism along with aggression, tough-mindedness, coldness and egocentricity;
Tellegen (1982) situates it within the domain of constraint along with traditionalism and harm avoidance and Costa and McCrae (1992) within the domain of conscientiousness along with competence and achievement striving. These differences are largely due to the different conceptualisation of the higher order trait across the different models. As is well known, the PEN model of Eysenck and the FFM of Costa and McCrae differ crucially in their treatment of conscientiousness and agreeableness; Eysenck encompasses both of these within the construct of psychoticism while the FFM constructs them as distinct and independent. Consequently, within the respective theoretical models, while impulsivity co-varies with both conscientiousness and agreeableness for Eysenck, for the FFM it co-varies only with conscientiousness.

What is important here are the theoretical implications of situating a trait such as impulsivity within one domain rather than another; the actual pattern of first order correlations is less important. This can be seen in the model of impulsivity proposed by Whiteside and Lynam (2001) discussed in Chapter 6. The NEO-PI-R facet of impulsivity, which occurs in the domain of neuroticism, is considered as a fundamentally different source of impulsivity behaviour to that identified by the facets of deliberation and self discipline which occur within the domain of conscientiousness. This distinction is maintained despite the fact that impulsivity correlates at least as well with self discipline and deliberation as it does with the other neuroticism facets.

A number of recent studies have attempted to explore the facet level structure of conscientiousness. Saucier and Ostendorf (1999) analysed two independent yet
representative lexical data sets, one in German and the other in English, each consisting of 500 adjectives, in order to identify sub-components, or facets, of the Big Five which generalised across the two languages. They identified four facets of conscientiousness; orderliness, decisiveness-consistency, reliability and industriousness — none of which could be unequivocally identified with impulsivity. Nor did they identify any trait resembling impulsivity in the other four Big Five domains.

Roberts et al (2004) similarly carried out a lexical analysis of a set of 83 trait adjectives all relating to the Big Five domain of conscientiousness. The results of their analysis identified eight sub-components of conscientiousness. Four of their components were close replications of the four components identified by Saucier and Ostendorf (1999); however, they also found a clear impulsivity factor, identified by the terms careless, uncautious (and their contraries) as well as reckless, rash and impulsive (!). Other subcomponents included formalness, conventionality and punctuality.

Roberts, Chernyshenko, Stark and Goldberg (2005) used a different strategy to identify the subcomponents of conscientiousness; they identified 36 extant scales which were conceptually related to conscientiousness and factor analysed the scale level (rather than item level) data from the administration of these scales to a large sample (N = 737). Industriousness, order and responsibility emerged clearly, as in the two previous analyses; additionally they found a self control factor and a traditionalism factor which seemed to correspond to the impulsivity and conventionality factors of the Roberts et al
(2004) analysis. However they did not identify a decisiveness factor as the two previous analyses did.

If we at least partly define the trait of impulsivity in terms of the company that it keeps (as when distancing impulsivity from sensation seeking) then the picture derived from the above analyses is not completely consistent. Roberts et al (2005) provide data which allow some exploration of the place of impulsivity within different models of conscientiousness. From their table 3 we can see that the six facets of the NEO conscientiousness domain divided into three groupings; four facets which loaded on the industrious factor (competence, achievement striving, self discipline and dutifulness), the NEO facet deliberation loaded on the impulsivity factor along with the MPQ self control scale while the NEO facet order on the order factor along with scales labelled orderliness and perfectionism.

Tellegen (1982) and Watson and Clark (1999) have proposed a three factor model consisting of positive emotionality (related to extraversion), negative emotionality (related to neuroticism) and constraint. This last factor consists of three sub-factors – control, harm-avoidance and traditionalism – and is unrelated to either positive or negative emotionality; i.e. it is affect neutral. Patrick, Curtin, and Tellegen (2002) found that an impulsivity scale correlated substantially with the MPQ control scale but much less so with the harm avoidance and traditionalism scales; thus the coherence of this constraint factor is open to doubt, and its overall relationship to impulsivity unclear.
Church (1994) studied the correspondence between the MPQ and the NEO models of personality and found that each of the major aspects in one questionnaire was included in the other. However this correspondence masked some significant and theoretically important differences. The negative emotionality dimension of Tellegen conflates neuroticism and agreeableness, dimensions which according to both the FFM and Eysenck are independent. Tellegen’s positive emotionality dimension subsumes not only the FFM domain of extraversion but also the achievement aspects of conscientiousness; this implies that Tellegen’s constraint factor contains only the ‘control’ aspects of the FFM trait of conscientiousness. The other two facets of constraint - harm avoidance (akin to low sensation seeking) and traditionalism – traits which the results of Church (1994) suggest are more akin to the FFM trait of openness to experience. Thus the lack of correspondence between Tellegen’s model and the FFM, and their different situating of impulsivity, are as severe as that between the FFM and Eysenck’s PEN model.

These different models of personality propose important differences in the way in which they group lower order traits, in particular in the way they situate impulsivity.

For the FFM, impulsivity relates to industriousness and achievement striving for Eysenck it relates to agreeableness and aggression and for Tellegen it relates to harm avoidance and traditionalism.

There would seem to be a lack of clarity in the implications of the structure in these models; a lack of commitment to the implications of the structure, in particular to the relationships between variables implied by different structures. The point of a particular
model of personality is the relationship between different aspects of behaviour which it models; the differences between different models is not simply in terms of the number of orthogonal traits it postulates but also in the way in which it clusters the lower level behaviours.

An interesting example is the difference between Eysenck's PEN model and the Big Five of the NEO. Eysenck's model of personality consists of extraversion, emotionality and psychoticism. At first impulsivity was conceptualised as a component part of extraversion along with sensation seeking and venturesomeness but later it was assigned to the psychoticism factor (Eysenck & Eysenck, 1985). This shift in the positioning of impulsivity is not a mere detail of factor rotation or facet covariance; it has important theoretical implications for the understanding of extraversion. Eysenck explains the covariance of sensation seeking and venturesomeness with the other facets of extraversion such as sociability and liveliness in terms of a common latent causal variable which he identifies as central nervous system, or cortical, arousal. The extraverts low basal arousal level leads him or her to seek out experiences which will raise that arousal level whereas the introvert with an already high level of arousal will avoid situations which raise that arousal above an uncomfortable level. It would seem that in this scheme sensation seeking is neither maladaptive nor benign, no more than is extraversion itself. Individual differences in impulsivity are explained in terms of the latent variable, latent inhibition, underlying psychoticism; the variable which explains the covariance between the psychoticism facets such as aggressiveness, tough/tender mindedness and
egocentricity. Impulsivity is thus maladaptive and carries a risk for both anti-social and personality disorders.

Eysenck's argument is that conscientiousness and agreeableness are facets of psychoticism because they are both a product of the same latent variable (perhaps latent inhibition) though there will be other latent/causal variables which will result in various levels of different facets within psychoticism. The reply from the Big Five theorists is however entirely based upon analyses of the co-variance of between rating scales which suggest that these two variables are orthogonal; they have no theoretical basis for their model and no explanation for either the covariance of behaviours which coalesce to produce the two traits nor the lack of relationship between them. Impulsivity then will be related to agreeableness in Eysenck's model but not in the FFM; once again we understand a trait in terms of the company it keeps.

Whiteside and Lynam (2001) have carried out a programme of research to relate different aspects of impulsivity to the FFM as operationalised in the NEO-PI-R of Costa and McCrae (1992). This 240 item scale allows not only for the measurement of the Big Five factors of personality but also of six facets of each of those five traits, giving a total of 30 variables; thus providing a hierarchical model of personality allowing for greater differentiation of individuals at different levels of the hierarchy. Within this model impulsivity relates to extraversion, conscientiousness and neuroticism; in their model of impulsivity Whiteside and Lynam (2001) identify two of the facets of conscientiousness (deliberation and self discipline), one of the facets of extraversion (excitement seeking)
and one of the facets of neuroticism (impulsivity) as being most clearly related to impulsivity. Thus this model in effect also separates sensation seeking from impulsivity and places it in the higher order trait of extraversion in agreement with Eysenck while the more traditional aspects of impulsivity are placed under the umbrella of conscientiousness. Their identification of an element of impulsivity, which they term urgency, with a facet of neuroticism is puzzling in the light of the research above which considers impulsivity to be affect neutral; this will be discussed further in chapter 6 where their model of impulsivity is considered in more detail.

It would seem that situating impulsivity within a structural model of personality involves some difficult and sophisticated conceptual issues; impulsivity may be situated within a model simply in terms of shared variance but it is the status of impulsivity within that model which is debatable. Within Eysenck's PEN model impulsivity is theorised to be a manifestation of the more basic trait of Psychoticism; a function of the interaction between Psychoticism and environmental influences, especially socialisation; however within five factor models of personality the relationship between levels is unexplored and under-theorised. Thus impulsivity may be seen as a manifestation of a higher order and more basic variable such as conscientiousness or constraint; alternatively it may be seen as itself a more basic trait which, in combination with other basic traits, produces the surface, or emergent, trait of conscientiousness. These two alternatives correspond to the distinction between reflective and formative models made by Borsboom, Mellenbergh and Heerden (2003). More radically one might even hypothesise impulsivity to be the core of conscientiousness; the latent causal variable which produces the covariation.
between the facets of conscientiousness. The parallel drawn here is with the discussion
around the core of extraversion, which Lucas, Diener, Grob, Suh and Shao (2000)
identify as reward sensitivity and Ashton, Lee and Paunonen (2002) identify as social
reinforcement. Despite their differences both sets of authors aim to identify the core of
extraversion which explains the covariance between the facets, however proponents of
the FFM provide little in the way of such explanation.

Given the fact that impulsivity is often found to correlate with neuroticism, extraversion
and agreeableness there is the further possibility that impulsivity as defined by the BIS11
is not a facet of only one higher trait but rather a blend of several traits, the parallel here
perhaps being with traits such as integrity or ‘customer service orientation’ (Schneider &
Hough, 1995).

Borsboom et al. (2003) point to the neglected causal status of the latent variables within
most models of personality; put another way one can point out that the psychometric
approach to personality almost invariably considers personality traits as independent
variables. There is little discussion or exploration of the antecedents or causes of the trait;
there is little attempt to explain either the causes of individual differences or the reasons
for the co-variation of the facets of the trait. An exception to this generalisation is the
study of the behaviour genetics of personality; however once it is conceded that all
behaviour is influenced by genetics there is little more to be said.
A model for the understanding of conscientiousness may be found in the research which seeks to identify the underlying latent variable which explains the covariance between the facets of extraversion. Clark and Watson (1999) argued that positive affect was at the core of extraversion on the basis that the various facets of extraversion correlated more strongly with an independent measure of positive affect than with each other. Lucas, Diener, Grob, Suh and Shai (2001) guided by the theorizing of Gray (1981) and of Depue and Collins (1999) provided evidence that it is reward sensitivity which is at the core of extraversion; though they used a measure of positive affect as a proxy measure of reward sensitivity. Such research however is limited by its reliance upon self report measures; the limits of such an approach as can be seen by the fact that Ashton, Lee and Paunonen (2002) used a very similar approach to argue that the central feature of extraversion is in fact the desire for social attention, not reward sensitivity.

Nevertheless these researchers are beginning to go beyond a merely descriptive account of personality traits and it is argued in this chapter, and throughout this thesis, that the trait approach can, if informed by careful conceptual and theoretical analysis based upon research in related areas of psychology, provide insight and understanding. For example it will be argued that related work on ADHD in both children and adults can support the argument for a cognitive as well as a behavioural aspect to impulsivity, and can begin to connect these traits to a neuropsychological substrate.
Impulsivity and adult psychopathology

Impulsivity is an element in a wide variety of psychiatric diagnoses; in particular impulsivity is typically identified as a symptom of personality disorder particularly in connection with the emotional dysregulation which characterises the patterns of narcissistic, borderline and histrionic personality disorders. While many theoretical formulations of personality disorder attribute the impulsivity to an underlying pathology, emotional dysregulation or disturbed attachment models (Meyer & Pilkonis, 2004) others however ascribe a causal role to impulsivity in the development or maintenance of personality disorders (Depue & Lenzeweger, 2004). Bornalova, Lejuz, Dauhters, Zachary and Lynch (2005) review evidence which shows measures of impulsivity, particularly self report measures, to correlate with number and severity of borderline personality disorder symptoms and with severity of both drug and alcohol use. However interpretation of the role of impulsivity in these behaviours is difficult due to the cross-sectional nature of the majority of such research and to the fact that impulsivity behaviours are often part of the criteria of personality disorder syndromes.

Impulsivity is often associated with the complex of anti-social behaviours comprising the syndromes of conduct disorder, delinquency and anti-social personality disorder, and is frequently attributed a causal role in the development of these syndromes. While in this area too the majority of studies are cross-sectional there are some longitudinal studies. Vitaro, Arseneault and Tremblay (1999) found a significant relationship between impulsivity assessed at 13 and problem gambling at 17 years of age; this relationship held
after controlling for demographic variables as well as gambling behaviour at the earlier assessment. Lynam et al. (2000) similarly found that impulsivity assessed at 13 predicted delinquency at age 17; once again the relationship held up when SES and baseline (age 13) delinquency were controlled. Nevertheless the interpretation of such longitudinal data is again difficult; if impulsivity is an element of delinquency at age 13 then it will equally be so at age 17, and this would be equally true of any manifestation of delinquency.

Krueger, Hicks, Patrick, Carlson, Jacono and McGue (2002) argued for a model in which a number of externalizing behaviours, conduct disorder, antisocial behaviour, alcohol and drug dependence as well as the trait of constraint derived from the MPQ are influenced by an underlying externalising latent variable. This model suggests that disinhibited personality style is as much a consequence of the latent trait as is antisocial behaviour; the comorbidity of traits such as constraint and impulsivity with disorders such as drug abuse is then attributable to a common latent trait. Krueger et al. (2002) draw a parallel with the work of Mineka, Watson and Clark (1998) who explain the comorbidity of mood and anxiety disorder in terms of the temperamental trait of negative affect influencing both disorders; the difference between the two models, however, lies in the fact that the temperamental trait in Krueger et al (2002) model is at the same level of the hierarchy as the disorders.

The relationship between the trait of impulsivity and various maladaptive behaviours such as binge drinking, driving violations and gambling suggests a trait which is intimately connected with a general dysinhibited life style. These associations between
impulsivity and maladaptive phenomena do not however allow any confident inferences as to cause and effect. It is as plausible to argue that the development of a maladaptive life style leads people to act in ways which do not involve a careful consideration of the consequences of their actions or even to a lack of concern as to those consequences; especially where a delinquent lifestyle leads to an alienation from, or even antipathy towards, the values of school and work.

To some extent this issue of interpretation is compounded by an element of ambiguity in many of the terms associated with the construct of impulsivity especially when studied as an element within delinquency and conduct disorder; an ambiguity seen most clearly in the adjectives careful/careless/carefree. Roberts et al. (2004) identify terms such as careless and cautious, as well as their antonyms, as core aspects of impulsivity. A sensitive reading of these terms might distinguish between a sense of carelessness which is typical of dyslexia or attention disorder and a second sense which is associated with conduct disorder or delinquency; the latter captured by the English idiom - 'He couldn't care less'.

The difficulty in distinguishing between explanation and mere description is seen in the work of Lynam and associates in their research examining the relationship between personality traits and antisocial behaviour. Miller, Lynam and Leukefeld (2003) identify the NEO-PI-R facets of low straightforwardness, low compliance and low deliberation as the strongest and most consistent predictors of antisocial behaviours. While the agreeableness facets of straightforwardness and compliance are almost part of the
definition of antisocial behaviour, the conscientiousness facet of deliberation - which
Whiteside and Lynam (2001) identify as impulsivity - exists in a limbo between
description and causation. The important point is not that impulsivity does not play a part
in either the causation or maintenance of antisocial behaviour but that this type of
evidence does not support such a claim.

Nevertheless considerable headway can be made in the explanation of impulsivity
through the study of traits and their inter-relationships; as argued in Chapter 1 it is
possible to differentiate between a relatively benign aspect of sensation seeking which
would seem to be part of extraversion and distinct from impulsivity, perhaps related to
the latent variable of reward sensitivity. Research reported in later chapters aims to
clarify the relationship of impulsivity to the Big Five personality traits and establish its
distinctive qualities. Chapter 6 examines the relationship between the trait of impulsivity
and the traits of inattention and hyperactivity/impulsivity derived from the study of
ADHD to explore the importance of the construct of inattention in relation to impulsivity.

Antecedents: genetic and neurological factors

One area of research where the trait of impulsivity has been treated as an dependent
variable is research in behaviour genetics and the effects of neurological development.
Estimates of genetic influences upon impulsivity typically produce heritability estimates
of .5 to .6 (Eysenck 1991); approximately half of the variance in impulsivity seems to be
the result of genetic factors – as indeed is the case with almost all personality traits. This
however tells us little about the nature of impulsivity or about the more proximal causes which bring about individual differences in impulsivity. One positive and fruitful contribution of behaviour genetic studies of traits is the light which they shed onto environmental effects upon traits, Eysenck reports that the effect of shared environmental factors is approximately half of the effect of specific or unique environmental factors; a finding which is common to most behaviour genetic studies of human traits.

Though the behaviour genetic data tell us that environmental factors are as important as genetic factors this does not tell us which aspects of the environment are causal. The understanding of the profound effects of heredity means that a correlation between parental and child characteristics does not imply the influence of the former upon the latter; similarly the erratic discipline or disorganised family background of the impulsive child may simply be a manifestation of the same tendencies in the parent rather than a causal factor. The relative lack of variance accounted for by common environmental factors suggests that the search for family wide factors such as socio-economic status and parental characteristics which are common to all children within the family is likely to prove fruitless. As Eysenck acknowledges the search for environmental factors unique to a particular child within a family presents considerable methodological challenges; one area of research is that which focuses upon neuropsychological factors and this will be discussed below.

Given the discussion above on the plausibility of taking the ADHD construct as a dimension which affects adult as well as child psychology and the relevance of that
dimension to the understanding of impulsivity, a consideration of the research on the aetiology of ADHD may be instructive. Barkley (2006) has reviewed data to suggest that the heritability of the ADHD syndrome is of a greater magnitude than that for most personality traits. His review of large scale twin studies suggests that “...the majority of the variance (70-95%) in the traits of ADHD is a result of genetic factors (averaging approximately 80%+) and that such a genetic contribution may increase as the scores along this trait become more extreme, although this latter point is debatable.” (Barkley 2006. p.227). This latter possibility may account for the high heritability estimates compared to other traits. Other types of evidence also attest to such a high heritability; Biederman et al. (1995) report that the risk of developing ADHD in an offspring of an ADHD parent is 57% to an offspring.

Such studies concur with Eysenck’s conclusion that the shared environmental risk is negligible; such environmental influence as there is operates individually for each child. One set of environmental factors which are unique to individuals within the family are neuro-psychological trauma or structural or bio-chemical deficits and on these there has been considerable research.

Studies of neurological function have been largely carried out in the areas of psychopathology and psychiatry and have studied impulsivity within the context of either ADHD or conduct disorder and criminality. Research in the area of delinquency is however more difficult to relate clearly to the construct of impulsivity and disinhibition. While impulsivity is a definitive part of the syndrome of ADHD, its role in conduct
disorder and anti-social personality disorder is as both description and explanation of the maladaptive behaviour. Most research in this latter area aims to establish the correlations between relatively distal areas such as neuropsychological constructs and pathological syndromes such as impulsive aggression and drug abuse, where the role of impulsivity is unclear and the correlations observed may be due to other aspects of the psychopathology, consequently this discussion will tend to focus on either ADHD or upon impulsive behaviours in non-clinical subjects.

Research into both ADHD and conduct disorders has assumed a similar explanatory framework involving a number of common elements; the most distal and most proximal of these being genetic influences and the construct of disinhibition respectively. Immediately proximal to the construct of inhibition lie the cognitive processes commonly referred to as executive functions.

The general model is one in which weaknesses in executive function lead to disinhibited behaviour which then results in maladaptive behaviour. The executive functions are usually identified with the functioning of the pre-frontal cortex; an identification which is supported by brain imaging data suggesting a lower or less efficient level of functioning in these areas. Malfunction in these areas is attributable to actual damage 'trauma' or to neurochemical abnormalities which compromise their efficient functioning.

As part of this picture research has explored the influence of perinatal and prenatal factors on maladaptive, externalising behaviour. While the link between maternal perinatal factors and ADHD is a clear indicator of a link between such factors and
impulsivity or disinhibition, the data from studies of conduct disorder and criminality rely upon the assumption that impulsivity is the key mediating process between disrupted neurological function and criminality.

The pathogenic factor most commonly identified is that of maternal cigarette smoking during pregnancy which has been associated with an increased risk of ADHD, conduct disorder and substance abuse; though there seems to be no effect upon the incidence of internalising disorders such as anxiety and depression (Barkley 2006, Brennan et al 2006). The effect of maternal smoking is evident even after various factors such as maternal behaviour and mental health as well as other perinatal factors are statistically controlled. While other pathogenic factors have been identified the specificity of their effects is unclear; for example, Taige et al (2007) review evidence indicating that antenatal maternal psychological stress has an influence on a variety of infant behaviours including both internalising (negative affect) and externalising (ADHD and conduct disorders) problem behaviours. These effects remain after controlling for a variety of co-varying factors including smoking behaviour. The problem in interpreting such results lies, at least in part, in identifying and understanding the mechanisms linking behaviour to ante-natal experiences.

One neuropsychological variable which continues to attract attention is that of physiological, and especially cortical, arousal; while research on anti-social behaviour has focussed on autonomic arousal that on impulsivity and ADHD has focussed on cortical arousal. Although this research is reminiscent of Eysenck’s suggestion that
extraversion and impulsivity are related to lowered cortical arousal the hypothesised causal relationships are here different. Eysenck would argue that these lower arousal levels cause people to seek out stimulation to increase their arousal level; conversely, those already high in arousal will seek to reduce stimulation. Impulsivity then is the behaviour which ensues when people seek out high levels of stimulation. In support of this theoretical formulation, Barratt (1993) reported research in which high impulsive subjects were less aroused on EEG measures than low impulsive subjects. Similarly Mathias and Stanford (2003) provided evidence for lower levels of autonomic arousal in high impulsive subjects both at rest and during a cognitively demanding task. Research on ADHD, too, reports lower arousal levels in cases of ADHD whether in children or adults; thus Barry, Clarke and Johnstone (2003) reviewed EEG studies showing patterns of electrical activity, higher rates of low frequency (beta) activity or an elevated ration of theta to beta wave activity. However these results have been interpreted as indicating an arousal or alerting problem in ADHD which results in poor attention and lack of inhibition of behaviour. Nigg (2006) suggests that the inattentiveness of ADHD sufferers reflects a state of low alertness which may reflect "a state of low cortical arousal which makes it difficult for the child to control or mobilise their resources." (Nigg, 2000 p. 100). Thus Nigg argues that low cortical arousal leads to inattention and impulsivity through interference with efficient cognitive and executive processes, unlike Eysenck and Zuckerman who argue for an energising function of low arousal - a drive to increase stimulation.
Two other approaches to exploring the neuropsychological underpinnings of individual differences in impulsivity are the study of neurotransmitters and of neurological mechanisms. Carver (2006) has recently reviewed a body of evidence suggesting a link between levels of the neurotransmitter serotonin and impulsivity. A variety of studies which either manipulated levels of serotonin or observed the relationships between serotonin levels and impulsivity in both normal and clinical samples, found that low levels of serotonin were related to impulsiveness, emotional volatility and aggression. For example Dolan, Anderson and Deakin (2001) in a study of male offenders found low serotonin levels to be related to impulsivity as measured by the Eysenck I7 scale; a scale which embodies a construct of narrow impulsivity similar to that proposed in chapter one. Carver (2006) argues that serotonin levels are not related to anxiety and so relate to the type of behavioural constraint captured by Rothbart et al (2000) in their construct of 'effortful control' as well as Depue and Collins (1999) construct of 'affect free' inhibition.

Evidence relating brain damage to behaviour indicates that the frontal lobes are implicated in the control and inhibition of behaviour. Suchy, Leahy, Sweet and Lam (2003) found a battery of tests of executive function to contribute significantly to differentiating between patients with damage to the frontal lobes and patients with damage elsewhere in the brain. This battery included the Trail Making Test, the Stroop Test and the COWAT; all three of which have been found to correlate with impulsivity and to discriminate significantly between cases of ADHD and normal controls. Other clinical evidence is however less clear since such injuries to the frontal lobes result in
anxiety and aggression as well as disinhibition (Zuckerman (1991). Similarly, studies which show brain injuries to be much more frequent in criminal offenders and especially in violent ones do not allow for specific linkages between brain function and impulsivity. Blair (2002) found that damage to the ventromedial frontal cortex led not only of impulsivity but also to lowered reactivity to disturbing stimuli and reduced responsiveness to punishment.

Nevertheless the role of the frontal cortex in executive functioning and the link between disinhibition and executive functioning support the hypothesised site of inhibition as the frontal cortex. Studies of functional neuroimaging in ADHD are particularly valuable in relevance to impulsivity. Durston and Konrad (2007) review studies which show decreased activation in prefrontal and striatal areas of the cortex during cognitive control tasks such as go/no-go tasks and the Stroop interference task; both of these tasks are taken to reflect individual differences in inhibition/impulsivity.

In terms of the causal modelling framework discussed by Morton and Frith (1995) the causal path from the genetic and neurological factors to the behavioural phenotype, impulsivity or inattention, requires an intermediary level of analysis and exploration. The following chapter will consider some laboratory performance measures which in the study of ADHD have been hypothesised to provide this intermediate level of causal explanation.
Chapter 3

Explaining impulsivity: laboratory studies of inhibition and attention.

Following Eysenck (1997) this chapter argues that the understanding and explanation of impulsivity requires the kind of research and theory which typifies the experimental approach to both guide the correlational approach and to establish its validity. Research and theory on ADHD provides a model for such an approach. While the syndrome and its sub-division into the inattention, hyperactivity/impulsive subtypes has been established through studies of behaviours and their covariation this occurs in the context of research and theorising involving genetic, neurological, cognitive and treatment studies. Thus, while the sub-types of attention and hyperactivity/impulsivity guide much of the research, the relationship between the subtypes is explored through studies of cognitive function.

The behavioural phenotype of ADHD is studied both as a dependant variable, in researching the causes of ADHD, and as an independent variable, in studying the effects of ADHD upon school performance, driving behaviour and workplace difficulties.

As the first section of chapter 1 indicates, definitions of impulsivity tend to emphasis the inhibition of an inappropriate behaviour; consequently studies of the trait of impulsivity have largely utilised measures of response inhibition. Logan, Schachar and Tannock (1997), noting the part it plays in personality theory and in both child and adult psychopathology, offer a conceptualisation of impulsivity which, they suggest, spans these various domains; they operationalised impulsivity “in terms of the ability to inhibit
prepotent courses of action: people who are impulsive have trouble inhibiting action, whereas people who are not impulsive find it easier to do so." (p. 60). The majority of recent laboratory studies of impulsivity have followed Logan et al. (1997) in the use of tasks which involve behavioural inhibition particularly the Stop Task and the Continuous Performance Test discussed below.

Research exploring the link between problems of behaviour inhibition and problems of attention has tended to occur most obviously in theory and research into ADHD and child psychopathology; there is however research within the study of trait impulsivity which has drawn attention to the importance of attentional processes in impulsivity. The chapter begins with an overview of two research programmes (Dickman, 1993 and Barrett, 1993) the results of which suggest a two facet model of impulsivity.

In the early stages of his research into impulsivity (summarised in Barratt, 1993) Barratt explored the relationship between self-reported impulsivity and a number of laboratory tasks relating to a variety of cognitive processes. Impulsivity scale scores were significantly related to intra-individual variability of performance on perceptual-motor tasks and to intra-individual variability of autonomic nervous system measures; this phenomenon of inter-subject variability will occur later in this chapter. Impulsiveness was also related to inaccuracy of fine perceptual motor performance on such tasks as paced tapping and the Porteus Maze. Results also suggested that high impulsive subjects were less aroused on EEG measures and that in an eye blink conditioned paradigm they conditioned better to positive than to negative stimuli. Barratt (1981) found impulsive
people to underestimate time intervals and to be characterised by visual-evoked potential (VEP) augmentation; these two variables being significantly correlated. Barratt et al (1987) confirmed the relationship between impulsivity and the augmenting/reducing of VEPs; note that in Zuckerman’s research this is found to be a characteristic of people high in impulsive sensation seeking. The relevance of cortical arousal to impulsivity and attention will also be discussed later in this chapter.

Dickman (1993, 2000) reviewed evidence on the relationship between self-reported impulsivity and a variety of cognitive tasks and suggested that deficits in attention regulation, particularly in the efficient maintenance of sustained attention, underlie and explain individual differences in impulsive behaviour. Dickman (1993) reviewed the evidence relating self reported impulsivity to a variety of cognitive tasks, including simple and complex reaction time tasks, short term and long term memory tasks and IQ tasks and concluded that the majority of such tasks did not differ between those high and low in impulsivity. The tasks that did differentiate between these groups were tasks that were sensitive to even momentary lapses of attention. According to the attentional fixity theory as outlined by Dickman (2000) impulsivity is related to the tendency for attention to remain fixed on the current source of input; in impulsive individuals attention is easily shifted from its current fixation while the attention of those low in impulsivity is difficult to shift. Dickman does not use the term distractibility though it seems central to his theory.
There are two interesting points to be drawn from Dickman’s review. The first is that it draws attention to the relationship between behavioural impulsivity and attentional failure suggesting a close relationship between the two and perhaps a common latent variable. It is noteworthy that Dickman’s scale of dysfunctional impulsivity contains no items relating to attention. This lack of overlap precludes the effects of response sets or common method variance and is particularly convincing evidence of the psychological affinity between behavioural and attentional inhibition. The second point is that failure to sustain attention may account for the phenomenon of intra-individual variability in performance reported by a number of researchers, including Barratt (1993) as discussed below; an hypothesis which is supported by Douglas (2005) in the study of ADHD.

Evidence thus far suggests two approaches to the clarification and explanation of impulsivity; the first focuses upon the construct of behavioural inhibition while the second emphasises sustained attention and distractibility. Both of these processes have been discussed in terms of the hypothetical construct of inhibition. Within the study of ADHD Barkley (1997) hypothesised that a construct of inhibition explained problems with attention and distractibility as well as impulsivity and hyperactivity. Nigg (2000) in reviewing the major tasks utilised in the study of ADHD acknowledges that there is considerable evidence for the role of executive inhibition as an important element in ADHD but at the same time points out the under-specification of the concept of inhibition, a problem like that which besets discussions of impulsivity but which is more acute given the desire to more precisely specify and delineate the former construct within the domains of both developmental and experimental psychology.
Nigg (2006) divides the executive control domain into two related but distinguishable areas; the first refers to the ability to identify and resolve interfering information while the second refers to a function of suppressing, interrupting or cancelling a prepared motor response. Similarly, in discussing the fundamental deficit which underlies ADHD, Kenemans, Bekker, Lijffijt, Overoom, Jonkman and Verbatim (2005) refer to basic deficits in two putative cognitive functions, attention and inhibition. Here attention refers to the ability to focus and maintain that focus, on a limited part of available information as far as the control of actions is concerned. The control of actions refers to the ability to suppress in-going reactions or pre-potent reactions. As they point out, the relative contributions of attention control and response inhibition to a particular task are often difficult to disentangle or identify. For example, while Robertson et al. (1994) describe the Stroop task as one of selective attention, Freedman and Miyake (2003) treat it as involving response suppression.

A further question refers to the relationships between these two cognitive functions; the first possibility is that they are manifestations of different processes, the second is that they may be the same processes manifested in different tasks, and the third is that there is a single inhibition function which in interaction with other processes leads to different executive functions. The last suggestion seems to underlie Barkley’s suggestion that there is a single inhibition process which affects a variety of tasks and executive functions.
Buss & Plomin (1975) suggest that inhibitory control is the core of impulsivity, though other characteristics such as inattention, distractibility, persistence and boredom are often included in the concept. Similarly, in developing a theoretical model of ADHD, Barkley (1997) identifies deficits in inhibition as the primary dysfunction which then affects the efficacy of a variety of executive functions including attentional control, distractibility, working memory and emotional regulation.

Friedman and Miyake (2003) used a latent modelling strategy to distinguish empirically between three conceptually defined inhibitory functions, two of which related to the cognitive functions described above. Referring to the taxonomy of inhibition related functions proposed by Nigg (2000) they tested a model in which nine tasks were classified as assessing either prepotent response inhibition, resistance to distractor interference and resistance of proactive inhibition. The first hypothesised function of prepotent response inhibition was assessed by a Stroop task, a Stop-signal task and an antisaccade task; it is worth noting that they classified the Stroop task as requiring response inhibition rather than resistance to interference. The second hypothesised function, of resistance to distractor interference was assessed by the Eriksen flanker task, a word naming task and a shape matching task; all of which tasks involved matching stimuli in the presence of a distractor. The final function was resistance to, inhibition of, proactive interference assessed through learning a series of tasks in which subjects had to resist the interference from earlier tasks. While the model distinguishing between these three hypothesised functions fit the data adequately there was a high degree of correlation between the latent variables of response inhibition and resistance to distractor.
interference (r = .68) though the correlation between both of these and the third function was close to zero and non-significant.

The distinction which Freeman and Miyake (2003) make between response inhibition and resistance to interference relates to the model of ADHD discussed in Chapter 1 which distinguishes between a cluster of symptoms related to problems of impulsivity and hyperactivity and a second relating to problems of attention. However whereas their response inhibition function seems conceptually to be closely related to the impulsivity component of ADHD the correspondence between their resistance to distractor interference and the inattention component of ADHD is less clear. As will be discussed below, identifying the aspect of attention which is affected in ADHD has proved difficult

**Impulsivity and ADHD**

Deficiencies in impulse control are conceptualised as central deficits in ADHD, with problems of attention and activity regulation viewed as secondary manifestations. Barkley (1997) identifies deficits in inhibition as a primary dysfunction which then affects the efficacy of a variety of executive functions including attentional control, distractibility, working memory and emotional regulation. Similarly, at least superficially, Quay (1997) argues for an under active behavioural inhibition system (BIS Gray, 1982) as the neuropsychological basis for ADHD. Thus in most models of ADHD the two clusters of symptoms are related both statistically and theoretically.
The theoretical perspective which sees disinhibition as the core of ADHD is similar to the conceptualisation developed in this thesis, of ‘narrow’ impulsivity as the failure of inhibition of both cognitive and behavioural processes, a faculty which is perhaps at the core of conscientiousness. A point of particular interest is the suggestion that the deficit in ADHD is more a matter of weak inhibition of impulses, rather than the strength of prepotent impulses. This is related to the finding that responses are generally slow rather than fast in the ADHD group, a puzzling finding which may implicate attentional and/or activational processes. A further point of contact is the conceptualisation of disinhibition within this model as being unrelated to emotional/motivational processes; this resonating with my own conceptualisation of narrow impulsivity as independent of negative affects or neuroticism. Experimental studies suggest a commonality of ADHD and impulsivity; the laboratory tasks which are utilised to tap into the cognitive basis of impulsivity (continuous performance task, go/no-go tasks and matching familiar figures) are also tasks which significantly differentiate ADHD cases from non-cases.

**Experimental studies of impulsivity**

The use of behavioural tests of impulsivity has served mainly three functions or strategies. The first is to use test performance as a laboratory analogue of impulsive behaviour; this occurs in animal studies where behaviour in an experimental procedure is defined as impulsivity and the effect of experimental manipulations upon that behaviour is observed. In studies of human subjects perhaps the most obvious analogue procedure is a delayed gratification task.
The second is to use tests to attempt to identify the elements of impulsivity; this is more
typical of studies employing humans where subjects who are assessed as more or less
impulsive complete tests of basic attentional or executive functions. The aim here is often
to explain impulsivity in terms other than behavioural descriptions of impulsive
behaviour; this approach satisfies the demand from Caprara and Cervone (2000) that
behaviour be explained in terms of phenomena other than the behaviour itself. For this
purpose studies of analogue laboratory behaviours are less useful; to relate self reports of
impulsivity to the inability to delay gratification to is not to explain impulsivity but
simply to describe a particular manifestation of impulsivity and to validate the self report
questionnaire. Furthermore it is far from obvious what processes are involved in the
behaviour being studied: one may distinguish between cognitive processes such as
inattention and motivational variables such as delay aversion (Solanto et al. 2001). On the
other hand laboratory tasks can serve to identify the cognitive processes which result in
impulsive behaviour, e.g. the attentional blink. Thus a number of studies using
continuous performance tests (CPTs) suggest a deficiency in inhibitory processes as an
explanation for impulsive behaviour. A sophisticated version of this strategy is provided
by studies which use a number of tasks to differentiate between possible cognitive
processes underlying impulsive behaviour.

An extension of this strategy is where tests of cognitive processes which are believed to
underpin impulsivity are used to understand problem behaviours which involve impulsive
behaviour. This strategy has been used in the exploration of ADHD, conduct disorder and
personality disorder. This strategy is discussed below in the sections on child and adult psychopathology. The third purpose of laboratory tasks is to aid the diagnosis of syndromes of psychopathology; this has occurred particularly in the study of ADHD and will be discussed below.

Explorations of impulsivity have used a wide variety of laboratory tasks, eg. Stroop Test, time estimation, reaction time, circle tracing, Matching Familiar Figures Test and Delay of Gratification tasks. Though such tasks are more precise and objective than self report measures, their underlying mechanisms are not always either clear or simple. As Nigg (2000) argues, it is not clear that that all these tests tap into the same mechanisms and few studies have included more than one such test. The small number of studies which have done so find few significant or sizeable correlations between the different tests. The remainder of this chapter discusses tests which can be argued to be measures of either response inhibition or attention control. In the majority of cases only one behavioural task is considered.

Inhibition of behaviour

This concept of impulsivity as a lack, or failure, of inhibitory control occurs in most self report measures whether these are single trait measures of Impulsivity, such as the Barratt impulsivity scale (BIS11 Patton et al. 1995) or as lower order traits in omnibus personality questionnaires such as the Personality Research Form (Jackson 1984).
This sense of impulsivity as lack of inhibition also informs many laboratory measures of impulsivity; such tasks define impulsivity as a tendency to make rapid and premature decisions such that fast reaction times coupled with high error rates are defined as impulsive behaviour. Three tasks in particular are discussed as clear manifestations of behavioural inhibition; the Stop Signal Paradigm (Logan et al. 1984), the Continuous performance task (Connors 1995) and the Stroop Colour-Word Interference Test (Stroop 1935) are argued to involve the ability to inhibit a prepotent motor response. These and other tasks emphasise the core function of disinhibition in defining Impulsivity.

The relationships between different measures of impulsivity has involved usually two of three putative measures; laboratory tasks which could be argued to involve response inhibition, self report measures of impulsivity and behaviours (either normal or pathological) which are believed to be manifestations of impulsivity. No one of these should be prioritised as the true measure of impulsivity and it is the agreement between two or more measures which supports the required inferences. The discussion below will consider first studies relating laboratory tasks to self report measures of impulsivity and secondly studies relating such tasks to pathological behaviours, in particular ADHD and conduct disorders.

The Stop Task would seem to be the paradigmatic inhibition task, and indeed Logan et al. (1997) argue it to be so – “We treat the stop-signal paradigm as a model of inhibitory control”. The task consists of a discrimination task where a subject is required to make a two-choice response to presented stimuli; a number of the stimuli are followed after a
variable time by a stop signal. The *stop signal reaction time* is the delay between go and stop signal which will allow the subject to consistently inhibit the response. The subject is entirely aware of the relevant stimuli, of the appropriate responses and is duly motivated to inhibit the response. The occurrence of the response can only be due to a failure of inhibition; other processes or explanations would seem unlikely. Logan, Schachar and Tannock (1997) found stop-signal reaction time to correlate .32 with impulsivity (as assessed by an earlier Eysenck scale) in undergraduates. Dolan and Fullam (2004) found significant correlations between BIS-11 scores and performance on a Stop task, but not a Go/No go task.

The Continuous Performance Test (CPT) occurs in a variety of forms and entails responding to some signals and not others; failure to respond when one should is an error of omission and is usually interpreted as a measure of attention, while responding when one should not do so is an error of commission and is interpreted as a measure of inhibition. Marsh et al. (2001) included a modified Stop task and their own CPT and two self-report measures of impulsivity; the CPT task correlated .31 and .30 with Eysenck's \( I^7 \) and the BIS-11 respectively, though the Stop task correlated significantly (.25) only with the \( I^7 \). Swann et al. (2002) also found significant correlations between the CPT and the BIS-11. Moeller et al. (2004) in a study involving drug abusers as well as control subjects found a correlation of 0.4 between overall BIS score and their own variant of a CPT. Dougherty et al. (2000) obtained a correlation of .42 between BIS-11 scores and CPT scores.
The Stroop task could be described in terms of either inhibition or distraction, though distinguishing between these possibilities is not easy. The Test of Everyday Attention manual identifies the Stroop as a test of visual selective attention, yet experimental manipulations which present the colour information before the word do not eliminate the interference effect. MacLoed and MacDonald (2000) suggest that all models of Stroop performance “...require: (1) maintenance of goal oriented processing and (2) blocking of more readily available word-reading responses.” (p. 390); however, as Kane and Bagley (2003) in the traditional form of presentation where the different forms of the stimuli are presented in block (i.e. a sheet of paper containing only coloured figures or only conflicting word/colour combinations) would seem to facilitate the goal maintenance process and make it a task of response inhibition.

A variety of other tasks have also been related to impulsivity. Barratt and his colleagues have focussed on two tasks; a delay of gratification task and their own form of a continuous performance task (CPT). Cherek et al. (1997) found a correlation of .42 between BIS-11 scores and the number of immediate reward choices in a delayed gratification task in a sample of male parolees. Spinella (2004) utilised an anti-saccade task and a simplified go/no-go task and found significant correlations with the BIS total score. Li et al. (2004) utilise a measure of ‘attentional blink’ and found a clear difference between high and low impulsive subjects as assessed by a Japanese translation of the BIS.
The above tasks have also been examined in ADHD research. A review by Woods et al. (2002) identified a number of tasks and processes which successfully differentiated between adult ADHD groups and matched controls. The most consistently successful were continuous performance tests, Stroop tests and controlled word association tasks (COWAT), all of which may be conceptualised as tasks involving inhibition of behaviour or response suppression. In a more recent meta-analysis of tasks differentiating ADHD adults and controls Hervey, Epstentin and Curry (2004) found effect sizes of .85 in stop signal reaction times, .51 in errors of commission on the Conners’ CPT and an effect size of .47 in performance on the colour word conflict condition of the Stroop though the effect size for an interference measure was only .15.

A problem in interpreting such data is that ADHD control subjects differ not only in the impulsivity aspect of ADHD but also in the inattention aspect. Attempts to differentiate subtypes of ADHD are not consistently successful; a recent large scale study by Murphy et al. (2001) (n = 105) reported differences between patient and control groups but no significant differences between inattention and hyperactivity/impulsivity subtypes on a number of tests including COWAT, Stroop and CPT.

The heuristic value of such theorising is the links which it affords with the domains of cognitive neuro-psychology, in which disinhibition is a key element in frontal lobe symptoms and the hypothesised executive functions, and with the domain of developmental psychology, wherein theories of ADHD often appeal to a concept of disinhibition.
The delineation of impulsivity described above—whereby an impulsive act is one which was carried out prematurely or inappropriately—is virtually synonymous with a failure of inhibition, where inhibition is described in terms of not carrying out a particular behaviour. In this sense, at least, the construct of inhibition explains little about impulsivity. The value of the construct of inhibition, as used in the study of ADHD and cognitive processes lies in the following considerations. The first is the distinction it makes between failures of inhibition which are related to cognitive processes and inhibition which is related to negative affect; in the former case the failure of inhibition is maladaptive, in the second case the occurrence of inhibition is the problem. The second is in clarifying the distinction between impulsivity and often related traits, such as venturesomeness, carefree ness and sensation seeking; venturesomeness is not a failure to inhibit a behaviour which the person will later regret. Similarly, in explaining the ‘impulse disorders’ of DSM-IV one is led to distinguish between those which are characterised by strong emotions (self harming), those which involve considerable planning (fire setting) and those which are more clearly a failure of inhibition (Trichotillomania).

A focus upon the construct of inhibition allows a further important distinction to be made—that between dis/inhibition due to a failure of inhibitory mechanisms and between dis/inhibition due to the press of urgency of the inappropriate impulse, where the inhibitory mechanisms are adequate for most purposes but are overwhelmed by affective arousal.
The heuristic value of such theorising is the links which it affords with the domains of cognitive neuro-psychology, in which disinhibition is a key element in frontal lobe symptoms and the hypothesised executive functions, and with the domain of developmental psychology, wherein theories of ADHD often appeal to a concept of disinhibition. Further delineation and differentiation of constructs of inhibition require a close consideration of behaviour, symptoms, situations and experimental procedures. A further sense of inhibition derives from studies of attention control or interference control.

Attention and impulsivity

The second approach identifies the role of sustained attention and distractibility in explaining impulsivity. These findings are particularly interesting since the task behaviours tend not to be cited as instances of impulsivity and hence cannot be seen as merely restatements of impulsive behaviour. Data on intra-individual variability in cognitive tasks was provided by Barratt’s early research and has since been substantiated; this variability can plausibly be attributed to variations in sustained attention. Dickman’s review of the relationship between impulsivity and information processing concludes that it is failure to sustain close attention to a task which characterises impulsive subjects. Dickman also points out that while impulsive people are often thought of as acting quickly they usually respond more slowly in experimental tasks; this may be attributed to a general slowing - perhaps due to low arousal - or because they more often experience
lapses of attention. Though impulsive subjects may appear to respond quickly in certain situations it may be that they simply respond prematurely. While it is conceivable that attention may simply weaken during the course of a task it is also plausible that attention may be distracted from the target task by either internal or external distracters.

Dickman’s characterisation of attentional fixity seems a too mechanical one; whether attention is fixed or shifted depends upon environmental stimulation and the differential sensitivity of the fixity mechanism in different individuals. Impulsivity is thus a bi-polar construct with positive and negative values and an implied neutral midpoint (akin to extraversion; extremes on either pole would then be maladaptive. In this it is similar to Block’s construct of ego control which can be either too strong or too weak. In contrast the conceptualisation of impulsivity as a failure in executive control, or effortful control to use Rothbart’s term, implies the ability to regulate attention and behaviour in the service of goals; a less mechanical conceptualisation of the construct as one of higher level – executive – control. Dickman’s review includes few studies which include measures of executive function.

In the theories of Rothbart or Barkley the dimension of impulsivity goes from low to high, in one direction only (a uni-polar dimension more like neuroticism or emotional stability); the more one is able to control impulses the better. Note that this is more akin to Block’s notion of ego flexibility, the ability to control behaviour when required. Excessive inhibition is not the converse of dis-inhibition - not the inhibitory mechanism set at a higher level. It is a consequence of negative affect and neuroticism - fear and
anxiety. My construct of narrow impulsivity is akin to Rothbart’s view of effortful control as independent of affect, an argument supported by Depue & Collins (1999).

A number of other tasks which may be classified as involving attention rather than response inhibition differentiate between ADHD adults and controls. As pointed out above, omission scores on the continuous performance test are interpreted as failures of attention. Hervey et al. (2004) in their meta-analysis of comparisons between ADHD and control adults reported a weighted mean effect size of .51 using the Conners CPT and .76 using more traditional CPTs. In their meta-analysis Hervey et al. (2004) reported that the largest differences in Wechsler Adult Intelligence Test performance were in the arithmetic and digit-symbol subtests, subtests which are often grouped within a freedom-from-distractibility factor. They also found an effect size of .83 for performance on the Paced Auditory Serial-Addition Tasks which they classify as involving sustained attention.

Recently a great deal of attention has been given in the field of ADHD to intra-personal variability of response. Hervey et al. (2004) report an effect size of .53 for differences between adult ADHD and control groups in reaction time variability in the Conners’ CPT. Klein, Wendling, Huettnr, Ruder and Peper (2006) reviewed studies comparing intr-subject reaction time variability in ADHD and control children and found significant differences in 16 out of 19 studies using a CPT task. They also noted a strong general trend towards significant differences in intr-subject variability in a number of tasks including Stop and Stroop tasks and the Matching Familiar Figures test. Among the
studies utilising the Stop task eight showed no significant difference in reaction time but
significant differences in reaction time variability.

Douglas (2004) discusses data which shows slower and more variable reaction times in
children with ADHD and reports further analysis which showed that the differences were
in the tail end of the reaction time distribution; the ADHD subjects showed abnormally
slow reaction times which Douglas interprets as indicating occasional attentional lapses.
This construct of attentional inconsistency is similar to the construct of vigilant attention
as described by Robertson et al. (19).

A number of researchers have suggested a link with the concept of arousal discussed at
variability show considerable consistency across tasks and that this suggests a general
impairment in state regulation or cortical under-arousal in ADHD children. Nigg (2006)
concludes from his review of the evidence that low levels of alertness in ADHD may be
attributable to low cortical arousal.

**Conclusion**

The evidence in this chapter supports a distinction between two related functions within
the general domain of impulsivity; two functions which in Chapter 2 were referred to as
attentional and behavioural impulsivity. This distinction is seen particularly clearly in the
research and theory in the area of ADHD; in the rating scale studies eliciting behavioural
descriptions from carers in the case of children and from self report in the case of adults as well as in the laboratory studies of cognitive functions.

Douglas (2004) identifies three components of self-regulation problems in ADHD; an attentional component which she refers to as *effortful attention*, an inhibitory component which involves controlling impulsive or inappropriate responding, and a strategic or organisational component. (p. 24). The differentiation of the first two of these parallels the division made by Nigg (2006) and Kenemans et al (2005) between the function of resolving interfering information and the function of suppressing or interrupting a prepotent or on-going response. There is a further parallel with the differentiation made by Feldman and Miyake between prepotent response inhibition and resistance to distractor interference.

Studies 5 and 6 in chapter 6 will pursue the dual nature of impulsivity in questionnaire measures of traits derived from ADHD while chapter 7 will aim to relate laboratory measures of these two functions to self report measures of those traits.
Chapter 4

Validation of the Barratt Impulsiveness Scale - Version 11 and the Development of a Short Form – the BIS-Short.

Introduction

The overall purpose of this chapter is to explore the construct validity of the Barratt Impulsiveness Scale- Version 11 (BIS-11; Patton et al 1995) and the model of impulsivity which it embodies. Barratt and his colleagues argue that the BIS-11 operationalises a tripartite model of impulsivity whereby the higher order trait of impulsivity consists of three highly correlated lower order factors. Study 1, reported in this chapter, had four aims. First, it was designed to replicate the tri-partite structure of the BIS-11 proposed by Patton et al (1995). Second, a 10-item version of the BIS-11 was developed and correlated with the total score of the BIS-11 as well as its subscales, with the aim of capturing the general factor within the BIS-11, as well as reflecting the different facets within that scale. Third the validity of the BIS-Short, the BIS-11 and the differential validity of its subscales was examined by evaluating their relationships with self report measures of aggressive behaviour, alcohol consumption and driving behaviour.

There is considerable evidence for the validity of the trait of impulsivity and for its utility in the prediction and understanding of both normal and pathological behaviour. Vitaro, et
al. (1999) found impulsivity to predict both delinquency and problem gambling in adolescents. Kahn et al (2002) found impulsiveness to be significantly positively correlated with sexual risk behaviours in young women. In a study of trauma patients Ryb, Dischinger, Kufera and Read (2006) found that a measure of impulsivity significantly predicted the occurrence of a range of risky behaviours including speeding, low seatbelt use, drinking and driving and binge drinking; odds ratios ranged from 1.53 to 2.91 after accounting for factors such as age, gender and socio-economic status.

Trait Impulsivity is usually measured by self-report questionnaires such as the BIS-11 (Patton, Stanford & Barratt, 1995), the Eysenck I7 (Eysenck, Pearson, Easting, & Allsopp, 1985) and Dickman’s scale of functional/dysfunctional impulsivity (Dickman, 1994); research described in the introduction shows these scales to share a considerable amount of variance. The oldest of these, the Barratt Impulsiveness Scale, was first described in 1959 (Barratt 1959), and has undergone continuous revision leading to the latest version the BIS-11 (Patton, Stanford & Barratt 1995). Throughout this development the aim has been to establish a measure which was as independent as possible of affective dimensions, particularly trait anxiety, and which was independent of other ‘action oriented’ dimensions such as sensation seeking (Fosssati, Di Ceglie, Aquarini & Barratt 2001). In this regard, Barratt can be seen to have anticipated the analysis of Depue and Collins (1999) who similarly identified an affect-free construct of control or lack of inhibition. On the basis of the analysis of the BIS-11, Barratt and his associates have proposed a three-component model of impulsivity consisting of motor impulsiveness, cognitive or attentional, impulsiveness and non-planning impulsiveness. (Moeller,
Barratt, Dougherty, Schmitz & Swann (2001). Patton et al. (1995) argued that item analysis of the BIS-11 supported an internally consistent and homogenous measure of impulsiveness (alpha = .82); together with the substantial correlations between these components, from 46 to .53, the data are congruent with an hierarchical model of a higher order single trait of impulsivity with three lower order facets.

The validity of the BS-11 has been demonstrated in a number of ways in areas of personality and psychopathology. Research discussed in chapter 1 illustrates the high correlations between different scales of impulsivity – generally in excess of .70 - attesting to the degree of agreement between different researchers as to the behaviour characteristic of impulsivity. Most of these approaches to impulsivity agree in two important respects; they distinguish between impulsivity and negative or positive affective traits and they distinguish between impulsivity and sensation seeking. Thus they provide evidence supporting the construct of impulsivity independent of affective traits as well as other ‘action oriented’ dimensions such as sensation seeking.

A number of studies have established the construct validity of the BIS-11 by exploring its relationships to behaviour which is typically considered to involve an element of impulsivity. Two recent studies found significant correlations between the total BIS-11 score and the scales of the Buss and Perry (1992) aggression questionnaire. Marsh et al. (2002) obtained correlations with the four aggression scales ranging from .25 to .46, while Wu and Clark (2000) obtained correlations ranging from .19 to .28. A basic yet frequently overlooked aspect of scale validity was addressed by Wu and Clark (2000)
who found a correlation of .45 between the total score on the BIS-11 and a behavioural report scale of impulsivity based upon daily records of behaviour.

The BIS-11 has also been utilised in a considerable number of clinical studies, demonstrating its validity in differentiating between impulse disorders, such as borderline personality disorders, and non-impulse disorders such as depression (Solof et al. 2000). The BIS-11 (as well as an earlier version the BIS-10) has significantly discriminated between violent and non-violent female and male parolees (Chéreck & Lance 1999), self-mutilating patients and patients manifesting other impulsive behaviours, and non-impulsive patients (Herpertz et al. 1997), alcoholic and non-alcoholic groups (Ketzenberger & Forrest 2000), as well as between bulimic patients and normal controls (Steiger et al. 2001). In an interesting recent study, Dom, Hulstijn and Sabbe (2006) compared early and late onset alcoholic patients and found the former to be significantly higher in impulsivity. The validity of the BIS-11 in research on both personality and clinical psychology suggests that the types of impulsivity discussed in the two domains have significant elements in common.

While many studies have employed the total score from the BIS-11, a smaller number have utilized the subscale scores- though here the results are less clear. Of the studies considered above, while Herpertz et al. (1997) found that self-mutilating patients scored more highly on the non-planning scale, as well as on total BIS-10 score, Steiger et al (2001) found significant differences between bulimic patients and normal controls in scores on the attention and motor subscales as well as the total BIS-10, though not on the
non-planning scale. Dougherty et al. (1999) found significant differences between Borderline patients and controls only in the attention subscale though also the BIS-11 total score. While the defining conditions of the patient groups in these three studies are nominally different they are frequently co-morbid with each other and thus could be assumed to share the same elements of impulsivity.

Other studies have failed to find evidence for the differential validity of the BIS-11 subscales. Miller et al. (2004) found correlations of the BIS-11 scales of attentional, motor and non-planning impulsiveness with Dickman's dysfunctional impulsivity scale to be .45, .56 and .63 respectively; the Eysenck impulsiveness scale gave correlations of .52, .58 and .58 with the same BIS-11 scales. Dom, Hulstijn and Sabbe (2005) found all three impulsivity subscales to differentiate significantly between early and late onset alcoholics.

Thus research has yet to demonstrate the value of differentiating between the facets of the BIS-11. Indeed the definition of the three factors has proved somewhat elusive in previous research. Barratt (1994) factor analysed the 34 item BIS-10 to extract 3 factors which were defined as ideo-motor impulsivity (consisting of cognitive and motor items), careful planning impulsivity and future orientation/coping stability impulsivity with alphas coefficients of .72, .73 and .50 respectively. More recently Patton et al. (1995) developed the BIS-11 by removing four items of the BIS-10 on the basis of item statistics and analyzing data from a more substantial and varied sample of 733 subjects, 34% of whom were psychiatric inpatients. Analysis of the new scale produced three factors.
which were similar, but not identical, to those of the BIS-10. In particular the cognitive and motor items now identified two distinct scales while careful planning and future orientation items were collapsed into one scale.

There has however been no independent replication of the factor structure of the BIS-11 in English. Fossati et al (2001) developed an Italian translation of the BIS-11 and produced a three-factor solution which bore only a moderate resemblance to the factor structure outlined by Patton et al (1996), with a substantial number of differences in the pattern and magnitude of individual item loadings. Values of Cronbach’s alpha ranged from .62 to .75, with correlations between three second-order factors ranging from .28 to .68. Fossati, Barratt, Carretta, Leonardi, Grazioli, and Maffei (2004) in a further study utilising the Italian translation of the BIS-11 found correlations between the three subscales ranging from .43 to .56, values similar to those reported by Patton et al. (1995); however values of Cronbach’s alpha for the subscales ranged from only .52 to .64.

**Study 1 Analysis of the BIS-11 and development of a short form**

The first aim of this study was to explore the replicability of the model of the BIS-11 proposed by Patton et al (1995); a model consisting of three highly correlated lower order factors and a single super-ordinate higher order factor. The first step was to carry out an exploratory factor analysis extracting three factors which led to the creation of 6 item subscales corresponding to the extracted factors. Fossati et al (2001) argued against using confirmatory factor analysis to analyse the factor structure of the BIS-11. (See note 2 at
the end of the chapter for more details). In the second step these subscales and the three factor scores from the factor analysis were correlated with the subscales as defined by Patton et al (1995). The second aim was to develop and assess a short form of the BIS-11 which would reflect the higher order factor. The third aim was to assess the differential validity of the sub-scales by comparing their correlations with a number of criterion variables.

Method

Participants and Procedure

The sample was composed of 975 undergraduate students attending the University of Surrey; 273 (28%) male and 702 (72%) female. The mean age was 20.28 with a SD of 5.8. The BIS-11 was distributed to groups of first year students consisting of social science and nursing students, over a period of 5 years. Subsequent to that a further sample of students completed the BIS-11 at the beginning of their academic year and then three months later completed the ten item BIS-short as a stand-alone measure (n = 47).

Of the total sample described above, 335 students also completed a self report scale of alcohol consumption, a scale of emotion regulation and the Driving Behaviour Questionnaire (DBQ; Westerman & Haigney 2000). Further, 241 of the above sample also completed the Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry 1992).
Measures

The BIS-11 is a 30-item self-report questionnaire; responses to each item are made on a 4-point Likert scale ranging from 1 = rarely/never to 4 = almost always/always (see table A.1 in appendix for items). Barratt and his associates have proposed a multi-faceted model of impulsivity derived from the analysis of the BIS-11 (Patton et al. 1995). While the authors argued that item analysis suggested an internally consistent and homogenous measure of impulsiveness (alpha = .82), they nevertheless carried out an exploratory factor analysis of the BIS-11 and extracted 6 primary factors, as their interpretation of the scree plot suggested. A higher order factor analysis of the correlations between these primary factors produced 3 secondary factors: motor impulsiveness, attentional impulsiveness, and non-planning impulsiveness. Correlations between the factors were merely summarized; they were described as ranging from .15 to .42 for the six primary factors and from .46 to .53 for the three secondary factors. The study did not report alpha coefficients for either primary or secondary factors. Patton et al. (1995) interpreted these data as indicating a hierarchical model of impulsivity whereby the three sub-factors are subsumed by a general impulsivity factor. Stanford et al. (1996) reported a Cronbach’s alpha coefficient for the whole scale of 0.80 for a sample of university students. Wu and Clark (2000) report Cronbach’s alpha values of .80 for the total scale and between .60 and .72 for the subscales the lowest being the attentional subscale. Correlations between the subscales ranged from .29 to .52. Though in the original scale responses are made on a
4-point Likert scale, in order to enhance item variance the present study employed a 6-point Likert scale ranging from 1 = disagree strongly to 6 = agree strongly.

The Buss-Perry Aggression Questionnaire (BPAQ Buss & Perry 1992) is a 29-item self-report questionnaire consisting of four subscales measuring four aspects of aggression — physical, verbal, angry and hostile aggression. Buss and Perry (1999) report values of Cronbach’s coefficient alpha as .85, .72, .83 and .77 for the subscales and .89 for the total scale; correlations between the subscales ranged from .25 to .48.

Alcohol consumption was assessed with a 10 item self-report scale developed for the author’s research programme (see table A.2 in appendix). The scale consisted of nine questions relating either to excessive alcohol consumption (e.g. ‘I have drunk alcohol until I felt ill’) or to the undesirable consequences of such consumption (e.g. ‘I have failed to do what was expected of me due to drinking too much alcohol’); the final question asked about the frequency of consuming more than 6 units of alcohol on one occasion - a commonly used measure of binge drinking, the full scale is included in the appendix. Questions required responses on a 6-point scale ranging from 1 = never to 6 = almost always and the total score was the simple sum of responses. Cronbach’s alpha for this scale was 0.91 in this sample. In a separate sample of students the correlation between self and peer report versions of this scale was $r = 0.62 (N = 266, p < .01)$ and the test-retest correlation between two administrations of the alcohol scale across approximately 12 weeks was $r = .74 (N = 144, p < .01)$. In that separate sample males
obtained a significantly higher score than females; a difference amounting to .64 of the standard deviation of the whole sample.

Driving behaviour was assessed with the Driving Behaviour Questionnaire (DBQ; Westerman & Haigney 2000) which assesses violations (deliberate infringements of the law or driving improperly), errors (errors of intention) and lapses (errors of action). Alpha reliability coefficients for the three scales, each of 8 items, were 0.74 for lapses, 0.67 for errors and 0.74 for violations. Westerman and Haigney (2000) reported a correlation of 0.59 between errors and lapses, suggesting considerable overlap between the two. In the interests of economy only the former two scales, violations and errors were utilised: thus there were 16 items to which responses were made on a 6-point Likert scale ranging from 1 = never to 6 = very often. In the present sample alpha reliability values were .80 for the violations scale and .82 for the errors scale; the violations and error scales correlated .50 (n = 550, p < .01)

Emotion regulation was assessed with a 6-item scale developed by the author and was derived from the DSM-IV description of borderline personality disorder— a disorder which is characterised by strong negative affect and behavioural disinhibition. The scale consisted of items relating to anxieties or difficulties in understanding or regulating emotions (e.g. ‘I get confused when my feelings get too strong’); none of the items however refer to either cognitive or behavioural inhibition. Items required responses on a 6-point scale ranging from 1 = never to 6 = almost always; and the total score was the simple sum of responses. (See table A.3 in appendix). Cronbach’s alpha for this scale
was .87. This scale correlated .64 with the urgency scale of the UPPS impulsivity questionnaire of Whiteside and Lynam (2001) which will be discussed in detail in chapter 4. The urgency scale is conceptually related to emotion regulation since it is a measure of impulsivity driven by negative affect; though there is no overlap in item content with the emotion regulation scale.

Results

Evaluating the factor structure of the BIS-11

The BIS-11 data for the entire sample (N = 975) were subjected to an exploratory factor analysis utilizing a principal axis factoring extraction and promax (oblique) rotation.

Figure 1.1 Scree plot of eigen values from factor analysis of BIS-11
The scree plot supported the extraction of three or four factors. Following the suggestion of Fabrigar, Wegener, MacCallum and Strahan (1999) that over factoring is unlikely to mislead while at the same time often serving to clarify the factor structure both three and four factor solutions were extracted. Comparing the two solutions in tables 2.1 and 2.2 it can be seen that extracting the fourth factor removes three items from the first factor but otherwise leaves the first three factors unchanged. As shown in table 2.3, the correlations between factors in the three factor solution ranged from .46 to .57; the correlations between the first three factors in the four factor solution ranged from .43 to .56, however the fourth factor correlated .33 with the factor from which it had split but hardly at all with the remaining two factors. Scrutiny of table 2.2 shows that when adopting a pattern loading of .30 or more as significant then factor 1 was identified by eight items, factor 2 by 6 items, factor 3 by seven items and factor 4 by three items. Six items did not load on any factor above the threshold level.
Table 2.1 pattern matrix for 3 factor extraction from factor analysis of BIS-11

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<th>Item</th>
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<th>Factor 2</th>
<th>Factor 3</th>
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<td>27</td>
<td>.202</td>
<td>.055</td>
<td>.042</td>
</tr>
<tr>
<td>16</td>
<td>-.114</td>
<td>.784</td>
<td>.051</td>
</tr>
<tr>
<td>14</td>
<td>-.061</td>
<td>.768</td>
<td>.011</td>
</tr>
<tr>
<td>3</td>
<td>-.074</td>
<td>.484</td>
<td>-.294</td>
</tr>
<tr>
<td>2</td>
<td>.146</td>
<td>.449</td>
<td>.129</td>
</tr>
<tr>
<td>18</td>
<td>.117</td>
<td>.436</td>
<td>.018</td>
</tr>
<tr>
<td>19</td>
<td>.252</td>
<td>.323</td>
<td>.044</td>
</tr>
<tr>
<td>24</td>
<td>.003</td>
<td>.260</td>
<td>-.048</td>
</tr>
<tr>
<td>25</td>
<td>.021</td>
<td>.151</td>
<td>.072</td>
</tr>
<tr>
<td>30</td>
<td>-.163</td>
<td>.130</td>
<td>.098</td>
</tr>
<tr>
<td>20</td>
<td>-.145</td>
<td>.064</td>
<td>.641</td>
</tr>
<tr>
<td>21</td>
<td>.063</td>
<td>-.114</td>
<td>.517</td>
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<td>-.095</td>
<td>.463</td>
</tr>
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<td>5</td>
<td>-.218</td>
<td>.231</td>
<td>.431</td>
</tr>
<tr>
<td>4</td>
<td>.218</td>
<td>.003</td>
<td>.411</td>
</tr>
<tr>
<td>10</td>
<td>-.142</td>
<td>-.099</td>
<td>.396</td>
</tr>
<tr>
<td>13</td>
<td>-.007</td>
<td>.334</td>
<td>.360</td>
</tr>
<tr>
<td>17</td>
<td>.016</td>
<td>.175</td>
<td>.193</td>
</tr>
</tbody>
</table>
Table 2.2 Pattern matrix for four factor extraction from factor analysis of BIS-11

<table>
<thead>
<tr>
<th>BIS-11 item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>-0.749</td>
<td>0.015</td>
<td>0.029</td>
<td>-0.004</td>
</tr>
<tr>
<td>1</td>
<td>0.694</td>
<td>0.044</td>
<td>-0.100</td>
<td>0.031</td>
</tr>
<tr>
<td>15</td>
<td>0.667</td>
<td>-0.093</td>
<td>0.108</td>
<td>-0.015</td>
</tr>
<tr>
<td>6</td>
<td>0.538</td>
<td>0.115</td>
<td>-0.112</td>
<td>0.016</td>
</tr>
<tr>
<td>7</td>
<td>0.525</td>
<td>0.018</td>
<td>0.090</td>
<td>-0.116</td>
</tr>
<tr>
<td>12</td>
<td>0.465</td>
<td>-0.038</td>
<td>-0.075</td>
<td>0.044</td>
</tr>
<tr>
<td>9</td>
<td>0.415</td>
<td>0.214</td>
<td>-0.135</td>
<td>0.018</td>
</tr>
<tr>
<td>22</td>
<td>0.375</td>
<td>-0.219</td>
<td>-0.093</td>
<td>0.294</td>
</tr>
<tr>
<td>28</td>
<td>0.230</td>
<td>0.031</td>
<td>-0.164</td>
<td>-0.015</td>
</tr>
<tr>
<td>16</td>
<td>0.002</td>
<td>0.725</td>
<td>0.065</td>
<td>-0.029</td>
</tr>
<tr>
<td>14</td>
<td>0.014</td>
<td>0.721</td>
<td>0.033</td>
<td>0.022</td>
</tr>
<tr>
<td>3</td>
<td>-0.150</td>
<td>0.510</td>
<td>-0.253</td>
<td>0.122</td>
</tr>
<tr>
<td>18</td>
<td>0.067</td>
<td>0.433</td>
<td>0.043</td>
<td>0.155</td>
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<tr>
<td>2</td>
<td>0.309</td>
<td>0.380</td>
<td>0.098</td>
<td>-0.102</td>
</tr>
<tr>
<td>19</td>
<td>0.201</td>
<td>0.315</td>
<td>0.056</td>
<td>0.159</td>
</tr>
<tr>
<td>24</td>
<td>0.086</td>
<td>0.230</td>
<td>-0.057</td>
<td>-0.075</td>
</tr>
<tr>
<td>30</td>
<td>0.125</td>
<td>0.119</td>
<td>0.073</td>
<td>0.069</td>
</tr>
<tr>
<td>20</td>
<td>-0.054</td>
<td>0.040</td>
<td>0.611</td>
<td>-0.026</td>
</tr>
<tr>
<td>21</td>
<td>-0.057</td>
<td>-0.094</td>
<td>0.545</td>
<td>0.220</td>
</tr>
<tr>
<td>8</td>
<td>0.367</td>
<td>-0.121</td>
<td>0.421</td>
<td>0.066</td>
</tr>
<tr>
<td>5</td>
<td>-0.121</td>
<td>0.205</td>
<td>0.416</td>
<td>-0.049</td>
</tr>
<tr>
<td>10</td>
<td>-0.182</td>
<td>-0.082</td>
<td>0.405</td>
<td>0.076</td>
</tr>
<tr>
<td>4</td>
<td>0.192</td>
<td>-0.004</td>
<td>0.395</td>
<td>0.130</td>
</tr>
<tr>
<td>13</td>
<td>0.211</td>
<td>0.256</td>
<td>0.321</td>
<td>-0.183</td>
</tr>
<tr>
<td>29</td>
<td>0.215</td>
<td>0.234</td>
<td>-0.255</td>
<td>0.213</td>
</tr>
<tr>
<td>17</td>
<td>-0.110</td>
<td>0.204</td>
<td>0.235</td>
<td>0.219</td>
</tr>
<tr>
<td>26</td>
<td>-0.064</td>
<td>0.003</td>
<td>0.180</td>
<td>0.566</td>
</tr>
<tr>
<td>23</td>
<td>0.182</td>
<td>-0.054</td>
<td>-0.027</td>
<td>0.461</td>
</tr>
<tr>
<td>27</td>
<td>-0.045</td>
<td>0.115</td>
<td>0.095</td>
<td>0.375</td>
</tr>
<tr>
<td>25</td>
<td>-0.131</td>
<td>0.192</td>
<td>0.117</td>
<td>0.234</td>
</tr>
</tbody>
</table>
One of the principal aims of this study was to attempt to replicate the structure of the BIS-11 as proposed by Patton et al. (1996); this was approached in two ways. The first approach was to compute the factor scores for the three factor solution and to correlate these with the scale scores computed from the data provided by Patton et al. (1995) and set out most clearly in Fossati et al. (2001). From Table 2.3 it can be seen that the correlations between the Patton et al. (1995) scales and the corresponding factor scores ranged from .87 to .94. Such high correlations reflect the fact that the present studied showed substantial agreement with Patton et al. (1995) in the identification of items with factors. The correlations between the factor scores (.55 to .63) strongly support the hypothesis of a hierarchical model of impulsivity.
Table 2.4 Correlations between Patton et al (1995) scales and factor scores from the present sample.

<table>
<thead>
<tr>
<th></th>
<th>planning 1995</th>
<th>attention 1995</th>
<th>motor 1995</th>
<th>factor score 1</th>
<th>factor score 2</th>
<th>factor score 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>planning 1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attention 1995</td>
<td>.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>motor 1995</td>
<td>.56</td>
<td>.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>factor score 1</td>
<td>.91</td>
<td>.61</td>
<td>.57</td>
<td></td>
<td></td>
<td></td>
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<td>factor score 2</td>
<td>.61</td>
<td>.52</td>
<td>.87</td>
<td>.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>factor score 3</td>
<td>.62</td>
<td>.94</td>
<td>.39</td>
<td>.49</td>
<td>.68</td>
<td>.63</td>
</tr>
</tbody>
</table>

All correlations significant \( p < .01 \)

*planning 1995*, *attention 1995* and *motor 1995* refer to the subscales computed as specified by Patton et al (1995); *factor 1*, *factor 2* and *factor 3* refer to the regression factor scores derived from the factor analysis of the present sample.

The second method was to create three sub-scales from the present data analysis using the items which loaded above the threshold level (.30) in the pattern matrix. Since only six items loaded significantly onto factor 2, only the first six items loading onto factors 1 and 3 were used. Thus the first six items loading onto each of the first three factors in the four factor solution were combined to produce three scales. Table A.1 provides the full 30 item scale and shows which items were selected for the sub-scales derived for this study. The responses to the six items identified with each factor were simply summed (after appropriate reversal) to produce a scale score. As can be seen in table 2.4 correlations between the subscales derived from the two data sets correlate substantially, correlations ranging from .90 to .92. These high correlations are due to the substantial similarity in the items making up the two sets of scales; five of the first six items loading onto factor 1 corresponded to non-planning items as defined by Patton et al (1996), all the six factor 2...
items correspond to their motor factor while five out of the six items loading on factor 3 corresponded to their attention factor.

Table 2.5 Correlations between scores derived from the Patton et al. (1995) scales and scores from the subscales created from the present sample.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>planning 1995</td>
<td>.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attention 1995</td>
<td></td>
<td>.43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>motor 1995</td>
<td>.56</td>
<td>.49</td>
<td>.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>planning 2006</td>
<td>.90</td>
<td>.44</td>
<td>.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>attention 2006</td>
<td>.55</td>
<td>.92</td>
<td>.44</td>
<td>.46</td>
<td></td>
</tr>
<tr>
<td>motor 2006</td>
<td>.52</td>
<td>.43</td>
<td>.90</td>
<td>.45</td>
<td>.47</td>
</tr>
</tbody>
</table>


Cronbach’s alpha coefficients were .70, .65 and .69 for the Patton et al. (1995) attention, motor and non-planning scales respectively and for the corresponding current six-item scales were .69, .70 and .73. Cronbach’s alpha for the full 30 item BIS-11 was .84, a figure very close to the Cronbach’s alpha value of .82 for the sample reported by Patton et al. (1995). Correlations between the Patton et al. (1995) scales ranged from .43 to .56 and from .45 to .47 for the scales derived from the present study. The correlations between the factor scores as well as the correlations between the scales scores support the claim that there is a higher order factor of impulsivity subsuming the three primary factors.
Development of a short form of the BIS-11

Since the results of the factor analysis support the existence of a single higher order factor/variable, the next step was to derive a short form of the BIS-11 which would correlate highly with the whole 30 item scale as well as the three sub-scales. In developing this short form the caetrats and recommendatons of Smith, McCarthy and Anderson (2000) were taken into account. Smith et al (2000) argue for the importance of showing that the new short form preserves the content domains represented by the subfactors of the original scale; to this end the items for the short form were selected so as to represent the three factors identified by the factor analysis above. See appendix 1 for the selection of items. They also argue the importance of showing the validity of the short form in an independent sample; to this end a small sample was administered the BIS-Short separately approximately three months after the administration of the BIS-11, these data were collected after the BIS-11 had been developed.

A principal components analysis was carried out on the total sample extracting only one factor. nine items were chosen from the 15 highest loading items such that there was an equal selection of items from the three factors, 4 from the motor impulsivity factor and 3 from each of the other factors; scores on these 9 items were simply summated to produce the scale BIS-Short. See appendix 1 for the BIS-Short items. Cronbach's alpha for the new scale was .81 and the correlation between the BIS-Short and the BIS-11 was .89. Table 2.5 illustrates the correlations between the BIS-11, the BIS-Short and the three subscales; it can be seen that the correlations of the subscales with the BIS-Short were
virtually the same as with the full scale BIS-11. The correlation between the BIS-Short and the regression factor score for the single factor extraction was .95.

Table 2.6 Correlations between the scales of impulsivity

<table>
<thead>
<tr>
<th></th>
<th>Bis-11</th>
<th>BIS-short</th>
<th>attention</th>
<th>motor</th>
<th>planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS-11</td>
<td>(.84)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIS-short</td>
<td>.89</td>
<td>(.81)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attention</td>
<td>.75</td>
<td>.75</td>
<td>(.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>motor</td>
<td>.75</td>
<td>.78</td>
<td>.47</td>
<td>(.70)</td>
<td></td>
</tr>
<tr>
<td>planning</td>
<td>.78</td>
<td>.75</td>
<td>.46</td>
<td>.45</td>
<td>(.73)</td>
</tr>
</tbody>
</table>

N = 975  All correlations significant p< .01.

Figures in parentheses on the diagonal are Cronbach’s alpha coefficients.

Table 2.6 shows the correlations between the BIS-11 administered at time 1, the BIS-Short assessed as a constituent part of the BIS-11, and thus also at time 1, and the BIS-Short administered independently (as a 10-item scale) at time 2, three months later. The correlation of .79 between BIS-Short at time 1 and BIS-Short at time 2 is an estimate of test-retest reliability; the virtually identical correlation between BIS-11 at time 1 and BIS-Short at time 2 implies that apart from the error due to temporal instability the BIS-Short as a stand alone 10 item scale relates to the longer BIS-11 as well as does the BIS-Short when it is extracted from items embedded within the parent scale.
Table 2.7 Correlations between BIS-11 and BIS-Short administered at time 1 and the BIS-Short administered at time 2.

<table>
<thead>
<tr>
<th></th>
<th>BIS-11</th>
<th>BIS-Short 1</th>
<th>BIS-Short 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS-11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIS-Short 1</td>
<td>.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIS-Short 2</td>
<td>.78</td>
<td>.79</td>
<td></td>
</tr>
</tbody>
</table>

N = 47 all correlations significant p < .01.
BIS-Short at time 2; alpha = .80.

Evidence for the validity of the BIS-Short as a stand-alone scale comes from data collected as part of a study to be discussed in a later chapter where a small sample (n = 114) completed only the 10-item BIS-Short as well as the driving scales described above. Correlations between the BIS-Short and the driving violations and driving errors scales were .51 and .48 respectively (both correlations were significant - p < .01); these correlations compare favourably with the correlations reported in table 2.7 below.

An exploratory factor analysis of the 9 items of the BIS-Short produced a scree plot strongly suggestive of a single factor. The first eigen value was 3.50 with the remaining eigen values forming an almost perfectly straight line; the next three values were 1.06, .89, ..80. Of course the items were initially chosen from a single factor extraction so that a new sample would be needed to confirm this finding.

Validity of the impulsivity scales

The final step in the validation of the BIS-11 involved examining the relative validity of the BIS-11 and its subscales and the BIS-Short by examining the correlations with
aspects of aggression as measured by the Buss – Perry aggression scale and with self report measures of drinking behaviour, emotion regulation and driving behaviour.

Table 2.6 shows the correlations between the BIS scales the aggression sub-scales of the Buss – Perry aggression questionnaire, the alcohol scale and the DBQ. The BIS-11 and the BIS-Short show essentially similar correlations with the four aggression scales and with the alcohol, driving and emotion regulation scales, attesting to the validity of the newly developed short scale. The BIS subscales do however show some degree of differentiation. While the cognitive subscale shows approximately equal correlations with each of the aggression scales, the motor subscale shows significant correlations with angry, physical and verbal aggression but not with hostility while the planning sub-scale does not correlate with any of the aggression scales. The alcohol scale shows similar relationships with the three impulsivity subscales. The emotion regulation scale shows a similar degree of relationship with motor and planning impulsivity but a considerably higher correlation with cognitive impulsivity.
Table 2.8 Correlations between impulsivity, aggression, drinking and emotion regulation scales.

<table>
<thead>
<tr>
<th>Physical</th>
<th>Verbal</th>
<th>Angry</th>
<th>Hostile</th>
<th>Drinking violations</th>
<th>Driving errors</th>
<th>Driving regulation</th>
<th>Emotion regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS-short</td>
<td>.21</td>
<td>.21</td>
<td>.25</td>
<td>.18</td>
<td>.42</td>
<td>.37</td>
<td>.33</td>
</tr>
<tr>
<td>BIS-11</td>
<td>.16</td>
<td>.24</td>
<td>.22</td>
<td>.13</td>
<td>.39</td>
<td>.34</td>
<td>.29</td>
</tr>
<tr>
<td>Attention</td>
<td>.22</td>
<td>.21</td>
<td>.28</td>
<td>.20</td>
<td>.26</td>
<td>.29</td>
<td>.17</td>
</tr>
<tr>
<td>Planning</td>
<td>.04</td>
<td>.09</td>
<td>.05</td>
<td>.05</td>
<td>.31</td>
<td>.20</td>
<td>.26</td>
</tr>
</tbody>
</table>

Aggression scales N = 242, drinking, emotion regulation and driving scales N = 335
Correlations in bold are significant p < .01

Discussion

The analysis of the data in large part replicates the tripartite structure of the BIS-11 suggested by Patton et al (1995). When scales were constructed from the items loading most substantially on the three factors identified in both three and four factor extractions there was a striking correspondence with the subscales derived from the items identified by Patton et al (1995) as marking the three factors. There was also agreement between the two investigations in the correlations between the factors; Patton et al. reported factor inter-correlations of .46 to .53, in this investigation they ranged from .55 to .68.

Correlations between the scales from the two investigations ranged from .90 to .92. The alpha coefficients for the subscales ranged from .69 to .73; satisfactory for scales of only
six items each, and the alpha coefficient for the whole questionnaire was .82. Test-retest reliability was found to be .78 in a small sample.

The new shortened version of the scale, the BIS-Short, correlated highly with the parent scale the BIS-11 (r = .89 p < .01) and with the three sub-scales (.71 to .78). Correlations with the outcome variables were not significantly different between BIS-11 and BIS-Short; suggesting that the short form can be substituted with confidence; this was further supported by data from a small study in which the BIS-Short administered alone correlated highly with the BIS-11. The use of a shortened form is particularly valuable when working with clinical samples or with disturbed adolescents, especially where a number of tests are to be administered.

The results overall support an analysis of the BIS-11 as a three factor structure in which the correlations between factors and between the constructed scales suggest a hierarchical structure in which a higher order factor of general impulsivity subsumes the three lower order factors.

Evidence considered in the introduction supports the validity of the BIS-11 as an overall measure of impulsivity; however evidence for the differential validity of the subscales is slight. As discussed in the introduction, Miller et al (2004) found correlations between the BIS subscales and Dickman’s dysfunctional impulsivity scale which ranged from .45 to .63, and for Eysenck’s impulsiveness scale between .52 and .58. The studies discussed in the introduction to this chapter which looked at correlations between the BIS-11 and
the degree of psychopathology found a consistent relationship with the BIS-11 total score but inconsistent relationships with the subscales. Likewise, the data presented in this chapter suggest that the correlations of the attentional and motor scales with the Buss and Perry (1992) aggression scales are essentially similar, though the planning subscale seems to stand apart in this respect.

When considering the present questionnaire, the BIS-Short and its subscales, it seems clear that the sense of impulsivity identified by the attentional and motor impulsivity scales is close to the conceptualization of impulsivity set out in the introduction to the thesis; momentary, though perhaps frequent, failures of inhibition, lapses of attention and distractibility, as well as frequent instances of acting without forethought. Furthermore the distinction between cognitive and motor (behavioural) impulsivity highlights the role of attentional factors in impulsivity as argued by both Barratt and Dickman.

The non-planning aspect of impulsivity, however, seems to reflect actions and behaviour on a larger scale; e.g. not planning trips well ahead of time, not planning for job security and not saving regularly. Planning trips involves controlling and coordinating diverse aspects of behaviour across a considerable time span; though paradoxically it may be that impulsive individuals make plans which they do not follow through or which they change soon after have conceived them. In the present study the non-planning subscale failed to correlate with any of the aggression scales while the other two scales correlated significantly with all of the aggression scales, with one exception. This difference between the impulsivity scales can be seen in two other studies which considered the
relationship between the BIS-11 subscales and the Buss and Perry aggression scales. Wu and Clark (2003) replicated the lack of significant correlations with the non-planning scales though they also failed to find a significant correlation between the aggression scales and the attentional subscale of the BIS-11. Marsh et al. (2002) found that the attentional and motor impulsivity scales correlated with all the aggression scales while the non-planning scale correlated only with the anger and hostility scales not with the physical and verbal aggression scales. Thus these three studies concur in finding the non-planning scale of the BIS-11 to be a less valid predictor of aggression than the attentional or the motor impulsivity scales; all three concur in finding significant correlations between the total BIS-11 score and all four of the aggression scales. Nevertheless the non-planning scale does correlate substantially with both the attentional and the motor scale; one possibility is that it may be the outcome of impulsivity rather than an integral element.

To what extent does this analysis of the BIS-11 illuminate impulsivity? Inferences as to the nature and structure of impulsivity are limited by the construct as operationalised by the set of items within any questionnaire or other instrument. A different conceptualization and operationalisation will suggest a different construct; an example of such a conceptualization — that of Whiteside and Lynam (2001) — will be considered in chapter 6. Evidence considered in the introduction (Parker and Bagby 1997) suggests a two factor rather than a three factor model of impulsivity though once again the substantial correlation between the methodical/disorganized and the cautious/spontaneous dimensions suggest that these are likely to be facets of a higher order trait of impulsivity.
It is not however clear that these two dimensions map onto the BIS-11 dimensions in any simple or obvious way. An alternative two factor model for impulsive behaviour is provided by the structure of ADHD behaviours as described in DSM-IV a model which also distinguishes between attention failure and behavioral inhibition; this model is explored in chapter 7. Though the factor structure of the BIS-11 has been replicated and further evidence provided for the validity of the scale and subscales it remains uncertain to what extent this is the best model of impulsivity.

Note 1. During the development of the BIS, Barratt has used the terms attentional and cognitive impulsivity somewhat interchangeably, though since Patton et al (1995) the term attentional has stuck. This thesis uses the term cognitive impulsivity to avoid confusion with the construct of inattention which occurs in later chapters.

Note 2. Fossati et al (2001) argued against using confirmatory factor analysis to confirm in a new sample the factor structure outlined by Patton et al (1995). Their argument was based on two considerations; – the first was that the item scores could not be normally distributed and thus would violate one of the required conditions for such an analysis. The second consideration was that with a questionnaire such as the BIS-11 with correlated sub-factors many items would load on more than one factor; a model which did not allow for factorial complexity i.e. which allowed for an item loading on one factor but specified zero loadings on the other two factor would inevitably register a poor fit. Alternatively allowing many cross factor loadings to appear in the model would result in a lack of identification of the model. Their argument repeats that of McCrae et al.
(1996) who argue against the use of confirmatory factor analysis in the confirmation of the NEO-PI-R; in that questionnaire facet scales which are assigned to a particular domain nevertheless have significant and meaningful secondary loadings on other domains. In their analysis even a model which allowed for numerous secondary loadings of the facet scales across domains failed to produce an acceptable fit. McCrae et al (1996) conclude that since the five factor structure of the NEO has been replicated in many studies "We believe this points to serious problems with CFA itself when used to examine personality structure." (p 563)

Nevertheless the author did carry out a confirmatory factor analysis with maximum likelihood estimation using AMOS 5.0.1 (Arbuckle 2003) upon the whole data set. The relevant fit indices chosen were the Goodness of Fit index, the Confirmatory Fit Index, the Root Mean Square Error of Approximation and the chi-square. The chi-square was significant, indicating a lack of fit between the model and the data, and the other fit indices were inadequate (GFI = .846, CFI = .637, RMSEA = .072.)
Chapter 5

Demonstrating the Incremental Validity of Impulsivity over the Big five Traits in the Prediction of Behaviour.

Chapter summary

The aim of this chapter was to compare the predictive validity of impulsivity with the Big Five personality traits and to examine whether the predictive validity of the trait of impulsivity is accounted for by the variance which it shares with a higher order trait, or traits, of which it may be considered a facet, or whether the variance independent of the higher order traits has independent predictive validity.

Study 2 shows that impulsivity adds incremental validity to the Big Five in the prediction of academic performance and self-reported alcohol consumption in first year female undergraduates. Study 3, using a more heterogenous sample and a different Big Five questionnaire, shows that impulsivity adds incremental validity to the Big Five in the prediction of behaviour which includes self and peer reports of alcohol consumption and self reports of driving behaviour.

Introduction

There is considerable evidence for the validity of the trait of impulsivity and for its utility in the prediction and understanding of both normal and pathological behaviour.
Kipnis (1971) reported significant correlations between impulsivity and academic performance in college students, and Vitaro, Arseneault and Tremblay (1999) found impulsivity to predict both delinquency and problem gambling in adolescents. Colder and Chassin (1997) found a significant correlation between impulsivity and alcohol consumption in young adolescents. Stanford, Greve, Boudreaux, Mathias, and Brumbelow (1996) found that impulsivity, assessed by the BIS-11, predicted aggression, drug taking and drunk driving in high school and college students - a relationship which was especially strong for females. The traits of sensation seeking and ego control, which are closely related to impulsivity, were found by Hampson, Severson, Burns, Slovic and Fisher (2001) to predict alcohol use in high school students. The results of the Kelly longitudinal study (Kelly & Conley, 1987) illustrate the continuing importance of impulsivity beyond the adolescent years; the trait of 'impulse control' predicted the incidence of divorce, marital satisfaction and alcohol abuse in males (though not in females) across a period of 15 years.

While the study of single traits such as impulsivity and related traits such as sensation seeking continues, recent decades have seen the rise of hierarchical trait models which aim to encompass the major aspects of personality the most prominent of these being the Five Factor Model (FFM; John & Srivastava, 1999). Such models tend to converge on five broad traits at the highest level of the hierarchy: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. At a lower level of the hierarchy more narrow traits such as deliberation and self discipline are identified as
facets of, for example, conscientiousness; while at the lowest level are narrowly defined traits such as tidiness and punctuality.

The success of the FFM in promoting the exploration of predictors of interesting behaviours in such areas as occupational psychology, and its growing acceptance as a map of human personality, has led FFM theorists to argue that those who study individual traits need to situate those traits with respect to the FFM. Adopting Goldberg’s simile - comparing the FFM to the latitude and longitude of cartography - Ozer and Reise (1994) suggested that “Personality psychologists who continue to employ their preferred measure without locating it within the five factor model can be likened to geographers who issue reports of new lands but refuse to locate them on the map for others to find.” (p. 361). Moreover, Costa and McCrae have argued that most questionnaire models of personality can be reduced to the Big five; thus they have re-analysed the MMPI to extract the big five.

The FFM subsumes the major traits, both singly and in combination, that are predictive of significant behaviours. For example, there is an extensive body of evidence relating the trait of conscientiousness to various indices of work performance (e.g. Barrick & Mount, 1991; Salgado, 2001) and research on the concept of integrity utilises a construct which is an emergent trait -- a blend of the independent traits of conscientiousness, neuroticism and agreeableness (Ones & Viswesvaran, 2001). Carver (2006) in discussing the trait approach to impulsivity identifies conscientiousness and agreeableness as the Big Five traits which most clearly relate to impulsivity; furthermore
the NEO-PI-R includes a facet of neuroticism which is labelled impulsivity. In the light of this it seems relevant to study the relationships between impulsivity and the Big Five in the prediction of behaviour.

**Study 2: The incremental validity of impulsivity in the prediction of academic performance in female undergraduates.**

**Introduction**

A number of studies have investigated the relationship between academic performance and the Big Five traits and the most consistent findings are the positive correlations with openness and conscientiousness (Busato et al., 2000). Research has also demonstrated the value of utilising the more narrow traits, or facets, which constitute the broad Big Five traits. Mershon and Gorsuch (1988) compared the amount of variance predicted in a variety of criteria by either five broad traits or the sixteen more narrow traits from the Sixteen Personality Factor Questionnaire and found the latter to predict almost double the criterion variance. Chamorro-Premuzic and Furnham (2003) similarly found that analysis at the level of facets predicted more variance in the educational performance of British undergraduates than analysis at the level of the Big Five traits (28% versus 13% respectively for total exam results). Such studies are, however, susceptible to two types of criticism. Goldberg (1999) pointed out that adding variance to the predictor side of a regression equation will almost always add to the predicted variance, and Ashton (1998) argued that the large number of lower order traits may produce “spuriously high multiple
correlations which are unlikely to survive cross validation.” Paunonen and Ashton (2001a) took a more focussed approach and “selected two Big Five factor predictors and compared each of them against only one lower level trait” (p. 81), the latter being selected by a panel of graduate students as most closely related to academic performance. They found that the lower level traits of ‘need for achievement’ and ‘need for understanding’, performed better than their super-ordinate traits conscientiousness and openness to experience in the prediction of undergraduate course grades.

Paunonen and Ashton (2001b) have argued for the importance of measuring narrow traits, those at lower levels of the Big Five hierarchy, providing evidence that the variance specific to the lower level traits – not shared with the higher order trait – carries predictive and explanatory value. This argument is part of an ongoing debate as to the appropriate level of analysis (Ones and Viswesvaran 1996); this debate is however concerned largely with predictive validity and says little about theoretical issues such as the nature of models of personality and the relationships between traits at different levels of a hierarchy. Indeed the results may seem to question the value of identifying and assessing higher order traits and – since the logic of the argument could be made to extend further down the hierarchy – may seem to question the validity of the trait approach itself. In this thesis it is argued that lower order traits may have greater theoretical value due to their relationship with significant latent variables which influence behaviour and which may even explain the covariance of the lower order traits which comprise higher order traits. Such a theoretical approach characterises Eysenck’s approach to personality; for example, he proposed that the various facets of extraversion,
and their covariance, are a consequence of individual differences in arousal (Eysenck & Eysenck 1985). A similar conceptual model characterises the attempts by Depue and Collins (1999) and by Lucas, Diener, Grob, Suh, and Shao (2000) to identify reward sensitivity not merely as a useful lower order trait but as the common variable underlying the various facets of extraversion.

Overview

Many impulsivity scales exist as elements within omnibus personality questionnaires. Within such questionnaires, and the models of personality which they embody, impulsivity is usually situated as a lower level trait, or facet, of a higher order trait—e.g. Constraint within the Multidimensional Personality Questionnaire (MPQ; Patrick et al 2003). The aim of this research was first to establish the relationship between impulsivity and the Big five and secondly to compare the predictive validity of impulsivity and the Big Five personality traits and examine whether the predictive validity of the trait of impulsivity is accounted for by the variance which it shares with a higher order trait, or traits, of which it is a facet or whether the variance independent of the higher order traits has independent predictive validity.

Since impulsivity has been considered a lower level trait subsumed by the higher level trait of conscientiousness, the first hypothesis to be tested was that impulsivity significantly predicts the criteria after the contribution of conscientiousness has been partialled out. Furthermore, since impulsivity is often found to correlate with
neuroticism, extraversion and agreeableness there is the possibility that impulsivity is not simply a facet of one higher level trait but rather may be a blend of several traits or of their facets; the parallel here being with traits such as integrity or 'customer service orientation' (Schneider & Hough, 1995). Therefore a second hypothesis was formulated whereby impulsivity predicts additional statistically significant amounts of variance in the criterion after the influence of all the Big Five traits has been partialled out. The criterion measures chosen were academic performance and alcohol consumption in the first year of undergraduate study; both of these behaviours having been previously associated with measures of impulsivity as well as the Big Five personality traits.

Method

Participants and Procedure

The present sample consisted of 236 female undergraduate students, made up of three consecutive years of students taking a freshman psychology class. All subjects participated in return for course credits. Age at onset of course ranged from 17 to 35 years with a mean of 20.3 (sd = 2.7). Respondents completed personality measures at the beginning of their first semester during class time and examination performance data were taken from records at the end of the year. A self report measure of alcohol consumption was also administered at the beginning of the first semester, but only to the latter two samples (N = 178).
Measures

The Big Five personality traits were assessed by the Big Five inventory (BFI; Benet-Martinez & John, 1998). The BFI is a 44 item self-report questionnaire wherein each of the Big Five traits is measured by between 8 and 10 items. Responses are made on a 5-point Likert scale ranging from 1 = disagree strongly to 5 = agree strongly. For the present sample, Cronbach’s coefficient alpha reliabilities ranged from .73 to .82 and were comparable to values published by the test authors (Benet-Martinez & John, 1998). Impulsivity was assessed with the short form of the Barratt Impulsiveness Scale – Version 11 (BIS-11 Patton et al., 1995) the BIS-Short, the development of which is described in Chapter 4.

There were three measures of academic performance. The first was a multiple choice statistics examination taken at the beginning of the second semester, the second was the aggregate of the multiple choice examinations taken at the end of the second semester and the third was the mean of the grades for four essay assignments which the students had completed during the course of the year.

Alcohol consumption was assessed with the 10 item self report scale described in chapter 4.
Results

Table 5.1 shows the correlations between impulsivity, the four criterion variables and the Big Five traits. Impulsivity correlated most strongly with conscientiousness but also significantly and negatively with agreeableness and positively with neuroticism. Regression of impulsivity on the Big Five traits produced a multiple correlation of .74, indicating a considerable amount of shared variance. Regressing the BIS-Short onto the Big Five produced significant independent effects for conscientiousness, extraversion, neuroticism and agreeableness; Beta weights of -.67, .25, .12 and -.10 respectively ($R^2 = .55, F = 59.97, df = 5, 231, p < .01$). The significant effect of extraversion upon impulsivity, despite the non-significant first order correlation, is attributable to the fact that extraversion correlates positively with both agreeableness and conscientiousness and negatively with neuroticism ($r = .11, .14$ and $-.36$ respectively) but has opposite effects upon impulsivity; this effect will appear again in later chapters. The partial correlation between impulsivity and extraversion, after controlling for neuroticism, agreeableness and conscientiousness was .33 ($df = 231, p < .01$).

Impulsivity correlated negatively and conscientiousness correlated positively — both significantly — with all four criteria. Agreeableness correlated negatively and neuroticism correlated positively with alcohol consumption though neither correlated significantly with any of the academic performance criteria. Extraversion correlated negatively with exam performance by with no other criterion variable.
Table 5.1 Correlations between criterion variables and personality traits.

<table>
<thead>
<tr>
<th></th>
<th>Stats Exam</th>
<th>Exam Assign Alcohol</th>
<th>Imp</th>
<th>E</th>
<th>A</th>
<th>C</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exam mean</td>
<td>mean mean scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examinations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examination mean</td>
<td>.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment mean</td>
<td>.46 .47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol scale</td>
<td>-.10 -.14 -.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulsivity</td>
<td>-.25 -.24 -.26 .35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>.04 -.15 -.12 .06 .11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.07 .01 .06 -.29 -.31 .14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.14 .18 .13 -.27 -.70 .13 .34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.09 -.11 00 .22 .20 -.34 -.29 .21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openness</td>
<td>-.10 00 00 .03 .07 .23 .07 .01 .03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in bold p < .05

For correlations involving academic criteria n = 236. For correlations involving the alcohol scale n = 178.

Table 5.2 shows the result of the regression analyses to predict the criterion variables. For each criterion two regression analyses were carried out. In the first set of analyses conscientiousness was entered as a first block and impulsivity as a second block. In each case the F value for the first block and the F change value for the second block was
significant; i.e. though conscientiousness predicted a significant amount of variance in the independent variable, impulsivity predicted a significant amount of additional variance. As might be expected from the pattern of first order correlations, when these regressions were reversed and impulsivity entered as a block before conscientiousness then in no case was the change in $R^2$ significant. In the second set of analyses, the Big Five traits were entered as a first block and impulsivity as a second block. In each case the $F$ value for the first block was significant. The $F$ change value for the second block value was significant for the alcohol scale criterion and for two of the three academic criteria- (statistics exam mark and essay grade average but not exam average). Thus the increment in $R^2$ due to the addition of impulsivity was significant in every analysis except one. When these regressions were reversed the Big Five entered as a second block added a significant additional amount of variance to the prediction of alcohol consumption and the examination average but not of statistics exam or assignment mean.
Table 5.2 Results of regression analyses

<table>
<thead>
<tr>
<th>Criterion variables</th>
<th>Step 1 variables</th>
<th>Step 1.</th>
<th>Step 2. impulsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R²</td>
<td>F</td>
</tr>
<tr>
<td>Statistics examination</td>
<td>conscientiousness</td>
<td>.03</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.05</td>
<td>2.2</td>
</tr>
<tr>
<td>Examination average</td>
<td>conscientiousness</td>
<td>.03</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.10</td>
<td>5.1</td>
</tr>
<tr>
<td>Assignment average</td>
<td>conscientiousness</td>
<td>.02</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.04</td>
<td>1.7</td>
</tr>
<tr>
<td>Alcohol scale</td>
<td>conscientiousness</td>
<td>.07</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.16</td>
<td>6.6</td>
</tr>
</tbody>
</table>

All values of F greater than 1.6 are significant, p < .05

N = 236 for academic criterion variables  N = 178 for alcohol criterion variable

Discussion

The results supported the hypotheses by demonstrating that impulsivity predicted the target criteria even after the effects of conscientiousness or the Big Five traits, were
The predictive validity of impulsivity was not attributable to its covariance with any, or all, of the Big Five traits. The data were all the more striking given the high correlations between impulsivity and conscientiousness (-.69) and the joint correlation with all the Big Five (.74). The results also suggested that not only did impulsivity add to the variance predicted by conscientiousness but that impulsivity was in fact a better predictor than conscientiousness. Indeed, in most cases if impulsivity was entered into the regression equations first then the Big Five added no significant amount of variance when added as a second block.

The results of the present study correspond closely to those of Busato et al. (2000) who found correlations between first year psychology undergraduate examinations and only extraversion and conscientiousness of the Big Five traits; correlations of -.13 and .16 respectively, values very close to those found in the present study.

The results also agree with those of Paunonen and Ashton (2001a) who found that adding predictor variables to a regression equation did not always add a significant amount of variance - that depended on the conceptual relationship between predictor and outcome. Impulsivity seems to be, to some extent, independent of conscientiousness and of the Big Five despite the large amount of shared variance.

Although the homogeneity of the sample (female undergraduate students tested in the first year of a psychology degree) prevents confident generalisation to a wider population, it makes it less likely that the results are affected by variables such as
intelligence and educational experience. Furthermore this degree of range restriction may well serve to attenuate the real relationship between traits and behaviour; indeed the high level of qualification required to enter the course attests to a high level of conscientiousness.

**Study 3: The incremental validity of impulsivity in the prediction of alcohol consumption and driving behaviour.**

This study is a partial replication of study 2. While the sample in study 2 was entirely female the sample in this study was 47% male. This study includes a peer report as well as a self report measure of alcohol consumption and self report measure of driving behaviour as well as using a different measure of the Big five. The present study utilised the same strategy as the previous study to assess whether the predictive validity of impulsivity in predicting alcohol consumption and driving behaviour is accounted for by the variance which it shares with the Big Five trait of conscientiousness or by the variance which it shares with all five of those traits. As in Study 2 the first hypothesis to be tested was that impulsivity significantly predicts the criteria after the contribution of conscientiousness has been partialled out, and the second hypothesis was that impulsivity predicts additional statistically significant amounts of variance in the criterion after the influence of all the Big Five traits has been partialled out.
Method

Participants and procedure

The sample consisted of 389 subjects, 48% of which were males, who completed the NEO-FFI and a self-report alcohol consumption scale. Of these, 323 (58% male) completed a driving questionnaire and 213 (59% male) returned a peer-report alcohol scale. Of the total sample 154 were undergraduate students of psychology, 16% of whom were male; this sample of undergraduates did not overlap with that in Study 2. The remaining 245 were a convenience sample of people from outside the university of whom 68% were male; age ranged from 17 to 65 with a mean of 34.1 and standard deviation of 13.7.

Undergraduate respondents completed questionnaires in class time. Data from the convenience sample were collected by the students who were asked to approach two friends or relatives, at least one of which should be male, and request that they complete the same questionnaires. Students themselves then completed a peer report version of the alcohol consumption questionnaire as a description of those friends. The participation of the undergraduate students was rewarded by course credits though not all students who volunteered completed their quota.
Measures

Impulsivity was assessed with the BIS-Short as in Study 5.1. The Big Five personality traits were assessed by the NEO-FFI (Costa & McCrae 1992). The NEO-FFI is a 60-item self-report questionnaire wherein each of the Big Five traits is measured by 12 items. Responses are made on a 5-point Likert scale ranging from 1 = disagree strongly to 5 = agree strongly. For the present sample, Cronbach’s coefficient alpha reliabilities ranged from 0.73 to 0.82 and were comparable to values published by the test authors (Costa & McCrae 1992).

Driving behaviour was assessed with the Driving Behaviour Questionnaire (DBQ; Westerman & Haigney 2000) described in chapter 4. The alcohol consumption scale was the same as that reported in Study 1. In addition a peer report version was constructed simply by changing the first person pronoun to the second personal plural; thus ‘I have found myself unable to stop drinking once I have started.’ became ‘They have found themselves unable to stop drinking once they have started.’ The correlation between self and peer alcohol reports was .62 (n = 211, p < .01).
Results

Table 5.3 shows the first-order correlations (Pearson’s r) between impulsivity, the four criterion variables and the Big Five traits. The pattern of correlations between The BIS-11 and the Big Five traits was very similar to that in study 5.1. Impulsivity correlated substantially and negatively with conscientiousness and to a lesser degree with agreeableness. Regressing the BIS-Short onto the Big Five produced significant independent effects for conscientiousness, extraversion, neuroticism and agreeableness; Beta weights of -.49, .31, .16 and -.16 respectively ($R^2 = .34$, $F = 49.20$, $df = 5$, 385. $p < .01$). Once again there is a significant effect of Extraversion upon impulsivity, despite the low first order correlation, attributable to the fact that extraversion correlates positively with both agreeableness and conscientiousness ($r = .23$ and .18) and negatively with neuroticism ($r = -.42$). The partial correlation between impulsivity and extraversion, after controlling for agreeableness, neuroticism and conscientiousness was .32 ($df = 380$, $p < .01$)

Both measures of alcohol consumption (self and peer reports) correlated significantly with impulsivity, extraversion and conscientiousness; agreeableness correlated significantly with self but not peer reports of alcohol consumption. In each case the self report trait scales correlated more substantially with self than with peer report alcohol scales; a pattern typically found and which is likely to reflect the effect of shared method variance though it may also reflect the fact that a person is more aware of certain aspects of their own behaviour than is a peer. Self reports of both driving violations and driving
errors correlated significantly with impulsivity, neuroticism, agreeableness and conscientiousness; extraversion correlated significantly with errors but not violations.

Table 5.3 Correlations between criterion variables and personality traits.

<table>
<thead>
<tr>
<th></th>
<th>Self Alcohol</th>
<th>Peer Alcohol</th>
<th>Violations</th>
<th>Errors</th>
<th>Impulsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impulsivity</td>
<td>.38</td>
<td>.23</td>
<td>.41</td>
<td>.36</td>
<td></td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.08</td>
<td>-.08</td>
<td>.12</td>
<td>.23</td>
<td>.15</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.19</td>
<td>.17</td>
<td>.03</td>
<td>-.14</td>
<td>.11</td>
</tr>
<tr>
<td>Openness</td>
<td>-.08</td>
<td>.05</td>
<td>-.11</td>
<td>-.09</td>
<td>-.07</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-.18</td>
<td>-.05</td>
<td>-.37</td>
<td>-.22</td>
<td>-.24</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-.33</td>
<td>-.20</td>
<td>-.30</td>
<td>-.34</td>
<td>-.50</td>
</tr>
</tbody>
</table>

Figures in bold p < .05

For correlations involving alcohol self report N = 389; for peer alcohol report n = 213, for both driving violations and errors n = 323.

Table 5.4 shows the result of the regression analyses to predict the variables - self and peer alcohol consumption, driving violations and driving errors. For each criterion variable two regression analyses were carried out. In the first set of analyses conscientiousness was entered as a first block and impulsivity as a second block. In each case the F value for the first block and the F change value for the second block was significant (p < .05); i.e. though conscientiousness predicted a significant amount of variance in the independent variable, impulsivity predicted a significant amount of additional variance. In the second set of analyses the Big Five traits were entered as a
first block and impulsivity as a second block; once again in each case the F values for both blocks were significant (p < .05).

Table 5.4 Results of regressing each of the criterion variables onto the predictors in a two step procedure

<table>
<thead>
<tr>
<th>Criterion variables</th>
<th>Step 1 variables</th>
<th>Step 1 results</th>
<th>Step 2 results</th>
<th>impulsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R²</td>
<td>F</td>
<td>R² change</td>
</tr>
<tr>
<td>Alcohol scale</td>
<td>conscientiousness</td>
<td>.11</td>
<td>47.9</td>
<td>.06</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.20</td>
<td>24.6</td>
<td>.02</td>
</tr>
<tr>
<td>Peer alcohol scale</td>
<td>conscientiousness</td>
<td>.04</td>
<td>8.2</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.08</td>
<td>4.4</td>
<td>.02</td>
</tr>
<tr>
<td>Violations</td>
<td>conscientiousness</td>
<td>.10</td>
<td>33.7</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.20</td>
<td>20.1</td>
<td>.05</td>
</tr>
<tr>
<td>Errors</td>
<td>conscientiousness</td>
<td>.13</td>
<td>46.1</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>Big Five</td>
<td>.16</td>
<td>15.5</td>
<td>.03</td>
</tr>
</tbody>
</table>

All values of F are significant, p < .05

Discussion

The results supported the study hypotheses by showing that impulsivity significantly predicted the target criteria after partialling out the effects of first conscientiousness and
secondly all five of the Big Five traits. As expected, conscientiousness correlated significantly with each of the criterion variables; between .30 and .34 with the self-report variables and .20 with the peer-report variable. Impulsivity correlated at least as well with the same variables; between .36 and .41 with the self-report variables and .23 with the peer report variable. When conscientiousness and impulsivity were entered as two blocks, impulsivity added a significant amount of variance in each of the criterion variables – between 3% and 6%. Entering the Big Five as a first block predicted significantly more variance that conscientiousness alone – between 3% and 6% more; nevertheless impulsivity when added as a second block again added a significant amount of variance – between 2% and 5%.

Chapter Discussion

Study 3 replicated the findings of Study 2 with a larger and more varied sample, a different measure of the Big Five and a new set of outcomes. The pattern of correlations between impulsivity and the Big Five were very similar across the two studies. In each case impulsivity correlated most strongly with conscientiousness (-.70 and -.50 in study 2 and 3 respectively) and moderately, though significantly, with agreeableness (-.23 and -.24 respectively). The correlations with the remaining traits were small or non-significant. In both studies, however, a relationship between impulsivity and extraversion emerged when the influence of the other traits was partialled out in the regression analysis; the partial correlation of extraversion with impulsivity was .33 and .32 in the two studies. The relationship between impulsivity and extraversion is masked
by the pattern of co-variance between impulsivity and the traits of conscientiousness, extraversion, agreeableness and neuroticism.

While using the same self report alcohol scale as Study 2, Study 3 also included a peer report alcohol scale as well as self report measures of driving errors and driving violations. In all cases impulsivity added significantly to the variance in the criterion variables explained either by conscientiousness or by the Big Five together. There was considerable consistency in the results across the two studies. In Study 2 self reported alcohol consumption correlated .35 and .27 with impulsivity and conscientiousness respectively, in Study 3 the corresponding correlations were .38 and .33; and the overall correlation of the Big Five traits with alcohol consumption was .40 in both studies. This is a striking degree of consistency across the two different Big Five scales.

Each study contained at least one variable which was not derived from self reports; measures of academic performance in Study 2 and peer reports of alcohol consumption in Study 3; while the correlations with these variables were consistently smaller than correlations with self report variables the pattern of results were the same — in particular the added variance contributed by impulsivity.

These results concur with those of Paunonen and Ashton (2001a) as well as Chamorro-Premuzic and Furnham (2003) discussed in the introduction to this chapter. The lower-level trait of Impulsivity predicted a significant amount of variance beyond that predicted by the higher-level trait of conscientiousness of which it is generally
considered to be a part. At issue however is the implication of these findings. Identifying the importance of lower level traits can serve two functions, one descriptive and predictive the other explanatory. The first of these involves identifying the most accurate predictor, or battery of predictors, of a criterion behaviour; an approach typical of areas of applied psychology such as occupational psychology. This approach however tends to eschew explanation and understanding and to treat personality traits as independent variables; as argued in chapter 2, this approach tends to effectively undermine the value of traits in understanding behaviour.

The second function is to develop explanations of behaviour and of traits themselves; to treat traits as dependant as well as independent variables. This approach to studying lower level traits, discussed at greater length in Chapter 2, can be seen in the attempts by Lucas et al (2000) and Ashton et al (2002) to identify the core of extraversion. However both of those studies apply a trait approach to the question and it may be that the apparently incommensurable differences in their results indicate the limitations of the trait approach as an explanatory framework.

In considering the relationship between impulsivity and conscientiousness the present thesis would argue for the status of impulsivity as a core aspect of conscientiousness rather than as simply a lower level facet; a status similar to that which Lucas et al (2000) would attribute to reward sensitivity as a core feature of extraversion. These issues will be revisited in the final chapter.
Chapter 6

An alternative model for impulsivity

Chapter summary

The aim of this chapter is to explore the model of impulsivity proposed by Whiteside and Lynam (2001). The first step in Study 4 replicated the three factor structure of the scales adapted from the Whiteside and Lynam (2001) UPPS impulsivity questionnaire. The second step demonstrated that the relationship between the UPPS scales and the Big Five personality traits is more complex than is implied by Whiteside and Lynam (2001) and that an independent measure of impulsivity, the BIS-Short, predicts a significant amount of variance in each of the Whiteside and Lynam (2001) variables after the influence of the Big Five is partialled out. The final step compared the facets of impulsivity identified by the APPS scales and the BIS-11; in their inter-relationships and in their correlations with other variables.

Introduction

This thesis has so far argued for a construct of impulsivity as a coherent, well defined trait which is independent of, though related to, the five factor model of personality; the model of impulsivity developed by Whiteside and Lynam (2001) presents a strong challenge to that construct. Whiteside and Lynam (2001) argued that the construct of
impulsivity is a description of behaviour with no implication as to the causes of that behaviour, and with no implication that all instances of impulsive behaviour reflect a common underlying variable. This approach echoes the arguments described in the introduction from Parker and Bagby (1997) and Depue and Collins (1999) who refer to a wide range of disparate behaviours described as impulsive. What is distinctive about the approach of Whiteside and Lynam (2001) is the use of the five factor model of personality to organise these disparate behaviours into homogenous and distinct categories.

This is expressed with particular clarity by Miller, Flory, Lynam and Leukfield (2003) when they define impulsivity as “... an artificial umbrella term that actually encompasses four distinct facets of personality associated with impulsive behaviour.” They distinguish between four types of impulsive behaviour; relating each of these to a different facet within the Big Five model of personality. The first two of these — lack of premeditation and lack of perseverance - refer, respectively, to acting without appropriate forethought and to an inability to persevere at a task which may be difficult or boring; these are related to the Big Five trait of conscientiousness; specifically, to the facets of deliberation and self discipline respectively. The third, sensation seeking, relates to the desire to pursue new and exciting experiences; this they relate to the Big Five trait of extraversion; specifically to the facet of excitement seeking. The fourth impulsivity trait is urgency, the tendency to act on the impetus of strong negatively affective impulses; this they relate to the Big Five trait of neuroticism; specifically to the facet of impulsivity. The degree of identification of the impulsivity traits with the NEO facets can be seen in the Miller et al
(2003) study which actually uses the relevant facet scores from the NEO as proxy measures of impulsivity.

A crucial aspect of this model is the implication that the different facets of impulsivity should relate differentially to different behavioural variables. Whiteside et al (2005) aimed to demonstrate the differential validity of the four UPPS scales in relation to clinical syndromes associated with impulsivity. Their study employed five groups of subjects; two groups of participants with alcohol problems, one with and one without symptoms of antisocial disorder (groups b and a), clients in treatment for borderline personality disorder (group c) and clients in treatment for pathological gambling (group d); the final group (e) was a control group. Though the authors argue that there was evidence of differential validity, from the perspective of the present thesis the results were equivocal. Subjects manifesting symptoms of alcohol abuse but not antisocial personality disorder and the control subjects, did not differ on any of the impulsivity measures. Groups b, c, and d did not differ on the premeditation, perseverance or urgency scales; though each differed from the control group on all three measures. Thus the three measures of impulsivity under scrutiny in the present study acted in concert in differentiating between the psychopathology groups and the control group. Whiteside et al (2005) concluded that urgency was the form of impulsivity most strongly associated with psychopathology; this may however be largely if not entirely attributable to its high covariance with negative affect.
Nevertheless the nature of this model is in crucial ways underspecified. Neither Whiteside and Lynam (2001) nor Whiteside et al (2005) report correlations between the UPPS scales and the NEO traits or facets, nor do they explicitly demonstrate that the UPPS scales correlate with their related facets in preference to other facets of the same trait. They do not discuss the relationship between premeditation and perseverance as manifestations of facets of a common trait – conscientiousness – a commonality which suggests that the possibility of a common latent variable. Rather they seem to assume that there is no more relationship between premeditation and perseverance than there is between either of those and sensation seeking or urgency; though of course the FFM itself is unclear as to the meaning of the relationship between facets and traits.

When they describe impulsivity as “being made up of multiple traits or pathways that can lead to a variety of impulsivity related behaviours” they seem to imply that impulsive behaviour (U, P, P and S are merely descriptive phenotypic constructs) is caused by the related personality traits, however the FFM, whether derived from lexical studies or from questionnaire studies, is not proposed as a causal model but rather a descriptive scheme which maps out the relations of covariance between behaviours. This covariance is not itself explained; thus the question remains as to how impulsivity is explained after it has been identified with facets of the Big Five since the FFM does not itself offer an explanation merely a description. The authors’ explanatory schema requires that the Big Five traits, and indeed their facets, are treated as causal variables but this requires justification, since relatively narrow traits such as deliberation are just as much phenotypical behaviour patterns as premeditation;
What is the relationship between premeditation, perseverance and the higher order trait of conscientiousness, apart from their covariance and what does the high correlation between these two types of impulsivity indicate? If the four varieties of impulsive behaviour are to be identified with three different Big Five trait domains which are themselves unrelated, at least theoretically, then the varieties of impulsivity ought to be uncorrelated. We see here again how the neglected causal status of the latent variables within most models of personality impedes the explanation and understanding of impulsivity.

Nevertheless the Whiteside and Lynam model of impulsivity has several positive qualities. Their data seems to indicate only a weak relationship between sensation seeking and other aspects of impulsivity, thus supporting the argument made in the introduction to this thesis. Whiteside and Lynam (2001) reported non-significant correlations of .00 and -.14 between sensation seeking and premeditation and perseverance respectively; Whiteside et al (2005) found correlations between the same traits of .20 and .02 respectively. Also of value is their emphasis upon the construct of perseverance which, as the authors point out, has received less attention than the construct of premeditation in the literature on impulsivity; though the high correlations obtained between premeditation and perseverance (.45 and .65 in the afore-mentioned studies) argues against their independence.

Of particular interest however is their emphasis upon the impulsive behaviour which they label ‘urgency’ which seems to have considerable relevance to the impulsive element of
many varieties of psychopathology. The implication of their argument seems to be that the impulsive behaviour which one sees in disorders such as borderline personality or bulimia is a function of the high levels of the negative affect which characterize such disorders rather than a function of conscientiousness or any of its facets; though once again because of their identification of urgency with a particular facet of neuroticism it is unclear what the relationship is with neuroticism as a whole and indeed to agreeableness which also contains a substantial measure of negative affect. A fruitful way to characterize the difference between a conscientiousness-based impulsivity and neuroticism-based impulsivity may be to consider the former as due to weakness of inhibition whereas latter is due to strength of impulses interacting with weakness of inhibition. This conceptualisation coincides with that of Depue and Lenzenweger (2005) who distinguish between an affect-free impulsivity and an “affective impulsivity (which) emerges from the interaction of nonaffective constraint with other distinct affective motivational systems, such as positive incentive motivation-agentic extraversion or anxiety-neuroticism” (p.421). The former configuration, of impulsivity interacting with positive affect, is discussed by Depue and Collins (1999) as the basis of sensation seeking while the latter configuration, of impulsivity interacting with negative affect, is discussed by Depue and Lenzenweger (2005) as the basis of personality disorder syndromes.
Study 4: Evaluating the Whiteside and Lynam (2001) model of impulsivity

Aims

The overall aim of the present study was to analyse and evaluate the model of impulsivity proposed by Whiteside and Lynam (2001) and compare it with that of Barratt and his colleagues Patton et al 1995). Given the results of Whiteside and Lynam (2001) relating to the sensation seeking dimension and given the general orientation of this thesis to distinguish between sensation seeking and impulsivity proper it was decided at an early stage to discard the sensation seeking scale and to utilise only the urgency, premeditation and perseverance (UPP) scales. More specific aims are as follows.

Whiteside and Lynam (2001) do not report a factor analysis of the final UPPS questionnaire, only of a 50-item preliminary version from which 5 items were removed due to low factor loadings; so the first step in this study was to carry out an exploratory factor analysis of the UPP scales to replicate the structure they proposed. Whiteside and Lynam (2001) argued that premeditation and perseverance are a function of conscientiousness while urgency is a function of neuroticism so the second step was to relate the UPP scales to two measures of the Big Five. Given that in the Whiteside and Lynam model there is no common underlying impulsivity variable influencing premeditation & perseverance and urgency there might be expected to be no correlation between these three traits; however the covariance of conscientiousness facets (Costa and McCrae report a correlation of .39 between the facets of deliberation and self discipline)
would lead to a prediction of a high correlation between premeditation and perseverance. On the other hand, given that the traits of neuroticism and conscientiousness are unrelated then two hypotheses follow; there should be but only minor correlations between the neuroticism trait of urgency and the conscientiousness traits of perseverance and premeditation; and premeditation and perseverance should correlate only with conscientiousness while urgency should correlate only with neuroticism.

The third step is to consider the relationship between the UPP scales, the Big Five and a measure of impulsivity – the BIS-11. If the UPP constructs of impulsivity are largely, or entirely, a function of personality then the BIS-11 should not predict a substantial amount of variance in these scales after their relationship with the Big Five have been partialled out. The fourth step is to map out the relationship between the aspects of impulsivity identified by the UPP scales and the BIS-11, and then to consider their relative efficacy in predicting impulsivity related behaviours.

Methods

Participants and Procedure

Participants consisted of a sample of 488 subjects, 16% male, all of whom were contained in the sample considered in chapter 4 (sample 1). The sample consisted of 54% nursing students and 46% psychology students. All 488 completed the UPP scales
and the BIS-11. Three hundred and forty five of the participants completed the Big Five Inventory and 272 of those also completed the NEO-FFI. Within this sample 241 completed the Buss and Perry (1992) scales of aggression and 236 completed scales of eating and drinking behaviour.

Measures

The UPPS scales of impulsivity were developed by Whiteside and Lynam (2001) from a joint analysis of a number of impulsivity scales, where impulsivity was broadly defined, and the facet scales of the NEO-PI-R. The questionnaire consists of four scales to measure urgency, premeditation, perseverance and sensation seeking; having 12, 11, 10 and 12 items respectively, and alpha coefficients of .86, .91, .82 and .90 respectively. Premeditation and perseverance correlated .45; these two traits correlated equally with urgency (.28 and .29 respectively) and non-significantly with sensation seeking (.00 and .14 respectively); sensation seeking and urgency correlated only .18. In summary it would seem that sensation seeking is largely unrelated to the other three types of impulsivity; a finding which corroborates the differentiation made by Eysenck between impulsivity and venturesomeness, as well as the research reviewed in the introduction to this thesis. Consequently only the urgency, premeditation and perseverance (UPP) scales were administered to the participants (Table A.4 in appendix).

The alcohol consumption scale is as described in study 1. The eating behaviour scale was developed for the author's research programme and was devised to parallel the
alcohol consumption scale. This is a 10-item self-report scale, consisting of items relating to a sense of lack of control over eating (see Table A.5 in the appendix). The BIS-11 and the Buss and Perry aggression scales were described in previous chapters as were the NEO-FFI and the BFI

A composite measure of the Big Five was created from an amalgamation of the NEO-FFI and the BFI; these composite scores were available for 269 subjects. Z scores for each trait from the two questionnaires were added to give a composite trait measure. The aim here was to avoid reliance upon only one operationalisation of the Big Five traits by using two independently developed questionnaires with different response formats and different behavioural representations of the five traits. Correlations between traits across the two measures were .70 for both conscientiousness and neuroticism; while the correlations between two measures of extraversion, openness and agreeableness ranged from .57 to .59. The latter figures especially suggest only a modest amount of overlap between the two measures of the same construct.

Results

Factor analysis of the Urgency, Premeditation and Perseverance (UPP) Items

The items from the UPP scales were subjected to an exploratory factor analysis which produced a scree plot, Figure 6.1, strongly suggestive of 3 factors which accounted for 41% of the total variance.
Extraction of three factors using principal axis factoring and subjected to promax rotation produced the following pattern. Factor 1 consisted of all twelve urgency items as defined by Whiteside and Lynam (2001), factor 2 consisted of nine of the ten perseverance items—the remaining perseverance item showed approximately equal loadings on all three factors—and factor 3 consisted of ten of the eleven premeditation items—the missing item did not load on any factor. Correlations between factors ranged from .36 to .63. Alpha reliabilities for the three 10-item scales, premeditation, perseverance and urgency, were .85, .80 and .88 respectively.
Table 6.1 shows the correlations between the UPP scales as defined by Whiteside and Lynam (2001) and the impulsivity measures used in previous chapters. The three UPP variables correlated highly, particularly premeditation with perseverance, and both of these correlated approximately equally with urgency though to a lesser degree. All of these correlations are substantially higher than those reported by Whiteside and Lynam (2001) though similar those reported in Whiteside et al (2005); in all three the pattern is the same.

In table 6.1 it can also be seen that the UPP scales correlate highly with each of the BIS-11 sub-scales, ranging from .59 to .71. It is clear, however, that there is no simple correspondence between the traits in the two models, each trait in one model correlates substantially with at least two of the impulsivity traits in the other model. The three UPP scales each correlate highly, and to a similar degree with the BIS-Short. This pattern of results suggests that the UPP variables share considerable variance with the BIS-11 and may be a function of the same underlying variable; they may in fact be facets of impulsivity rather than different types of impulsive behaviour.
Table 6.1 Pearson product moment correlations between UPP scales, (premeditation, perseverance, and urgency), BIS-11 (planning, motor, and cognitive) and BIS-Short

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Premeditation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Perseverance</td>
<td>.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Urgency</td>
<td>-.40</td>
<td>-.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Planning</td>
<td>-.73</td>
<td>-.65</td>
<td>.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Motor</td>
<td>-.45</td>
<td>-.27</td>
<td>.54</td>
<td>.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Cognitive</td>
<td>-.46</td>
<td>-.52</td>
<td>.63</td>
<td>.50</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>7 BIS-Short</td>
<td>.68</td>
<td>.61</td>
<td>.68</td>
<td>.71</td>
<td>.77</td>
<td>.75</td>
</tr>
</tbody>
</table>

N = 488. All correlations are significant p< .01

The six impulsivity scale variables were subjected to an exploratory factor analysis (using principle axis factoring and promax rotation). The scree plot indicated a clear single factor solution accounting for 56% of the total variance; with eigen values of 3.36, 1.00, .59, .39, .35, .29. Scores of the un-rotated first factor correlated .90 with scores on the BIS-Short.

To further assess the possibility that the relationships between these impulsivity traits reflect an underlying variable, the first-order correlations between premeditation, perseverance and urgency were compared with the partial correlations when the BIS-Short score was partialled out. The first-order correlation between premeditation and
perseverance of .59 was reduced to a partial correlation of .30 when BIS-Short was partialled out; i.e. the shared variance was reduced from 35% to 9% implying that 74% of the variance shared by premeditation and perseverance is shared with impulsivity as measured by the BIS-short. The first-order correlation between premeditation and urgency of .39 reduces to .13 and that between perseverance and urgency from .36 to .08; implying that 87% and 99% of the variance shared by these pairs of variables is attributable to the variance which they share with the BIS-Short.

Correlations between UPP scales and the Big Five

Table 6.2 depicts the correlations between the UPP scales and the composite measures of the Big Five. Premeditation correlated primarily with conscientiousness and secondarily with extraversion and agreeableness; perseverance correlated predominantly with conscientiousness and secondarily with neuroticism, extraversion and agreeableness while urgency correlated primarily with neuroticism but also substantially with conscientiousness and agreeableness.
Table 6.2 Correlations between UPP scales and the Big Five composite measures

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>E</th>
<th>O</th>
<th>A</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.00</td>
<td>-.28**</td>
<td>-.07</td>
<td>.23**</td>
<td>.45**</td>
</tr>
<tr>
<td>2</td>
<td>-.24**</td>
<td>.18**</td>
<td>-.07</td>
<td>.16*</td>
<td>.71**</td>
</tr>
<tr>
<td>3</td>
<td>.57**</td>
<td>-.02</td>
<td>.00</td>
<td>-.42**</td>
<td>-.39**</td>
</tr>
</tbody>
</table>

N = neuroticism, E = extraversion, O = openness to experience, A = agreeableness, C = conscientiousness.

The relationship between the UPP traits was further investigated utilizing regression analysis. The regression analyses show that the Big Five personality traits predicted a substantial amount of the variance in each of the 3 UPP traits. Premeditation was a function of conscientiousness and extraversion (standardised Beta = .46 and -.34 respectively; $R^2 = .33$, df = 5,264, $F = 26.0$, $p < .01$). Perseverance was very largely a function of conscientiousness, with a minor though significant relationship with agreeableness (standardised Beta = .75 and .17 respectively; $R^2 = .53$, df = 5,264, $F = 59.6$, $p < .01$). Urgency was largely a function of neuroticism with lesser though significant relationships with conscientiousness, extraversion and agreeableness (standardised Beta = .53, -.22, .21 and -.18 respectively; $R^2 = .46$, df = 5,264, $F = 44.2$, $p < .01$). This pattern of Beta weights suggests that the traits of conscientiousness, extraversion and agreeableness together share as much variance with urgency as does neuroticism.
The next step in the analysis was to assess the Whiteside and Lynam (2001) claim that the UPP traits are simply a manifestation of the Big Five personality traits rather than a manifestation of an independent impulsivity dimension by examining whether the BIS-Short measure of impulsivity would add to the prediction of the UPP traits if entered into a regression model after the Big Five. Table 4.3 shows the results of a hierarchical regression analyses whereby each of the UPP variables was independently regressed onto the Big Five composite variables as a first step and onto the BIS-Short as a second step. The results show that while the Big Five predicted significant and substantial amounts of variance in the UPP variables when the BIS-Short was added to the equation a significant amount of additional variance was added in each case, ranging from 4% to 18%.

Table 6.3 Hierarchical regression of each UPP variable on the Big Five traits as a first step followed by BIS-Short as a second step

<table>
<thead>
<tr>
<th>Criterion variables</th>
<th>Step 1. Big Five</th>
<th>Step 2. Impulsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>$F$</td>
</tr>
<tr>
<td>Premeditation</td>
<td>33%</td>
<td>25.9</td>
</tr>
<tr>
<td>Perseverence</td>
<td>53%</td>
<td>59.4</td>
</tr>
<tr>
<td>Urgency</td>
<td>46%</td>
<td>44.1</td>
</tr>
</tbody>
</table>

N = 269. All F values are significant p< .01.

Given the important role of negative affect in influencing urgency according to the model, the next analysis examined the contribution of BIS-Short impulsivity to urgency
over and above the contributions of neuroticism and agreeableness. When urgency was regressed onto neuroticism, agreeableness and BIS-impulsivity simultaneously (method enter) the standardised beta weights were .41, .09 and .52 respectively with the effect of agreeableness not achieving significance. The joint correlation of neuroticism and BIS-impulsivity with urgency was .78, with the two traits making approximately equal contributions to the predicted variance (Beta = .41 and .52 respectively; $R^2 = .61$, df = 3,266 $F = 141.78$, p < .01).

Correlations between Impulsivity Traits and Criterion Behaviour: Eating, Drinking and Driving

The final analysis entails comparing the degree to which the UPP scales and the BIS-Short correlate with behaviours typically thought to reflect impulsivity. Table 6.4 shows the correlations with self reports of eating and drinking behaviour. The most striking aspect of the data here is the high correlation between urgency and both of the dependant variables. Inspection of the table shows that among the UPP scales urgency was the best predictor of both eating and drinking. When a regression analysis was conducted whereby the eating and drinking variables were regressed onto the three UPP variables, only urgency showed a significant effect; accounting for 23% of the variance in eating and 17% in drinking.
Table 6.4 Correlations between impulsivity traits and eating and drinking behaviour.

<table>
<thead>
<tr>
<th></th>
<th>Premed</th>
<th>Persevere</th>
<th>Urgency</th>
<th>BIS-Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating</td>
<td>-.21**</td>
<td>-.23**</td>
<td>.48**</td>
<td>.34**</td>
</tr>
<tr>
<td>Drinking</td>
<td>-.26**</td>
<td>-.23**</td>
<td>.42**</td>
<td>.35**</td>
</tr>
</tbody>
</table>

N = 236. All correlations significant p<.01 (2-tail)

In the light of the analysis following Table 6.3 which showed that impulsivity and neuroticism together accounted for 61% of the variance in urgency, a further regression analysis was carried out which regressed eating and alcohol consumption onto BIS-short and neuroticism as a first block and urgency as a second block. BIS-Short impulsivity and neuroticism together accounted for 16% of the variance in eating behaviour while urgency added only another 2% ($r^2 = .18, df = 3, 207. F = 14.88, p < .01$) a small but significant amount. A similar analysis found that BIS impulsivity and neuroticism together accounted for 11% of the variance in eating behaviour while urgency added a more substantial 8% ($r^2 = .19, df = 3, 207. F = 13.02, p < .01$).

A further subset (n = 241) of this sample completed the Buss and Perry (1992) scales of aggression. Of the UPP scales urgency showed the strongest correlations with the aggression scales. Once again, among the UPP scales urgency correlates most substantially with the criterion variables. Regression analyses where each aggression scale was regressed separately onto premeditation, perseverance and urgency showed that only urgency made a significant independent contribution to the angry, verbal and physical aggression scales.
Table 6.5 Pearson product moment correlations between anger scales and impulsivity scales of UPP and BIS-11.

<table>
<thead>
<tr>
<th></th>
<th>Premed</th>
<th>Persever</th>
<th>Urgency</th>
<th>BIS-Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angry</td>
<td>-.19**</td>
<td>-.12</td>
<td>.57**</td>
<td>.36**</td>
</tr>
<tr>
<td>Hostile</td>
<td>.00</td>
<td>-.22**</td>
<td>.45**</td>
<td>.26**</td>
</tr>
<tr>
<td>Physical</td>
<td>-.14*</td>
<td>-.18**</td>
<td>.44**</td>
<td>.29**</td>
</tr>
<tr>
<td>Verbal</td>
<td>-.13*</td>
<td>-.01</td>
<td>.31**</td>
<td>.23**</td>
</tr>
</tbody>
</table>

N = 261 ** significant at 0.01 level (2 tailed) * significant at 0.05 level

The importance of urgency as a predictor of aggression was further explored through a regression analysis to assess whether urgency significantly predicted aggressive traits as well as eating and drinking behaviour when the influence of the negative affect traits of neuroticism and agreeableness were partialled out. Table 6.7 shows the results of regressing each of the aggression, eating and drinking variables in turn onto neuroticism, agreeableness and urgency as a single block (method enter). Urgency made a significant independent contribution to all of the variables except hostility, and was the only significant predictor of eating and drinking.
Table 6.6 Regression of aggression, eating and drinking scales onto neuroticism, agreeableness and urgency.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Standardised Beta coefficients</th>
<th>Total $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>Physical</td>
<td>.04</td>
<td>-.46**</td>
</tr>
<tr>
<td>Verbal</td>
<td>-.19**</td>
<td>-.59**</td>
</tr>
<tr>
<td>Angry</td>
<td>.21**</td>
<td>-.45**</td>
</tr>
<tr>
<td>Hostile</td>
<td>.55**</td>
<td>-.27**</td>
</tr>
<tr>
<td>Eating</td>
<td>.03</td>
<td>.06</td>
</tr>
<tr>
<td>Drinking</td>
<td>.03</td>
<td>-.03</td>
</tr>
</tbody>
</table>

N = 270. ** Beta significant p < .01

Discussion

Analysis of the data from this sample replicated the structure proposed by Whiteside and Lynam (2001) for the three scales urgency, premeditation and perseverance; 31 of 33 items loaded significantly on the appropriate factor. Of the two exceptions, one item loaded significantly on all three factors and the other on none. All three scales had high levels of internal consistency (Cronbach's alpha .85, .80 and .88) and were normally distributed (skewness statistic ranging from -.29 to .35).
The correlations between scales were somewhat higher than those obtained by Whiteside and Lynam (2001) but similar to those obtained Whiteside et al. (2005). The pattern of relationships across the three samples was essentially the same in that the two conscientiousness scales, premeditation and perseverance, correlated highly, .59, and each correlated to an equal but lesser degree with urgency, -.39 and -.36 respectively. Though Whiteside and Lynam argue for the conceptual and empirical separation and independence of their impulsivity scales the essentially similar correlations between their scale and the BIS-11 (.71 .59 .62) as well as the BIS-short (.65, .58, .71) are compatible with a hierarchical model of impulsivity as argued by Patton et al (1995).

There were substantial correlations between all six of the impulsivity scales studied in this chapter and a factor analysis supported a single factor interpretation; the first unrotated factor accounting for 56% of the total variance. The correlation between the factor score on this first factor and the BIS-Short was .90

An important contribution of the model of Whiteside and Lynam (2001) is their identification and treatment of the type of impulsivity which they term ‘urgency’ and which they argue should be identified with the facet of impulsivity within the domain of neuroticism; however they do not explore the relationship between urgency and the other facets of neuroticism. To identify urgency solely with the impulsivity facet of neuroticism may simply be to say that the two scales are measuring the same trait; more interestingly however, to make the point that urgency is a facet of neuroticism has conceptual point if it draws a commonality with other aspects/facets of neuroticism.
Since the facet of impulsivity correlates substantially with the other facets of the neuroticism then urgency would also be correlated with the other neuroticism facets. The results of the present study which find urgency to correlate highly with the trait domain of neuroticism support such a possibility. It is not clear from the discussion by Whiteside and Lynam (2001) whether urgency is considered to be a function of the facet impulsivity in particular rather than the domain of neuroticism, or whether they consider urgency to be a consequence of the latent variable neuroticism while the facet impulsivity is a measure of the behaviour which they identify by the construct urgency.

The data reported in the present study finds urgency to correlate substantially with agreeableness as well as neuroticism (-.42 and .57 respectively, combined $R^2 = .39$) suggesting that behaviour which is described as urgent may be a function of agreeableness as well as neuroticism; a possibility which does not conflict with the general thrust of the argument of Whiteside and Lynam (2001). The data from this study suggests however that urgency is also predicted by an independent measure of impulsivity, the BIS-Short. As reported earlier regression of urgency onto neuroticism, agreeableness and BIS-Short finds neuroticism and BIS impulsivity to predict approximately equal amounts of variance in urgency. That this not attributable to BIS impulsivity being a function of other Big Five traits is supported by the regression results reported in table 4.3 where BIS impulsivity can be seen to add a substantial and significant amount of variance when entered into the regression equation after the Big Five.
The high correlation of BIS-short and urgency (.71) is of particular interest since the
correlation of the two impulsivity traits with neuroticism is markedly different (.26 and
.57). Partial correlations between BIS impulsivity and urgency remained very high when
neuroticism was partialled out (partial r = .68 p< .01). This was even true when both Big
Five traits of negative affect, neuroticism and agreeableness were partialled out (partial r
= .63 p<.01). The implication seems to be that urgency is a function of an independent
measure of impulsivity as well as negative affect.

Conceptual weaknesses in this model relate to the lack of clarity within the hierarchical
model of the FFM. The relationship between a domain – conscientiousness – and its
facets has implications for the relationship between premeditation and perseverance and
the trait of C. Does the substantial correlation between premeditation and perseverance
reflect – is it explained by – the correlation between deliberation and self-discipline? Do
these correlations imply a common latent variable, and if so is it conscientiousness? The
discourse of the FFM neglects issues both of causation and of interactions between traits
– at whatever level of the hierarchy. Typically for the FFM approach, there is no
consideration of interactions between Big Five traits so that the issue of impulsive
behaviour as a function of more than one personality trait and perhaps of the interaction
between traits is not examined.

There is furthermore something of a lurking reductionism implicit in much of the
research of FFM theorists whereby interesting traits are reduced to – are seen as nothing
but – Big Five traits or their facets. The danger is that traits which were embedded in a
research domain which explores relationships between phenomena at different levels of explanation are now reduced to the essentially descriptive framework of the FFM. The study of impulsivity as a separate trait explores the relationship between impulsivity and bio-chemical and neuropsychological substrates as well as identifying laboratory tasks which might identify the cognitive processes involved in causing impulsive behaviour.

Whiteside & Lynam (2001) developed a model of impulsivity which is rooted in the five factor model of personality and which distinguishes four types, or sources, of impulsivity. The first two, premeditation and perseverance, they relate to the Big Five trait of conscientiousness, the third, urgency, they relate to neuroticism and particularly to the facet 'impulsivity' as operationalised by the NEO-PI-R, while the fourth is sensation seeking, which they identify with Eysenck's venturesomeness and Zuckerman's sensation seeking scales.

Their identification of urgency as an independent aspect of impulsivity is however less clear and, indeed, there are substantial correlations between urgency and both premeditation and perseverance. The correlation of urgency with both premeditation and perseverance also requires explanation, though their identification with two distinct and orthogonally related factors should make them unrelated. The factor analysis reported by Whiteside and Lynam (2001, p.684) shows a substantial secondary loading of urgency on the same factor as premeditation and perseverance, while the data from this study shows that urgency correlates significantly with conscientiousness (the domain subsuming premeditation and perseverance); a relationship which persists after urgency is regressed.
onto all five personality traits. These data suggest that there may be a latent trait common
to the three impulsivity facets of Whiteside and Lynam (2001).

These data further suggest that urgency may in fact be a combination of factors, although
here there are two possibilities. The first is that urgency is a joint product of low
conscientiousness and high neuroticism; a possibility which would not conflict with the
model which they propose, but which they do not discuss. The second possibility, which
fits the model underlying this thesis, is that the latent variable of narrow impulsivity- a
central aspect of conscientiousness- interacts with neuroticism to produce the behaviour
which they label urgency and which others have labelled emotional dysregulation.

This thesis argues that urgency is not a primary trait within the higher order trait of
neuroticism but rather that it is an emergent trait; an amalgam, or even interaction
between impulsivity, neuroticism and perhaps agreeableness. This conceptualisation fits
with the argument of Depue and Collins (1999) and Depue and Lenzenweger (2005) that
constraint is itself affect neutral but that it interacts with negative affect to produce
complexes of behaviour such as sensation seeking or emotion dysregulation. The simplest
evidence for this is the result of the regression of urgency on BIS-Short together with
either the Big Five personality traits or only the traits of neuroticism and agreeableness.
In the first analysis neuroticism and impulsivity make substantial contributions
(standardised betas of .44 and .56), agreeableness and conscientiousness making minor
though significant contributions with Beta weights of .11 and the remaining traits not
significant. In the second analysis only neuroticism and impulsivity make significant
contributions with beta weights of .41 and .52, while agreeableness makes no significant contribution. Thus it seems that urgency is largely a function of impulsivity and neuroticism.

Despite their radical critique, the results of Whiteside and Lynam (2001) do contribute to the clarification of the construct of impulsivity. Their sensation seeking scale correlated only minimally with the other aspects of impulsivity, confirming Eysenck et al.'s (1985) separation of narrow impulsivity and venturesomeness, and questioning the validity of Zuckerman's trait of impulsive-sensation seeking. Their distinction between premeditation and perseverance reflects a number of distinctions made within single trait models of impulsivity which explore the facets of impulsivity; e.g. Parker and Bagby's distinction between their two dimensions — cautious/spontaneous and methodical/disorganized and the Barratt BIS-11 facets of planning and cognitive/attentional impulsivity. Whiteside and Lynam (2001) point out that the perseverance trait — which reflects the individual's ability to remain focused on a task and to work under conditions which require resistance to distracting stimuli — is not well represented in most measures of impulsivity, though it is given due salience in the model which the present thesis derives from the theoretical framework of ADHD.

The examination of the two questionnaires under consideration suggests two conclusions. Starting from different theoretical perspectives the two questionnaires both divide the domain of impulsivity into three facets but there is no simple and clear correspondence between the facets in the two questionnaires. Nevertheless the data, by showing
substantial correlations between the six facets, as well as the substantial and
approximately equal correlations between the three UPP variables and the BIS-Short, are
consistent with the hypothesised construct of narrow impulsivity defended by this thesis.
While the two questionnaires are based upon two very different conceptualisations of
impulsivity there is the possibility of rapprochement through recognising that impulsivity
may interact with other aspects of personality to produce emergent traits such as urgency
and emotion dysregulation.
Chapter 7

ADHD traits as a model for impulsivity

Summary

The overall aim of this chapter was to explore the way in which an understanding of ADHD behaviour as one or more dimensional traits contributes to an understanding of the multi-dimensional nature of impulsivity. As outlined in chapter 1, there is a considerable overlap between the constructs of ADHD and impulsivity; not only in terms of the behavioural phenotype (surface behaviours such as acting or speaking without thought, distractibility and disorganisation) but also in terms of the latent variable of inhibition which is hypothesised as a fundamental cause of both sets of behaviour.

This chapter aims first to demonstrate the validity of the trait concept of ADHD in a sample of non-clinical adults and secondly to explore the relationships between the facets of ADHD and those of impulsivity as identified by the BIS-11.

Study 5 provided evidence for the validity of a trait conception of ADHD behaviour. Factor analysis of an 18-item scale designed to assess ADHD behaviours in adults produced a clear two factor structure paralleling the sub-type analysis of ADHD symptoms in the Diagnostic and Statistical Manual of Mental Disorders, 4th ed.

Construction of scales based upon this analysis produced ‘traits’ which were normally distributed and which showed relationships with the Big Five traits similar to those
obtained in previous research. The total ADHD scale also correlated significantly with self and peer reports of two categories of behaviour, driving behaviour and alcohol consumption, which have previously been shown to differ between ADHD cases and non-cases; this relationship remained significant after the variance attributable to the Big Five was partialled out.

Study 6 explored the relationships between the two ADHD sub-scales and the three facets of the BIS-11. The first aim was to explore the relationships between the five facet scales; the second aim was to compare the predictive validity of the ADHD and BIS scales in relation to both self and peer reports of driving behaviour and alcohol consumption; and the third aim was to carry out an exploratory factor analysis of the ADHD and BIS-11 items together.

Introduction

The research of Barratt and his colleagues as well as the data presented in earlier chapters of this thesis suggests a model of impulsivity wherein a higher order general impulsivity construct subsumes three correlated facets. If this model is conceptualised simply as a description of co-variances between measures then it has a similar conceptual logic to the five factor models of personality whether derived from lexical or questionnaire studies. Alternatively it may be conceptualised as a causal model in which an hypothesised latent variable is manifest as three correlated facets. In this latter model the differences between
individuals in impulsivity as well as the covariance between the facets is caused by the latent variable.

The model presented by Whiteside and Lynam (2001) is an extension of the former, descriptive, model. They argue for the independence of their impulsivity facets by identifying them with facets within the Big Five model of personality as operationalised by the NEO-PI-R; yet the relationships between the identified factors within the NEO are merely descriptions of covariance. If their impulsivity facet 'urgency' is simply identified with the neuroticism facet of 'impulsivity' then little is explained except perhaps to say that the NEO already contains a ready made measure of 'urgency. The model of Whiteside and Lynam (2001) incorporates the same theoretical assumptions as most five factor models of personality; for example, they do not discuss the possibility that some of the varieties of impulsive behaviour which they describe may be a function of a number of different traits - emergent traits. As argued in the previous chapter, this may be true of the facets of urgency and sensation seeking.

A model which may more fruitfully contribute to the explanation and understanding of impulsivity is the model of ADHD from child psychopathology; as pointed out in the introduction, especially in its dual emphasis upon both cognitive and behavioural aspects of impulsivity. Most discussions of impulsivity tend to focus upon behaviour, whether expressed or inhibited; note the definitions in the introduction. Paradigm laboratory tasks such as delay of gratification or stop tasks are specifically focussed upon the inhibition of overtly observable behaviours. Nevertheless there is, in a number of research programs
an acknowledgement of the role of cognitive as well as behavioural inhibition in impulsivity. Within the individual differences literature on impulsivity the BIS-11 contains a facet of cognitive or attentional impulsivity which refers to problems of concentration and attention and the presence of distracting thoughts: this facet of attentional impulsivity correlates substantially (between .46 and .63) with the UPP scales of Whiteside and Lynam (2001), though there are in fact no items in the UPP scales which refer to such cognitive phenomena. Furthermore, as discussed in the introduction and to be discussed further in the next chapter, Dickman (1993, 2000) reviewed evidence on the relationship between self-reported impulsivity and a variety of cognitive tasks and suggested that deficits in attention regulation, particularly in the efficient maintenance of sustained attention, underlie and explain individual differences in impulsive behaviour.

Perhaps the clearest explication of the inhibition of cognitive factors such as attention and distractibility is in the domain of child psychopathology. Goldsmith et al. (2004) illustrate the way in which developmental psychology has enriched the theorising of impulsivity. They identify a regulatory domain of temperament which involves the ability to inhibit behaviour when required, the ability to deploy attention effectively and the ability to dampen negative affect. These three regulatory functions are clearly identified in the theorising of Rothbart et al. (2000) as well as the model of ADHD defined by the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; American Psychiatric Association 1994).
Derryberry and Rothbart (1997) employ the construct of 'effortful control', defined as the ability to inhibit a dominant response to perform a subdominant response; a construct which involves the effortful control of both attentional processes and behaviour. Rothbart et al. (2000), while pointing out the similarities between some of their temperamental variables and the Big Five personality traits, nevertheless also suggest that descriptive models of personality tend to reinforce a simple trait-based model of personality without either dynamic or developmental elements. They argue that temperamental models are more likely to lead to the exploration of the interaction of organism and environment (and, I would add, the interaction between temperamental traits).

Attention Deficit Hyperactivity Disorder (ADHD) is commonly conceptualised as a disorder arising in early childhood involving impairments in attention, poor resistance to distraction, deficient response inhibition and hyperactivity (Barkley, 1997). The Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; American Psychiatric Association 1994) divides the symptoms of ADHD into three subtypes: an inattentive type, a hyperactive/impulsive type and a combined type.

As pointed out in the introduction, a number of theorists (e.g.; Barkley, 1997; Quay, 1997; Schachar et al., 2000) identify deficiencies in impulse control as central deficits in ADHD. For example, Barkley (1997) identifies deficits in inhibition as a primary dysfunction which then affect the efficacy of a variety of executive functions including attentional control, distractibility, working memory and emotional regulation, while
Quay (1997) argues for an under-active behavioural inhibition system (BIS, Gray, 1982) as the neuropsychological basis for ADHD.

Although early conceptualisations of ADHD saw it as a disorder of middle childhood which tended to remit by late adolescence, largely as a consequence of maturation (Mendelson, Johnson, & Stewart, 1971), Willoughby (2003) reviewed evidence to show that the sequelae of childhood ADHD continue into late adolescence and early adulthood and include negative educational and occupational outcomes, relationship problems and substance use. For example, Barkley, Murphy, DuPaul and Bush (2002) found that young adults with a history of childhood ADHD differed significantly from a control group in the number of driving offences recorded and in both self and peer assessments of their driving ability. Furthermore, the status of ADHD as a chronic disorder which continues into adulthood is now supported by a considerable amount of evidence (Faraone, Biederman, Spencer, Wilens, Seidman, Mick, & Doyle 2000, McGough & Barkley 2004).

Researchers are beginning to explore a conceptualisation of ADHD behaviour as a continuous dimension rather than as a diagnostic category, in line with developments in other areas of clinical psychology. Although DSM-IV provides a system for the categorical classification of mental disorder, Widiger and Sankis (2000) point out that "increasing amounts of attention and interest are being given to alternative dimensional models of classification, from the personality disorders... through the mood and anxiety disorder.... to the schizophrenic and affective psychotic disorders. (Widiger & Sankis
O'Connor (2002) reviewed evidence to suggest that analysis of both personality and psychopathology inventories produces the same dimensions in clinical as in non-clinical respondents. Particularly germane to the present discussion is his conclusion that, with regard to psychopathology inventories, “Their subscales sometimes have clinical-type names, but the dimensions that are assessed by these instruments are readily found in non-clinical populations.” (O'Connor, 2002, p. 974).

With regard to ADHD specifically, Buitelaar (2002) argued that since the diagnostic threshold as defined by DSM-IV involves a number of symptoms, and that symptoms can be substituted for one another, there is an explicit acknowledgement of an underlying dimension. Buitelaar (2002) reviewed epidemiological evidence to support a dimensional view of ADHD symptoms as assessed by rating scales, finding such data to support a two or three factor interpretation of ADHD symptoms, similar to the DSM-IV sub-categories of inattentive, hyperactive and combined type. Frazier, Youngstrom and Naugle (2007) examined the latent structure of ADHD through the analysis of self report and neuropsychological data from a sample of 437 individuals and found no evidence for the taxonomic nature of ADHD; nor did they find evidence for a qualitative distinction between the inattention and hyperactivity sub-types.

Evidence for a dimensional view also comes from behaviour genetics research. Sherman, Iacono and McGue (1997), on the basis of their behaviour genetic data, concluded that ADHD should be considered as a composite of two quantitative, continuously distributed dimensions rather than a homogenous, categorical disorder. Levy, Hay, McStephen,
Wood and Waldman. (1997) in their study of the heritability of ADHD came to a similar conclusion: “These findings suggest that ADHD is best viewed as the extreme of a behaviour that varies genetically throughout the population rather than as a disorder with discrete determinants.” (p. 737).

A number of studies have used self and peer report scales consisting of items based upon DSM-IV symptoms to derive a dimensional assessment of ADHD behaviours. Whalen, Jammer, Hencker, Delafino and Lozano (2002), used DSM-IV symptom subscales and derived a total ADHD score by summing the ratings given for the 18 items, each item being rated on a four-point scale. They divided their non-clinical sample of young adolescents into high, low and middle scores on the ADHD symptom scale, or ADHD ‘spectrum’, and found significant differences in alcohol consumption and smoking behaviour, variables which research has associated with the diagnostic status of ADHD.

Researchers have also begun to examine the relationships between normal personality traits and ADHD symptoms. Nigg, Blaskey, Huang-Pollock, Hinshaw, John, Wilcutt and Pennington (2002) reported a large scale study using a number of indicators to retrospectively assess the presence of childhood ADHD and sought to relate these to the Big Five personality traits in adulthood as assessed by the NEO-FFI. They found the ADHD symptom cluster of inattention to correlate negatively with conscientiousness and, to a lesser extent, positively with neuroticism. The symptom cluster of hyperactivity-impulsivity correlated most strongly with low agreeableness (-.45), suggesting that this cluster is perhaps closer to conduct disorder than to ADHD. Though working within a
conceptual framework which considers ADHD as a category, Nigg et al. (2002) derived scores on a continuous scale from their indicators, thereby adopting a dimensional view of ADHD behaviour. Parker, Majeski and Collin (2003) employed scales derived from Conners, Erhardt, and Sparrow (1999) based upon DSM-IV symptoms which assess inattention and hyperactivity/impulsivity as dimensions; these scales having been demonstrated by Erhardt, Epstein, Conners and Sitarenios (1999) to discriminate between clinical cases of ADHD and non-clinical subjects with a high degree of accuracy. Using the NEO-FFI measure of the Big Five personality traits they found conscientiousness and, to a lesser extent, neuroticism to predict 41% of the variance in Inattention; a pattern of results very similar to that of Nigg et al (2002). Hyperactivity/impulsivity was again predicted most strongly by agreeableness with neuroticism, extraversion and conscientiousness making significant though lesser contributions: the Big Five traits together predicted 26% of the variance in hyperactivity/impulsivity.

**Study 5 ADHD traits in young adults**

The aim of the first study was to demonstrate the validity of DSM-IV ADHD Scales from the Conners Adult ADHD Rating Scale (Conners, Erhardt, and Sparrow 1999) as measures of trait dimensions in young adults without psychopathology. This involved a number of steps. The first was to explore the structure of the 18-item scale to assess ADHD. In line with the DSM-IV model of ADHD sub-types we hypothesized that factor analysis would identify two independent though highly correlated factors accounting for
a substantial portion of the variance in the data, and that these factors would correspond closely to the symptom definition of the ADHD subtypes within DSM-IV. Further evidence for the validity of these traits would be provided by the analysis of peer report versions of the same scales; it was hypothesised that the peer report data would produce the same factor structure as the self report scales and that the scale scores across informants would correlated meaningfully.

The second aim was to explore the relationship between the two ADHD scales and the Five Factor model (FFM) as operationalised in the NEO-FFI. From the studies of Parker et al (2003) and Nigg et al (2002), it was hypothesised that the ADHD inattention scale scores would be predicted by a combination of conscientiousness and neuroticism, while ADHD hyperactivity/impulsivity scale scores would be predicted by agreeableness, conscientiousness, extraversion and neuroticism.

The third aim was to explore the correlations between the total ADHD score and driving behaviour and alcohol consumption. Previous research discussed above (e.g. Whalen et al., 2002; Barkley et al., 2002) has concentrated upon the total ADHD score rather than subtypes; in keeping with these prior studies it was hypothesised that scores on the total ADHD scale would correlate positively and significantly with both self and peer reports of driving behaviour and alcohol consumption.

In Chapter 5 the incremental validity of impulsivity was demonstrated despite its sizeable relationship with the Big Five personality traits; in the same way the fourth aim was to
demonstrate the incremental validity of the total ADHD scale over the Big Five in the prediction of the chosen behavioural criteria despite the sizeable relationships established in previous research between ADHD and Big Five personality traits,

Method

Participants and procedure

The total sample consisted of 320 subjects of which 64% were males. Sample 1 consisted of 118 male university students, ages ranging from 18 to 22 (mean = 19.1 years, sd = 1.2). Sample 2 consisted of a convenience sample of people from outside the university comprising 202 subjects, of whom 43% were males with ages ranging from 18 to 64 (mean = 33.4 sd = 13.1).

Data were collected by final year psychology students. For sample 1 students were asked to each approach two male student friends and request that they complete the questionnaire. Students then completed a peer report version of the same questionnaires as a description of those same friends. For sample 2 students were requested to each approach four subjects who were not at university, two male and two female, without regard to age. No peer reports were obtained for this second sample. All 320 subjects completed the ADHD and Big Five scales. Of these, 282 reported driving behaviour, 38 reporting that they did not drive, while 303 completed alcohol scales, 17 reporting that
they did not drink alcohol. Peer report versions of the alcohol consumption and driving scales were returned by 95 and 110 respectively of the fellow students.

Measures

ADHD traits were assessed with the 18 item ADHD scale from Conners, Erhardt and Sparrow (1999) based upon the 18 symptoms specified by The Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; American Psychiatric Association 1994). Nine of these relate to the inattentive sub-type and nine to the hyperactive/impulsive sub-type (Table A.6 in appendix). However, as explained below in the results, a factor analysis of the scale led to one of the hyperactivity-impulsivity items being dropped; resulting in a 17 item scale. Items consisted of statements which required responses on a 6- point scale ranging from 1 = never/disagree strongly to 6 = very often/agree strongly. The total ADHD trait score was the simple sum of responses to all 17 items.

The ADHD inattention and ADHD impulsivity trait scores were obtained by summating the responses to the relevant statements, nine in the case of inattention and eight in the case of impulsivity. Alpha reliability values were 0.88 for the ADHD scale, 0.85 for the inattention scale and 0.78 for the impulsivity scale (n = 320).

Driving behaviour was assessed with the Driving Behaviour Questionnaire (DBQ; Westerman & Haigney 2000) which assesses violations (deliberate infringements of the law or driving improperly), errors (errors of intention) and lapses (errors of action). Alpha reliability coefficients for the three scales, each of eight items, were 0.74 for
lapses. 0.67 for errors and 0.74 for violations. Westerman and Haigney (2000) report a correlation of 0.59 between errors and lapses, suggesting considerable overlap between the two. In the interests of economy only the former two scales, violations and errors were utilised: thus there were 16 items to which responses were made on a 6-point Likert scale ranging from 1 = never to 6 = very often. In the present research, violations and errors correlated 0.50 and the Alpha reliability values were .80 for the violations scale and .82 for the errors scale (n = 284). Self-rated violations correlated significantly more highly with peer-rated violations than with peer-rated errors (.67 versus .23, t = 5.67, df = 92, p < .05). Self rated errors correlated significantly more highly with peer rated errors than with peer rated violations (.51 versus .17, t = 3.79, df = 92, p < .05).

The Big Five personality traits were assessed by the NEO-FFI (Costa & McCrae 1992). The NEO-FFI is a 60-item self-report questionnaire wherein each of the Big Five traits is measured by 12 items. Responses are made on a 5-point Likert scale ranging from 1 = disagree strongly to 5 = agree strongly. For the present samples, Cronbach's coefficient alpha reliabilities ranged from 0.73 to 0.82 and were comparable to values published by the test authors (Costa & McCrae 1992).

Alcohol consumption was assessed with a 10-item self report scale developed by the authors for this and other studies, consisting of nine questions relating either to excessive alcohol consumption or to the undesirable consequences of such consumption, the final question asked about the frequency of consuming more than 6 units of alcohol on one occasion - a commonly used measure of binge drinking. See Chapter 4 for the actual scale items. Questions required responses on a 6 point scale ranging from 1 = never to 6
= almost always and the total score was the simple sum of responses. Cronbach's alpha for this scale was 0.91. In an earlier study, the test-retest correlation between two administrations of the alcohol scale across approximately 12 weeks was $r = .74$ ($N = 144$, $p < .01$) and the correlation between self and peer report versions of this scale was $r = 0.62$ ($N = 266$, $p < .01$). In the present sample the correlation between self and peer reports of alcohol consumption was $r = 0.72$ ($N = 110$, $p < .01$).

Results

Factor analysis of ADHD items

The 18 ADHD items were subjected to an exploratory factor analysis, using a principal axis factor extraction followed by Promax rotation ($N = 320$). The scree plot showed two distinct factors accounting for 36% of the total variance, with the rest of the factors forming an almost perfectly straight line of scree (first six Eigen values were 5.9, 1.8, 1.1, 1.0, .90, .85): A two-factor solution produced a division of items into two clear groups corresponding almost exactly to the sub-types proposed by DSM-IV. The exception was an item referring to the respondent being 'always on the go' which loaded equally but in opposite directions on the two factors; i.e. negatively on the first 'inattention' factor and positively on the second 'impulsivity' factor. That item was dropped from consideration in the analyses which follow. Factor analysis of the 17 items again produced a clear two factor structure with the items divided into the predicted grouping; the correlation between the two factors was .65. The distribution of the scores was essentially normal; skewness statistics for inattention and impulsivity were .69 and
.52 respectively, values which were comparable to those obtained for the Big Five traits of extraversion and agreeableness, -.60 and -.65 respectively.

Factor analysis of the peer-report ADHD data (available for a sub-sample of 116) produced a very similar result; item 9 again loaded in opposite directions on the two factors. Factor analysis of 17 items again produced a clear two factor structure, accounting for 47% of the variance, with a between factor correlation of .49. Once again the items divided into the predicted groups.

Comparing correlations and cross correlations between self and peer reports provided evidence for the validity of the trait scales. The correlation between the sub-scales was .60 for self-report and .49 for the peer-report data. Self-rated inattention correlated significantly more highly with peer-rated inattention than with peer-rated hyperactivity/impulsivity (.54 versus .22, t = 3.97, df = 113, p < .05), while self-rated hyperactivity/impulsivity correlated significantly more highly with peer-rated hyperactivity/impulsivity than with peer-rated inattention (.47 versus .31, t = 1.90, df = 113, p < .05, one-tailed.). All of these correlations were significant; p < .05.

ADHD symptoms and the Big Five personality traits

Table 7.1 shows the correlations between the two ADHD traits of inattention and impulsivity and the Big Five personality traits. Regression of the two ADHD traits separately onto the Big Five provided results which were very similar across sexes.
Inattention was predicted primarily by conscientiousness and secondarily by neuroticism and extraversion; Beta = -.57, .25 and .13 respectively ($R^2 = .44$, $F = 62.3$, df = 4,318, $p< .01$). Hyperactivity/impulsivity was predicted by extraversion, agreeableness, neuroticism and conscientiousness; Beta = .37, -.34, .22 and -.22 respectively ($R^2 = .29$, $F = 31.8$, df = 4,318 $p< .01$).

Table 7.1 Correlations between two ADHD sub-traits and the Big Five traits

<table>
<thead>
<tr>
<th></th>
<th>Inatten</th>
<th>hyper</th>
<th>neuro</th>
<th>extra</th>
<th>open</th>
<th>agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.60**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>neuroticism</td>
<td>.32**</td>
<td>.17**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>extraversion</td>
<td>-.09</td>
<td>.16**</td>
<td>-.39**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>openness</td>
<td>.06</td>
<td>-.10</td>
<td>.05</td>
<td>.15*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>agreeableness</td>
<td>-.27**</td>
<td>-.37**</td>
<td>-.12*</td>
<td>.21**</td>
<td>.12*</td>
<td></td>
</tr>
<tr>
<td>conscientiousness</td>
<td>-.62**</td>
<td>-.32**</td>
<td>-.20**</td>
<td>.16**</td>
<td>.08</td>
<td>.33**</td>
</tr>
</tbody>
</table>

n = 320

** significant at 0.01 level (2 tailed)  * significant at 0.05 level (2 tailed)

ADHD characteristics and driving behaviour and alcohol consumption

Table 7.2 shows the correlations between the total ADHD scale score and the dependent variables, driving violations, driving errors and alcohol consumption; each of these being
assessed by both self and peer reports. As hypothesised, self-reported ADHD correlated significantly with self reports of both types of driving behaviour and alcohol consumption. Self-reported ADHD trait scores correlated significantly with peer reports of alcohol consumption and driving errors but not of violations. Peer reported ADHD correlated significantly with both self and peer reports of all three of the dependent variables. Among the Big Five traits, agreeableness, conscientiousness and neuroticism correlated significantly with self reports of violations, errors and alcohol consumption but with no peer reports. Extraversion was unusual in correlating with both self and peer reports of alcohol consumption as well as with peer reports - though not self reports - of violations.

Table 7.2 Correlations between ADHD and Big Five traits and the independent variables, driving behaviour and alcohol consumption.

<table>
<thead>
<tr>
<th></th>
<th>Self ADHD</th>
<th>Peer ADHD</th>
<th>N</th>
<th>E</th>
<th>O</th>
<th>A</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self violations</td>
<td>.46**</td>
<td>.21*</td>
<td>.14*</td>
<td>.10</td>
<td>-11</td>
<td>-.42**</td>
<td>-.35**</td>
</tr>
<tr>
<td></td>
<td>(282)</td>
<td>(100)</td>
<td>(282)</td>
<td>(282)</td>
<td>(282)</td>
<td>(282)</td>
<td>(282)</td>
</tr>
<tr>
<td>Self errors</td>
<td>.46**</td>
<td>.23*</td>
<td>.25**</td>
<td>-.07*</td>
<td>-.06</td>
<td>-.25**</td>
<td>-.38**</td>
</tr>
<tr>
<td></td>
<td>(282)</td>
<td>(100)</td>
<td>(282)</td>
<td>(282)</td>
<td>(282)</td>
<td>(282)</td>
<td>(282)</td>
</tr>
<tr>
<td>Peer violations</td>
<td>.14</td>
<td>.35**</td>
<td>-.10</td>
<td>.20*</td>
<td>.01</td>
<td>-.05</td>
<td>-.01</td>
</tr>
<tr>
<td></td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
</tr>
<tr>
<td>Peer errors</td>
<td>.32**</td>
<td>.53**</td>
<td>-.08</td>
<td>-.05</td>
<td>.06</td>
<td>-.15</td>
<td>-.16</td>
</tr>
<tr>
<td></td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
<td>(95)</td>
</tr>
<tr>
<td>Self alcohol</td>
<td>.51**</td>
<td>.24*</td>
<td>.11*</td>
<td>.21**</td>
<td>.02</td>
<td>-.25**</td>
<td>-.43**</td>
</tr>
<tr>
<td></td>
<td>(303)</td>
<td>(110)</td>
<td>(303)</td>
<td>(303)</td>
<td>(303)</td>
<td>(303)</td>
<td>(303)</td>
</tr>
<tr>
<td>Peer alcohol</td>
<td>.24*</td>
<td>.26**</td>
<td>-.07</td>
<td>.21*</td>
<td>.03</td>
<td>-.08</td>
<td>-.07</td>
</tr>
<tr>
<td></td>
<td>(110)</td>
<td>(110)</td>
<td>(110)</td>
<td>(110)</td>
<td>(110)</td>
<td>(110)</td>
<td>(110)</td>
</tr>
</tbody>
</table>

* significant at 0.05 level (2 tailed)  ** significant at 0.01 level (2 tailed)
Table 7.3 shows the results of a number of hierarchical regressions whereby each dependent variable was regressed onto a two-step model in which the first step was always the Big Five traits and the second was the self-report ADHD trait. Analysis of the self report data showed that the total ADHD scale added significantly to the amount of variance predicted in the independent variables - driving behaviour and alcohol consumption - when added to a regression equation after the Big Five. In the peer-report data the ADHD scale added significant variance in the prediction of driving errors only. However, the results for peer-reported alcohol consumption were suggestive since the combination of the Big Five traits and ADHD was significant ($R^2 = .11, F = 2.61, df = 5,105 p = .03$) though the separate steps in the hierarchical regression were not. In a post hoc analysis, peer-reported alcohol consumption was regressed onto ADHD and extraversion simultaneously, (these being the only traits with which it correlated significantly, see table 7.2). Both traits were significant predictors of peer-reported alcohol consumption with approximately equal beta coefficients .24 and .21 respectively.
Table 7.3 Hierarchical regression of each dependent variable on the Big Five traits at step 1 followed by the addition of ADHD at step 2

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Model 1</th>
<th>R square change</th>
<th>F change</th>
<th>Significance of F change</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violations</td>
<td>1</td>
<td>.297</td>
<td>29.2</td>
<td>.00</td>
<td>5, 276</td>
</tr>
<tr>
<td>self report</td>
<td>2</td>
<td>.037</td>
<td>15.3</td>
<td>.00</td>
<td>1, 275</td>
</tr>
<tr>
<td>Errors</td>
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<td>.198</td>
<td>17.2</td>
<td>.00</td>
<td>4, 276</td>
</tr>
<tr>
<td>self report</td>
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<td>.062</td>
<td>23.4</td>
<td>.00</td>
<td>1, 275</td>
</tr>
<tr>
<td>Violations</td>
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<td>.073</td>
<td>1.8</td>
<td>.14 ns</td>
<td>5, 89</td>
</tr>
<tr>
<td>peer reports</td>
<td>2</td>
<td>.011</td>
<td>1.0</td>
<td>.31 ns</td>
<td>1, 88</td>
</tr>
<tr>
<td>Errors</td>
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<td>.042</td>
<td>.99</td>
<td>.41 ns</td>
<td>5, 89</td>
</tr>
<tr>
<td>peer reports</td>
<td>2</td>
<td>.074</td>
<td>7.5</td>
<td>.00</td>
<td>1, 88</td>
</tr>
<tr>
<td>Alcohol</td>
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<td>32.8</td>
<td>.00</td>
<td>5, 297</td>
</tr>
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<td>25.1</td>
<td>.00</td>
<td>1, 296</td>
</tr>
<tr>
<td>Alcohol</td>
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<td>.082</td>
<td>2.4</td>
<td>.06 ns</td>
<td>5, 105</td>
</tr>
<tr>
<td>peer report</td>
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<td>3.4</td>
<td>.07 ns</td>
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</tr>
<tr>
<td>Alcohol</td>
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<td>.10</td>
<td>6.08</td>
<td>.00</td>
<td>2, 108</td>
</tr>
</tbody>
</table>

1 Model 1 = neuroticism, extraversion, openness, agreeableness and conscientiousness

Model 2 = neuroticism, extraversion, openness, agreeableness, conscientiousness and ADHD

2 model 1 = ADHD and extraversion entered simultaneously (‘method enter’)

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Exploratory factor analysis of the 18 ADHD characteristics in both the self-reported and peer-reported data led to the extraction of two factors which corresponded very closely to the ADHD subtypes identified by DSM-IV. The two scales based upon those factors were significantly correlated to a degree similar to previous research. Conners, Erhardt and Sparrow (1999) report correlations between their DSM subtype scales of 0.43 for males and 0.52 for females, while Nigg et al., (2002) found an overall correlation of .56 across their samples using a DSM-IV based rating scale for recalled childhood ADHD symptoms.

When the inattention scores were plotted against conscientiousness, the Big Five trait with which it was most highly correlated (r = -0.62), and against self-reported alcohol consumption (r = 0.51), inspection of the scatter plots suggested that the relationships held across the full range of both traits with no indication that inattention might be related only to the higher levels of conscientiousness or of alcohol consumption. The scores for the ADHD sub-traits were moderately positively skewed though to a similar degree as the personality traits of extraversion and agreeableness.

The results of correlating the two ADHD sub-traits with the Big Five traits confirmed the hypotheses and correspond closely to those reported by Parker et al. (2003) and by Nigg et al. (2002). All three sets of data found the inattention sub-trait to correlate most substantially with conscientiousness (r ranging from -.48 to -.62) and secondarily with
neuroticism (.23 to .42); all three studies also found the hyperactivity/impulsivity sub-
trait to be correlated predominantly with agreeableness and conscientiousness and, to a
lesser extent, neuroticism and extraversion. There were also close similarities between
the present results and those of Parker et al. (2003) in the amount of variance in the
ADHD sub-trait predicted by the Big Five. In the present study the Big Five traits
predicted 44% of the variance in inattention and 29% of the variance in impulsivity, the
corresponding figures from Parker et al., (2003) were 41% and 26%.

The ADHD total score correlated significantly with driving behaviour and alcohol
consumption as hypothesised on the basis of previous research relating ADHD cases to
these behaviours. The results relating the total ADHD trait to the behavioural variables
are in line with those of Whalen et al. (2002) who construed ADHD characteristics as a
spectrum and demonstrated differences in behaviour (including alcohol consumption)
between young people identified as high, medium or low on that spectrum. The results of
the present study support the hypothesis that such a pattern of results is found when the
ADHD spectrum is treated as a trait dimension.

Though the multiple correlation of the Big Five traits with the ADHD score was 0.64,
the variance in ADHD which was independent of the Big Five significantly predicted the
dependent variables. Thus these results concur with those of Nigg et al. (2002) who
conclude that “... personality traits seem to reflect an important element of the ADHD
syndrome, whereas ADHD itself includes surplus symptoms and problems not fully
captured by the personality measures.” (p. 463). Nigg et al. (2002) treat ADHD
symptoms as distinct from personality traits as conceptualised and operationalised by Big Five models of personality. However, personality traits may predispose to ADHD disorder or ADHD symptoms may influence the development of personality. Moreover, ADHD behaviours may be manifestations of traits which are at the core of personality. Watson, Gamez, and Simms (2005) argue for just such a ‘spectrum’ or dimensional, approach when accounting for the relationship between levels of negative emotionality and the development of depressive disorder; arguing for a fundamental continuity between normal and abnormal psychological processes.

**Study 6 ADHD traits and the BIS-11**

**Aims**

The aim of this study was to compare the constructs derived from the ADHD trait scales and the BIS-11. The BIS-11 was developed as a bespoke measure of impulsivity; research into the construct validity of the scale and its development through various forms has resulted in a three-faceted model which, by implication, proposes a three factor model of impulsivity itself. The importance of the cognitive impulsivity facet, referring to distractibility and difficulties in maintaining attention, suggests a clear parallel with the model of ADHD which includes an attentional as well as a behavioural element.

The first step was to map the relationships between the two facet scales of the ADHD scale and the three facet scales of the BIS-11; these scales were then compared in their
relationship to a number of outcome variables relating to driving and drinking behaviour.

The second step was to carry out a joint factor analysis of the items from the ADHD and the BIS-11 scales to explore the factors which might emerge from this sample of 48 impulsivity-related items.

Method

Participants and Procedure

The sample for this study included the 320 subjects from Study 5.1 plus an extra 159 subjects, 129 (81%) of whom were females; thus the total sample for Study 5.2 consisted of 479 subjects, 49% of whom were male. The extra sample consisted of second year psychology students who completed a number of self and peer report scales in return for course credit. All subjects in the new sample completed the self report version of the ADHD trait scales, the BIS-11 and the alcohol consumption scales and 143 completed the NEO-FFI. Of these new subjects 129 obtained peer reports of ADHD trait and 121 peer report alcohol consumption scales. Of these, 50 subjects also provided self and peer report versions of the driving scales. All of the scales administered to this new sample were the same as those utilised in study 5.1. An independent samples t test found the two samples not to differ significantly in self rated ADHD traits, the BIS-11 and its sub-scales and alcohol consumption.
Results

The 17 ADHD items identified in Study 1 were subjected to a factor analysis utilising the expanded data set. As before the items were analysed using a principal axis factor extraction followed by Promax rotation (n = 479). The scree plot once again showed two distinct factors accounting for 41% of the total variance, with the rest of the factors forming an almost perfectly straight line of scree (the first six Eigen values were 5.5, 1.7, 1.1, 1.0, .86, .81). A two-factor solution produced a division of items into two clear groups corresponding to the sub-types proposed by DSM-IV; the correlation between the two factors was .61.

Figure 7.1 scree plot of data from the 17 ADHD traits: n = 479.
The correlation between scale scores was .55 for the whole sample; .59 for males and .52 for females. Alpha for the nine item inattention scale was .83 for the whole sample; .84 for males and .80 for females. For the eight item hyperactivity scale, alpha was .75; .76 for both males and females. The scale score for inattention and hyperactivity were moderately positively skewed (.64 and .52 respectively), values which were comparable to those for extraversion and agreeableness (-.52 and -.63 respectively).

Table 7.4 shows the correlations between the ADHD subtraits and the BIS-11 facets. Each of the BIS-11 facets correlated significantly with both inattention and hyperactivity; however there were differential relationships between the two ADHD traits and the three BIS-11 facets. While the correlation between inattention and motor impulsivity was significantly less than the correlations between inattention and both cognitive and planning impulsivity (which did not themselves differ) the correlation between hyperactivity and cognitive impulsivity was significantly higher than with either planning or motor impulsivity (which also did not themselves differ).
Table 7.4 Correlations between ADHD scales and BIS-11 Scales.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.55**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive imp</td>
<td>.59**</td>
<td>.51**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor imp</td>
<td>.27**</td>
<td>.37**</td>
<td>.46**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning imp</td>
<td>.45**</td>
<td>.31**</td>
<td>.43**</td>
<td>.47**</td>
<td></td>
</tr>
</tbody>
</table>

N = 479

* significant at 0.05 level (2 tailed)  ** significant at 0.01 level (2 tailed)

Differences between the following pairs of correlations were significant; df = 476 for all.

Inattention and cognitive v inattention and motor (t = 8.20 p< .01)

Inattention and planning v inattention and motor (t = 4.25 p<.01)

Hyperactivity and cognitive v hyperactivity and motor (t = 3.4 p<.01)

Two sets of regression analyses were carried out; the first analysis regressed inattention and hyperactivity separately onto the three BIS-11 facets, the second regressed each of the three BIS-11 facets separately onto inattention and hyperactivity.

The results of the first regression analysis, whereby inattention and hyperactivity were separately regressed (method enter) onto the three BIS-11 facets, showed that inattention was predicted primarily by cognitive impulsivity and secondly by planning impulsivity with motor impulsivity non-significant; beta weights of .48 and .25 respectively; R^2 = .39 (F = 154.4, df = 3, 475, p < .01). Hyperactivity was predicted primarily by cognitive impulsivity and secondarily by motor impulsivity with planning impulsivity now non-
significant; beta weights of .43 and .17 respectively; $R^2 = .28$ (F = 62.2, df = 3, 475 p < .01).

The results of the second regression analysis whereby each of the BIS-11 facets were regressed (method enter) onto inattention and hyperactivity showed that attentional impulsivity was significantly predicted by both inattention and hyperactivity with beta weights of .40 and .26 respectively ($R^2 = .39$, F = 154.40, p < .01). Motor impulsivity was predicted significantly only by hyperactivity ($R^2 = .14$, F = 39.32, p < .01) while planning impulsivity was predicted significantly only by inattention ($R^2 = .21$, F = 62.86, p < .01).

Table 7.5 compares the correlations of the ADHD scales and the BIS-11 scales with the Big Five personality traits as measured by the NEO-FFI. Cognitive impulsivity is similar to the inattention scale in correlating primarily with conscientiousness while having lesser but significant correlations with neuroticism and agreeableness. Planning impulsivity, like inattention, has its primary correlation with conscientiousness but, unlike inattention, does not correlate significantly with neuroticism. Motor impulsivity resembles hyperactivity in showing approximately equal correlations with extraversion, agreeableness and conscientiousness.
Table 7.5 Correlations between ADHD scales, BIS-11 scales and the Big Five.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>E</th>
<th>O</th>
<th>A</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td>.31**</td>
<td>.09</td>
<td>-.09</td>
<td>-.20**</td>
<td>-.61**</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.09</td>
<td>.18**</td>
<td>-.06</td>
<td>-.33**</td>
<td>-.28**</td>
</tr>
<tr>
<td>Cognitive imp</td>
<td>.28**</td>
<td>.00</td>
<td>.00</td>
<td>-.30**</td>
<td>-.46**</td>
</tr>
<tr>
<td>Motor imp</td>
<td>.02</td>
<td>.27**</td>
<td>.07</td>
<td>-.20**</td>
<td>-.31**</td>
</tr>
<tr>
<td>Planning imp</td>
<td>.09</td>
<td>-.02</td>
<td>-.11*</td>
<td>-.19**</td>
<td>-.63**</td>
</tr>
</tbody>
</table>

N = 463

* significant at 0.05 level (2 tailed)  ** significant at 0.01 level (2 tailed)

Table 7.6 shows the results of regressing each of the impulsivity traits separately onto the Big Five personality traits, only significant results are shown. The pattern of Beta weights largely corresponds to the pattern of first order correlations, though with some notable differences; agreeableness does not now predict either inattention or planning impulsivity and conscientiousness is now the only Big Five predictor of planning impulsivity. When the other Big Five traits are partialled out, extraversion emerges as a salient predictor of both hyperactivity and motor impulsivity.
Table 7.6 Results of regression of impulsivity variables onto Big Five personality traits.

<table>
<thead>
<tr>
<th>outcomes</th>
<th>Beta weights of Big Five traits as predictors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Inattention</td>
<td>.25</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>ns</td>
</tr>
<tr>
<td>Cognitive imp</td>
<td>.28</td>
</tr>
<tr>
<td>Motor imp</td>
<td>.10</td>
</tr>
<tr>
<td>Planning imp</td>
<td>ns</td>
</tr>
</tbody>
</table>

N = 464 for all regression analyses.

All f values significant p < .01

Given the frequent identification of impulsivity as a facet of conscientiousness, the trait of conscientiousness was regressed onto the five impulsivity related facet traits. In this analysis conscientiousness was predicted predominantly and equally by inattention and planning impulsivity (beta weights of -.44 and -.44 respectively). The contribution of the other facets was minor; only hyperactivity made a significant contribution (beta = .14 p < .01) while cognitive and motor impulsivity had non-significant beta weights of -.08 and -.00 respectively. When the regression was carried out in two steps, entering inattention and planning impulsivity as a first block produced a highly significant R² of .53 while entering the remaining three facets as a second block produced an increase in R² of only .01 (though this was significant due to the large sample). Analysis of semi-partial correlations showed that the overlap between inattention and planning impulsivity
accounted for 24% of the variance in conscientiousness while the remainder was predicted independently and equally by inattention (13%) and planning impulsivity (16%).

Table 7.7 shows that self reports of driving violations correlated significantly, and to an equal extent, with inattention, hyperactivity, cognitive and motor impulsivity; with correlations ranging from .33 to .38. The correlation between planning impulsivity and self-reported violations (.18) was significantly less than the correlation (.31) between hyperactivity and self reported violations (t = 2.12, df = 332, p<.05).

Self-reported driving errors showed the strongest correlations with inattention and hyperactivity with lesser though still significant correlations with cognitive, motor and planning impulsivity. Correlation between self-reported errors and planning impulsivity (r = .22) was significantly different from the correlation of self-reported errors and inattention (r = .39, t = 2.85, df = 332, p<.05) The pattern of correlations between trait scores and peer reports of driving behaviour followed the same pattern though all the correlations were weaker. Overall planning impulsivity showed the weakest, and non-significant, correlations while the correlation between inattention and peer report errors was significantly stronger than the others. The correlation of self reported alcohol consumption with motor impulsivity was significantly greater than with either cognitive or planning impulsivity (t = 2.10 and 2.79, df = 377, and p<.05 for both) though not significantly greater that with either inattention or hyperactivity. There were no
significant differences between the correlations of any of the impulsivity traits with peer reports of alcohol consumption.

Table 7.7 Correlations of ADHD scales and BIS-11 scales with driving behaviour and drinking variables.

<table>
<thead>
<tr>
<th></th>
<th>Self violations</th>
<th>Self errors</th>
<th>Peer violations</th>
<th>Peer errors</th>
<th>Self alcohol</th>
<th>Peer alcohol</th>
</tr>
</thead>
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<td>.39**</td>
<td>.21**</td>
<td>.38**</td>
<td>.33**</td>
<td>.24**</td>
</tr>
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<td>Hyperactivity</td>
<td>.31**</td>
<td>.32**</td>
<td>.16*</td>
<td>.25**</td>
<td>.32**</td>
<td>.24**</td>
</tr>
<tr>
<td>Cognitive imp</td>
<td>.32**</td>
<td>.19**</td>
<td>.11</td>
<td>.21*</td>
<td>.31**</td>
<td>.21**</td>
</tr>
<tr>
<td>Motor imp</td>
<td>.34**</td>
<td>.20**</td>
<td>.22**</td>
<td>.12</td>
<td>.40**</td>
<td>.28**</td>
</tr>
<tr>
<td>Planning imp</td>
<td>.18**</td>
<td>.22**</td>
<td>.05</td>
<td>.07</td>
<td>.27**</td>
<td>.20**</td>
</tr>
</tbody>
</table>

* significant at 0.05 level (2 tailed)  ** significant at 0.01 level (2 tailed)

N = 335 driving self reports. N = 139 driving peer reports.

Item level factor analysis of the five impulsivity facet scales

Exploratory factor analysis of the 17 ADHD items together with the 30 items of the BIS-11 (N = 479) produced a scree plot (see appendix) suggestive of three factors. Three factors were extracted using principal axis factors and subjected to a promax rotation; the first three factors accounted for 32% of the variance (28% after PFA extraction).
As can be seen from the pattern matrix in Figure 7.3, the 21 items which loaded .30 or above on the first factor, after factor rotation, consisted of 17 of the ADHD items plus five of the BIS-11 items - items which were included in the cognitive impulsivity factor in the analysis of the BIS-11 in chapter two. The 11 items of factor two contained the six planning impulsivity items identified in chapter 2 and four further planning items from the Patton et al (1995) analysis, while 10 items of factor three contained the six motor impulsivity items identified in chapter 2. (See table 1 in appendix.) Factors one and two correlated .55; factor three correlated .40 and .35 with factors one and two respectively.
Figure 7.3 Pattern matrix of 17 ADHD items and 18 BIS-11 items after Principal Axis factoring and Promax rotation.

<table>
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<tr>
<td>BIS24</td>
<td>-.09</td>
<td>.31</td>
<td>.24</td>
</tr>
<tr>
<td>BIS7</td>
<td>.09</td>
<td>.30</td>
<td>.17</td>
</tr>
</tbody>
</table>

| BIS16  | .03  | -.04 | .78  |
| BIS14  | -.06 | .10  | .76  |
| BIS2   | .01  | .25  | .49  |
| BIS18  | -.10 | .16  | .45  |
| BIS3   | -.18 | .04  | .42  |
| BIS25  | -.00 | -.16 | .40  |
| BIS13  | .23  | .12  | .37  |
| BIS5   | .25  | -.20 | .34  |
| BIS19  | -.04 | .31  | .33  |
| BIS17  | .066 | .061 | .31  |
| BIS27  | .119 | -.033| .21  |

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Discussion

The internal, factorial, validity of the ADHD scales was maintained in the enlarged sample, as was the reliability of the scales. Consideration of males and females separately showed very similar values for scale inter-correlations and reliability. Correlations between the inattention and hyperactivity scales and the Big Five personality traits as assessed by the NEO-FFI were again very similar to the values obtained in study 5.1.

Analysis of the data showed a substantial overlap in variance between the facet subscales of the ADHD and BIS-11 questionnaires. When the inattention and hyperactivity variables were correlated with the BIS-11 facet scales all the scales correlated significantly. Cognitive impulsivity overlapped substantially with both inattention and hyperactivity (.59 and .51 respectively). Planning impulsivity correlated significantly with both inattention and hyperactivity but more strongly with the former (.45 and .31 respectively). Motor impulsivity similarly correlated with both inattention and hyperactivity but more strongly with the latter (.27 and .37 respectively).

Correlations of the impulsivity facet scales and personality trait scales showed conscientiousness to be the trait most highly correlated with inattention, cognitive and planning impulsivity. Planning impulsivity however differed from attention and cognitive impulsivity in its relationship with the negative affects of neuroticism and agreeableness; while planning impulsivity correlated almost entirely with conscientiousness, attention and cognitive impulsivity correlated significantly with both neuroticism and
agreeableness. Motor impulsivity and hyperactivity both showed lower correlations with conscientiousness' and neither correlated significantly with neuroticism, though both correlated significantly with extraversion. This latter relationship was made clearer in the regression analyses reported in Table 5.2.3 where extraversion shows the strongest beta weight of the Big Five personality traits. The fact that extraversion and conscientiousness correlate positively while they have opposite effects upon impulsivity (extraversion positive and the conscientiousness negative) exerts a suppressor effect upon the influence of extraversion; when the influence of conscientiousness is partialled out of the equation the influence of extraversion upon motor impulsivity and hyperactive becomes clear.

Chapter discussion

Data analysed in this chapter support two arguments. The first is that ADHD behaviours can be treated as traits which are normally distributed within a non-clinical population. This argument concurs with a number of authors who argue that the diagnostic categories of DSM are an artefact of diagnostic algorithms. The relationships between the two ADHD traits obtained by other research were confirmed and, furthermore, evidence was provided for the predictive validity of these traits. The second argument is that the traits identified by ADHD scales and the traits identified by impulsivity scales show considerable overlap and that this is attributable to their tapping into common variables.
The picture from the scales level analysis is that while planning impulsivity is relatively unrelated to affect, inattention and cognitive impulsivity are related to neuroticism with motor impulsivity and hyperactivity related to extraversion. This tripartite parsing of impulsivity facets is reflected, albeit imperfectly, by the results of the item-level factor analysis of the ADHD and BIS-11 questionnaires. The item-level factor analysis separated out motor and planning impulsivity as separate factors and combined inattention and cognitive impulsivity, however hyperactivity items combined with inattention and cognitive impulsivity rather than with motor impulsivity.

The relationships between impulsivity and affect are not easily explained. It has been argued that extraversion is at least in part a consequence of rewards sensitivity producing strong approach behaviours to potential rewards (Smillie and Jackson 2006); thus extraversion coupled with disinhibition would produce impulsive behaviours. The effects of neuroticism might be somewhat different; anxiety in general produces inhibition of behaviour, however it also interferes with concentration leading to rumination, intrusive thoughts and distractibility. This however implies that neuroticism is itself an independent source of cognitive impulsivity, distinct from the construct of inhibition. It may of course interact with inhibition to produce the hot impulsivity which is described by Whiteside and Lynam (2001) as urgency. Extraversion thus amplifies the effects of disinhibition in producing behavioural impulsivity while neuroticism is an influence on attentional impulsivity independent of disinhibition.
Conceptual analysis of the non-planning impulsivity construct and a consideration of its relationship to other variables suggest that this aspect of impulsivity stands somewhat apart from the other two aspects in an interesting way. Planning impulsivity correlated highly with conscientiousness and non-significantly with the other Big Five traits and showed the weakest correlations with the driving and alcohol consumption variables. It may be that while the other impulsivity traits may be conceptualised as aspects of temperament, non-planning impulsivity may be a more complex trait such as conscientiousness. Martel and Nigg (2006) distinguish between temperament and personality by proposing that temperament be “defined in terms of constitutionally-based differences in behavioural style, in particular reactivity and self regulation, whereas personality includes additional characteristics such as attitudes, values, self concept and long term motives”. They further suggest that in the adult at least, “personality includes many elements beyond temperament”; thus while attentional and motor impulsivity may be at the core of conscientiousness, as necessary though not sufficient conditions, ‘planning’ develops as a part of the general trait of conscientiousness. Data presented throughout this thesis suggest that temperamental factors continue to exert a notable effect into adulthood.
Chapter 8.

On the relationship between self report measures of impulsivity and laboratory measures of inhibition and attention.

Summary

This chapter investigates the relationship of laboratory measures of attention regulation and of response inhibition to self report measures of in-attention and impulsivity. Factor analysis of a number of tasks chosen to relate to either attention regulation or response inhibition produced two independent factors which separated the two sets of tasks as hypothesised. The first of these, the attention regulation factor, correlated significantly and equally with both of the self report scales; supporting the hypothesis that attention regulation is a cognitive underpinning to both aspects of the behavioural phenotype of impulsivity. The second component (the response inhibition component) did not correlate significantly with either of the self report scales or with the attention component.

Introduction

The introduction to this thesis (chapters 1 to 3) identified two lines of research into the underlying elements of impulsivity; studies of response inhibition and studies of inattention. The study of impulsivity, whether as a personality trait or as an element in
psychopathology, takes as its paradigm case the failure to inhibit a behavioural response. Behaviours typically characterised as impulsive are speaking and acting without appropriate aforethought, spending money that one cannot afford to spend; in each case, as argued in chapter 1, the behaviour is often quickly regretted. In the study of psychopathology the behaviours are more dramatic and more readily visible and disruptive; impulsive aggression, compulsive gambling, alcohol and drug abuse. In each of these cases the behaviour which is not inhibited, as well as its consequences, are readily observable. Thus the laboratory tasks typically employed to assess impulsivity involve the suppression of a well defined and observable response; a prepotent response is defined and established and its inappropriate occurrence is the manifestation of impulsivity. The term inhibition when used to describe behaviour in such tasks has a descriptive rather than an explanatory or theoretical function unlike its use in a number of theoretical formulations discussed below, e.g. Barkley (1997).

Research in developmental psychopathology takes a broader view of impulsivity; As described in chapter 3, the theories of Goldsmith et al. (2004) and Derryberry and Rothbart (1997) identify a temperamental trait which involves the control of attention and interference control as well as inhibition of a behavioural response. In his theorising on ADHD, Barkley (1997) argues that inhibition (though this construct is not explicitly defined or delineated) is manifested as both poor response inhibition (of a pre-potent response) and as poor interference control (inhibition of irrelevant information or stimuli). Barkley’s inclusion of cognitive as well as behavioural inhibition reflects the symptoms of ADHD as defined by DSM-IV, which are differentiated into symptoms of
hyperactivity/impulsivity and symptoms of inattention. The strong degree of co-variation between these two sets of symptoms suggests a common latent variable which Barkley identifies as inhibition; though the nature of this inhibition is left under-specified it is argued to have wide ranging effects upon a variety of cognitive functions such as working memory.

This construct of cognitive inhibition or attentional control is typically characterised in terms of distractibility, forgetfulness, disorganisation and a tendency to lose things; behaviours which are less easy to observe and monitor and which as often involve an omission of appropriate behaviour as much as the commission of an inappropriate behaviour. Whether or not to describe such processes as inhibition is a moot point though in fact there is a general lack of agreement in classifying various tasks as involving inhibition or some aspect of attentional malfunction. An interesting example is the Stroop test which has been classified as a measure of response inhibition (Friedman & Miyake 2004) as well as a measure of selective attention (Hervey et al 2004). Nigg, Stavro, Ettenhofer, Hambrick, Miller and Henderson (2005) describe the Stroop test as measuring “...the ability to shift attention and inhibit interfering information.” This description is interesting for its use of the term inhibition in connection with information rather than behavioural response tendencies.

At the level of observable behaviour it is clear that these two varieties of impulsivity, or inhibition, covary to a degree which suggests a common latent variable. Friedman and Miyake (2004) found a correlation between their latent variables of .68 and ADHD.
studies find correlations in excess of .50 between the inattention and hyperactivity/-
impulsivity components of the syndrome (Barkley 2006). Data from two studies
reported in chapter 7 of this thesis found correlations of .55 and .60 between trait
measures of inattention and hyperactivity-impulsivity; those two trait measures correlated
.59 and .51 respectively with the cognitive impulsivity scale of the BIS-11.

The evidence considered in the preceding chapters concurs with this developmental data
in a number of ways; in particular in the identification of a cognitive as well as a
behavioural element within impulsivity and the substantial correlation between the two.
Chapter five explored the relationship between facets of impulsivity identified by the
BIS-11 and ADHD traits in a non-clinical sample, obtaining a substantial overlap in
variance between the two domains.

The aim of the present study was to identify a number of experimental tasks which reflect
predominantly either response inhibition or sustained attention and to relate the factors
derived from a factor analysis of these tasks to self-report measures of inattention and
behavioural impulsivity. If the self-report variables refer to separate underlying functions
then they should correlate differentially with the two sets of tasks; inattention with the
attention regulation tasks and impulsivity with the response inhibition tasks. However if
both inattention and behavioural impulsivity reflect a common underlying variable then
each self-report variables should correlate with both factors.
Experimental design and choice of tasks and measures

As Nigg (2000) has pointed out, it is not clear that all tasks purporting to assess the same cognitive function do in fact tap into the same underlying latent variable. In the majority of cases only one behavioural task is considered and few studies have included more than one such test. The small number of studies which have done so found few significant or sizeable correlations between the different tests which are purportedly tapping into the same function. Rabbitt (1998) argues that inhibition is used as a description of task demands rather than an indication of cognitive functional processes; an argument which is rehearsed in the discussion, chapter nine. To establish the construct validity of a number of tests purportedly of the same cognitive function requires evidence that they rank order a sample of subjects in the same way. Attempts to establish such construct validity have shown only modest success. Kramer et al (1994) gave a number of inhibition related tasks, including a stop task, the Wisconsin Card Sorting Task and a negative priming task to 62 older adults and found correlations ranging from .01 to .35, most of which were non-significant. More dramatically, Shilling, Chetwynd and Rabbitt (2002) in a study of 49 older adults found very low correlations between variants of the Stroop task, ranging from -.13 to .22; all of which were non-significant.

Such results may bring into question the existence of a general inhibitory function, however there are a number of possible reasons for such results. As Shilling et al. (2002) argued, the nature of the tasks typically employed often implies low reliability; either because the tasks are susceptible to strong practice effects or because they rely upon
difference scores which are known to increase measurement error. A second
consideration of validity applies to these tasks - the problem of task impurity (Miyake,
Friedman, Emerson, Witzki and Howarter, 2000). All inhibition related tasks will involve
processes other than inhibition, thus any relationships between the inhibitory processes
will be at least partly masked by individual variance in the other processes.

Miyake et al. (2000) argued for the value of an approach which identifies tasks
involving different hypothesised processes and using these to construct a latent
variable model which is then assessed by structural equation modelling
techniques. Thus Miyake et al. (2000) tested a model which related a number of
cognitive tasks to three executive functions - mental set shifting, information
updating and inhibition of prepotent impulses. Confirmatory Factor Analysis
confirmed that the three executive functions were clearly separable though the
latent variables showed substantial inter-correlations, between .42 and .63. The
inhibition function was defined by performance on three tasks, the Stroop, an
anti-saccade task and a stop signal task. The correlations between these three
inhibition based tasks were low and ranged from .18 to .20; these being all
significant (n = 136, p< .05)

In a later study, Friedman and Miyake (2004) elaborated a model which
distinguished between three inhibition related functions; prepotent response
inhibition (defined by the same three tasks as in the earlier study), a factor,
labelled 'resistance to distracter interference' (defined by the Eriksen flanker
task among others), and a factor of proactive interference. Though the fit statistics supported a model distinguishing between these three clusters of tasks there was a correlation of .68 between the first two latent variables. A composite variable made up of these two factors correlated significantly with the self report Cognitive Failures Questionnaire (Broadbent, Cooper, Fitzgerald & Parkes 1982). Here again correlations between related tasks were generally low; .15, .16 and .23 among the response inhibition tasks (similar in magnitude to the earlier study); .11, .13 and .18 between the distractor interference tasks. All except the lowest of these was significant given the sample size of 220.

Nigg et al. (2005) carried out a similar study in the area of ADHD amongst adults which identified a two factor model of cognitive tasks; an executive function factor and a processing speed factor, the two factors correlating .58. Once again the correlations between the executive function tasks were very low, ranging from .08 to .22, half of which were non-significant. In these three studies the low correlations between variables, typical of much of the literature in this area, nonetheless allowed for an analysis into coherently definable and distinguishable, though related, latent variables.

*Tasks involving response inhibition.*

The Stroop test is variously described as a test of response inhibition, selective attention, interference control and response conflict. Macleod and MacDonald (2000) characterise
Stroop performance as requiring both the maintenance of goal-oriented processing and the suppression of more readily available word reading responses. Kane and Eagly (2003) however argue that the traditional presentation of the Stroop test, in which the incongruent stimuli are presented as a blocked continuous sequence, minimises the demands upon the first of the elements – the effort to maintain the goal in mind. The implication then is that performance on the incongruent condition in the traditional blocked presentation task entails only the suppression of the prepotent reading response.

The Controlled Oral Word Association Test (COWAT) has been used as a measure of inhibition in a number of studies (e.g. Wodushek and Neumann 2003), in keeping with Perret's (1974) suggestion that performance on a word fluency task requires the suppression of habitual word associations (usually semantic) to previous words in a list. Perret (1974) argued, on the basis of data from a group of patients with left frontal lesions, that the Stroop task and the typical word fluency task make similar cognitive demands despite their difference in format and behaviour; in that they both require the subject to suppress an habitual response.

The Hayling Test was developed by Burgess and Shallice (1996) as a measure of efficiency of the separate processes of response initiation and response suppression following frontal lobe lesions; the dimension of interest in the present context being the ability to suppress, or inhibit, an habitual or highly cued response – i.e. to provide a final word to complete a sentence which does not make sense of the sentence.
Tasks involving regulation of attention.

The Sustained Attention to Response Task (SART) was developed by Robertson, Manly, Andrade, Baddeley and Yiend. (1997) as a task which would be sensitive to brief and transitory reductions in attention leading to slips and errors; they argue for a construct of sustained attention which entails transient lapses of attention which may characterise both patients with traumatic brain injury as well as non-clinical subjects who report attentional slips in everyday life. Evidence for the validity of this measure comes from the fact that SART measures showed a stronger correlation to other measures of sustained attention, such as the Telephone Search with Counting subtest (discussed below) than to measures with a strong response inhibitory component, such as the Stroop Test (Robertson et al. 1997).

The Telephone Search with Counting subtest from the Test of Everyday Attention (TEA) is argued by Robertson et al (1994) to be a measure of attention regulation. A factor analysis of the TEA subtests together with a number of other tests of attention found that the Telephone Search with Counting subtest loaded onto a factor which they label sustained attention. In that factor analysis the Stroop test loaded on a different factor, a selective attention factor.

The Digit Symbol Substitution Task from the WAIS-III (Wechsler 1997) was included as a measure of processing speed which would be an element in all of these speeded tasks.
Self report scales

This thesis argues that impulsivity is most fruitfully conceptualised as consisting of two aspects, response inhibition and inattention. As a self report measure of inattention the scale derived from DSM symptoms of ADHD-inattention was used; data in chapter 5 attests to its reliability and validity in a non-clinical sample. The BIS-Short was used as a measure of the standard conceptualisation of impulsivity; the reliability and validity of this scale having been demonstrated in previous chapters. However the BIS-Short also contains items derived from the cognitive impulsivity facet of the BIS-11, a facet which was shown in chapter 5 to overlap considerably with inattention (r = .58), so the BIS-Short was modified for the present study by the removal of 3 items clearly related to the construct of inattention. In this way there were two scales with little obvious overlap in item content.

Study 7

Hypotheses

This discussion has identified a number of tasks which divide into two groups; the first group includes three tasks which are argued to reflect the ability to inhibit a prepotent response (Stroop, Verbal Fluency and Hayling tasks) while the second group reflect the ability to sustain and regulate attention (SART and Telephone Search Task) and the DSST task as a measure of processing speed.
The first hypothesis is that an exploratory factor analysis will separate the experimental tasks according to the a-priori classification into two groups; the Stroop task, Hayling task and COWAT will load onto one factor and the SART and Telephone Search task will load onto the second factor. The DSST as a measure of speed is predicted to correlate with both. The second hypothesis is that the factor scores will correlate differentially with the two self report measures. The third is that the two factor scores will correlate significantly.

Method

Participants
There were fifty-nine participants, twenty-seven male and thirty-two female, aged between 18 and 40 (M = 22.42 years, SD = 3.9 years). The age range was highly skewed (skew statistic = 2.45); while fifty-five (93%) of the sample were 27 or less, there were four participants aged 30, 31, 35 and 40. Thirty-eight of the subjects were undergraduate students and most of the remainder were postgraduate students or researchers. Two exceptions were an administrator and a technician. Four participants were excluded from the analysis because of failure to complete one of the tasks, thus all of the tasks were completed by all of the subjects; there were no missing values.

Procedures
Participants were recruited by public posters around the university campus offering £5 for participation in an experiment. The tasks were administered in two blocks by two
experimenters, each block administered by each experimenter an approximately equal number of times; in the same way the two blocks were administered in an approximately random order. One block consisted of the computer administered SART, the self-report scales and the DSST. The second block consisted of the telephone task, the Hayling task, the verbal fluency task and the Stroop task. Within each block the tasks were administered in a fixed order. The entire procedure took approximately 30 minutes.

Measures

Self report measures.

Impulsivity was assessed with a modified form of the BIS-Short, a short form of the BIS-11, developed for the purposes of the study described in chapter 2. The BIS-Short was modified by the removal of 3 items which were clear instances of attentional problems in order to avoid overlap with the inattention scale; items relating to being able to concentrate and pay attention and the occurrence of extraneous and distracting thoughts while thinking. Reliability for this 8-item scale was .76 while the reliability of the 11-item scale was .81. The 8-item scale correlated .94 with the full-11 item scale. Data relating to the 11-item BIS-Short is taken from chapter 2.

Inattention was assessed utilising a scale derived from Conners et al (1999) consisting of 9 items based upon the 9 symptoms specified by The Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; American Psychiatric Association 1994) as diagnostic of ADHD inattention. This scale was previously used in the ADHD trait study
reported in chapter 5. In the present study item response data indicated that one of the inattention items failed to show an acceptable item-total correlation and was also dropped; the item referred to a dislike of activities where one has to think a lot. The total inattention trait score was the simple sum of responses to all 8 items. Alpha reliability for the inattention scale in the previous study was 0.85 and in the present study 0.80.

Items on both scales consisted of statements which required responses on a 6 point scale ranging from 1 = *never/disagree strongly* to 6 = *very often/agree strongly*. The correlation between the BIS-Short and the attention scale was .69; this was reduced to .54 after the removal of the three items as outlined above.

*Laboratory tasks.*

1. The Stroop Colour-Word test here consisted of two conditions. In the first condition participants were presented with 60 colour blocks arranged in 12 lines of five block each on a single A4 sized sheet; they were required to name the colour of each block. The colours were red, yellow, green and blue spread randomly across the page. In the second condition the stimuli were 60 colour words, red, yellow, green or blue, which were written in incongruent ink colours; e.g. the word red was printed either in yellow, blue or green. In both conditions participants were requested to work across the lines and down the page naming the colour of the ink. They were instructed to work as quickly and as accurately as possible. Their performance was timed with a stop watch. Each condition began with six sample stimuli on the reverse of the sheet which subjects were allowed to
work through as a practice session. Timing on the main task was started when the experimenter turned over the sheet and spoke the word ‘start’; timing ended when the last stimulus was named. The dependent variable was the time taken to read each stimulus, errors were not recorded.

2. The Hayling task as devised by Burgess and Shallice (1996) consists of 30 sentences from which the final word is omitted; sentences were chosen which had a particularly high probability of one particular word for completion. The sentences were divided by the authors into two groups of 15 which served as material for the two sections of the test. In both conditions sentences were read to the participants at a normal reading speed and participants were required to complete the sentence with a single word as quickly and as accurately as possible. In the first condition they were required to complete the sentence with a word which made good sense of the whole sentence, in the second condition they were required to provide a word which made no sense in the context of the sentence. Response latency was timed with a stop watch which the experimenter started as soon as he read the last word and then stopped as soon as the participant began their response. Responses in the second condition were also scored as correct or error responses, as advocated by Burgess and Shallice (1996) A response received an error score of 2 if it was a reasonable completion of the sentence, an error score of 1 if it was semantically connected to the subject of the sentence and an error score of 0 if it was completely unconnected to the sentence. These individual error scores were added to produce an overall error score for each subject. As a check on the reliability of the error
ratings a second rater judged the error rating of responses, blind to the rating of the first judge, for 20% of the subjects; the two raters agreed on the error score in 90% of trials.

3. The Telephone Search Task utilised in this study is a combination of two subtests from the Test of Everyday Attention (TEA: Robertson, Ward, Ridgeway & Nimmo-Smith, 1994). The first task is a simple search of a telephone directory page for certain combinations of symbols. On an A3 size page there are 100 entries for a type of service—e.g. plumber. Each entry is followed by two symbols and participants have to indicate when a certain combination of symbols occurs by circling the symbols, there are 20 target combinations. Time taken is measured by a stop watch which the experimenter starts as he gives the participant the signal to begin and stops when the participant has checked the box at the end of the list of entries. Participants are asked to work as quickly and as accurately as possible. The experimenter also counts the number of targets correctly identified. In the second condition the subject repeats a version of the first task with different stimuli but in combination with another task, counting strings of tones which are presented on a tape recorder. After each sequence of tones the participant hears the words “how many?” on the tape and they must answer correctly. The strings of tones vary from 2 to 7 tones and are heard in the same order by all participants. A practice string of tones is given before the task to ensure that the instructions are understood. The experimenter notes the time taken and errors on the telephone search part of the task as well as the number of tone strings correctly or incorrectly counted.
4. The Sustained Attention to Response Task (SART) as developed by Robertson et al (1997) involved presenting the digits 1 to 9 singly in random order, each digit presented for 250 msec followed by a 900 msec mask. Thus the period from digit onset to digit onset was 1150 msec. Participants were required to respond with a key press to each digit except when the digit 3 appeared, when they had to withhold the response. Participants were asked to give equal importance to accuracy and speed when doing the task.

Robertson et al (1997) presented participants with 225 digits of which 25 were the target digit. The present study modified the procedure to present three variants of the task. In the first condition (900S) the original procedure was followed except that there were only 100 digits overall, 15 of which were the target digit 3. In the second condition (600S) the number and distribution of digits was the same but the rate of presentation was changed; while the time that the digit was presented was unchanged at 250 msec the length of the mask was reduced to 600 msec so that the period from data onset to data onset was 850 msec. In the third condition (600L) the rate of presentation remained the same as the second condition as did the number of target digits but the number of non-3 digits was increased to 125 so that 140 digits were presented in all. The mean time taken for the three conditions was 115, 85 and 119 seconds respectively. Each condition was preceded by a practice session consisting of 12 digits of which 3 were targets. The dependant variables were the number of commission errors (pressing the key to the target 3 digit) and the number of omission errors (not pressing the key to any of the other digits) as well as the response time for correct and incorrect (commission) responses.
5. In the Verbal Fluency Task participants were required to produce as many words as possible beginning with a specified letter within 60 seconds. They were required to do this three times, once with each of the letters F, A and S. Instructions were to not use either proper names or numbers and to avoid using the same word but with a different suffix. Responses were recorded onto audio tape for later analysis. Performance was scored by counting the number of permissible words produced, errors were also scored.

6. In the Digit Symbol Substitution Task there are 9 symbols each paired with one of the digits 1-9 (Wechsler 1997). A single sheet containing 140 symbols distributed randomly in 7 lines was presented to the participants who were required to write the appropriate digit beneath each symbol in spaces provided. Participants were required to work quickly and accurately, from left to right across each line. Performance was scored by simply counting the number of symbols coded; errors were not scored.

Results

The first part of the results section reports the data from the various tasks and assesses whether the data from this study matches the pattern of data found in previous research. The second part carries out an exploratory factor analysis of the six task variables chosen and relates the emerging components to the self report scales of attention and impulsivity.
Stroop task

The classical Stroop manipulation was clearly effective; all subjects took longer on task 2 (the interference condition where colour name and colour of ink conflicted) than task 1 (naming the colour of a colour block). The difference between conditions was highly significant ($t = 9.65, p < .01$), with differences ranging from 5 to 82 sec. The variable ‘Stroop interference’ was computed as the difference between task 2, the interference condition, and task 1. This variable takes into account individual differences in the speed of simple colour recognition and naming and estimates the cost of the interference control required by the second condition. The mean Stroop interference effect was 29.8 with a standard deviation of 23.8.

Table 8.1 Means and standard deviations for Stroop task variables.

<table>
<thead>
<tr>
<th></th>
<th>Min-max</th>
<th>mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop task 1</td>
<td>24-49</td>
<td>35.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Stroop task 2</td>
<td>33-115</td>
<td>65.4</td>
<td>27.2</td>
</tr>
<tr>
<td>interference</td>
<td>5-82</td>
<td>29.9</td>
<td>23.8</td>
</tr>
</tbody>
</table>

The correlation between the two tasks was .66. In keeping with the literature which utilises the Stroop as a measure of interference or inhibition, the interference variable was utilised as the variable to enter into the results model.
The interference effect is evident in that time to complete task 2, where subjects were required to produce an incompatible word, was significantly longer than task 1, where subjects were to produce a compatible word (29 as against 12.5 sec, $t = 7.00, p < .01$.) The mean number of errors in task 2 was also significantly greater than in task 1 (3.14 against .29, $t = 10.01, p < .01$). Five subjects registered negative interference time scores indicating that their time on task 2 was faster than on task 1 and four subjects registered more errors on task 1 than task 2; only two subjects were in both groups. Nevertheless the correlation between time and errors was significant in both conditions (.37 and .30); subjects with longer performance times committed the most errors, implying no trade-off between speed and accuracy; the interference affected both speed and errors. An interference variable was constructed by computing the difference between the time taken to complete the incompatible and incompatible conditions with the aim of estimating the cost of the interference control required by the second condition.

In line with the use of the Stroop the Hayling interference variable was entered into the results model.
Table 8.2 Means and standard deviations for Hayling task variables.

<table>
<thead>
<tr>
<th>Time variables</th>
<th>Mean (SD)</th>
<th>Error variables</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hayling 1</td>
<td>12.5 (4.4)</td>
<td>Errors 1</td>
<td>.29 (.70)</td>
</tr>
<tr>
<td>Hayling 2</td>
<td>29 (12.9)</td>
<td>Errors 2</td>
<td>3.14 (3.14)</td>
</tr>
<tr>
<td>Interference time</td>
<td>16.5</td>
<td>Interference errors</td>
<td>2.85</td>
</tr>
</tbody>
</table>

**Verbal fluency test**

The number of words produced to the F, A and S stimuli were 13.8, 12.4 and 16.1 respectively. The three conditions of the verbal fluency test correlated between .56 and .65 and were simply summated to produce an overall score; mean = 42.6, SD = 11.8.

Though the correlation between number of words produced and number of errors was .27 (p < .05) the number of errors was very small, mean = .56, sd = 1.28. Only two subjects made more than two errors and 70% of the subjects made no errors. Only the number of words variable was entered into the factor analysis.

**DSST**

Scores showed a mean of 83.4 items attempted with a standard deviation of 15.7. The number of errors was small, mean = .46, SD = 1.1. Forty-five of the participants committed no errors and nine committed only one; the remaining five participants committed between 2 and 5 errors. The correlation between number of items checked and errors was non-significant (r = -.20, p = .06, 1-tailed) there was thus no evidence of participants trading speed for accuracy.
Telephone task

Here three variables were computed;

a. time per target (tpt) for both sub-tests as suggested by Robertson et al. 1994.

b. an interference variable, analogous to the interference variable in the Stroop test, was computed by subtracting tpt task 1 from tpt task 2; a measure of the increase in tpt caused by the secondary task.

c. dual task decrement variable which takes into account the number of counting errors on the secondary task as suggested by Robertson et al. 1994.

Average time per target for task 2 was significantly longer than for task 1 (3.1 and 2.7 sec, t = 3.36 p<.01). The number of tone clusters correctly identified in task 2 correlated negatively and significantly with both tpt 2 (r = -.32) and time per task interference (r = -.28); thus again there was no trade-off between accuracy in the two tasks. The interference variable and the decrement variable correlated r = .77, and both correlated highly with the tpt2 (r = .68 and .61 respectively) but non-significantly with tpt1. The decrement variable was highly skewed, (mean = .76, sd=1.41, skew statistic = 2.46): the data provided by Robertson et al (1994) for a control group of subjects also suggest a high degree of skew (mean = 2.03, sd = 3.4) though they do not provide skew statistics.

A number of transformations failed to reduce this statistic to less than 2 so the dual task variable was ranked. This ordinal variable was entered into the results model.
This analysis will concentrate on four variables, two error variables and two reaction time variables, across the three conditions. Errors of commission, or false alarms, the number of times a participant pressed the key when the digit 3 was presented and errors of omission, where the subject failed to press the button when a digit other than 3 was presented. Hit reaction time, the time taken to respond to the non-targets, digits other than 3, and false alarm reaction times, where the subject pressed in response to the target digit 3.

Condition 900S, the baseline condition where each of the 100 stimuli were separated by a 900 msec mask, produced significantly less false alarms (mean = 7.73) than either the 600S condition, in which the inter-stimulus interval was decreased to 600 msec (mean = 9.12, t = 4.01, p < .01) or 600L condition, where in addition the number of stimuli was increased to 125 (mean = 9.39, t = 4.08, p < .01); there was no significant difference between the latter two conditions. Increasing the speed of presentation produced more false alarms but decreasing the proportion of targets did not. False alarms correlated significantly across all three conditions; from .60 to .72. A composite false alarm score was computed by adding the number of false alarms across the three conditions.

The number of errors of omission was very small; in the 900S condition the average number of omissions was 1.1, in the 600S it was 2.0 and in the 600L it was 3.1; thus the percentage of responses missed were 1.3%, 2.4% and 2.5% respectively, of omissions again is in accord with the tendency to respond automatically to the stimuli. A composite omissions score was computed by adding the number of omissions across the three
conditions. There was a significant correlation between the aggregate number of false
alarms and the aggregate number of omissions, .43; those subjects making more false
alarm response also had a tendency to make more omissions.

Hit reaction times were significantly slower in 900S condition (mean = 302 msec) than in
600S (mean = 286 msec, t = 2.85, p<.01) or 600L (275 msec, t = 3.76, p<.01) conditions;
the latter two conditions did not differ significantly. Hit reaction times correlated highly
across the three conditions, from .65 to .77. A composite hits reaction time score was
computed by averaging the reaction time across the three conditions. Hit reaction time
correlated negatively with the number of false alarms in all three conditions, ranging
from -.70 to -.74; the faster the overall speed of responding the more false alarms. The
correlation between the composite false alarm variable and hit reaction times scores was
-.82.

A composite false alarm reaction time variable was created out of the mean of the three
conditions which correlated strongly with the composite hit reaction times variable \( r =
.80 \). Mean false alarm reaction times were significantly faster than mean hit reaction
times (255.38 and 284.00 msec, t = -7.44, df = 58, p < .01).

A composite SART errors variable was created out of the commission and omission error
variables; each variable was standardised and the Z scores added. The composite error
variable was entered into the factor analysis.
Table 8.3 SART results

<table>
<thead>
<tr>
<th>variable</th>
<th>Conditions</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>900s</td>
<td>600s</td>
</tr>
<tr>
<td>Commission errors</td>
<td>7.7 (3.8)</td>
<td>9.12 (3.3)</td>
</tr>
<tr>
<td>Omission errors</td>
<td>1.1 (1.6) [1.3%]</td>
<td>2.0 (2.4) [2.4%]</td>
</tr>
<tr>
<td>Hit reaction time</td>
<td>302 (62.9)</td>
<td>286 (62.2)</td>
</tr>
<tr>
<td>Commission reaction time</td>
<td>262 (43.4)</td>
<td>261 (70.5)</td>
</tr>
</tbody>
</table>

Figures in brackets are standard deviations. Figures in square brackets are percentage scores. Reaction times are in milliseconds.

Exploratory Factor analysis

The aim of this phase of the analysis was first to confirm the predicted distribution of tasks between factors and secondly to use the extracted factors as measures of latent variables which will then be correlated with the self report scales.

The six chosen task variables were subjected to a principal axis factor analysis followed by a promax rotation. The eigen values for the six components were 1.73, 1.46, 1.00, .74, .62 and .45; the first two factors accounting for 36% of the total variance and correlated
Table 8.4 shows the loadings of each variable on the two factors. Factor 1 was defined by SART and telephone search task variables (both positive loadings) and the DSST variable (negative loading), with a secondary negative loading from verbal fluency. This pattern of loadings implies that a high factor score reflects poor performance on these tasks. Factor 2 was defined by the Stroop and Hayling interference tasks and the verbal fluency task with a secondary loading from DSST. The positive loadings of the Stroop and Hayling tasks (which are measures of interference) and the negative loading of the verbal fluency task (where a high score is hypothesised to be a measure of resistance to interference) imply that the component score is a measure of interference; i.e. a high component score reflects a high degree of interference.

Table 8.4 Pattern matrix from factor analysis of laboratory tasks.

<table>
<thead>
<tr>
<th>task</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop</td>
<td>.10</td>
<td>.54</td>
</tr>
<tr>
<td>Hayling</td>
<td>-.14</td>
<td>.54</td>
</tr>
<tr>
<td>Verbal fluency</td>
<td>-.28</td>
<td>-.49</td>
</tr>
<tr>
<td>Decrement</td>
<td>.90</td>
<td>-.19</td>
</tr>
<tr>
<td>DSST</td>
<td>-.50</td>
<td>-.28</td>
</tr>
<tr>
<td>SART</td>
<td>.20</td>
<td>-.05</td>
</tr>
</tbody>
</table>

Factor loadings equal to, or greater than, .30 in bold.

While the loadings of the three tasks onto factor 2 were relatively similar, ranging from .49 to .56, the loadings of the tasks onto factor 1 varied considerably. The high loading of
the telephone search task suggests that the variance captured by factor 1 is virtually identical with the variance attributable to that task. The low loading of the SART task on factor 1 suggests that little of the variance in that task was captured by the factor.

Diagram 8.1 depicts the factor loadings of the task variable scores (loadings less than .20 are ignored) and the Pearson product moment correlations between the factor scores and the self report scales of inattention and impulsivity. Both of the self report scales correlated positively and significantly with factor 1, the correlations were not significantly different (df = 56, t = 0.68)

The response inhibition component did not correlate significantly with either impulsivity or inattention.
Diagram 8.1 Principal Axis Factor analysis. Loadings of tasks upon derived factors and the correlations between factors and the self report measures of impulsivity and inattention.

In the light of the low loading of the SART variable on factor 1 and the lack of any significant correlations of SART with variables (see table 8.4 below) a secondary factor analysis was carried out of the five tasks minus the SART variable (reported as figure x)
in appendix.), the results of that analysis correspond to the primary analysis except for the absence of the SART variable. Factors 1 and 2 are defined by the same variables and the correlation of factor 1 with the impulsivity and inattention are almost exactly the same.

Nigg et al. (2005), in the analysis of their data, drew attention to a processing speed factor operating in the laboratory tasks which they employed, a factor which they identified by the Stroop and Trails non-interference conditions. The equivalent tasks in this study are the Stroop 1, Hayling 1 and Telephone 1 tasks; these were subjected to a principal components analysis and a single component score computed, this first component accounted for 45% of the variance. The eigen values were 1.35, .93 and .72.

Due to the loading of the relevant tasks a high component score indicates a low processing speed. This processing speed component correlated significantly with both the attention regulation and the response inhibition factors (r = .38 and .28 respectively) as well as with DSST performance (r = -.51); thus both factors 1 and 2 involve an element of speed. Low processing speed is associated with a high degree of both attentional failure and response inhibition failure. However the processing speed component did not correlate significantly with either the inattention or the impulsivity self report variables (though this latter correlation was just short of significance); consequently partial correlations between the attention regulation factor and both inattention and impulsivity (.28 and .33 respectively) remained significant when the processing speed component score was partialled out.
Table 8.5 depicts the zero-order correlations among factor scores, the task variables and the self report measures. Correlations between the inattention variables range from .17 to .38; between the response inhibition variables they range from .25 to .29. These compare favourably with values reported in the research described above. Note that while factors 1 and 2 were derived from the analysis of all six tasks, component 3 was derived from a separate analysis as described above.

Table 8.5 Pearson product moment correlations between factor scores and task variables and self report data.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Factor 1</td>
<td>.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Factor 2</td>
<td>.38</td>
<td>.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Component 3</td>
<td>.07</td>
<td>.70</td>
<td>.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4. Stroop</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Hayling</td>
<td>-18</td>
<td>.70</td>
<td>-08</td>
<td>.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. VF</td>
<td>-27</td>
<td>-62</td>
<td>-34</td>
<td>-29</td>
<td>-25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. DSST</td>
<td>-82</td>
<td>-33</td>
<td>-51</td>
<td>-22</td>
<td>-05</td>
<td>-23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. SART</td>
<td>-22</td>
<td>.06</td>
<td>.18</td>
<td>-02</td>
<td>.05</td>
<td>.01</td>
<td>-17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Dual task</td>
<td>.98</td>
<td>-30</td>
<td>.29</td>
<td>-05</td>
<td>-27</td>
<td>-38</td>
<td>.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. impulse</td>
<td>.39</td>
<td>.01</td>
<td>.25</td>
<td>.06</td>
<td>-14</td>
<td>-25</td>
<td>-19</td>
<td>.08</td>
<td>.38</td>
<td></td>
</tr>
<tr>
<td>11. inattention</td>
<td>.31</td>
<td>.04</td>
<td>.14</td>
<td>.02</td>
<td>-13</td>
<td>-08</td>
<td>-24</td>
<td>.22</td>
<td>.29</td>
<td>.54</td>
</tr>
</tbody>
</table>

Correlations of .25 and above are significant; p < .05 in bold type.

The correlations between task variables and factor scores largely reflect the factor loadings, though the correlation between the telephone task variable and the factor score
is now near unity; consequently the correlations of the self report scales with factor 1 were almost exactly the same as with the telephone task.

A secondary analysis of the data involved dividing the sample into extreme groups on the two self report variables. The sample was divided approximately into thirds according to the distribution of scores. Thus the lowest third and the highest third for each of the two self report variables were compared on the six tasks. These results paralleled in large part the correlation data in Table 4, the only exception being the results for the DSST task.

The high and low impulsivity groups differed significantly, mean scores of 79.2 and 91.4 respectively (df = 2, 38, t = 2.51, p < .05). There was also a significant difference between the high and low in-attention groups with mean scores of 77.0 and 87.8 respectively (df = 2, 39, t = 2.24, p < .05). High scorers on impulsivity and on inattention performed less well in the DSST task.

Discussion

The essential findings of this study relate to the relationships between the self report measures of the behavioural phenotypes of inattention and impulsivity and the laboratory tasks as measures of cognitive functions. Both inattention and impulsivity correlated with the DSST and the telephone search task; in addition impulsivity correlated with the verbal fluency task. This pattern of relationships suggests that the correlation between inattention and impulsivity at the level of every day behaviour is echoed in their common cognitive processes. Of these five significant relationships, four involve the
hypothesised attention regulation tasks and only one involved a response inhibition task. Neither the Stroop task nor the Hayling task showed a significant relationship with either of the self report variables.

Following the suggestions of a number of theorists, discussed at the beginning of this chapter, the tasks were subjected to an exploratory factor analysis to produce factors which would represent the common variance shared by the tasks, which factors could then be interpreted as a latent variable affecting each task. As hypothesised, the purported attention and response inhibition tasks loaded onto two different and uncorrelated factors. A third component was extracted from the non-interference versions of the Stroop, Hayling and telephone tasks; which component may be surmised to be a processing speed component. This component correlated .38 and .28 with factors 1 and 2 respectively, suggesting a speed element common to all the tasks — which were indeed all speeded tasks. The two self report measures, impulsivity and inattention, correlated approximately equally with the attention regulation component (.39 and .31), and close to zero with the response inhibition component.

The results of the exploratory factor analysis ‘confirmed’ the grouping of the tasks based upon the hypothesised latent variables (or hypothetical constructs) - attention regulation and response inhibition. While the grouping of the tasks does not in itself define the nature of the latent variables it is at least consistent with the hypothesised scheme. The response inhibition factor was defined by the Hayling task, the Stroop task and the COWAT. The Hayling task would seem to be a relatively clear instance of a task
requiring response inhibition; the majority of errors are prepotent responses - words which are highly likely to occur in that particular context, suggesting that the extra cost involved in the interference condition is due to the cognitive effort entailed in suppressing or inhibiting the prepotent response. The Stroop task, despite its multifarious designations, is argued by McCloed and Macdonald (2000) to crucially require the suppression of prepotent word reading responses. While the role of response inhibition in the COWAT is more debatable its position on the factor structure supports its commonality with the other two tasks.

Among the tasks loading on attention component the telephone search task would seem to be a clear case of attention regulation; Robertson et al (1994) found it to load strongly onto a factor along with two other tests of sustained attention from the Test of Everyday Attention. The SART is argued by Robertson et al (1997) to be a function of sustained attention though it bears considerable similarities to Go/no-Go tasks reported in the literature which are considered as involving response inhibition. In support of their argument is the high negative correlation obtained in this study between hit rate reaction time and number of commission errors (false alarms) such that subjects who made rapid correct responses (hits) also tended to make more incorrect responses (false alarms). A comparison of response times found the false alarm reaction times to be significantly faster than the hit response times, this is consistent with the suggestion by Robertson et al (1997) that false alarms occur because responding becomes automatic and inattentive as indicated by their finding of fast response times before a false alarm. The positive correlation between the number of false alarms and the aggregate number of omission
would seem to argue against false alarms being a consequence of automatic responding; it was however the experimenter's impression that omissions were particularly likely to occur after a subject had 'caught themselves making a false alarm. To assess this possibility as well as the possible speeding up of responses before a false alarm would require the tracking of response times across trials, which the present data do not allow. It should be noted that while Robertson and Garavan (2000) referred to the SART as involving a dynamic interaction between inhibitory abilities and sustained attention there are near zero correlations in this data between the SART and any of the response inhibition tasks.

The DSST loaded onto both factors 1 and 2 (-.52 and -.33); it also correlated substantially (.51) with component 3 which was made up of the simpler speeded tasks. Given the lack of correlation between factors 1 and 2 it would seem that there are two non-overlapping areas of variance within DSST performance which may be identified with the two factors. The variance in DSST performance which overlapped with factor 1 (attention regulation) was thus not the variance shared with factor 2 (response inhibition) nor with the speed component, as shown by the partial correlation of DSST with factor 1 of -.42 after partialling out factor 2 and the speed component.

While the correlations between the tasks within each factor were low in magnitude - .17, .18, .38 for the inattention tasks and .25, .25, .29 for the response inhibition tasks - they compare favourably with the magnitude of correlations reported in previous studies; across two studies which identified a response inhibition factor the correlations between
the tasks making up that factor ranged from .18 to .23 (Miyake et al 2000, Friedman & Miyake 2004).

The two self report measures, impulsivity and inattention, were highly correlated ($r = .54$, dis-attenuated $r = .70$ on the basis of alpha reliabilities) and correlated approximately equally with the attention regulation factor, .38 and .30, suggesting that it is the variance they share which relates to the attention regulation component. Such a conclusion concurs with the data from ADHD studies which fail to differentiate between the inattention and impulsivity sub-types by cognitive tasks in either the child or adult literature (Nigg et al 2002, Murphy et al. 2001). The magnitude of these correlations compares favourably with those of Nigg et al. (2005) who, in a study of adult ADHD cases, obtained correlations between their executive function composite and ADHD rating scale measures of inattention of .28 and hyperactivity/impulsivity of .19; both correlations being significant.

The present sample was unlikely to manifest traits of either inattention or impulsivity at all comparable to either ADHD patients or to other disorders of impulse control; but that does not explain the difference between the two factors in their relationship with the self report scales. While the impulsivity scores were normally distributed, inattention scores were positively skewed (.18 and .79); however removing the three highest inattention scores (which reduced the skewness statistic to .02) did not affect the correlations of interest.
Both factors 1 and 2 involve an element of speed; all the tasks are speeded though the majority are self paced, the exception is the SART task. The tasks themselves are scored in such a way that a high level of the factor indicates poor performance. For example factor correlates positively with the degree of decrement due to the second task in the telephone task and with the number of false alarms in the SART. This factor correlated positively with impulsivity; i.e. impulsive participants are likely to be both slower and to make more errors on such tasks. In all tasks there was a negative relationship between speed and errors – rather than there being a trade-off between speed and accuracy, slower performance went with more errors. In some cases errors may have caused a slowing; in the Stroop task participants rarely make errors without then correcting themselves. The importance of a speed factor is shown by the correlation of component 3 with factors 1 and 2. The tasks in Component 3 were scored such that a higher score indicates a slower speed, thus the positive correlation between factor 3 and the other two factors suggests a relationship between speed of processing and task performance.

Component 3 correlated significantly and positively with the impulsivity scale but not with the attention scales, suggesting that impulsive subjects responded more slowly on simple speeded tasks. However the correlation between factor 1 and both impulsivity and inattention was reduced only marginally after partialling out the speed component (.33 and .28 respectively) and remained significant. Other researchers, e.g. Dickman (2000), have pointed out that impulsive individuals are slower at speeded tasks despite the common perception that impulsive people respond quickly. It seems likely that
apparent speed of response in impulsive people is due to premature responding rather than rapid responding, which is then likely to lead to error. However it was not the effect of impulsivity with speed of response which determined its relationship with the attention regulation factor.

Depending on the nature of the task it is also possible that inattention would lead to slower responding. Perhaps paradoxically in the SART there was a significant negative correlation of -.28 between hit reaction time and the inattention scale, implying that those scoring higher in inattention responded more quickly when making correct responses; this does however fits with Robertson et al’s (1994) argument that false alarms are due the subject tending to respond automatically.

One of the most interesting findings in these data is that the two self report measures, of inattention and impulsivity correlated equally with the inattention component; a finding which supports the hypothesis that these two behavioural phenotypes express the same underlying variable. This finding also fits with the model of impulsivity maintained throughout this thesis which consists of two correlated facets subsumed by a higher order variable.

Further interpretation as to the nature of the underlying variable depends upon the meaning of the variable identified in the factor analysis; this has important implications for the exploration of the cognitive processes underlying impulsivity. Robertson and his colleagues describe both the SART and the telephone task used in this study as tests of
sustained attention (Robertson et al., 1997 and Robertson et al., 1994), however the two
tasks did not correlate significantly. Nor did the SART correlate with either of the self
report scales, a finding which echoes that of Whyte, Grieb-Neff, Gantz and Polansky
(2006) who found no significant correlation between the Cognitive Failures
Questionnaire (Broadbent, Cooper, Fitzgerald & Parkes, 1982) and SART errors of
either commission or omission in a non-clinical group.

While the DSST correlate significantly with the telephone task it did not correlate
significantly with the SART. This, together with the factor loadings suggests that the
extracted factor primarily reflects the telephone task and secondarily the DSST. A
supplementary factor analysis omitting the SART produced two factors which correlated
very highly with the factors from the analysis containing the SART (both $r = .99$). the
correlations between the factors and the

The purpose of this study was to begin to identify cognitive processes which underlie the
phenotype of impulsivity. The aim of the factor analysis was to identify the variance
shared by laboratory tasks and to relate that shared variance to self-report measures of
impulsivity.

The factor analysis identified two factors which captured the variance shared by two
clusters of tasks which were hypothesised to involve regulation of attention (factor 1) and
inhibition of pre-potent behaviour (factor 2). The first of these correlated significantly and
equally with both of the self report scales but the second did not correlate with either of the self report scales not with the first factor.

The reason for the lack of any significant correlation between the second factor and either of the impulsivity scales is unclear. Woods et al. (2002) identified Stroop Tsk and COWAT among a number of behavioural inhibition tasks differentiating between adult ADHD patient and control groups; however Nigg et al. (2005) failed to find a correlation between their Stroop interference measure and either of the ADHD symptom domains.

The correlation between the attention regulation factor and both of the self report scales support the proposal of Dickman (2000) that impulsivity involves problems of attention. Factor 1 correlated very highly with the telephone task from the TEA (Robertson et al., 1994); the cognitive processes producing individual differences in this task are related to individual differences in impulsivity. Exploration of this task and other cognate tasks should help to identify the cognitive processes which produce impulsive thought and behaviour.
Chapter 9

Discussion

- The broad goal of this thesis has been to explore and explain the nature of impulsivity. The first aim was to clarify the nature of impulsivity; to define it in terms of what it is and what it is not – this latter being achieved through the differentiation between impulsivity and closely related traits.

- The second aim was explore the structure of impulsivity as a hierarchical construct whereby a higher order trait of impulsivity subsumes two or more correlated sub-traits or facets.

- The third aim was to establish the importance of impulsivity as a predictor of behaviour independent of its overlap, the variance shared with a standard model of personality. This was done firstly by exploring its relationship with the Big Five traits of personality and secondly by examining a model of impulsivity which sought to reduce impulsivity to the operation of aspects of those Big five traits.

- The fourth aim was to explore the relationship between impulsivity traits and ADHD traits as a way of shedding light upon the nature of impulsivity and to
bring out the importance of 'cognitive' impulsivity, in particular the role of inattention and distractibility for the construct of impulsivity.

• The fifth aim was to explore the cognitive underpinnings of the two aspects of impulsivity in an experiment utilising tasks related to inattention and impulsivity.

Chapter 1 argued that despite persistent claims that there is little agreement as to the nature of impulsivity or its measurement there is in fact general agreement upon a narrow construct of impulsivity which is characterised by weakness of inhibition. The research considered in Chapter 1 suggests that an emphasis upon failure of inhibition would clarify the construct of sensation seeking by separating out the relatively benign aspect of sensation seeking, described as venturesomeness, sensation seeking or functional impulsivity, from the maladaptive aspects such as boredom susceptibility and dysinhibition. Sensation seeking and the reward sensitivity characteristic of extraverts is not in itself impulsivity. In the light of evidence suggesting a differentiation between impulsivity and sensation seeking a suggestion was made to modify the sensation seeking construct of Zuckerman to align it more clearly with narrow impulsivity. This narrow construct (weakness of inhibition) can be found operationalised in a number of self-report measures of impulsivity; an examination of research studies comparing different scales indicated their substantial shared variance.

Chapter one attempted to clarify a narrow construct of impulsivity which could be differentiated from high level traits such as neuroticism and extraversion and from lower
level traits such as adventurousness and this same research suggested a multi-faceted, hierarchical, model of impulsivity consisting of two or three correlated lower level facets subsumed by a higher level construct.

Nigg (2001) argued cogently for the distinction between inhibition of behaviour in the service of plans or goals – where failure of inhibition is maladaptive – and inhibition which is due to fear or anxiety – where inhibition itself can be maladaptive. Following the argument of Depue and Collins (1999) who argue that a biologically rooted variable should be unipolar rather than bipolar it could be argued that there are two types of inhibition, two independent traits which can occur in any combination; in the same way that the variables of positive and negative affect are independent and indeed unipolar. The potential conflict which can occur in anxious and disinhibited individuals is perhaps captured by the construct of borderline personality. Here again one is reminded of the limitations of the FFM which assumes the bipolar nature of the Big Five though without further analysis. While many theorists would recognise the commonality between extraversion and positive affect, the former is generally treated as a bipolar trait while the latter is usually considered a unipolar trait. On the other hand the trait of neuroticism – like the trait of negative affect is, at least implicitly, considered a unipolar trait.

Chapter 1 also considered research which suggested that questionnaire studies of impulsivity, while arguing for a relatively narrow construct of impulsivity, nevertheless allowed for a sub-division of impulsivity into facets. While most of the questionnaires converged on a common construct of impulsivity there was less agreement on the nature of the facets. Some instances of faceted models of impulsivity are deceptive; Eysenck
does not identify two facets of impulsivity but rather two traits, impulsivity and venturesomeness, which he locates in different and independent areas of his PEN model. Similarly Dickman's model of functional and dysfunctional impulsivity is misleading since they are independent traits with the former being more related to extraversion and the relatively benign form of sensation seeking. A few studies have endeavoured to separate out facets of impulsivity with some success. Parker, Bagby and Webster (1993) after establishing the substantial variance shared by three different self report questionnaires concluded from their analysis that it was possible to differentiate two highly correlated dimensions — a cautious/spontaneous dimension and a methodical/disorganised dimension. The Barratt Impulsiveness Scale has undergone continuous development in the light of its clinical application in particular; in its latest form, the BIS-11 (referring to its 11th incarnation) contains three substantially correlated facets. These facets however cannot be easily identified with the Parker et al (1996) facets.

Chapter 1 identified the BIS-11 as perhaps the most fruitful questionnaire measure of impulsivity, given its extensive validity in both normal and clinical research. Study 1 in Chapter 4 carried out a factor analysis to replicate the factor structure of the BIS-11 reported by Patton et al. (1995). The development of such a scale over time and its validation in a variety of research projects has provided evidence not only for the utility of the questionnaire but also for the underlying model of a three facetted model of impulsivity. This study was the first attempt at replication of the factor structure in the
English language; the factor structure obtained provided a close replication of the three sub-factors proposed by Patton et al (1995). Correlations between the extracted factors ranged from .55 to .68; these substantial correlations accord with the hypothesised hierarchical model of three lower level factors subsumed by a higher order factor. Furthermore the factor scores correlated very highly (.87 to .94) with the scale scores derived from the analysis of Patton et al (1995). The value of this replication lies not only in the replication of the factor structure but also in its confirming the existence and importance of a cognitive dimension to impulsivity; an impulsivity of attention as well as behaviour.

Study 1 also aimed to clarify and simplify the original version of the BIS-11. In the factor analysis of the 30 items of the BIS-11 the pattern of factor loadings led to the identification of six items from each facet as a reduced version of the original. The value of these new scales was shown by the high correlations with the Patton et al. (1995) defined scales and with the factor scores from the analysis of the BIS-11. These high correlations are of course attributable to the fact that the present analysis identified factors in terms of the same items as the original Patton et al (1995) analysis; nevertheless the degree of correspondence across two data sets is striking. These short form scales were used in the following studies.

A single factor extraction allowed for the identification of 9 items with high loadings on the first factor and which represented equally the three facets; factor analysis of the BIS-
Short produced evidence for a single factor; that plus the three factors identified in the full scale. The correlations between the BIS-Short and the scales defined by Patton et al. (1995) ranged from .68 to .80 and correlated with the new facet scales developed in study 1 between .72 and .78; the BIS-Short correlated .89 with the 30 item BIS-11. Factor analysis of the nine item BIS-Short suggested a single factor solution. These data support the use of the BIS-Short as a convenient measure of 'narrow impulsivity' and its facets. It should be noted however that the new scales require cross validation in a new sample.

The implication of these results for an understanding of the nature and structure of the variable impulsivity (rather than of a particular measure) are interesting but far from definitive. The factor structure of any measure is determined in large part by the items or elements included in that measure; while many studies of the Big Five rest their legitimacy upon the widest selection of possible items, the items of more focussed scales tend to be selected to represent a particular construct pursued by the researchers. There are a number of concerns with regard to the choice of BIS-11 items; in particular there are a number of cases of item redundancy. Of the six items identified in the factor analysis as the best examples of factor one (non-planning impulsivity), three begin "I plan..." Scrutinising the items making up the motor impulsivity scales suggests that two highly correlated (.66) items make up the core of that factor. These are in fact instances of the weaknesses of the factor analytical approach discussed in chapter 2. Nevertheless the questionnaire data does allow for the identification of a cognitive aspect to impulsivity; failures of attention and concentration and a susceptibility to extraneous and racing thoughts are as much a part of impulsivity as saying things or doing things without
thinking. This emphasis on cognitive impulsivity echoes the role of attentional
disinhibition identified in the study of ADHD as well as the perseverance trait identified
by Whiteside and Lynam (2001).

Apart from Parker et al. (1996) there has been no attempt to map the entire terrain of
impulsivity—a strategy akin to the explorations of personality which attempt to
encompass as much of the natural language lexicon as possible. Part of the reason may be
that the analysis of trait adjectives is less fruitful the lower one descends in the trait
hierarchy—witness the odd and probably artefactual effects in the Roberts et al (2004)
analysis. The analysis of a large number of items, adjectives or sentences, has not yet
been tried; the analyses of Parker and Bagby (1996) and of Whiteside and Lynam (2001)
both analyse the relationship between scales.

The field remains open therefore for an attempt both more thorough and more refined to
map out the contours of impulsivity through the analysis of a large number of descriptors.
While utilizing previous questionnaires provides a valuable resource there are surely
ways of casting the net more widely, in terms of both items and subjects. The analysis of
the BIS-11 relied to a large extent upon student subjects who were likely to be not
excessively high on impulsivity and without serious psychopathology. Recruiting
subjects who are likely to display high levels of impulsivity will help to bring the domain
of impulsivity into clearer focus.
Following the lead of Whiteside and Lynam (2001), items could be chosen, or constructed, so as to tap into the 'hot' impulsivity characteristic of personality disorders.

For example, Study 1 utilises a scale of emotion regulation devised by the author to tap into a sense of not understanding or not being in control of one's emotions; this scale correlated substantially with the BIS-Short. Alternatively, people who describe themselves as impulsive could be asked (with appropriate guidance and perhaps examples) to provide instances of their own impulsive behaviours which may not figure in any extant questionnaires; for example while non-planning is a recognised aspect of impulsivity it is also true that impulsive people may make many plans but fail to carry them out or change them on a whim. This inability to follow through plans may or may not be related to either the construct of perseverance (Whiteside and Lynam, 2001), or to that of delay aversion (Solanto et al. 2001). While there is no set corpus of impulsivity items, as there are trait adjectives in various languages, trawling more widely may raise interesting insights into neglected varieties of impulsivity.

Chapter 2 argued for the need to examine the relationship of impulsivity to the Five Factor Model of personality and in the process argued for a critique of the limits of the trait approach to personality. The weaknesses of the personality trait approach to the study of impulsivity is its purely descriptive approach and its treatment of all traits as independent variables at whatever level of a hierarchy of personality they may occur. Embedding the trait of impulsivity within a large scale model of personality thus tends to deflect attention away from an understanding of the nature and causes of impulsivity. The problem of constructing models which, at least to some extent, reflect semantic rather than psychological constructs has its counterpart in research which demonstrates
relationships between variables which are merely re-descriptions of the variable to be explained. Demonstrating that syndromes such as borderline personality disorder are characterised by high levels of negative affect is simply to re-describe the diagnostic criteria. Nevertheless, as pointed out in chapter 2 there can be considerable utility in studying the relationship between impulsivity and other traits when guided by theoretical rather than merely descriptive considerations.

Studies 2 and 3 in chapter 5 demonstrated that impulsivity could not be subsumed by any or all of the Big five traits. Not only did the trait of impulsivity, as measured by the short form of the BIS-11 developed in chapter 4, include variance which was not encompassed by the Big Five but that distinctive variance proved to have incremental validity in the prediction of a number of variables which would be considered on both empirical and conceptual grounds to be a function of impulsivity. This occurred despite the large amount of variance which impulsivity shared with the Big Five and with conscientiousness in particular.

Study 2 demonstrated incremental validity of the BIS-Short over a particular measure of the Big five – the BFI – in the prediction of measures of academic performance as well as a self report measure of alcohol consumption in first year female undergraduates. Previous research had established a link between maladaptive behaviours in students and both impulsivity and conscientiousness; by studying both of the predictors in the same study it was possible to replicate those previous findings and demonstrate the distinctive contribution of impulsivity.
Study 3 involved a partial replication of study 2 testing the same hypotheses but utilising a different set of variables. The measure of the Big Five was a composite measure derived from two different self-report questionnaires – the NEO-FFI and the BFI. While different measures of the Big Five do share substantial variance the correlations between them suggest differences in emphasising different aspects of the same trait; utilising two measures makes more likely a more thorough coverage of each trait. The measure of alcohol consumption was the same as in study 2 and the very similar relationships between the variables across the two studies inspired confidence in the results. In addition study 3 included a peer report measure of alcohol consumption and self-report measure of driving behaviour. In regression analyses impulsivity added to the variance predicted by the Big Five to each of the outcome variables.

The aim in these two studies was to show that a measure of impulsivity would predict conceptually related outcome criteria and that it would do so as least as well as any of the Big Five traits which shared variance with impulsivity. The aim was not simply to demonstrate the incremental predictive validity of a lower level trait but to begin to explore the relationship between impulsivity and the Big Five, particularly conscientiousness. The data reported in these studies suggest a number of avenues for further investigation.

Studies 2 and 3 while demonstrating the distinctive nature of impulsivity leave open the question of the relationship between impulsivity and the other Big Five traits. One
possibility is that impulsivity may be the core trait which binds together the facets of conscientiousness in the same way that Lucas et al (2000) propose that reward sensitivity binds the facets of extraversion. The theoretical interest in this possibility is that impulsivity may well be a more basic temperamental trait with clear links to neuropsychological factors while conscientiousness is a product of a number of additional factors such as socialisation into a work ethic, a sense of responsibility to others, or of a commitment to a career or organisation. The relationship between impulsivity and its cognates and values and attitudes such as a strong work ethic may be that the former traits would be a necessary condition for the development of the latter but they would not be sufficient. This is a more complex and theoretically interesting relationship than simply grouping all of these facets under a larger umbrella trait and affords richer possibilities for the development of causal models.

The use of impulsivity as a lever to open up conscientiousness may reveal a bifurcation between behaviours such as impulsivity, distractibility, disorganisation and carelessness and more sophisticated traits such as responsibility, achievement and order; a bifurcation between traits of temperament and traits of personality (Martel and Nigg, 2006). Among other possibilities one may explore the relationship between instances of careless behaviour and the traits of inattention and disorganisation and the trait (or facets) of agreeableness; irresponsible behaviour may be a product of either cognitive failure or of negative attitudes towards the organisation. The relationship between impulsivity and workplace behaviour may be particularly obvious in adolescents and young adults in the
same way that Barkley et al. (2002) find a relationship between ADHD symptoms and work behaviour.

Chapter 5 confronted a challenging approach to conceptualising impulsivity proposed by Whiteside and Lynam (2001); a proposal to deconstruct the concept of impulsivity. Their argument is that there is no latent variable, that the construct of impulsivity has value only as a description of behaviour – behaviour which is usually carried out without appropriate aforethought and which is usually regretted afterward – but does not imply that all instances of impulsivity are caused by a single underlying trait nor that they serve the same function. A parallel may be drawn with approaches to aggressive behaviour; an instance of aggressive behaviour may be caused by different factors (fear or anger), may serve different purposes (defence, robbery, to impress others, to win a boxing match), and may manifest in various forms (verbal or physical, direct or indirect).

Whiteside and Lynam utilise the conceptual framework of the Big Five and its facets as operationalised by the NEO-PI-R. After an attempt to map out the terrain of impulsive behaviours – through an analysis of a number of impulsivity related scales - they identify four sources of impulsivity behaviour. Two of these are typically identified as aspects of impulsivity – a lack of premeditation and a lack of perseverance; people who are characterised by these traits will typically behave in ways described as impulsive. The authors identify these impulsivity traits with two facets in the domain of conscientiousness - deliberation and self control respectively. Their argument seems to be that the lack of premeditation typically identified in studies of impulsivity is in fact the
personality trait of deliberation; indeed in subsequent research they are willing to use these NEO facets as proxy measures of impulsivity. What is not altogether clear is the theoretical implications of this approach; implications depend on how one conceptualises the relationship between facets and domains within a structured hierarchical model of personality. If one sees facets as types of behaviour which correlate to a substantial degree such that they form part of a higher order trait then the theoretically neutral conclusion might be that impulsivity (as identified by the two facet scales) correlates with other aspects (facets) of conscientiousness. To put it another way; the NEO already contains a measure of impulsivity — note that the two facets of deliberation and self control are highly correlated. A more theoretically committed view of personality models might, on the other hand, argue that all of the facets of conscientiousness are influenced by, or are manifestations of, a common underlying variable — conscientiousness. It seems to the present author that this more theoretical model is implicit in the writing of Whiteside and Lynam and it is this which gives force and theoretical import to their deconstruction of impulsivity. As argued above, a commitment to such an explanatory model would raise interesting questions as to the nature of the latent variable, question which would go beyond simply noting the shared variance.

Their identification of a complex of behaviours which they refer to as urgency — impulsive behaviours which are driven by strong negative affects raises a number of interesting issues. The first is the issue of differentiating between impulsive behaviour which is the effect of strong impulses and impulsive behaviour which is the consequence of weak inhibition; or which may indeed be a mixture of the two. This last point raises
the second issue of whether urgency should be seen as a simple unitary trait or whether it can be understood as a mix of, or an interaction between, two separable traits; in this case an interaction between negative affect and narrow impulsivity. A further point is that the data of Whiteside and Lynam (2001) as well as the data from Study 4 are not incompatible with a higher order impulsivity which subsumes premeditation and perseverance and which interacts with neuroticism to produce urgency.

The neuroticism facet of impulsivity (which Whiteside and Lynam identify with urgency) has the lowest correlations with the other neuroticism facets from -.31 to .40, while it correlates -.37 and -.46 with self discipline and deliberation from the conscientiousness domain. Data from Study 4 showed urgency to correlate moderately with both premeditation and perseverance (-.40 and -.37) despite their positioning on an orthogonally related dimension. The data from Study 4 supported the hypothesis that urgency is a function of both neuroticism and narrow impulsivity. Regressing urgency simultaneously onto the composite neuroticism measure and the BIS-Short found the two variables to contribute approximately equally to the 61% variance explained. The joint correlation of .78 between urgency and the two traits compares with the correlation usually obtained between two measures of the same trait; John and Shrivastava (1999) found the highest correlation between BFI and NEO-FFI traits to be .79.

Notwithstanding the above criticism the identification by Whiteside and Lynam (2001) of a trait which they call urgency seems fruitful and requires further investigation. While it may not be the case that there is a distinctive unitary trait behind such ‘urgent’
behaviours which is entirely accounted for by negative affect, there are clearly
behaviours which are 'pushed' by strong negative emotions so that people will lash out
verbally or physically without sufficient aforethought and then regret having done so.
What is at issue from the point of view of the present thesis is whether it is still possible
to identify the influence of a narrow, affect free impulsivity interacting with strong
affective reactions and cognitions to produce a 'hot' impulsivity. Such hot impulsivity
may help to explain the wild swings of mood and attitude characteristic of certain
personality disorders, as suggested by Depue and Lenzenweger (2005). Within the
domain of the treatment of psychopathology there is scope for experimental interventions
aimed at either the negative affect or the impulsivity element of disorders such as
borderline or narcissistic personality disorder.

Chapter 1 argued for the relevance of ADHD research to the understanding of
impulsivity; Studies 5 and 6 in Chapter 7 had two aims; the first was to validate the use of
ADHD trait scales in normal subjects and the second was to explore the relationship
between ADHD traits and the traits of impulsivity derived from the BIS-11. Conjoining
the two areas of investigation is of considerable theoretical and heuristic value
particularly for the study of impulsivity as a personality trait. Firstly it draws attention to
problems with attention and distractibility as well as the more overt instances of
impulsive behaviour emphasised by theorists of impulsivity. Secondly, it links the rather
narrow trait approach described in chapter 2 with the more complex theoretical
framework of ADHD which aspires to the causal modelling approach discussed by
Morton and Frith (1995). Thirdly, it encourages research into the possibility of
interactions between impulsivity and other traits, particularly negative affect. As discussed in Chapters 2 and 6 explanations within the five factor model generally treat traits, at whatever level of the personality hierarchy as independent traits, making merely additive contributions to behaviour; within the study of developmental psychopathology there is an awareness of the interaction between effortful control and negative affect during early childhood to affect the development of emotion regulation.

In both studies Conner's ADHD scale was factor analysed; when two factors were extracted the grouping of the items into factors paralleled almost exactly the division of symptoms in DSM-IV, a division which identified the inattention and the hyperactivity-impulsivity subtypes. Further evidence for the validity of these trait scales came from correlations between self and peer reports. The dimensions which emerged from constructing two scales behaved like typical personality traits; they were slightly positively skewed, typical of trait measures of 'problem' behaviours but no more so than some of the Big Five personality traits in this study. Furthermore their relationships with other variables were invariably trait-like; the scattergram of inattention against conscientiousness showed a clear relationship across the range of both variables. These data are in accord with the research of Frazier et al. (2007) who found no evidence for the taxonomic structure of ADHD and that of Sherman et al. (1997) who concluded that ADHD should be treated as two quantitative and continuously distributed dimensions.

Studies 5 and 6 replicated the pattern of relationships between the two ADHD dimensions and the Big Five personality traits obtained in previous research whereby
inattention was predicted predominantly by conscientiousness and secondarily by neuroticism while hyperactivity/impulsivity was predicted by extraversion, agreeableness, neuroticism and conscientiousness. In both of the studies, and commensurate with the earlier research, the overlap between inattention and conscientiousness was greater than that between hyperactivity and conscientiousness. Despite the covariance of ADHD and Big Five traits an overall measure of ADHD derived from both sub-traits demonstrated incremental validity in the prediction of driving behaviour and alcohol consumption.

The relationship between impulsivity and the traits of ADHD suggest a number of lines of investigation particularly into driving behaviour. The data in study 6 indicate that driving errors are strongly related to the cognitive-inattention aspect of impulsivity; suggesting that further investigation into the driving errors of young adults at the beginning of their driving career would be fruitful. One possibility is a short term, prospective, longitudinal study carried out over the first six months of a person’s driving career, during which the person’s driving skills continue to mature.

The relationships between impulsivity and affect are not easily explained. It has been argued that extraversion is at least in part a consequence of reward sensitivity producing strong approach behaviours to potential rewards (Smillie, Jackson & Dalgleish, 2006); thus extraversion coupled with dis-inhibition would produce impulsive behaviours. The effects of neuroticism might be somewhat different; anxiety in general produces inhibition of behaviour; however it also interferes with concentration leading to
rumination, intrusive thoughts and distractibility. This however implies that neuroticism is itself an independent source of cognitive impulsivity, distinct from the construct of inhibition. It may of course interact with inhibition to produce the hot impulsivity which is described by Whiteside and Lynam (2001) as urgency. Extraversion thus amplifies the effects of dis-inhibition in producing behavioural impulsivity while neuroticism is an influence on attentional impulsivity independent of dis-inhibition.

Conceptual analysis of the non-planning impulsivity construct and a consideration of its relationship to other variables suggest that this aspect of impulsivity stands somewhat apart from the other two aspects in an interesting way. Planning impulsivity correlated highly with conscientiousness and non-significantly with the other Big Five traits and showed the weakest correlations with the driving and alcohol consumption variables. It may be that while the other impulsivity traits may be conceptualised as aspects of temperament, non-planning impulsivity may be a more complex trait such as conscientiousness. Indeed data in earlier chapters show that conscientiousness is more strongly related to non-planning than to the other facets of impulsivity.

Martel and Nigg (2006) distinguish between temperament and personality by proposing that temperament be “defined in terms of constitutionally-based differences in behavioural style, in particular reactivity and self regulation, whereas personality includes additional characteristics such as attitudes, values, self concept and long term motives”. They further suggest that in the adult at least, “personality includes many elements beyond temperament”; thus while attentional and motor impulsivity may be at the core...
of conscientiousness, as necessary though not sufficient conditions, ‘planning’ develops as a part of the general trait of conscientiousness.

The final study in this thesis sought to relate two aspects of impulsivity to laboratory measures of cognitive function. Throughout, this thesis has proposed two related arguments; the first is that the ‘narrow’ construct of impulsivity is to be explained in terms of cognitive functions rather than in terms of motivation, emotion or lifestyle, the second is that the domain of impulsivity contains both behavioural and cognitive aspects. In terms of the heuristically valuable concept of inhibition, impulsivity is a weakness in the inhibition of both behaviour (response inhibition) and of cognitive functions (interference control).

I have argued for the importance of a cognitive as well as a behavioural element to impulsivity; an element which is captured by the cognitive impulsivity facet of the BI-11 and the inattention facet of the ADHD scales. The study in chapter 8 sought to relate this conceptualisation to laboratory tasks which could be argued to reflect cognitive or behavioural impulsivity.

The first aim of the final study was to identify two sets of task which would correspond to the distinction between behavioural and attentional impulsivity. Three tasks were identified as reflecting response inhibition and two reflected control of attention as well as a third task which reflected speed of response. The exploratory factor analysis extracted two factors which were identified by the hypothesised groupings of tasks.
Conceptual analysis suggested the hypothesis that the attention factor would correlate with the inattention scales and the response inhibition factor would correlate with the impulsivity scale. Since the self report scales correlated significantly ($r = .54$, $p < .01$) it was hypothesised that the two factor scores would also correlate. Contrary to expectation, while the two self report scale correlated substantially the correlation between the factor scores was very low and non-significant. Again contrary to expectation, neither of the two self report scales correlated significantly with the response inhibition factor and both correlated only with the attention factor.

Despite the issues raised in the discussion to Study 7 there is no obvious or simple explanation for either the lack of correlation between the two components extracted nor for the lack of correlation between the response inhibition factor and the two self report scales. The positive and striking finding is that a composite measure of attention control correlated with both behavioural and attentional aspects of self reported impulsivity and indeed with the variance which they shared. This finding accords with two sets of findings discussed earlier. In the first instance it accords with the argument of Dickman (2000) that failures of attention lie at the core of impulsivity; secondly it accords with the findings that in the majority of executive function tasks there are few, if any, significant differences between sub-types of ADHD.

While the model of impulsivity and the model of ADHD which has informed much of this thesis give due weight to both the constructs of response inhibition and inattention/distractibility the relationship between the two requires further investigation.
Here the exploration of more laboratory tasks would seem fruitful to map out the underlying cognitive underpinnings of impulsivity. The traits of impulsivity and inattention utilised in this study correlated significantly with a measure of sustained attention (SART) and a measure of attentional control in a dual task paradigm (Telephone task). Further investigation should explore laboratory tasks which tap into the distractibility which is so typical of both child and adult ADHD cases. Distractibility is often discussed within ADHD at the level of behavioural description; however the cognitive basis for everyday distractibility is little explored or understood. Here the construct of vigilant attention as described by Robertson and Gavaran (2000) and the construct of momentary fluctuations of attention described by Douglas (2005) would prove fruitful. Recent research has indicated the importance of the variable of intra-individual variability in task performance a variable which has been linked by Douglas with fluctuations in attention. Such fluctuations may be a consequence of either a central neuro-cognitive state such as level of arousal or it may be a consequence of distractions either in the environment or internally generated (a wandering mind).

The study of arousal and its relationship to both self reported impulsivity behaviour and to performance on laboratory tasks could provide a framework for an explanatory model of impulsivity which would embrace elements of neurological, neurocognitive and behavioural levels. Thus the line of research begun in the final study would be extended by including measures of cortical arousal, measures of a number of tasks relating to the attention control and response inhibition functions as well as self and peer reports of inattention and impulsivity; hypothesising that individual differences in arousal would
relate to measures of sustained attention as well as to self-report measures of inattention and attention failures.
Appendix

Table A.1 Barratt Impulsiveness Scale-11 and its transformations

This table shows the 30 items of the BIS-11. The first column identifies the impulsivity subscale according to Patton et al (1995); A = attentional, M = motor, P = non-planning. The second column denotes the subscales identified in the present sample, the third column identifies the BIS-Short items as S.

<table>
<thead>
<tr>
<th></th>
<th>I plan tasks carefully</th>
<th>P</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>I do things without thinking</td>
<td>M</td>
<td>M</td>
<td>S</td>
</tr>
<tr>
<td>3</td>
<td>I make up my mind quickly</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I don’t pay attention</td>
<td>A</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>5</td>
<td>I have racing thoughts</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I plan trips well ahead of time</td>
<td>P</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I am self-controlled</td>
<td>A</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>8</td>
<td>I concentrate easily.</td>
<td>A</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>9</td>
<td>I save regularly.</td>
<td>P</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I ‘squirm’ at plays or theatres.</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I am a careful thinker.</td>
<td>P</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I plan for job security</td>
<td>P</td>
<td>P</td>
<td></td>
</tr>
</tbody>
</table>

243
<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
<th>A</th>
<th>P</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>I say things without thinking.</td>
<td></td>
<td>P</td>
<td>A</td>
</tr>
<tr>
<td>14</td>
<td>I act on the spur of the moment.</td>
<td></td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>15</td>
<td>I am a steady thinker.</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I act on impulse.</td>
<td>M</td>
<td>M</td>
<td>S</td>
</tr>
<tr>
<td>17</td>
<td>I often change hobbies and interests.</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>I buy things on impulse.</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>I spend more than I earn.</td>
<td>M</td>
<td>M</td>
<td>S</td>
</tr>
<tr>
<td>20</td>
<td>I often have extraneous or distracting thoughts when thinking.</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>I am restless at theatres or lectures</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>I like to think about complex problems</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>I like puzzles</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>I am more interested in the present than the future</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>I change residences</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>I get easily bored when solving thought problems.</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>I do things without thinking</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>I can only think about one problem at a time.</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>I am future oriented</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>I am happy-go-lucky</td>
<td>M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table A.2 Emotion regulation scale

I get frightened when my feelings are too strong.
I get confused when my feelings get too strong.
I don’t know what’s going on inside me.
I worry that my feelings will get out of control.
When I am upset I don’t know if I am sad, frightened or angry.
I have feelings I can’t quite identify.

Table A.3 Alcohol consumption scale

I drink a large amount of alcohol in a short time.
I drink alcohol in a slow and controlled way.
I have drunk alcohol until I felt ill.
At social occasions I drink more alcohol than I should.
I have found myself unable to stop drinking once I have started.
I have failed to do what was expected of me due to drinking too much alcohol.
I have been unable to remember the night before due to drinking alcohol.
I have had a feeling of guilt or remorse after drinking too much alcohol.
Friends or relatives have expressed concern over my drinking habits.
I have six or more drinks on the same occasion. (Think of one drink as being equivalent
to a glass of wine or half a pint of beer.)
Table A.4 Items from premeditation, perseverance and urgency scales of Whiteside and Lynam (2001)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I have a reserved and cautious attitude towards life.</td>
<td>Pr</td>
</tr>
<tr>
<td>2.</td>
<td>I have trouble controlling my impulses.</td>
<td>U</td>
</tr>
<tr>
<td>3.</td>
<td>I generally like to see things through to the end.</td>
<td>Pe</td>
</tr>
<tr>
<td>4.</td>
<td>My thinking is usually careful and purposeful.</td>
<td>Pr</td>
</tr>
<tr>
<td>5.</td>
<td>I have trouble resisting my cravings [for food, cigarettes, etc.]</td>
<td>U</td>
</tr>
<tr>
<td>6.</td>
<td>I tend to give up easily.</td>
<td>Pe</td>
</tr>
<tr>
<td>7.</td>
<td>I am not one of those people who blurt things out without thinking.</td>
<td>Pr</td>
</tr>
<tr>
<td>8.</td>
<td>I often get involved in things I later wish I could get out of.</td>
<td>U</td>
</tr>
<tr>
<td>9.</td>
<td>Unfinished tasks really bother me.</td>
<td>Pe</td>
</tr>
<tr>
<td>10.</td>
<td>I like to stop and think things over before I do them.</td>
<td>Pr</td>
</tr>
<tr>
<td>11.</td>
<td>When I feel bad I will often do things I later regret in order to make myself feel better now.</td>
<td>U</td>
</tr>
<tr>
<td>12.</td>
<td>Once I get going on something I hate to stop.</td>
<td>Pe</td>
</tr>
<tr>
<td>13.</td>
<td>I don’t like to start a project until I know exactly how to proceed.</td>
<td>Pr</td>
</tr>
<tr>
<td>14.</td>
<td>Sometimes, when I feel bad, I can’t seem to stop what I am doing even though it is making me feel worse.</td>
<td>U</td>
</tr>
<tr>
<td>15.</td>
<td>I concentrate easily.</td>
<td>Pe</td>
</tr>
<tr>
<td>16.</td>
<td>I tend to value and follow a rational ‘sensible’ approach to things.</td>
<td>Pr</td>
</tr>
<tr>
<td>17.</td>
<td>When I am upset I often act without thinking.</td>
<td>U</td>
</tr>
<tr>
<td>18.</td>
<td>I finish what I start.</td>
<td>Pe</td>
</tr>
<tr>
<td>19.</td>
<td>I usually make up my mind through careful reasoning.</td>
<td>Pr</td>
</tr>
<tr>
<td>20.</td>
<td>When I feel rejected I will often say things that I later regret.</td>
<td>U</td>
</tr>
<tr>
<td>21.</td>
<td>I’m pretty good about pacing myself so as to get things done on time.</td>
<td>Pe</td>
</tr>
<tr>
<td>22.</td>
<td>I am a cautious person.</td>
<td>Pr</td>
</tr>
<tr>
<td>23.</td>
<td>It is hard for me to resist acting on my feelings.</td>
<td>U</td>
</tr>
</tbody>
</table>
24. I am a productive person who always gets the job done.

25. Before I get into a new situation I like to find out what to expect from it.

26. I often make matters worse because I act without thinking when I am upset.

27. Once I start a project I almost always finish it.

28. I usually think carefully before doing anything.

29. In the heat of an argument I will often say things that I later regret.

30. There are so many little jobs that need to be done that I sometimes ignore them all.

31. Before making up my mind, I consider all the advantages and disadvantages.

32. I am always able to keep my feelings under control.

33. Sometimes I do things on impulse that I later regret.

U = urgency, Pr = premeditation, Pe = perseverance.

Table A.5 Eating behaviour scale

<table>
<thead>
<tr>
<th>Description</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel in control whilst eating.</td>
<td></td>
</tr>
<tr>
<td>I eat slowly</td>
<td></td>
</tr>
<tr>
<td>I eat until I feel uncomfortable.</td>
<td></td>
</tr>
<tr>
<td>I eat large amounts when not hungry.</td>
<td></td>
</tr>
<tr>
<td>I sometimes eat alone</td>
<td></td>
</tr>
<tr>
<td>After overeating I feel guilty. I know when I have eaten enough.</td>
<td></td>
</tr>
<tr>
<td>I eat large amounts over a small time scale.</td>
<td></td>
</tr>
<tr>
<td>When I am having my favourite foods I tend to eat too much.</td>
<td></td>
</tr>
<tr>
<td>I sometimes eat myself sick.</td>
<td></td>
</tr>
</tbody>
</table>

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Table A.6  ADHD scale

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I lose things necessary for tasks or activities.</td>
<td>A</td>
</tr>
<tr>
<td>I talk too much.</td>
<td>I</td>
</tr>
<tr>
<td>I have trouble doing leisure activities quietly.</td>
<td>I</td>
</tr>
<tr>
<td>I leave my seat when I am not supposed to.</td>
<td>I</td>
</tr>
<tr>
<td>I have trouble waiting in line or taking turns with others.</td>
<td>I</td>
</tr>
<tr>
<td>I have trouble keeping my attentions focussed when working.</td>
<td>A</td>
</tr>
<tr>
<td>I am forgetful in my daily activities.</td>
<td>A</td>
</tr>
<tr>
<td>I have trouble listening to what other people are saying.</td>
<td>A</td>
</tr>
<tr>
<td>I am always on the go.</td>
<td>I</td>
</tr>
<tr>
<td>I fidget [with my hands or feet] or squirm in my seat.</td>
<td>I</td>
</tr>
<tr>
<td>I make careless mistakes or have trouble paying close attention to detail.</td>
<td>A</td>
</tr>
<tr>
<td>I don't like homework or job activities where I have to think a lot.</td>
<td>A</td>
</tr>
<tr>
<td>I am restless or overactive.</td>
<td>I</td>
</tr>
<tr>
<td>I give answers to questions before the questions have been completed.</td>
<td>I</td>
</tr>
<tr>
<td>I have trouble finishing my tasks or schoolwork.</td>
<td>A</td>
</tr>
<tr>
<td>I interrupt others when they are working or playing.</td>
<td>I</td>
</tr>
<tr>
<td>I am distracted when things are going on around me.</td>
<td>A</td>
</tr>
<tr>
<td>I have problems organising my tasks and activities.</td>
<td>A</td>
</tr>
</tbody>
</table>

A = inattention item, I = impulsive/hyperactive item
Diagram A.1 Principal Axis Factor analysis. Loadings of 5 tasks (excluding SART) upon derived factors and the correlations between factors and the self report measures of impulsivity and inattention.
Table A7. Correlations between factors and tasks including the two SART measures separately

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Factor 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Factor 2</td>
<td>.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Compon 3</td>
<td>.37</td>
<td>.32</td>
<td></td>
</tr>
<tr>
<td>4. Stroop</td>
<td>.06</td>
<td>.72</td>
<td>.37</td>
</tr>
<tr>
<td>5. Hayling</td>
<td>-.22</td>
<td>.68</td>
<td>-.08</td>
</tr>
<tr>
<td>6. VF</td>
<td>-.27</td>
<td>-.67</td>
<td>-.31</td>
</tr>
<tr>
<td>7. DSST</td>
<td>-.49</td>
<td>-.38</td>
<td>-.51</td>
</tr>
<tr>
<td>9. Dual task</td>
<td>.99</td>
<td>-.19</td>
<td>.29</td>
</tr>
<tr>
<td>8. SART</td>
<td>.19</td>
<td>-.03</td>
<td>.18</td>
</tr>
<tr>
<td>10. fatotal</td>
<td>.26</td>
<td>.02</td>
<td>.17</td>
</tr>
<tr>
<td>11. misstotal</td>
<td>.06</td>
<td>.08</td>
<td>.13</td>
</tr>
<tr>
<td>10. impulse</td>
<td>.40</td>
<td>.03</td>
<td>.25</td>
</tr>
<tr>
<td>11. inattentio</td>
<td>.31</td>
<td>.02</td>
<td>.14</td>
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</tbody>
</table>
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