Antisocial behaviour in adolescence: The role of reward processing.

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I DEDICATE THIS THESIS

To my mum,

For everything...

DECLARATION

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Summary of Thesis

Rewards are fundamental in directing our behaviour, yet maladaptive reward processing can lead to risky and impaired decision making. The nature of reward processing in individuals who display antisocial behaviour is poorly understood, particularly in adolescents. The present thesis examined reward processing in young male offenders involved in the criminal justice system. A multi-method approach to the examination of reward was adopted, using personality, neuropsychological and psychophysiological approaches. The heterogeneity of antisocial behaviour was explored by using self-report and official criminal records.

The first study explored reward traits in young offenders (n=85) and non-offending controls (n=50). Trait reward drive was heightened in offenders and reward seeking traits positively predicted antisocial behaviour measures, while the response to reward was negatively associated with psychopathic traits and conduct problems. The second chapter focussed on neuropsychological and behavioural measures of reward and the results showed that young offenders (n=56) and matched controls (n=44) both demonstrated an increased preference for reward. However, reward seeking became deficient resulting in increased punishment for the young offenders only. The third study provided evidence that young offenders (n=33) are able to condition to reward but not to fear. The fourth study (n=66) explored descriptively the nature of substance use in young offenders; cannabis and alcohol were used frequently by a number of offenders and aspects of this behaviour were related to increased offence rate, and reward and psychopathic traits.

In summary, the findings showed that young offenders differed from controls in terms of personality traits, neuropsychological and emotional functioning. Reward processing was altered in young offenders as a group compared to controls, but reward processing was not consistently associated with any particular dimension of antisocial behaviour. The results also supported past research on the importance of punishment insensitivity in antisocial behaviour. The research has extended the literature on biobehavioural factors associated with antisocial behaviour in adolescent offenders in the community and emphasises the importance of examining multiple dimensions of both reward and antisocial behaviour. The implications of these findings for policy and practitioners working with young offenders were discussed.

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GLOSSARY OF ABBREVIATIONS

ADHD	Attention Deficit Hyperactivity Disorder
ANS	Autonomic Nervous System
ASPD	Antisocial Personality Disorder
ASB	Antisocial Behaviour
BIS/BAS	Behavioural Inhibition System/Behavioural Activation System
CD	Conduct Disorder
CPT	Card Playing Task
DLPFC	Dorsolateral Prefrontal Cortex
EF	Executive Functioning
FAST	Fast Alcohol Screening Test
FC	Fear Conditioning
HR	Heart Rate
NC	Normal Control
ODD	Oppositional Defiant Disorder
OFC	Orbitofrontal Cortex
RC	Reward Conditioning
RPQ	Reactive Proactive Aggression Questionnaire
RST	Reinforcement Sensitivity Theory
SCR	Skin Conductance Response
SPSS	Statistical Package for the Social Sciences
SU	Substance Use
WASI	Wechsler Abbreviated Scale of Intelligence.
WCST	Wisconsin Card Sort Test
YO	Young Offender
YOT	Youth Offending Team
YPI	Youth Psychopathic traits Inventory
YSR	Youth Self Report

Chapter One – General introduction, literature review and thesis overview

1.1. Introduction and research aims

Reward seeking is fundamental for the survival and reproduction of humans and animals alike. Human behaviour is motivated by the pursuit of rewards and also the avoidance of punishment. Nevertheless, the seeking of rewards can become maladaptive and result in risky and impaired decision making as observed in those who engage in gambling, substance use and elements of antisocial behaviour (ASB; Fareri, Martin, & Delgado, 2008). Indeed, various research strategies have converged on the idea that one aspect driving ASB may be oversensitivity to reward and consequently extreme reward seeking (e.g., Newman, Widom, & Nathan, 1985; Quay, 1993; Scerbo et al., 1990; Steinberg, 2008). Multiple approaches have been adopted to examine the role of reward sensitivity including neuroimaging, personality, neuropsychological and psychophysiological measures. However, rarely are these different approaches integrated, particularly in relation to ASB.

ASB has been defined and studied in many ways; clinicians tend to focus on externalising disorders such as conduct disorder (CD) in children and adolescents, and antisocial personality disorder (ASPD) in adults, as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000). In addition, the personality disorder of psychopathy is a clinical construct that has been extensively studied in adults (e.g., Cleckley, 1976; Cooke, Michie, Hart, & Clark, 2005; Hare, 1991, 1998, 2003; Hart & Hare, 1996; Salekin, Rogers, & Sewell, 1996) with research more recently emerging on youth psychopathy (e.g., Farrington, 2005; Frick, Kimonis, Dandreaux, & Farrell, 2003; Lynam & Gudonis, 2005; Petrila & Skeem, 2003; Salekin, 2006; Salekin & Frick, 2005; Skeem & Petrila, 2004). From a legal standpoint, the focus is on criminal and delinquent behaviours that include vandalism, theft, assault and so forth (Seguin, 2004). Aggression is also considered a component of ASB (Rhee & Waldman,

2002) and the distinction between reactive and proactive aggression is often made in both adults and young people (e.g., Blair, Mitchell, & Blair, 2005; Raine et al., 2006). These approaches to ASB are related in many ways, nevertheless there is also considerable heterogeneity within these different operationalisations. It is important that research attempts to examine the different approaches and elucidates the heterogeneity in the risk factors implicated in ASB.

Research on ASB often focuses on adults or incarcerated and clinical samples. However, offending peaks during the adolescent period (Moffitt, 1993) and poses a particularly serious problem for society and the individuals involved. Studies that explore risk factors in young people are required, particularly those using community youths, so that the developmental course of the behaviour can be further understood. Furthermore, adolescence is characterised by increased reward seeking and an immature reward system has been implicated (Geier, Terwilinger, Teslovich, Velanova, & Luna, 2010). In addition, there is increasing evidence that biobehavioural factors are important in the understanding of ASB in general and adolescent ASB in particular. Evidence implicates neuropsychological and cognitive factors (e.g., executive functioning; Moffitt, 1993) and psychophysiological factors (e.g., low heart rate and poor fear conditioning; Fairchild, van Goozen, Stollery, & Goodyer, 2008; Gao, Raine, Venables, Dawson, & Mednick, 2010a), amongst others. Again, rarely are these different approaches integrated in one study and of importance here, I argue that reward sensitivity and how it manifests in these approaches is not given the necessary prominence.

As such the primary goal of this research is to examine biobehavioural risk factors for ASB in adolescents, particularly focusing on the role of reward processing. The heterogeneity of ASB will be explored by using different approaches to the assessment of the behaviour (e.g., official criminal records, clinical symptomatology, and self-report measures). In addition, multiple approaches to the measurement of reward will be used, specifically

personality, neuropsychological and psychophysiological assessment (reward traits, reward seeking behavioural measures, autonomic reward conditioning). This will permit a greater understanding of the relation between different aspects of reward processing and ASB, as well as further exploring biobehavioural risk factors in general. Importantly, these constructs will be assessed in adolescent community offenders, who demonstrate variation in their offending behaviour, rather than in incarcerated samples who may be relatively quite far on in their criminal career and demonstrate only extreme levels of ASB. It also allows for the investigation of the development of ASB and the factors that lead to continuation and discontinuation of the behaviour. Essentially the complex association between ASB and reward processing in adolescence will be elucidated by using multiple approaches to the measurement of both constructs.

The remaining aspects of this general introduction will begin by providing a brief summary of the nature and importance of rewards, followed by a description of the brain regions implicated in reward processing. Subsequently, a discussion of reward processing during adolescence will be presented, along with an introduction to the approaches to reward measurement. The approaches to the examination of ASB will then be described, considering legal and clinical approaches, psychopathic traits, aggression and substance use. Finally, past research on biobehavioural (i.e., personality, neuropsychological and psychophysiological) risk factors for ASB will be presented, with the aim of emphasising gaps in the literature and the need for the examination of reward related variables in these research domains. The more specific literature on the relationship between reward and ASB will be reviewed in the subsequent relevant chapters; including personality reward traits in Chapter three, neuropsychology and reward in Chapter four and psychophysiology and reward in Chapter five.

1.2. Literature review

1.2.1. Reward processing

1.2.1.1. The nature and importance of reward

Various definitions of reward exist; in broad terms rewards can be defined as any objects, stimuli or events that positively reinforce behaviour (McClure, York, & Montague, 2004). Primary rewards reinforce behaviour without any learning being necessary, these include stimuli such as food, water and sex. Secondary or conditioned rewards, become rewarding after learning an association with a primary reward, a notable example of this is money (McClure et al., 2004). Other rewards include novelty, cognitive rewards and social rewards such as positive social feedback and peer approval. Rewards can affect both short-term and long-term goal directed behaviour (e.g., from satisfying primitive needs such as obtaining nutrients to obtaining career goals; Delgado, 2009; Fareri et al., 2008) and they can impact on simple everyday behaviours as well as more complex social interactions such as developing trust (Delgado, 2009). Clearly, rewards are diverse constructs and what is experienced as a reward and therefore motivates behaviour is often subjective and dependent on the individual.

Rewards are one of the most fundamental forces directing our behaviour; they are involved in increasing the frequency and intensity of approach behaviour, for maintenance and prevention of extinction of the behaviour and for associated feelings of pleasure and positive emotion (Naranjo, Tremblay, & Busto, 2001). Nevertheless, reward seeking can become maladaptive and lead to poor decision making such as that exemplified in taking risks, gambling, substance use and ASB (Fareri et al., 2008). In simplistic terms, for rewards to have an impact on our behaviour, they must be detected by the brain; attributes of the stimulus (such as valence and magnitude) need to be integrated to form a reward value

representation and then this information used to show preference toward particular rewards, to predict the availability of rewards and guide our behaviour (Delgado, 2009). Often this reward processing leads to positive and pleasurable outcomes. However, sometimes aspects of this reward processing can go astray which can result in "abuse of behaviours that lead to rewarding feelings and contribute to social maladies" (Delgado, 2009; p. 345). In order to understand how maladaptive reward processing can lead to ASB it is necessary to begin with a summary of the neural structures thought to be involved in reward processing.

1.2.1.2. Brain reward structures and reward processing

Experimental research in animals has been essential for elucidating the neural structures involved in reward processing. The use of neuroimaging techniques has allowed for great advances in the understanding of the structures and functions in the putative neural structures associated with reward in humans. This research tends to converge on several brain structures that constitute the reward system. These include the midbrain, ventral striatum (including nucleus accumbens), orbitofrontal and medial prefrontal cortex and amygdala (Rademacher et al., 2010). These structures all carry the neurotransmitter dopamine which is strongly implicated in this system. More specifically, dopaminergic neurons are located in the mid brain structures of the substantia nigra (pars compacta) and ventral tegmental area; the dopamine neuron axons project to the striatum (caudate nucleus, putamen and ventral striatum including nucleus accumbens), and the dorsal and ventral prefrontal cortex amongst other structures. In addition, reward signals are found in the projection structures themselves (including orbitofrontal cortex, striatum and amygdala; Schultz, 2007a; For a review see Shultz 2007b).

The ventral striatum and particularly the nucleus accumbens (NAcc) are the structures most consistently linked to the processing of reward and for integrating reward processing

(Elliott, 2004). Projections from the NAcc to the ventral tegmental area produce a prediction error signal that codes novelty mismatch between predictors and rewards (Elliott, 2004). Projections from the NAcc to the amygdala appear to control the response to conditioned rewards while projections to the prefrontal areas are involved in integrating reward with experience and the forming of behavioural responses (Elliott, 2004). The amygdala has predominantly been associated with the processing of aversive stimuli, negative emotions and fear. However, research has suggested that it is also implicated in responding to positively reinforcing stimuli (e.g., Baxter & Murray, 2002; Hamann & Mao, 2002; Murray, 2007). Studies now suggest that the amygdala is also involved in reward conditioning (Elliott, 2004).

The orbitofrontal cortex (OFC) represents the reward value of primary reinforcers and can associate other stimuli with these. The OFC produces representations of the expected reward value of a diverse range of stimuli including monetary reward (Rolls & Grabenhorst, 2008). Therefore, it is argued that the OFC plays a central role in emotion by representing the goal for action (Rolls & Grabenhorst, 2008). Non-human primates and human patients with OFC damage show perseveration of reward and a failure of extinction on response reversal and extinction tasks (tasks that involve a change in reinforcement contingencies after a response has been learned) therefore continue to respond to non-reinforced stimuli. These findings imply that the OFC is involved in the reappraisal of the motivational or affective significance of stimuli (Happaney, Zelazo, & Stuss, 2004; Rolls, 2004). It appears that while the amygdala is involved in the learning of the response-reward contingencies, the OFC is responsible for the reappraisal of these relations. Furthermore, individuals with damage to the OFC and related areas such as the ventromedial prefrontal cortex show problems in affective (motivated) decision making and social functioning (Happaney et al., 2004) and this has been explored extensively using the Iowa Gambling Task (e.g., Bechara, Damasio, Damasio, & Anderson, 1994; for a review of the role of the OFC in reward processing see Rolls, 2000).

Deficits in these reward structures (particularly the amygdala and OFC) and dopamine transmission have been implicated in ASB and will be referred back to throughout the thesis. It must be noted that in comparison to adults, the understanding of these processes during adolescence is more limited (Geier et al., 2010). Yet, adolescence is a time of dramatic changes in brain development and it is important to consider the development in regions associated with reward processing as well as brain regions that affect cognitive control and impulsivity as these changes have provided the framework for a neurobiological model of increased risk taking behaviour during adolescence.

1.2.1.3. Brain reward development and behaviour in adolescence

Adolescence is a time of striking changes in both behaviour and brain reward development. It is widely acknowledged that adolescence is a time of increased risk taking relative to both children and adults. For instance, adolescents are more likely to smoke cigarettes, binge drink, have car accidents and engage in criminal activity (Steinberg, 2008) and this has been related to heightened reward seeking, amongst other factors, during this period (Steinberg, 2010).

In terms of brain development, evidence suggests that neural structures specifically associated with goal directed behaviour, such as the corticobasal ganglia networks, are continuing to mature during adolescence (Fareri et al., 2008). Indeed, although the human brain has reached 90 % of its adult size by the age of six, neuroimaging has revealed that there are considerable changes occurring in the cortical grey and white matter and in structures implicated in reward processing throughout adolescence (Casey, Getz, & Galvan, 2008; Fareri et al., 2008; Giedd et al., 1996). More specifically, there is a decline in grey matter and an increase in white matter which has been reported to be due partly to synaptic pruning and continued myelination (Geier et al., 2010; Steinberg, 2010). In addition, in

subcortical areas there are increases in dopamine neurotransmission in limbic, striatal and prefrontal pathways, which have been associated with changes in reward directed activity (Geier et al., 2010; Steinberg, 2010). It has been argued that these changes in primary reward regions during adolescence could contribute to various reward processing deficits including limitations in the identification of reward cues, limited ability to integrate reward information and heightened sensitivity to rewards (see Geier et al., 2010).

Recent theories of decision making during adolescence have begun to more clearly link the changes occurring in the brain to behaviour. It has been proposed that the interaction between two neurobiological systems leads to increased risk taking behaviour during this period (Steinberg, 2010). According to this dual systems hypothesis, one system termed the socioemotional system is localised in the limbic and paralimbic areas of the brain and include the amygdala, ventral striatum and orbitofrontal cortex; the other is termed the cognitive control system and consists of the lateral and parietal cortices and anterior cingulate (Steinberg, 2008, 2010). The theory argues that the increase in reward seeking during adolescence is a result of an increase in dopaminergic activity in the socioemotional system during the time of puberty. This increase in activity occurs alongside a still maturing self-control system such that adolescents are less able to inhibit their reward seeking tendencies (Steinberg, 2004, 2010). It is argued that this temporal gap between increased reward seeking and the development of self-control results in an increase in vulnerability to risk taking behaviour during adolescence.

Steinberg (2010) tested the dual systems model by using self-report and behavioural measures of both reward seeking and impulsivity in 935 individuals aged between 10 and 30. The study found support for the model showing that age differences in reward seeking follow a curvilinear pattern, increasing during adolescence and declining thereafter, whereas impulsivity followed a linear pattern declining from age 10 onwards. Steinberg asserts that

although the increase in reward seeking occurs alongside puberty, it is not likely to be completely as a result of the changes in gonadal hormones at this time. However, the changes are biologically programmed and evolutionarily viable, with an increase in risk taking during this period likely to have been necessary for survival and reproduction. In addition, adolescence is a time where risks are required to promote independence from adults (Steinberg, 2008).

1.2.1.4. Individual differences in reward sensitivity

Although, these arguments suggest that reward seeking during adolescence may be a normative part of development, it is important to note that there is clearly scope for individual difference in this functioning and extreme reward seeking may be associated with more extreme problematic behaviour such as ASB. Individual differences in reward and impulse related processing have long been shown and examples come from classic studies of delay of gratification in children (Mischel, Shoda, & Rodriguez, 1989). These studies involve presenting children with the option of receiving a small reward immediately (e.g., one cookie) or waiting and receiving a larger reward (e.g., two cookies) later. The results of these studies provide evidence of marked differences in the ability of children to wait for the large reward even in childhood and this has been shown to persist into young adulthood (Casey et al., 2008).

In terms of explanatory factors for these individual differences, some have implicated individual variation in the dopaminergic mesolimbic circuitry thought to underlie reward seeking behaviour (Casey et al., 2008). It has been argued that allelic variants in dopamine related genes may result in altered levels of dopamine which may predispose some young people to seek more rewards than others (O'Doherty, 2004). Steinberg (2008) also posits that there are many factors that could moderate the extent to which reward seeking leads to risk

taking behaviour and these include the opportunity to engage in such behaviour (e.g., the extent of parental monitoring, the availability of drugs and alcohol, etc.), maturational timing and other temperamental factors such as fearfulness.

1.2.1.5. Hypo/Hyperfunctioning in the reward system

It is important to note that the direction of functioning in the reward system in relation to reward seeking behaviour is not completely specified in adolescents (e.g., Galvan, 2010). That is, some postulate that hypersensitivity in the reward system (striatal system in particular) may be associated with risky behaviour, while others have hypothesised that hyposensitivity in the reward system may be implicated, with the involvement in risky, reward seeking behaviour an attempt to increase the underarousal in the reward system (e.g., Spear, 2000). This latter theory suggests that adolescents require more intense or frequent rewards to achieve the same level of activation or pleasure obtained previously (Galvan, 2010). As Steinberg (2004) asserts " it's as if they need to drive at 70 mph to achieve the same degree of excitement that driving 50 mph had provided previously" (p. 54). Spear (2000) suggests that adolescents may experience a sort of mini reward deficiency syndrome similar to that seen in adults with dopamine hypofunctioning in the reward system.

Although, support for both hypo-responsiveness (e.g., Blum, Cull, Braverman, & Comings, 1996; Bjork et al., 2004; Spear, 2000**)** and hyper-responsiveness (e.g., Chambers, Taylor & Potenza, 2003, Van Leijenhorst, Gunther Moore, et al., 2010, Van Leijenhorst, Zanolie, et al., 2010**)** have accumulated, the compelling evidence tends to maintain that it is over-activation in the striatal dopaminergic circuit, leading to increased dopamine release in response to rewards that results in an increased drive for reward seeking during adolescence (Galvan, 2010). Steinberg (2008) argues that a loss of buffering capacity leads to an increased level of circulating dopamine and this results in rewards becoming even more rewarding. It is

interesting to note that some evidence points to the relationship being even more complex than hyper versus hypo functioning, with certain temporal phases of reward processing being overactive and other phases being underactive (Geier et al., 2010). These opposing theories could be somewhat explored using psychophysiological approaches to the measurement of reward sensitivity. Nevertheless, of particular interest here is the attempt to study the personality, behavioural and psychophysiological manifestations of reward sensitivity, in terms of increased reward seeking behaviour, and the association with ASB.

1.2.1.6. Approaches to the measuring of reward in humans.

Reward processing has been studied extensively in animals, yet in humans the processes are less well understood. This may be partially as a result of the difficulty of developing an objective measure of reward experience (Elliot, 2004). Nevertheless, neuroimaging evidence has made the study of human reward processing more feasible. The use of reward paradigms such as the monetary incentive delay task (Knutson, Westdorp, Kaiser, & Hommer, 2000) has provided evidence on the brain areas activated when obtaining a variety of rewards. Alternatively, self-report measures that examine reward as a personality trait have also been frequently used; for instance, the Sensitivity to Punishment and Reward Scale (Torrubia, Avial, Molto, & Caseras, 2001), the revised Temperament and Character Inventory (Cloninger, 1999), the Sensation Seeking Scale (Zuckerman, 1994) and Carver and White's (1994) Behavioural Inhibition System/Behavioural Activation System scales all have components that are thought to reflect different aspects of reward processing. Neuropsychological approaches to reward processing tend to examine the winning and losing of points/money, including gambling tasks such as the classic Iowa Gambling Task (Bechara et al., 1994) and the Card Playing Task (Newman, Patterson, & Kosson, 1987). Psychophysiological approaches (e.g., galvanic skin conductance response) are particularly

useful given their more objective nature, although research exploring reward sensitivity using these approaches is more scarce. It is interesting to note that the majority of these tasks use money as a reward as it is a strong behavioural motivator, easy to manipulate, and robustly recruits the dopamine circuitry (Galvan, 2010). These various methodological approaches will be explored further in relation to different aspects of ASB.

1.2.2. Antisocial behaviour and approaches to measurement

ASB is a heterogeneous construct and has been defined and assessed in a multitude of ways. It is important that research explores the different forms of ASB so that different risk factors can be identified. ASB has been operationalised in two main ways; firstly, in legal terms and secondly with reference to categorical clinical disorders (e.g., Morgan & Lilienfeld, 2000). An additional construct that has been examined in relation to ASB is that of aggression (e.g., Rhee & Waldman, 2002). These approaches and the assessment measures will be described in turn, as elements of each will be examined in the present research.

1.2.2.1. The legal approach: Criminality and delinquency

The legal approach is informed by legal concepts such as criminality; essentially composed of behaviours that are against the law and that bring people in contact with the criminal justice system (e.g., arrest, conviction, and incarceration) and delinquency; unlawful acts committed as a juvenile (Morgan & Lilienfeld, 2000; Rhee & Waldman, 2002). This behaviour is usually examined using official records and self-report instruments. Official records of criminal behaviour (e.g., from police databases; youth offending databases etc.) provide important information on ASB, although it is important to note that it is likely that these records reflect only the tip of the iceberg in terms of the number of actual offences committed. On the other hand, self-report measures are useful, given that they can potentially assess behaviour that were not brought to the attention of criminal justice (e.g., individuals

were not caught for an offence), but clearly have their limitations in terms of honest responding for instance. Studies that incorporate both approaches to the assessment of offending can contribute to a more thorough understanding of ASB.

It is worth noting here that the patterns of involvement in crime are clearly very different across individuals. It is widely acknowledged that it is common for young people to become involved in illegal behaviour at some point in their life, for example underage drinking and minor shoplifting (e.g., Rutter, Giller, & Hagel, 1998). The majority of young people will have no formal contact with the police, while a minority will acquire a criminal record. Some young people reoffend more frequently and some argue that there is a small number of young offenders who are persistent in this behaviour and as such is disproportionately responsible for the number of crimes committed (e.g., Rutter et al., 1998).

Of relevance here is the classic theory of adolescent ASB outlined by Moffitt (1993). In brief, the theory makes the distinction between the adolescent-limited (AL) and life-course-persistent (LCP) offender; Moffitt proposes that it is the LCP offender, who begins offending early and as a result of neuropsychological (e.g., verbal and executive) deficits interacting with a criminogenic environment, persists with this offending behaviour throughout the life course. Alternatively, the AL offender is considered to engage in offending as a result of a maturity gap (between biological development and access to adult privileges) and also the imitation of the LCP's behaviour; as the name suggests the AL offenders are proposed to desist from criminality as they get older. Not surprisingly, the pattern has been shown to be more complex than this dichotomy (e.g., Skardhamar, 2009) yet Moffitt's theory has garnered much support and the distinction appears to be useful. Much research has focused on identifying the small subgroup of offenders who begin early and are thought to persist with ASB throughout the life course (i.e. the LCPs).

One can draw comparisons here with the neurobiological theory of reward seeking discussed previously (Steinberg, 2008). Steinberg has argued that the increased reward seeking of adolescence could be biologically adaptive, normative, occurring alongside puberty to encourage risk taking and independence. Moffitt (1993) suggests that the risk taking by ALs is normative and delinquency is reinforcing in many ways including as a sign of independence and maturity. However, it is conceivable that individual differences in reward sensitivity that are seen from an early age (e.g., as shown in Mischel's classic delay of gratification tasks in children) and may have a genetic basis (e.g., allelic variants in dopaminergic neurocircuitry) could develop in the context of many additional risk factors (e.g., social deprivation, emotional dysfunction) into more extreme reward seeking during adolescence (a time of already increased reward seeking) and continue into atypical levels in adulthood. This increased reward sensitivity could manifest in neuropsychological and psychophysiological impairment in adolescence.

It can be argued then that in terms of the legal approach to ASB, frequency and severity of offending appear to be two of the important variables identified in the literature as worthy of study. These variables will allow differentiation amongst the offender subgroup and it appears theoretically plausible to suggest that increased frequency/severity will be associated with increased impairment on biobehavioural risk indicators including reward sensitivity.

1.2.2.2. Clinical diagnoses

When ASB becomes persistent and affects an individual's functioning in various areas of their life, often a clinical disorder is diagnosed. The clinical approach includes clinical diagnoses such as antisocial personality disorder (ASPD) in adults and conduct disorder (CD) and oppositional defiant disorder (ODD) in young people as defined in the

Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000**)**. ASPD is referred to as ‘‘a pervasive pattern of disregard for, and violation of, the rights of others that begins in childhood or early adolescence and continues into adulthood’’ (pp. 645-650). To be diagnosed with ASPD, individuals are required to be aged over 18 and there should be evidence of CD in childhood. According to the DSM, a diagnosis of CD includes “a repetitive and persistent pattern of behaviour where social norms and rules are violated” (pp. 98-99). Criteria include aggression to people and animals, destruction of property, deceitfulness and theft. In addition, in terms of reward sensitivity, there is evidence that CD is associated with an overactive reward system in children (e.g., Daugherty & Quay, 1991; Quay, 1993).

Ideally, these psychiatric diagnoses are best made by trained clinicians, however self-report measures are often utilised for research purposes. For instance, the Youth Self Report (YSR; Achenbach & Rescorla, 2001) is a widely used self-report measure of various externalizing problems in young people aged between 11 and 18. It contains six DSM-oriented scales which were developed based on psychiatrist’s impressions of the items; affective problems, anxiety problems, somatic problems, attention deficit/hyperactivity problems, oppositional defiant problems and conduct problems. The YSR has adequate psychometric properties in terms of validity, reliability and temporal stability (Achenbach & Rescorla, 2001; Fonseca-Pedrero et al., 2012). Of interest here is that the YSR symptoms have also been shown to successfully predict DSM clinical diagnoses in community and clinical samples (e.g., Morgan & Cauce, 1999; Weinstein et al., 1990). As such the YSR is thought to be an efficient and effective tool for the screening of mental health problems in the general population, providing a basis for examining behavioural and emotional problems using both a categorical and continuous approach.

1.2.2.3. Psychopathy

Psychopathy is another important clinical construct that has been extensively studied. Psychopathy is a personality disorder characterised by a constellation of behavioural, affective and interpersonal traits (Cleckley, 1976; Cooke & Michie, 1999; Hare, 1991). Behaviourally, those with psychopathy are sensation seeking and impulsive; they lack responsibility, violate social norms and often engage in ASB. Affectively, they are emotionally shallow; lack empathy, remorse and guilt. Interpersonally, individuals with psychopathy are egocentric, manipulative, glib and superficial (Cooke & Michie, 1999; Hart & Dempster, 1997). Based on Cleckley's (1976) classic descriptions and his own observations, Robert Hare developed the now considered gold standard measurement instrument of psychopathy in adults; the Psychopathy Checklist and the revised version; Psychopathy Checklist –Revised (PCL-R; Hare, 1991, 2003).

Factor analyses of items on the PCL-R have revealed two dimensions; factor one reflecting the "callous and remorseless use of others" and factor two reflecting the "chronically unstable and antisocial lifestyle" (Hare, 1991, p.38; Harpur, Hakstian, & Hare, 1988). These factors have demonstrated differential correlations with a range of relevant external correlates including measures of reward sensitivity. The research findings in this area are complex, although more recent research has suggested that reward sensitivity is implicated to a certain extent in both factors, but more research is required to elucidate the relationship between the constructs. In addition, there is very limited research exploring these constructs in young people.

In the last decade, a burgeoning literature has focused on the examination of psychopathy in children and adolescents. There are clear reasons for studying psychopathy in young people; it is hoped that the traits of psychopathy may provide one way to parse the

heterogeneity associated with ASB in young people and identify a more homogenous subgroup of youths (that perhaps share an emotional dysfunction) that are thought to develop into the serious and persistent offenders in adult life. Similar to the construct of ASPD in adults, the DSM-IV diagnosis of CD in young people has been criticised. Reportedly, 97-100 % of adolescent offenders meet criteria for a diagnosis of CD, however only approximately 30 % of these CD offenders would qualify for a diagnosis of psychopathy. Therefore, it has been suggested that CD lacks discriminability from normative behaviours during adolescence and as such predictive validity (e.g., Lynam, 1996; Salekin, 2006). Alternatively, psychopathic traits in young people may be more useful in identifying individuals that have particular problems and go on to become serious and persistent offenders in adulthood. Indeed, Lynam (1996) has suggested that psychopathic traits (in particular hyperactive and antisocial traits) may identify those 5 - 6 % of offenders who proceed to be the chronic offenders responsible for 50 - 60 % of known crimes.

Various instruments have been developed to measure psychopathy in young people; consistent with the development of self-report measures in the adult population research has more recently focused on developing self-report measures of youth psychopathy. One such self-report measure is the Youth Psychopathic traits Inventory (YPI: Andershed, Kerr, Stattin, & Levander, 2002) which was designed for young people aged 12 years old and above and is intended for community samples as opposed to those in correctional facilities. It was designed to measure the core traits outlined in the PCL-R and the preliminary evidence suggests that the YPI is a useful instrument that correlates with various deviant behaviours in the community and institutionalised samples (Andershed et al., 2002; Andershed, Hodgins, & Tengstrom, 2007; Declercq, Markey, Vandist, & Verhaeghe, 2009; Dembo et al., 2007; Poythress, Dembo, Wareham, & Greenbaum, 2006; Skeem & Cauffman, 2003). However, additional research is required that examines the relation between the YPI and external

correlates such as reward sensitivity. This research would be helpful for understanding psychopathic traits in young people as well as investigating further the usefulness of the self-report instrument.

1.2.2.4. Aggression

Aggression is defined here as "behaviour deliberately aimed at inflicting physical and/or psychological damage on persons or property" (van Goozen, Fairchild, Snoek, & Harold, 2007; p. 150). Aggression is an important component of some aspects of ASB, although clearly not all antisocial acts are aggressive (e.g., Dodge, Coie, & Lynam, 2006). Two major types of aggression have been identified: an impulsive reactive-hostile-affective subtype and a controlled proactive-instrumental-predatory subtype (e.g., Crick & Dodge, 1996). The reactive type is triggered by a threatening or frustrating event and is usually accompanied by anger and high arousal (Blair et al., 2005; van Goozen et al., 2007). Importantly, this type of aggression does not usually involve any particular goal and is defined as negatively reinforcing (Seguin, 2004). In comparison, the proactive aggression type is controlled and the aggression is instrumental such that it is initiated in order to achieve a desired goal beyond harming the victim. For instance, the goal may be to gain the victim's possessions or to gain peer approval and to increase status within the hierarchy (Blair et al., 2005) and is considered positively reinforcing. It is conceivable that reward sensitivity may demonstrate an increased association with the instrumental, goal-oriented aggression and research should aim to elucidate the relationships involved.

Elements of this distinction are often criticised on the basis of the difficulty of delineating the motives of human aggression in specific episodes (e.g., Bushman & Anderson, 2001). Furthermore, it is important to emphasise that these two aggression types are not mutually exclusive and both may come into play in a complex antisocial act (van

Goozen et al., 2007). The difficulties in making the distinction notwithstanding, some authors have emphasised the importance of attempting to delineate between these types, particularly in the understanding of disorders such as psychopathy (e.g., Blair et al., 2005). Instruments designed to measure this distinction have yielded variable results; however one promising measure is the self-report Reactive-Proactive Aggression Questionnaire (Raine, et al., 2006) designed for use with adolescents. The instrument is a reliable and valid brief self-report which has been shown to confirm and extend the differential correlates of reactive and proactive aggression. The authors make the point that although motives may seem obscure to an observer they are usually very salient to the perpetrator, therefore the use of self-report should be useful in this regard.

1.2.2.5. Substance misuse

The association between drug and alcohol use and ASB is complex and not completely clear. Similar to ASB more generally, alcohol and drug use increases during the adolescent period also and there has long been an association between the two (Hellandsjo, Watten, Foxcroft, Ingebrightsen, & Relling, 2002; Steinberg, 2008). There is some evidence that ASB predisposes to substance use, while there is also evidence suggesting that substance use facilitates violence and aggression in youths (Welte, Barnes, Hoffman, Wieczorek, & Zhang, 2005). The notion that antisocial peers may provide an ethos where the use of substances are seen as acceptable have garnered some support while there is evidence that violence is more likely to occur while under the influence of alcohol and other drugs. There is also research showing that some people commit crimes such as stealing to fund substance use (Rutter et al., 1998). Substance use is a particularly serious problem among young offenders (Abrantes, Hoffman, & Anton, 2005).

Substance use is particularly relevant in this investigation of reward processing in antisocial individuals; given that drugs and alcohol are thought to act on reward pathways and are rewarding. A number of models of addiction have suggested that exaggeration of reward processing related to abnormal amygdala functioning may be implicated (see Bechara, Dolan, & Hindes, 2002). In addition, the incentive salience model of addiction argues for the importance of an increase in the salience of the rewarding substance following initial use. This leads to an increase in and sometimes pathological 'wanting' of drugs; this model implicates hypersensitivity of mesolimbic dopaminergic reward pathways (Dawe, Gullo, & Luxton, 2004; Jentsch & Taylor, 1999; Robinson & Berridge, 2003). Substance use and ASB more generally can be seen as forms of reward seeking that may be closely associated and share common risk factors; the substance using offender may be particularly reward sensitive and differ from the non-substance using offender in terms of offending behaviour and the factors that contribute to that behaviour.

These various approaches; frequency and severity of delinquency, psychopathic traits, conduct symptoms, aggression and substance misuse are useful for parsing the heterogeneity within the behaviour of the offenders and are related in many ways. For instance, substance use is often comorbid with clinical disorders, aggression is related to both the clinical and legal approaches and is implicated in the diagnostic criteria for clinical disorders and some types of criminal behaviour are aggressive in nature. In addition, the clinical syndromes often involve criminal behaviour. Furthermore, they tend to involve engaging in decision making that appears non-optimal and sometimes risky. Nevertheless, there are distinctions between these different approaches. It is important that research attempts to examine the different approaches and elucidates the heterogeneity in the risk factors implicated in the behaviour. In this project, young people were recruited from youth offending teams so we work primarily within the legal and judicial approach; however, it is within the scope of our research to

incorporate elements of each of these approaches and therefore attempt to appreciate and explore the heterogeneity of the behaviour.

1.2.3. An introduction to biobehavioural risk factors for ASB and the role of reward.

The main aim of this research is to explore risk factors for ASB with a particular emphasis on the role of reward processing. Advances have been made in understanding risk factors for ASB by using very different approaches to measurement (e.g., self-report, neuropsychological and psychophysiological measures). This section aims to provide a brief introduction to the literature, emphasising the gaps in relation to reward processing and young people and to provide the context for the empirical chapters.

1.2.3.1. The personality approach to antisocial behaviour and reward

Surprisingly, the role of personality traits in the development of ASB was given very little attention for many years. This was perhaps as a result of the fear of biological reductionism and the dominance of sociological theory (e.g., Romero, Luengo, & Sobral, 2001). Since Eysenck's (1964) seminal book 'Crime and Personality', the contribution of personality traits has been given increased emphasis in relation to ASB (e.g., Daderman, 1999; Romero et al., 2001). Many studies have demonstrated that antisocial individuals differ from non-antisocial individuals in terms of personality characteristics and these differences feature heavily in certain theories of crime (Cloninger, Przybeck, & Svrakic, 1991; Eysenck, 1964; Rutter et al., 1998; Zuckerman, 1994). Research has tended to focus on traits such as extraversion, impulsivity, sensation seeking and the role of reward sensitivity. Traits such as callousness and unemotionality are also considered important. Often these personality traits are examined using self-report personality questionnaires.

Eysenck's (1964) key biological theory of personality emphasised the three traits of Extraversion, Neuroticism and Psychoticism all of which have been implicated in delinquency. Eysenck's theory suggests that Extraversion is associated with low cortical arousal which can impair classical conditioning. Eysenck considered classical conditioning as integral to the development of the conscience and socialisation. He argued that those who display criminal behaviour are high on Extraversion and impaired with respect to classical conditioning. In addition, Neuroticism was considered to be related to emotional instability and to exaggerate behavioural tendencies (Romero et al., 2001). As such, Eysenck suggested that those high on both Extraversion and Neuroticism were particularly at risk for ASB. Furthermore, Psychoticism has also been implicated given its associations with hostility and emotional insensitivity (Romero et al., 2001). Some evidence for higher levels of the traits have been found in delinquent children (e.g., Center, Jackson, & Kemp, 2005) while other studies have not provided support for the association (e.g., Yule & Fonseca, 1995). Given the inconsistencies, other approaches to understanding the role of personality in ASB have been examined.

Other traits that have been implicated include Zuckerman's (1994) concept of sensation seeking which refers to the need for varied and novel sensations. In addition, the multifaceted trait of impulsivity has been emphasised, which appears to incorporate many different factors including an insensitivity to delayed rewards or the inability to delay gratification, and an inability to inhibit behaviour when inhibition is required (e.g. Ainslie, 1975; Cherek, Moeller, Dougherty, & Rhoades, 1997; Gerbing, Ahadi, & Patton, 1987; Schachar & Logan, 1990). Moreover, Cloninger's (1987) tridimensional theory of personality is also relevant and mentions three particular dimensions; harm avoidance; novelty seeking and reward dependence. The novelty seeking dimension appears particularly important here and is related to excitement and reward seeking.

These traits (e.g., extraversion, sensation seeking and impulsivity) share many conceptual similarities with each other and also to reward seeking. Indeed, these traits have been referred to as approach traits (Romero et al., 2001; Zuckerman, 1994) and are characterised by sensitivity to rewarding experiences but also insensitivity to punishment. Jeffrey Gray (1970) developed a personality theory that attempted to relate the brain reward and punishment systems to behaviour and the theory has been particularly useful for providing a framework for reward-psychopathology relations. Gray's (1970) Reinforcement Sensitivity Theory (RST) is a neuropsychological theory of personality that comprises three motivational systems thought to underlie behaviour and affect. The RST was based upon animal responses to rewarding and punishing stimuli in behavioural paradigms and was developed as a modification to Eysenckian biosocial personality theory (Carver & White, 1994; Corr, 2002; Corr, 2004; Matthews & Gilliland, 1999).

The most widely referred to systems in Gray's model are the Behavioural Approach System and the Behavioural Inhibition System. The Behavioural Approach System (BAS; Gray, 1987) also known as the Behavioural Activation System is an appetitive system and is considered to be sensitive to signals of reward, non-punishment, and escape from punishment. BAS activity leads the person to begin movement towards a goal. The BAS is said to mediate impulsivity and is responsible for positive affect. The biological basis of the BAS is thought to be governed by catecholaminergic especially dopaminergic pathways, including the ventral tegmental area and the nucleus accumbens of the ventral striatum (Brenner, Beauchaine, & Silvers, 2005; Carver & White, 1994). The Behavioural Inhibition System (BIS; Gray, 1987) is an aversive system and was originally considered to be sensitive to signals of punishment, non-reward, and novelty. It is thought to inhibit behaviour that may lead to negative outcomes. Therefore, activity of the BIS leads to inhibition of movement toward goals. It is argued that BIS activation is responsible for negative affect such as fear,

anxiety and sadness (Carver & White, 1994). The biological basis of the BIS is thought to involve the amygdala and septohippocampal system (Carver & White, 1994). The structures are supplied by serotonergic projections of the raphe nucleus and noradrenergic projections of the locus ceruleus (Brenner et al., 2005).

Gray's theory has been useful for providing a framework for the understanding of personality and psychopathology relations (Bijttebier, Claes, & Vandereycken, 2009). In very general terms heightened activity in the reward system is associated with vulnerability to externalising disorders, while heightened BIS is associated with internalising disorders (e.g., Bijttebier et al., 2009). Specific hypotheses have been postulated; for instance high BAS is proposed to be associated with conduct disorder and antisocial personality disorder (Quay, 1993) and to psychopathy, whereas low BAS is associated with depression (Depue, Krauss, & Spoont, 1987). On the other hand, high BIS has been related to anxiety (Gray, 1982) and low BIS associated with attention deficit hyperactivity disorder (ADHD; Quay, 1997) and psychopathy (Fowles, 1980). In addition, relations to other types of psychopathology have also been investigated such as the association with alcohol and drug abuse.

BIS and BAS have frequently been examined using the BIS/BAS scales questionnaire (Carver & White, 1994) where BIS is conceptualised as a unitary system and BAS is further divided into three subscales: BAS Drive, Fun Seeking and Reward Responsiveness. There has been very little research exploring the relation between the BIS/BAS and particularly the different facets of reward processing and ASB in young people. The present research aims to extend knowledge on the relationship between BAS and reward traits and the diversity of ASB, in an adolescent group of offenders and non-offenders.

1.2.3.2. The neuropsychological approach to antisocial behaviour and reward.

Biological predispositions to ASB may manifest through the disruptions of neural mechanisms that control behaviour. As such, neuropsychological assessments have provided a way to uncover evidence of neurological dysfunction in ASB (Raine, 1993). There has been substantial evidence documenting neuropsychological deficits in those with ASB (Moffitt, 1993; Morgan & Lilienfeld, 2000; Pennington & Ozonoff, 1996; Raine et al., 2005), particularly notable are impairments in executive functioning, which are related to the frontal lobes of the brain (Moffitt, 1993).

A meta-analytic review on the relation between ASB and executive function (EF) found that antisocial groups performed significantly worse on EF measures, with effect sizes ranging from medium to large. Effect sizes were larger for studies of criminality and delinquency than for other antisocial groups (Morgan & Lilienfeld, 2000). However, Morgan and Lilienfeld note that a limitation of the study was the failure to divide EF measures in terms of their associations with different regions of the brain (e.g., dorsolateral prefrontal cortex, orbitofrontal cortex). Indeed a limitation of this research in general is the failure to distinguish between different types of executive function and related prefrontal regions. Research has often focused on tasks such as the Wisconsin Card Sort Test (Heaton, 2005) which is thought to relate to the dorsolateral prefrontal cortex, an area of the brain not strongly implicated in ASB (Blair et al., 2005). It has been argued that evidence for an association between dorsolateral functioning and ASB may be the result of comorbid conditions such as ADHD. Indeed, executive function deficits are more consistently shown in relation to ADHD than CD (Pennington & Ozonoff, 1996). Therefore research on neuropsychological functioning in ASB should consider comorbid conditions such as ADHD and target more specific sub-regions of the prefrontal cortex.

As noted previously, the orbitofrontal cortex is involved in the evaluation of reward processing and assigning incentive value to stimuli. One of the capacities found to be reliant on the OFC that is impaired in ASB is the ability to achieve response reversal and extinction (Budhani & Blair, 2005). A typical EF extinction task, that is thought to involve the OFC, is the Card Playing Task (CPT; Newman et al., 1987). The CPT involves establishing a dominant response set for reward by initially providing participants with a high level of reward for their responses. However, as the task progresses the level of punishment increases and reward declines. To be successful, participants need to take into account environmental changes and interrupt their dominant plan. Impairments on this task have been found in a range of antisocial samples (e.g., Daugherty & Quay, 1991; Fisher & Blair, 1998; Matthys, van Goozen, de Vries, Cohen-Kettenis, & van Engeland, 1998); however, research in community based antisocial youths is scarce. In addition, there is a need to further explore the processes of reward and punishment sensitivity and compare these to more globalised measures of executive function.

It is clear that although EF impairments are implicated in ASB, there are a number of limitations in the literature, including a failure to take into account comorbid problems such as attention deficits. Furthermore, different EF tests have rarely been used in the same studies, with more research needed using tasks that tap into different regions of the prefrontal cortex, (e.g., the orbitofrontal cortex). Finally, few studies have examined EF in adolescent community offenders. This thesis aims to explore EF and reward processing in adolescent offenders and compare to control adolescents matched on IQ and self-report attention deficit symptoms.

1.2.3.3. The psychophysiological approach to antisocial behaviour and reward

There has been considerable research on the psychophysiological basis of ASB in adults. Measures of skin conductance (SC) and heart rate (HR) have frequently been used to examine autonomic nervous system arousal (Ortiz & Raine, 2004; Raine, 1993). HR is reflective of both sympathetic and parasympathetic nervous system activity, whereas SC activity reflects sympathetic processes only. Reduced autonomic nervous system (ANS) arousal (e.g., low heart rate and skin conductance) has consistently been found to be associated with ASB leading to the psychophysiological theory that antisocial individuals are chronically underaroused (van Goozen et al., 2007). The fearlessness theory purports that the reduced arousal reflects low levels of fear (Raine, 1993). Individuals who are fearless may engage in greater levels of ASB because they do not fear the negative consequences of their actions (e.g., physical injury, punishment). An alternative theory is the sensation seeking theory (Zuckerman, 1979) which proposes that low arousal represents an aversive physiological state, which individuals seek to raise to a more optimal level. Accordingly, ASB is a form of stimulation seeking and comparisons can be made here with the reward seeking literature.

Poor autonomic nervous system fear conditioning has been one of the best replicated correlates of ASB in adults and it has been argued that this may result from low arousal and an inability to learn from punishments in childhood which could contribute to a failure to develop moral socialisation (Raine, 1993). Lower skin conductance responses (SCRs) can serve as an indicator of low arousal and of poor fear conditioning. SCRs can be elicited in a number of ways but often a classical conditioning paradigm is used. In this paradigm, a neutral stimulus (NS) is repeatedly paired with an aversive stimulus (unconditioned stimulus [US]), such as a loud sound. The US naturally produces an innate response called the

unconditioned response (UR). After repeated pairings of the NS and US the NS elicits a conditioned response (CR) that is similar to the innate response produced by the US. The NS is now termed the conditioned stimulus (CS).

Although poor conditioning is a robust finding in the adult literature, more research is required that explores poor fear conditioning in adolescent antisocial samples. Interestingly, the role of reward in these classical conditioning techniques has rarely been examined in humans (Martin-Soelch, Linthicum, & Ernst, 2007). This is likely to be because it is more challenging to examine appetitive processing given the difficulty of producing a suitable reward that would elicit a response similar to that demonstrated with aversive stimuli. Like fear learning, reward conditioning has also been shown to relate to amygdala functioning (Johnstrude, Owen, White, Zhao, & Bohbot, 2000). It would be interesting to assess whether antisocial individuals who display deficits in fear conditioning also show similar deficits in appetitive conditioning. It could be argued that given the proposed hypersensitivity to reward in antisocial individuals that they may condition more appropriately where reward is involved. In contrast, the evidence suggesting that antisocial individuals have low physiological arousal thus leading to stimulation seeking would argue for a reduced physiological response to reward.

1.2.4. Additional points to consider

1.2.4.1. Punishment

A thesis on reward sensitivity cannot ignore the role of punishment sensitivity. In addition to heightened reward sensitivity, research has also implicated reduced punishment sensitivity and fear in antisocial individuals. For instance, an underactive Behavioural Inhibition System (Gray's punishment system) is implicated in disorders such as attention deficit hyperactivity disorder (Quay, 1997) and psychopathy (Fowles, 1980). Furthermore,

evidence of low heart rate and skin conductance in antisocial individuals has been taken as evidence of reduced fear in these individuals (Raine, 1993). Many antisocial acts require a degree of fearlessness to execute. Furthermore, low fear of punishment may impair the ability to condition appropriately resulting in poor socialization (Raine, 1993). Research has found reduced reactivity to threatening stimuli, reduced fear conditioning and reduced responses to the anticipation of punishment in those with psychopathy (Blair et al., 2005). So although the present thesis focuses on the role of reward sensitivity in particular, it is acknowledged that many antisocial acts also involve an element of reduced punishment sensitivity. Where possible, these processes will be distinguished and compared, but the main focus here is on the role of reward processing.

1.2.4.2. Intelligence quotient

It is well established that young offenders have an Intelligence quotient (IQ) below that of the general population (Rutter et al., 1998). This is a robust finding having been replicated on a number of occasions (Moffitt, 1993). In fact, evidence suggests that antisocial young people score approximately eight IQ points lower than non-antisocial young people **(**Hirschi & Hindelang, 1977; Raine, 1993; Rutter et al., 1998). Furthermore, studies have shown that a substantial number of young offenders have IQs in the learning disability range with a recent study on young offenders showing 20 % of the sample had IQs below the cut off for intellectual disability and 41 % had an IQ below average (Chitsabesen et al., 2007).

It was important to take IQ into consideration in this study particularly because of the effect low IQ could have on neuropsychological performance and comprehension of measures in general. An IQ measure constituting both a verbal and spatial component was utilized for this purpose. In the diagnoses of mental retardation , criterion A of DSM-IV-TR (APA, 2004) states ‘the essential feature... is significantly sub-average general intellectual

functioning' (this is defined by an IQ of approximately 70 or below). The ICD-10's (World Health Organisation, 1992) criteria for learning disability is an IQ score below 70. Consistent with these definitions and with the Wechsler scale classifications, an IQ less than 70 was considered the cut off for intellectual disability and anyone scoring below this was not included in the analyses of the present research.

1.2.4.3. Socioeconomic status (SES)

Low SES has long been associated with ASB and is a social variable related to many other factors that have been implicated in ASB, such as living conditions (e.g., poverty, large family, poor housing), family variables (e.g., parenting) and individual factors such as IQ (Raine, 1993). Given these associations SES is usually controlled for in analyses on ASB. The present research will also control for SES in our between groups analyses and perhaps is particularly important given our emphasis on the reward of money in some of our tasks.

1.2.4.4. What is adolescence?

Adolescence is defined in numerous ways including on the basis of age, puberty, educational level and the law (Galvan, 2010). A very broad definition of adolescence that is suitable for the current study is "the gradual period of transition from childhood to adulthood" (Spear, 2000, p. 417). Studies that have purported to examine adolescence have differed considerably in their operationalisations of adolescence and as such in the individuals that constitute the adolescent sample, with some including quite a narrow age range (e.g., age 14-15; Van Leijenhorst, Zanolie et al., 2010) while others have included a much wider range (e.g., age 9-17; Ernst et al., 2005) .We have attempted to keep the age range of the participants in the present study deliberately wide (i.e., aged 13-17) so that we can capture reward sensitivity and ASB at different stages of development, but in doing this it is important to appreciate the wide age range and the different developmental stages therein.

For instance, a 13 year old will likely differ in many ways from a 17 year old, perhaps in the extent of their ASB and also in aspects of their reward sensitivity (e.g., different appreciation of money, often used as a reward in our paradigms). Therefore, it is important to analyse the results appropriately in view of this, controlling for age and analysing the effects of age where appropriate.

1.3. Hypotheses

The aim of the research is to examine the relationship between reward processing and ASB in adolescence. A multi-method approach to the examination of reward processing was adopted, including neuropsychological, psychophysiological and self-report personality measures. ASB was explored using official crime records and self-report measures of aggression, psychopathic traits and clinical symptomatology as well as examining substance use behaviour. By integrating multiple approaches to the measurement of both reward and ASB it was hoped that the complex relationship between the two constructs will be further elucidated. Young offenders from the community were recruited to better understand the ASB in non-institutionalised adolescents. Of particular interest was the examination of reward processing within this group and an exploration of the relationship with different aspects of ASB. Young offender behaviour and reward processing were also compared to the performance of non-offending young people, and this was particularly important for novel neuropsychological and psychophysiological measures. It was hypothesised that:

(1) Antisocial young people would be characterized by altered reward processing compared to the normal control group. More specifically, they would display:

(a) increased levels of traits associated with reward on self-report personality measures (i.e., behavioural approach, reward drive, reward seeking, reward responsiveness);

(b) neuropsychological impairments on tasks involving reward processing (i.e., response perseveration, increased attention to rewards; executive function deficits associated with reward processing).

(c) altered autonomic reward conditioning on psychophysiological measures.

(2) Young offenders differ in the frequency and severity of offending, level of psychopathic traits, aggression, substance misuse, clinical symptomatology and emotional and behavioural problems (e.g., conduct disorder symptoms, attention deficit hyperactivity problems). Of particular interest in this study was the relationship between these different dimensions that inform our understanding of ASB and reward processing within the young offender group. It was predicted that antisocial youths will differ in biobehavioural factors associated with reward processing and that these factors explain variations in ASB.

The present chapter has considered the importance of examining reward processing in relation to ASB in adolescence, provided a review of the literature emphasising the areas where more research is required and subsequently presented the PhD study aims and hypotheses. Chapter two will present an overview of the methodology common to the project as a whole, provide generic details of the sample (more specific details will be presented in each of the subsequent empirical chapters), describe the recruitment procedure, and the ASB measures that reoccur throughout the thesis.

Chapter three will explore reward and punishment personality traits using the Behavioural Inhibition System /Behavioural Activation System scales (Carver & White, 1994) in adolescent offenders and non-offending controls. More specifically, reward and punishment traits will be compared between the groups and then the relationship between BIS and BAS and various approaches to ASB (i.e., offending frequency and severity, psychopathy, conduct symptoms, aggression) will be explored in the group as a whole. This chapter aims to explore

the extent to which different traits of reward (e.g., reward drive and reward response) are implicated in adolescent ASB. BAS/BIS traits have rarely been examined in relation to ASB in young people and this research aims to provide much needed knowledge in the area.

Chapter four will examine the relationship between neuropsychology, reward processing and ASB, within offenders and between groups. Executive functioning will be assessed using a measure related to global prefrontal functioning and a measure associated with the orbitofrontal cortex that incorporates both reward and punishment contingencies. These measures will also be compared to a novel reward processing measure developed in our laboratory that aims to assess the extent of reward and punishment monitoring. Neuropsychological investigations of ASB have tended to assess global functioning and by examining specific tests related to particular areas of the frontal lobes it is hoped that a clearer understanding of neuropsychological functioning in these young people will be gained. Importantly, by comparing functioning in adolescent offenders and matched non-offending controls we can assess whether reward processing deficits are generally associated with adolescent development or more specific to ASB.

Chapter five will make use of psychophysiological procedures to explore emotional functioning and learning in adolescent offenders. Deficits in fear learning in antisocial individuals are established in adults and increasing evidence is accumulating in young people. Nevertheless, research in community offenders is scarce and more importantly the examination of reward processing and learning using psychophysiological methods is a neglected area. Thus Chapter five will examine autonomic fear conditioning and reward conditioning in adolescent offenders and controls. This chapter aims to assess the extent to which the emotional learning impairment is a global one or rather it is more specific to fear.

Chapter six will explore the relation between substance use and ASB in the young offender sample. The chapter aims to examine to what extent substance use, a reward seeking behaviour, is a problem in the young offenders and how substance use relates to offence frequency, offence severity and psychopathic traits. Furthermore, the role of reward processing traits (BAS) will be examined in relation to substance use. These four empirical chapters are written as individual articles which are in the process of or have been submitted for publication, as such there will be some replication in the account of methodological details in particular, rather than cross referencing between chapters.

Chapter seven will evaluate the evidence from the previous four chapters, discuss this in relation to the different reward processing approaches and assess to what extent different reward measures can explain variation in ASB. The chapter concludes with a discussion of the implications of these findings in terms of clinical practice and policy making and points towards further research required in the area.

Chapter Two – Methodological overview

This chapter provides an overview of the project methodology common to all of the empirical chapters with the specific details related to each chapter (e.g., participant numbers; reward processing and substance use measures) included in the relevant subsequent chapters. The chapter will briefly review the participant details for both the young people engaged in the criminal justice system and the non-offending young people who formed the comparison control group. In addition, the recruitment process, the full description of the non-reward processing measures (i.e., offence history, psychopathic traits, clinical symptom measures, aggression and the intelligence functioning measure) and data collection procedure will be described.

2.1. Participants

2.1.1. Young offenders

The participants were male offenders aged between 13 and 17 years old engaged in the criminal justice system. The number of participants who completed each measure varied considerably due to the difficulty in recruitment, keeping participants engaged and time limitations for particular individuals. In addition, certain measures were added to the testing protocol at a later stage. The exact numbers involved in each study and who completed each measure will be provided in the subsequent chapters, along with specific explanations for any reduction in numbers. Female participants were also initially recruited (nine participants aged between 14 and 17; mean age = 16.22; SD = 0.97). However, given the small numbers obtained; reflecting the smaller number of female offenders at the youth offending team, it was deemed appropriate to include only the male participants recruited in the study analyses. Gender comparisons would not be possible given the small number and combining the groups was not appropriate given the possible gender differences in performance. Explicit exclusion criteria consisted of an IQ score below 70 and use of illegal substances on the day of testing;

as such five participants were recruited but did not complete the rest of the test battery; three participants had an IQ score below our cut off and two reported being under the influence of illegal substances.

Explicit criteria for inclusion into the offender group was the presence of delinquent (criminal) behaviour that had brought them in contact with the criminal justice system. This offending behaviour may have resulted in a court conviction or instead have resulted in reprimands and final warnings (pre-court measures provided for first offences). The young offender (YO) group were composed of young people who were required to attend at Cardiff youth offending team (YOT) because they had engaged in offending behaviour; the offenders had committed offences at different levels of frequency and severity and were also diverse in their offending types. Offending types included criminal damage, motoring offences, burglary, theft and handling, drug offences and violence against the person. Figure 2.1 shows the frequency of the different types of offences committed by 80 offenders in our study; the total number of offences committed was 796 (mean = 9.95; SD = 8.66; Minimum = 1; Maximum = 36). The modal offence type was theft and handling. More detailed information will be provided in later chapters on offence frequency and severity levels.

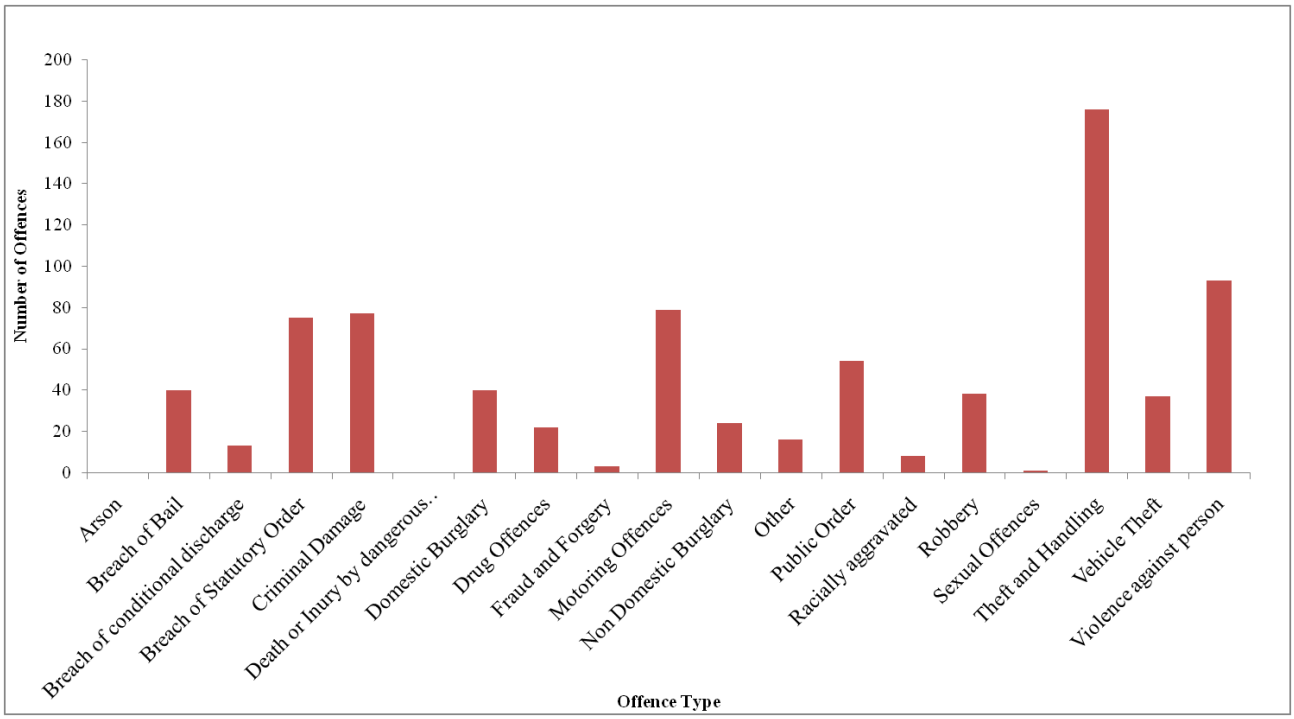

Figure 2.1 Type and frequency of offences in the young offender group (n = 80).

The young people were recruited from the youth offending team (YOT). YOTs are multi-agency partnerships with representatives from a wide range of services; for instance from probation, police, substance misuse, career and social services. There are YOTs in every local authority in England and Wales and they are overseen by the Youth Justice Board which reports to the Ministry of Justice. The primary aim of YOTs is to prevent offending and recidivism in young people aged 10-17 years old. The achievement of this aim is attempted through the assessment of young people's needs and the administration of various programmes and official orders (e.g., reparation, intensive surveillance).

YOTs are involved with young people at each stage of their pathway through the youth justice system; at the prevention stage - preventing offending in young people at risk of offending; at the pre-court stage - preventing young people who have committed a first or second offence from becoming further drawn into the criminal justice system; at the court

stage - assisting when young offenders have been charged by the police after committing further offences, or charged with a serious offence; after sentencing - working with young people who have been sentenced to the community on any orders that they may have been given by the court. (Please see Appendix A for a flow chart of the process through the youth justice system for a young offender). Although YOTs increasingly work with young people who are at risk of offending, our research recruited only the young people who have engaged in offending behaviour; the inclusion criteria specified that this offending behaviour should have brought them in contact with the criminal justice system resulting in a court conviction or pre-court reprimands and final warnings. Nevertheless, we were unable to recruit any young people with pre-court outcomes only and instead all had instead at least one court conviction.

Young offender participants (hereafter known as the YO group) were recruited from the YOT in collaboration with their allocated case workers; the caseworkers would make referrals of young people they deemed appropriate to take part in the research. In addition, the researchers had access to a list of each of the caseworker's current caseload and this allowed for a more systematic recruitment procedure whereby the researcher contacted the caseworker about each open case. Young people identified were firstly approached by the caseworker and then if interested, the researcher would contact the young person and give a brief summary of the research aims and procedures and also provide the study information and informed consent forms. Parental/guardian consent as well as young person assent was required. Upon return of the parental/guardian consent forms a suitable time was arranged for the study to take place. Participants were provided with £5 per hour in vouchers for participation. These vouchers are entitled love2shop vouchers and can be spent in various UK stores. It is necessary to note that limitations at each of the recruitment stages is likely to have impacted on the representativeness of the recruited individuals, relative to the population

available to be assessed. For instance, the offenders that took part may have been the more willing volunteers and identified by caseworkers as the most likely to engage etc. Given the lack of information available on the non-recruited individuals, the representativeness of the sample is difficult to quantify. Nevertheless, the substantial variation in offending frequency and severity of the offenders recruited would suggest that the sample studied was suitably representative. The total number of offenders that took part in the study was determined based on a pragmatic approach whereby the most offenders that could be recruited in the time given was achieved.

2.1.2. Control group

The data from the young offenders were compared to data from non-offending normal control children (numbers who took part in each study will be provided in each subsequent chapter). The control group consisted of young males aged between 13-17 years. These young people were recruited from several schools in the local area of Cardiff. Participants were excluded if they had engaged in antisocial behaviour that had brought them in contact with the criminal justice system (e.g., been arrested for an offence). Contacts in the school provided students with a summary of the research. The researcher then approached any interested students and provided further information on the research study and handed out the relevant information and consent forms. On return of the parental consent form, a time was scheduled to complete the study. The control participants were also provided with £5 per hour for participation. Similar to the YO group, there are also possible limitations in the recruitment process such that the participants who engaged in the study may not be representative of all school children (they may be the more motivated children) and this must be considered when interpreting the results.

2.2. Measures

2.2.1. Antisocial behaviour measures

The measures described in this section were used in the empirical chapters and are proposed to link with the diverse operationalisations of ASB outlined in the literature (Morgan & Lilienfeld, 2000; Rhee & Waldman, 2004; Seguin, 2004). They will be described in some detail here and more briefly in the subsequent chapters.

2.2.1.1. The Youth Psychopathic traits Inventory (YPI: Andershed et al., 2002). The Youth Psychopathic traits Inventory is a self-report measure for the assessment of psychopathic traits. The YPI is designed for young people aged 12 years old and above and is intended for community samples as opposed to those in correctional facilities.

The YPI is a 50 item measure, with each item rated on a 4 point scale (1 = does not apply at all; 2 = does not apply well; 3 = applies fairly well; 4 = applies very well). Items are scored 1, 2, 3, and 4 accordingly, except for certain reverse scored items, created in order to prevent a response set and also to dissuade from social desirability bias. It contains 10 subscales with five items each and is hypothesised to possess three higher order factors: interpersonal, affective and lifestyle factors (e.g., Andershed et al., 2002). It was designed to measure the core traits outlined in the Psychopathy Checklist-Revised (Hare, 1991; which is considered the gold standard in adult psychopathy assessment): dishonest charm, grandiosity, lying, manipulation, remorselessness, callousness, unemotionality, impulsivity, irresponsibility, and thrill seeking.

The subscales are combined into three domains; (1) Grandiose-Manipulative (dishonest charm, grandiosity, lying, manipulation) (2) Callous-Unemotional (remorselessness, unemotionality, callousness) and (3) Impulsive-Irresponsibility (thrill

seeking, impulsiveness, irresponsibility; Andershed et al., 2002; Dembo et al., 2007). Example items include 'I'm better than everyone on almost everything' (Grandiose-Manipulative domain), 'I seldom regret things I do, even if other people think they are wrong' (Callous-Unemotional) and 'I prefer to spend my money right away rather than save it' (Impulsive-Irresponsibility). The questionnaire takes approximately 10 minutes to complete. Total scores range from 50-200 with higher scores reflecting higher levels of psychopathic traits. The continuous variables of the total sum score and three domain scores were of particular interest and recorded.

The evidence suggests that the YPI is a useful instrument that correlates with various deviant behaviours in the community and institutionalised samples (Andershed et al., 2002; Andershed et al., 2007; Declercq, Markey, Vandist & Verhaeghe, 2009; Dembo et al., 2007; Poythress, Dembo, Wareham , & Greenbaum, 2006; Skeem & Cauffman, 2003). The YPI has been shown to possess good internal consistency for total scores and factor scores (ranging from Cronbach (1951) alpha α = .77 to .92; Skeem & Cauffman, 2003).

2.2.1.2. Youth Self Report (YSR; Achenbach & Rescorla, 2001). The YSR is a self-report questionnaire for the assessment of competencies and problems in individuals aged between 11 and 18. The YSR is a widely used tool in both community based and clinical research on problem behaviour in adolescents.

The questionnaire contains two subsections; section one containing 20 competence items for the assessment of the participant's involvement in sports, hobbies, activities, games, jobs, friendships and school performance. Section two contains 112 items that assess behavioural and emotional functioning in eight designated syndromes: anxious/depressed (e.g., crying, fears, nervousness), withdrawn/depressed (e.g., shy, sad, prefers to be alone), somatic complaints (e.g., nausea, headaches, dizziness), rule breaking behaviour (e.g., lying,

stealing, substance use), aggressive behaviour (e.g., teasing others, arguing, fighting), social problems (e.g., jealous of others, clumsy, teased by others), thought problems (e.g., hallucinatory experiences, strange behaviours) and attention problems (e.g., impulsivity, immaturity, day dreaming). These items were used by psychiatrists to create six DSM-oriented scales: affective problems, anxiety problems, somatic problems, attention deficit/hyperactivity problems, oppositional defiant problems and conduct problems. The following scales were of particular interest; YSR conduct problems (15 items) which was composed of items from the rule breaking behaviour (example item; I steal from home) and aggressive (example item; I get in many fights) syndromes and YSR attention deficit hyperactivity problems (7 items) which is mainly composed of items from the attention syndrome (example item; I fail to finish things I start).

Participants rate how true each item is for them now or within the past six months on a 3-point scale (0 = not true; 1 = somewhat or sometimes true; 2 = very true or often true). The questionnaire takes approximately 15-20 minutes to complete. The YSR scoring program converts the participant's total score for each scale to a standardized t score (i.e., mean score of 50, standard deviation of 10), with higher scores reflecting higher levels of the dimension measured.

Internal consistencies of the YSR in the derivation sample (Cronbach's alpha) have been show to be substantial ranging from .76 for DSM-oriented scales to .95 for total problems. The test-retest reliability ranging from .79 for DSM-oriented scales to .87 total problems (Achenbach & Rescorla, 2001). Furthermore, the YSR clinical scales significantly predict DSM diagnoses in adolescents in the community and inpatient settings (Morgan & Cauce, 1999; Weinstein et al., 1990).

2.2.1.3. Reactive-Proactive Aggression Questionnaire (RPQ; Raine et al., 2006). This is a self-report questionnaire for the assessment of proactive and reactive aggression in children and adolescents. The questionnaire contains 23 items, 11 items for the measurement of reactive aggression and 12 items for the assessment of proactive aggression. Participants are asked to rate how often they engage in a number of aggressive behaviours, by choosing from the following three response options; 0 = never, 1 = sometimes, 2 = often. Examples items include how often have you 'hit others when teased' (reactive aggression) and 'had fights to show who's on top' (proactive aggression). Total aggression scores range from 0 – 46 (i.e., 0-22 for reactive aggression and 0-24 for proactive aggression). The questionnaire demonstrates good reliability and validity (see Raine et al., 2006). The questionnaire takes approximately 5 minutes to complete.

2.2.1.4. Official crime records. All participants provided informed consent to give the researcher permission to access their file information held on the YOT database. These data files were used to access official crime records and background information (e.g., living arrangements, parental relationships) on each young person. The crime records were used to obtain details of any offences the young people had committed and to particularly derive frequency and severity of offence scores.

A total frequency score was calculated by summing the total number of offences committed by each young person. A rate variable was obtained by dividing the frequency score by age; it was important to take age into consideration given the wide age range of participants taking part (13-17 years old) and as such older participants would have had more time to commit offences than younger participants.

In addition, severity scores were calculated by using the seriousness scale developed by the Youth Justice Board (please see Appendix B for a copy of this seriousness scale). This

scale ranges from 1 - 8 with a rating of 1 given to minor offences such as littering, using abusive language and breaches of conditional discharge, while a score of 8 corresponds to murder, manslaughter, rape and causing death by dangerous driving. Given the ordinal nature of this scale the median offence severity score was obtained for each individual.

2.2.2. Additional variables

2.2.2.1. Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). The WASI provides a brief and reliable estimate of a person's intellectual functioning. The two sub-test form was selected; this contains the vocabulary and matrix reasoning components, which tap into crystallized and fluid abilities. In the vocabulary component the participant is required to provide oral definitions of words of increasing difficulty. In the matrix reasoning test participants are required to examine a matrix in which a section is missing and complete the matrix by choosing from five response options. A total t-score from the individual t-scores of the two sub-tests is calculated and converted into an IQ estimate, in conjunction with the respondent's age. The test takes approximately 15 minutes to complete.

2.2.2.2. Socioeconomic status (SES). SES was estimated using the Office for National Statistics (ONS) estimates of average household total weekly income based on each participant's post code (Low = £ 0-£520; Middle = £521-£670; High = £671+).

The ONS estimates provide the average household income for small areas within England and Wales; the estimate is based on the income a household receives from wages and salaries, self employment, benefits, pension and other sources of income. The software for the estimation of post code based income is readily available and can be found on the ONS website along with detailed accounts on accuracy, validation and quality assurance of the data (www.neighbourhood.statistics.gov.uk).

Post codes were easily obtainable from our participants and were deemed suitable as estimates of SES (in the absence of more comprehensive estimates) for the current project purposes (comparison of SES between YOs and NCs). In addition, this method is particularly useful when participants are children and adolescents who may have difficulties reporting on parental income, education and occupation and so forth.

UK postcodes are usually shared by only 15-20 households and these estimates can more accurately predict social status than more aggregated data such as from electoral wards (Danesh, Gault, Semmence, Appleby, & Peto, 1999). Family income is an important estimate of SES recommended as a measure of inclusion in guidelines in several papers (Entwistle & Astone, 1994; Hauser, 1994; Hernandez, 1997). Post code income estimates have been used frequently in past research and are a good estimate of SES (Danesh et al., 1999).

2.3. Procedure

The study was approved by Cardiff University's School of Psychology Research Ethics Committee (SREC). Data from the young offenders were collected at the Cardiff youth offending team (YOT). Each young offender was tested individually by the researcher in a sound and light attenuated interview room at the YOT. Each normal control participant was tested individually by one researcher in allocated classrooms in each school. On arrival at the testing room, the participants were given a full explanation of the research procedure. In particular, the aims of the study were described, along with the tests they would be required to complete. In addition, they were informed of the voluntary nature of their participation, their right to withdraw at any time and the confidentiality of the data obtained. As such, the participants provided written informed consent and for the young offenders this also included consent for the researchers to access their file information held at the YOT.

All computerised tasks were presented on a laptop computer (type: VAIO) with a 14" display and responses were made using a mouse or keyboard buttons. Participants were informed that the researcher would read out and/or explain anything as required and that they did not have to answer any questions that they did not want to. The total duration of testing was four hours and therefore to ensure optimal attention and performance the session was divided into 2 x 2 hour sessions separated in time by one week; this was also necessary for the psychophysiological measures to reduce potential carry over effects on the tasks.

The studies presented in the subsequent chapters form part of a larger investigation examining behavioural inhibition and emotional functioning in young offenders and therefore the tasks described in this thesis were accompanied with additional emotional functioning tests unrelated to the present thesis aims. As mentioned previously, the reward related and substance use measures will be discussed in detail in the subsequent relevant chapters (i.e., personality measure in Chapter three; neuropsychology measures in Chapter four; psychophysiology measures in Chapter five; substance use measures in Chapter six).

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Chapter Three - The relationship between reward and punishment traits and antisocial behaviour.

3.1. Introduction

Theories that emphasize the biological basis of personality, such as the Reinforcement Sensitivity Theory (RST; Gray, 1970), have contributed to a better understanding of the aetiology of antisocial behaviour (ASB). The RST proposes that reward and punishment systems underlie behaviour and affect. Although increasing research has focussed on the examination of the RST in relation to aspects of ASB, there is a dearth of studies in antisocial adolescents. Adolescence is a particularly interesting time for investigating ASB, given that offending has been shown to peak during this period and is said to conceal at least two types of offender each with a different aetiology and predicted course (Moffitt, 1993). Furthermore, it has been speculated that the increase in risk taking in adolescents is a result of heightened reward seeking (e.g., Steinberg, 2008, 2010), so the exploration of reward sensitivity traits during this time has particular importance. In addition, it must be noted that ASB is a complex construct encompassing clinical approaches (e.g., externalising disorders such as conduct disorder and psychopathy), legal approaches (e.g., criminality and delinquency) and aggression. Studies of RST have examined many of these components separately; the present research aims to explore multiple aspects of ASB to appreciate the heterogeneity in the behaviour and the risk factors involved during adolescence.

3.1.1. Reinforcement Sensitivity Theory

The RST comprises three motivational systems that respond to different reinforcing events and are mediated by separate brain structures; the Behavioural Activation System (BAS), Behavioural Inhibition System (BIS) and the Fight-Flight-Freeze system (FFFS). The BAS is an appetitive system and is considered to be sensitive to signals of reward, non-punishment, and escape from punishment. BAS activity leads the person to begin movement towards a goal. The BAS is said to mediate impulsivity and is responsible for positive affect.

The BIS is an aversive system and was originally considered to be sensitive to signals of punishment, non-reward, and novelty. It is thought to inhibit behaviour that may lead to negative outcomes. Therefore, activity of the BIS leads to inhibition of movement toward goals. It is argued that BIS activation is responsible for negative affect such as fear, anxiety and sadness (Carver & White, 1994). Recent revisions to the RST suggest that the FFFS is now responsible for mediating reactions to aversive stimuli and the BIS is involved in resolution of goal conflict in general (i.e., conflict between reward and threat; Corr, 2004; Gray & McNaughton, 2000). Current personality measures of BIS are based on the original theory and therefore actually reflect combined BIS and FFFS functioning and in the absence of new measures, this paper refers to BIS/ FFFS as BIS functioning.

A number of personality questionnaires have been developed to assess BIS/BAS. Some research has focused on examining indirect traits such as the approach traits of impulsivity and extraversion. For instance, the impulsivity subscales of the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1964) and the Impulsiveness Venturesomeness and Empathy Questionnaire (IVE; Eysenck, Pearson, Easting, & Allsopp, 1985) and also the reward dependence and novelty seeking subscales of Cloninger's Tridimensional Personality Questionnaire (TPQ; Cloninger, Przybeck, & Svrakic, 1991). Nonetheless, this indirect approach can be problematic, as the traits have subtle differences and are based on different theoretical frameworks. For instance, researchers have argued that BAS and impulsivity are related but separate and distinct constructs and the use of impulsivity measures to assess BAS may be inappropriate (Carver & White, 1994; Quilty & Oakman, 2004; Smillie et al., 2006). It has been suggested that researchers often focus on the label of impulsivity given to the BAS dimension rather than the behaviours that Gray described as resulting from behavioural activation and behavioural inhibition (Torrubia, Avila, Molto, & Caseras, 2001). Indeed, recent research has emphasised the multidimensional

nature of the impulsivity construct and that reward sensitivity may be just one aspect of the wider impulsivity construct (Quilty & Oakman, 2004; Smillie et al., 2006). Measures designed to assess reward sensitivity specifically are required.

A number of direct measures have been developed and include the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001) and the Generalised Reward and Punishment Expectancy Scales (GRAPES; Ball & Zuckerman, 1990), which have been used in a considerable number of studies. In addition, the Gray-Wilson Questionnaire (Wilson, Barrett, & Gray, 1989) has been developed to examine approach, active avoidance, passive avoidance, extinction and fight and flight behaviours (Gomez & Gomez, 2005). Unfortunately, this measure has not demonstrated adequate validity and reliability. Arguably, the most extensively used questionnaire for assessing Gray's theory is the Carver & White Behavioural Inhibition/Activation Scales (BIS/BAS scales; Carver & White, 1994). The scales have been used extensively in adults, but have also been found to be suitable for use in younger samples, although there is less research in young people (Cooper, Gomez, & Aucote, 2007; Coplan, Wilson, Frohlick, & Zelenski, 2006; Muris, Meesters, de Kanter, & Timmerman, 2005). The BIS/BAS scales include the Behavioural Inhibition System scale and the Behavioural Activation System scale. Whereas the BIS is unidimensional, the BAS is further divided into three subscales; BAS Drive (the relentless pursuit of goals), BAS Fun Seeking (the craving for and seeking out of novel potential rewards), BAS Reward Responsiveness (the positive response to reward and the anticipation of reward).

There has been limited research validating the BIS/BAS against objective measures of reward processing. For instance, BAS has been related to riskier performance on the Iowa Gambling Task in a number of studies (e.g., Franken & Muris, 2005; Suhr & Tsanadis, 2007). In the development of the measure, Carver and White (1994) showed that the scales

demonstrate expected correlations with other related personality dimensions; for instance BAS has been shown to be positively associated with extraversion and novelty seeking.

Although separable BAS dimensions were not delineated in the original RST theory, factor analyses have revealed three subscales that yield diverse relations with various outcomes related to ASB (e.g., Roose, Bijttebier, Claes, & Lilienfeld, 2011). The separate dimensions would seem appropriate when considering the complexity of reward processing. For instance, reward processing constitutes both a motivational (pursuit of rewards) and a consummatory (enjoyment of rewards) component (e.g., Corr, 2008), a distinction similar to what in neuropsychological terms has been called the 'wanting' and 'liking' components of reward (e.g., Berridge, 2007; Berridge, 2009; Berridge & Robinson, 2003). However, typically, in research only the global BAS measure is used with little attention being paid to these subscales.

3.1.2. Reinforcement Sensitivity Theory and Antisocial Behaviour

Gray's theory has been useful for providing a framework for the understanding of the relationship between personality and psychopathology (Bijttebier, Beck, Claes, & Vandereycken, 2009). The RST generally assumes that individuals at the extremes of BAS and BIS (high and low) are associated with vulnerability to different and specific psychopathologies. In terms of externalising disorders, for instance, Quay (1993; 1997) suggested that higher engagement of the reward system resulting in extreme responses to signals of reward may be associated with conduct disorder; whereas a weak BIS, associated with failure of inhibition in response to signals of punishment may be associated with attention deficit hyperactivity disorder. A recent study in young children showed that high BAS Fun Seeking (but not the other subscales) was associated with increased externalising problems. Conversely, increased sensitivity to punishment was associated with internalising

problems (Colder & O'Connor, 2004). In adults, there have been more studies examining the relation between personality measures of BIS/BAS and psychopathology, with results generally converging on the association between elevated BAS and externalising, and elevated BIS and internalising problems (Bijttebier et al., 2009).

There has been considerable research interest on the role of reward and punishment sensitivity in the personality disorder of psychopathy in adults. The BIS is thought to be deficient (i.e., reduced) in psychopaths leading to deficits in the experience of anxiety and to impulsivity as cues for punishment fail to inhibit reward seeking behaviour (e.g., Fowles, 1980; Hart & Dempster, 1997). In addition, it has been suggested that psychopathy may result from an overactive BAS with hypersensitivity to reward leading to disinhibited behaviour (Gorenstein & Newman, 1980; Uzieblo, Verschuere, & Crombez, 2007).

However, psychopathy is now considered to encompass discrete subtypes that may be differentially related to reward and punishment. For instance, Karpman (1941) made the seminal distinction between primary and secondary psychopathy, with primary psychopathic symptoms reflecting an affective deficit, whereas secondary psychopathic symptoms are associated with an affective disturbance based on early learning. Primary psychopathy was seen as encompassing the emotional and interpersonal impairment and secondary psychopathy incorporating the non essential components such as ASB (Bijttebier et al., 2009). Lykken (1995) built on Karpman's distinction and incorporated Gray's theory, detailing the expected temperamental characteristics of primary and secondary psychopathy.

Lykken (1995) postulated that primary psychopaths possess an innate fearless temperament and consequently demonstrate reduced sensitivity to punishment. On the other hand secondary psychopathy is thought to be associated with an abnormal sensitivity to cues of reward. As such Lykken argued that primary psychopathy was related to a weak BIS and

average BAS whereas secondary psychopathy was associated with a heightened BAS and an average BIS. Empirical studies have demonstrated that the relation between reward and punishment sensitivity and psychopathy types is complex and the findings are mixed (e.g., Hundt, Kimbrel, Mitchell, & Nelson-Gray, 2008; Ross, Benning, Patrick, Thompson, & Thurston, 2009; Newman, MacCoon, Vaughn, & Sedeh, 2005; Uzieblo et al., 2007), but the results can tentatively be summarised by suggesting that BAS hypersensitivity is a risk factor for both primary and secondary psychopathy, whereas BIS underactivity is related to primary psychopathy only (Bijttebier et al., 2009). There have been few studies on BIS/BAS in young people potentially high in psychopathic traits.

Research examining the relationship between the RST and delinquency in adolescents is rare. In a notable exception, Hasking (2007) used the BIS/BAS scales in non-offending adolescents and demonstrated that self-reported delinquency was positively correlated with BAS Drive and Fun Seeking, but contrary to predictions there was a negative correlation between BAS Reward Responsiveness and delinquency. Although they explained this in terms of mediation by coping variables, the study was susceptible to floor effects as the young people were recruited from private schools and displayed very low levels and a limited range of ASB. Further research is required to examine reward and punishment sensitivity in youths with increased levels of ASB.

In addition, research has examined the relationship between BAS and aggression in adults. Findings show that increased BAS activation (BIS/BAS scales) is associated with hostile and aggressive behaviour (Wingrove & Bond, 1998), increased attention to aggressive facial signals (Putman, Hermans, & van Honk, 2004), heightened experience of anger (Carver, 2004) and increased laboratory aggression involving the delivery of shocks (Siebert, Miller, Pryor, Reidy, & Zeichner, 2010). BAS Drive in particular has been shown to be predictive of responses in brain regions implicated in aggression when participants viewed

facial signals of aggression (relative to neutral and sad expressions; Beaver, Lawrence, Passamonti, & Calder, 2008). Further research examining these constructs in young people is necessary as well as research exploring the important distinction made between reactive (hostile) aggression and proactive (instrumental) aggression (e.g., Blair et al., 2005; Crick & Dodge, 1996). Reactive aggression is triggered by a frustrating or threatening event and does not involve any particular goal. Instrumental aggression involves an attempt to achieve a desired goal (e.g., material goods, victim possessions, status in the hierarchy) and is considered positively reinforcing (Blair et al., 2005). It could be hypothesised that BAS may demonstrate an increased association with the instrumental, goal-oriented aggression and research should aim to elucidate the relationships involved.

3.1.3. The present study

The present research examined the association between reward and punishment traits and ASB in adolescent males. Firstly, BAS and BIS (measured using the BIS/BAS scales; Carver & White, 1994) were assessed and compared in young offenders (YOs) and non-offending- normal controls (NCs). As noted previously, reward seeking peaks in adolescence and this is thought to underlie the increased risk taking characteristic of this developmental period. Nevertheless, there are clearly individual differences in the extent of reward seeking and risk taking that adolescents engage in. It was interesting to assess whether the YOs, who exhibit more extreme levels of ASB, were also more extreme on the reward dimension compared to NCs. Secondly, the study explored BAS and BIS personality dimensions in relation to various aspects of ASB in the group as a whole. Several measures of ASB were obtained; including psychopathy (using the Youth Psychopathic traits Inventory; Andershed, Kerr, Stattin, & Levander, 2002); conduct problems, (using the Youth Self Report;

Achenbach & Rescorla, 2001); and offence rate and severity (obtained from the youth offending team official records).

Based on previous research it was hypothesised broadly that higher BAS would be associated with ASB, therefore being elevated in the YO group compared to the NC group, and that it would demonstrate a positive relationship with multiple aspects of ASB. We were also interested in the dimensions of reward processing as measured by the BAS subscales; given the lack of evidence in relation to ASB in adolescents using these scales, this was necessarily an exploratory process. Finally, it was hypothesised that reduced BIS would be associated with ASB and given past evidence particularly with the primary (unemotional and interpersonal) components of psychopathy.

3.2. Method

3.2.1. Participants and procedure

The young offender (YO) group consisted of 85 young males, aged 13 - 17 years old. At the time of participation they were engaged in the criminal justice system having exhibited delinquent behaviour at different levels of frequency and seriousness. They were recruited from the local youth offending team, a statutory body that manages YOs in the community, and in collaboration with their case workers. Almost all YOs who engage with Youth Offending Services are male and our decision to research male YOs reflects this. The non-offending normal-control (NC) group (n = 50) were adolescent males aged 13 - 17 years old, recruited from local comprehensive schools, who had no prior contact with and were not currently engaged in the criminal justice system. The number of participants who completed each measure is shown in Table 3.1 and further participant details are provided in Table 3.2.

The exclusion criteria for participation was an IQ score of less than 70 as estimated using the vocabulary and matrix reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999). Socioeconomic status was estimated using the Office for National Statistics estimates of average household weekly income, based on each participant's post code (Low = £ 0 - £520; Middle = £521-£670; High = £671 +).

All participants were tested individually by a researcher; this happened in interview rooms at the youth offending team (YOs) or in classrooms at their school (NCs). They completed the measures as part of a larger study on ASB. Parental consent and young person assent were obtained in writing and additional consent was obtained to access the offence data. All participants were given vouchers in compensation for their time. All aspects of the study were scrutinised and approved by Cardiff University's School of Psychology Research Ethics Committee.

Table 3.1 Number of participants who completed each of the measures [a]

Measure	YO n	NC n
BIS/BAS scales	85	50
YPI	85	50
YSR	78	45
RPQ	33	30
Offence Data	78	-
WASI	68	34

Notes: YO = Young Offender; NC = Normal Control; BIS/BAS = Behavioural Inhibition System/ Behavioural Activation System; YPI: Youth Psychopathic traits Inventory; YSR = Youth Self Report; RPQ = Reactive-proactive aggression questionnaire; WASI = Wechsler Abbreviated Scale of Intelligence.

[a] The number of participants who completed each measure differed due to difficulties in participant engagement and time limitations for some individuals. The RPQ was added to the test battery at a later stage therefore explaining the much reduced numbers. Offence data was reduced as a result of file error/missing data in the YOS databases.

3.2.2. Measures

3.2.2.1. The Behavioural Inhibition System/Behavioural Activation System Scales (BIS/BAS scales; Carver & White, 1994). The BIS/BAS scales consist of a 24 item self-report questionnaire for the assessment of reward and punishment sensitivity. Each item is answered on a four point scale; ranging from 'very true for me' to 'very false for me'. The scales consist of a number of subscales; BAS Drive (four items e.g., 'I go out of my way to get things I want'), BAS Fun Seeking (four items, e.g., 'I crave excitement and new sensations'), and BAS Reward Responsiveness (five items, e.g., 'When good things happen to me, it affects me strongly') and BIS (seven items e.g., 'I worry about making mistakes'). There are also four additional filler items that do not correspond to any scale.

The BIS/BAS Scales have a Flesch Reading Ease of 79 (indicating a fairly easy to read document), and a Flesch–Kincaid Grade Level of 5.1 (indicating that an individual with a grade 5 level can understand the document). Thus, from a language comprehension perspective, the BIS/BAS scales should be easy to comprehend (e.g., Cooper, Gomez & Aucote, 2007). Internal consistencies and test-retest reliabilities have been demonstrated with the scales (Carver & White, 1994). Cronbach's alpha for the current offender sample was as follows; Drive = .84; Fun = .74; Reward = .83; and BIS = .81 and in the control sample was as follows; Drive = .74; Fun = .72; Reward = .71; and BIS = .68. (Please see Appendix C for a copy of the BIS/BAS scales).

3.2.2.2. The Youth Psychopathic traits Inventory (YPI: Andershed et al., 2002). The YPI is a self-report measure for the assessment of psychopathic traits in young people aged 12 and above. The YPI is a 50 item measure, with each item rated on a 4 point Likert-type scale that ranges from 'does not apply at all' to 'applies very well'. The scale contains three core dimensions: (1) Grandiose-Manipulative (2) Callous-Unemotional and (3) Impulsive-

Irresponsibility; Andershed et al., 2002). These three factors tend to represent the interpersonal, affective and behavioural components delineated in adult psychopathy. Example items include 'I can make people believe almost anything' (Grandiose-Manipulative), 'I think crying is a sign of weakness even if no one sees you' (Callousness-Unemotional) and 'If I get the chance to do something fun, I do it no matter what I was doing before' (Impulsive-Irresponsible). The reliability and validity of the YPI has been confirmed in several studies (e.g., Andershed, Hodgins, & Tengstrom, 2007; Skeem & Cauffman, 2003). Cronbach's alpha in the current offender group was as follows for each of the three factors; Grandiose-Manipulative = .94; Callous-Unemotional = .87 and Impulsive-Irresponsibility = .91; and in the control group was; Grandiose-Manipulative = .83; Callous-Unemotional = .74 and Impulsive-Irresponsibility = .77.

3.2.2.3. Youth Self Report (YSR; Achenbach & Rescorla, 2001). The YSR is a self-report questionnaire that assesses behavioural and emotional problems in individuals aged between 11 and 18 years. We were interested in the externalising related scales of the YSR and focussed on the DSM-oriented scale of conduct problems in particular, which contains 15 items; Exemplar items from this scale include 'I get into many fights' 'I break rules at home, school or elsewhere' and 'I destroy things belonging to others.' Participants rate how true each item is for them now or within the past 6 months on a 3 point scale ranging from 'not true' to 'very true or often true'. The reliability and validity of the YSR are well established (Achenbach & Rescorla, 2001). In the current sample the Cronbach's alpha for the CD scale in the offenders = .808 ; and in the controls = .814.

3.2.2.4. Reactive-Proactive Aggression Questionnaire (Raine et al., 2006). This is a self-report questionnaire for the assessment of proactive and reactive aggression in children and adolescents. The questionnaire contains 23 items, 11 items for the measurement of reactive aggression and 12 items for the assessment of proactive aggression. Participants are asked to

rate how often they engage in a number of aggressive behaviours, on a three point scale ranging from 'never' to 'often'. Examples items include how often have you 'hit others when teased' (reactive aggression) and 'had fights to show who's on top' (proactive aggression). The questionnaire has demonstrated good reliability and validity (see Raine et al., 2006).

3.2.2.5. Official crime records. These records were used to obtain details of any offences the young people had committed and been convicted for. A frequency score was calculated by summing the total number of offences for each young person. A rate variable was obtained by dividing the frequency score by age. The median severity of all offences committed for each individual was also obtained by using the seriousness scale developed by the Youth Justice Board. This scale ranges from 1 to 8, with a rating of 1 given to minor offences such as littering and using abusive language while a score of 8 corresponds to murder, manslaughter, rape and causing death by dangerous driving.

3.3. Data Analysis

One way ANOVAs were used to compare BIS/BAS scores between groups. In order to examine within group variation, intercorrelations between BAS subscales, BIS and ASB measures were examined using Pearson's correlations (offence severity was treated as an ordinal measure and Spearman's rho correlations were conducted). Subsequently, hierarchical regressions using the enter method for each block were employed for each antisocial criterion measure, with BAS subscales and BIS as predictors. Age was entered in the first step in order to control for this variable and BAS Drive, Fun Seeking, Reward Responsiveness and BIS were entered in the second step. This method replicates previous research (e.g., see Hundt et al., 2008; Hasking, 2007).

Prior to analysis all variables were examined for accuracy of data entry and fit between their distributions and the assumptions of univariate and multivariate analyses.

Inspection of univariate normality revealed that conduct disorder, proactive aggression and offence rate were positively skewed and that a square root transformation would correct for this. Descriptive statistics represent non-transformed data for ease of exposition. Offence severity was treated as an ordinal measure and non-parametric tests were conducted. There were three univariate outliers on the offence rate variable that were considered random and the sample size was large enough to allow their removal. Three other outliers were identified through Mahalanobis Distance as significant multivariate outliers ($p < .001$; although they were not influential on Cook's distance measure) and were also deleted. This resulted in 132 participant's data available for the regression analyses. The assumptions of the multiple regression model were all met (e.g., collinearity, linearity and normality). There was no correction for multiple comparisons as we did not want to inflate type II error, although clearly the potential for type I error can not be ruled out; this was considered to be justified in this exploratory study. Effect sizes are reported as Cohen's *d* (small, *d*=.2, medium, *d*=.5, and large, *d*=.8). All analyses were performed using SPSS 16.0 (SPSS Inc., Chicago, Illinois).

3.4. Results

3.4.1. Demographic information

Data on demographic characteristics were analysed using independent t-tests or chi-square tests. Table 3.2 presents demographic information for each group. There were no differences between the groups in estimated IQ [$t(56.46) = -1.65$, $p = .104$] ethnicity [χ^2 (1) = .88, p = .347] or in socioeconomic status [χ^2 (2) = .95, $p = .623$]. However, the YO group were significantly older than the NC group [$t(133) = 4.09$, $p < .001$]. Age was associated with a number of ASB measures but not associated with any of the BAS subscales or BIS so was not controlled for in the between groups analyses.

Table 3.2 Participant descriptive characteristics

	YO (n=85)		NC (n=50)	
Measures	Mean	SD	Mean	SD
Age (years)	15.95	1.12	15.10	1.25
Estimated IQ (WASI)	86.49	11.05	90.91	13.78
	n	%	n	%
Ethnicity[a]				
Caucasian	60	70.60	39	78.0
Non white	25	29.40	11	22.0
Socioeconomic Status				
Low	48	56.5	31	62.0
Middle	27	31.8	12	24.0
High	10	11.8	7	14.0

Note. YO = Young Offender; NC = Normal Control; WASI; Wechsler Abbreviated Scale of Intelligence.

[a] YO Ethnicity; 60 = White British; 8 = African; 2 = Caribbean ; 1 = Mixed White and Asian; 2 = Mixed White and Black African; 8 = Mixed White and Black Caribbean; 1 = Pakistani ; 2 = Indian; 1 = Other. NC Ethnicity; 39 = White British; 3 = African; 1 = Mixed White and Asian; 2 = Bangladeshi; 2 = Pakistani; 3 = Indian.

3.4.2. Between groups analyses

Mean scores and standard deviations for the YO and NC group are shown in Table 3.3. One way ANOVAs were used to explore group differences in the BIS/BAS scores[1]. The YO group scored significantly higher than the NC group on BAS Drive [$F(1,133) = 4.22$, $p = .042$] and significantly lower on BIS [$F(1, 133) = 9.82$, $p = .002$].

An examination of between group differences on ASB measures indicates that the YO group scored higher than the NCs on a number of measures as would be expected, given their offending status. Nevertheless, the main focus is on the between group differences in reward and punishment at this stage.

[1] One way ANCOVAs with age as a covariate revealed that age was not a significant covariate ($p > .05$) and the significant group differences remained. The YO group scored significantly higher than the NC group on BAS Drive [$F(1, 132) = 3.93$, $p = .049$] and significantly lower on BIS [$F(1, 132) = 9.11$, $p = .003$].

Table 3.3 BIS/BAS and ASB scores for young offenders (n=85) and normal controls (n=50)

	YO		NC			
Measures [maximum score]	Mean[a]	SD	Mean	SD	Sig	Effect Size (Cohen's *d*)
BAS Drive [16]	11.29	2.84	10.28	2.66	p=.042	0.36
BAS Fun [16]	12.39	2.03	11.94	2.33		0.21
BAS Reward [20]	15.69	2.89	16.42	2.48		0.26
BIS [28]	16.68	3.86	18.72	3.25	p=.002	0.56
YPI Grandiose-Manipulative [80]	39.00	11.77	39.36	8.63		0.03
YPI Callousness-Unemotional [60]	35.40	7.75	32.86	6.25		0.35
YPI Impulsive-Irresponsible [60]	43.65	7.92	38.02	6.35	p<.001	0.76
YSR Conduct Problems [100]	64.12	10.01	57.18	7.98	p<.001	0.74
Reactive Aggression [22]	11.48	4.33	8.90	4.51	p=.024	0.58
Proactive Aggression [24]	5.94	4.26	2.33	2.29	p<.001	1.04
Offence Rate [na]	0.62	0.54	-	-	-	
Offence Severity [8]	3.38[a]	1.15	-	-	-	

Note: YO = Young Offender; NC = Normal Control; BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; YPI = Youth Psychopathic Traits inventory; YSR = Youth Self Report.

[a] The median severity of offence for each individual was obtained and this is the mean of that value. The median = 3 (IQR = 1).

3.4.3. Within group analyses

Both groups were combined to explore the relationship between BAS subscales, BIS and ASB dimensions[2]. Bivariate correlations are shown in Table 3.4 and multiple regression analyses in Table 3.5.

3.4.3.1. Correlational analyses

Table 3.4 shows that BAS Drive was positively associated with all criterion measures of ASB, except offence severity. BAS Fun Seeking was positively associated with two of the psychopathy subscales (Grandiose-Manipulative and Impulsive-Irresponsible) and also offence rate. BAS Reward Responsiveness was positively associated with Grandiose Manipulative only. BIS was negatively associated with psychopathy subscales (Callous-Unemotional and Impulsive-Irresponsible), conduct problems and proactive aggression. In addition, as could be expected a number of the reward and punishment scales were intercorrelated as were the ASB measures. Regression analyses were conducted on all measures that were associated with BIS/BAS scales in the correlational analyses. More distinct relationships were obtained from the regression analyses.

[2] Correlational analyses were also examined in each group separately and the correlations were very similar in direction although there were some differences in magnitude. It was decided to combine these groups as the constructs were dimensional and allowed exploration in the whole group (please see Appendix D for the Pearson's correlation analyses separated by group).

3.4.3.2. Regression analyses

As can be seen in Table 3.5, multiple regression analyses showed that age significantly contributed to the regression analyses for the YPI Grandiose-Manipulative subscale (β = -.19 , p = .034), but did not contribute significantly to any of the other ASB measures. BAS Drive was a significant predictor of each of the three psychopathy subscales; Grandiose-Manipulative (β= .37, p = .002), Callous-Unemotional (β = .37, p = .001) and Impulsive-Irresponsible (β = .30, p = .006). In addition, Drive was predictive of conduct problems (β = .48, p <.001) and proactive aggression (β = .38, p = .023). BAS Fun was a significant predictor of the Impulsive-Irresponsible psychopathy subscale (β= .35, p = .003), as well as offence rate (β= .44, p = .005).

Interestingly, BAS Reward Responsiveness was a negative predictor of the Impulsive-Irresponsible psychopathy subscale; (β= -.30, p < .001) and conduct problems (β= -.34 p < .001). Finally, BIS was a negative predictor of the Callous-Unemotional psychopathy subscale (β= -.31, p = .001).

Table 3.4 Pearson correlations[a] between all measures of interest in the whole group (N = 135)

	BAS Drive	BAS Fun	BAS Rew	BIS	YPI Grandiose Manipulative	YPI Callousness Unemotional	YPI Impulsive Irresponsible	YSR Conduct Problems	Reactive Aggression	Proactive Aggression	Offence Rate	Offence Severity
BAS Drive	1	.621***	.489***	.043	.305***	.320***	.410***	.362***	.255*	.249*	.256*	-.202
BAS Fun		1	.513***	.153	.177*	.143	.411***	.162	.252*	.144	.302**	-.166
BAS Reward			1	.473***	.172*	-.056	.001	-.115	-.098	-.212	.048	.106
BIS				1	-.020	-.363***`	-.195*	-.195*	-.113	-.286*	-.148	.037
YPI Grandiose					1	.435***	.432***	.422***	.155	.321*	-.203	.018
YPI Callous						1	.478***	.341***	.211	.411**	.051	-.119
YPI Impulsive							1	.582***	.445***	.599***	.295*	-.270*
YSR Conduct								1	.452**	.754***	.118	-.264*
Reactive Aggression									1	.616***	.185	.059
Proactive aggression										1	.119	-.144
Offence Rate											1	-.271*
Offence Severity												1

Notes: BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report; * $p < .05$, ** $p < .01$, *** $p < .001$; [a] Spearman's rho correlations conducted on offence severity.

Table 3.5 Regression analyses for each antisocial behaviour measure (N= 132)

Regression	**YPI Grandiose- Manipulative**					**YPI Callousness-Unemotional**					**YPI Impulsive-Irresponsible**				
	F	ΔR^2	*B*	*SE B*	β	*F*	ΔR^2	*B*	*SE B*	β	*F*	ΔR^2	*B*	*SE B*	β
Step 1	4.59*	.03				.18	-.01				.22	.00			
Age			-1.68	0.79	-.19*			-0.23	0.53	-.04			.27	.58	
Step 2	4.11**	.11				6.56***	.18				8.86***	.27			
BAS_{Drive}			1.43	0.45	.37**			0.94	0.29	.37**			0.84	.30	.30**
BAS_{Fun}			-0.99	0.65	-.19			-0.04	0.42	-.01			1.35	.44	.35**
BAS_{Rew}			0.45	0.46	.12			-0.16	0.29	-.07			-0.82	.31	-.30**
BIS			-0.26	0.28	-.09			-0.59	0.18	-.31**			-0.25	.19	-.12

Table 3.5 continued

Regression	YSR Conduct Problems					Reactive Aggression					Proactive Aggression				
	F	ΔR^2	*B*	*SE B*	β	*F*	ΔR^2	*B*	*SE B*	β	*F*	ΔR^2	*B*	*SE B*	β
Step 1	.03	-.01				2.30	.02				2.62	.03			
Age			0.01	0.05	.02			.75	.49	.19			.69	.43	.20
Step 2	6.74***	.20				2.31	.09				3.62*	.18			
BAS_{Drive}			0.10	0.03	.47***			.17	.29	.09			.58	.25	.38*
BAS_{Fun}			0.01	0.04	.04			.82	.43	.35			-.05	.35	-.03
BAS_{Rew}			-0.08	0.03	-.34**			-.43	.29	-.27			-.16	.24	-.12
BIS			-0.01	0.02	-.08			.01	.19	.01			-.29	.15	-.28

Notes: BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report;

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

Table 3.5 continued...

Regression	**Offence Rate**				
	F	ΔR^2	*B*	*SE B*	β
Step 1	0.32	-0.01			
Age			0.02	0.04	0.07
Step 2	3.36*	0.15			
BAS_{Drive}			0.02	0.02	.15
BAS_{Fun}			0.07	0.02	.44*
BAS_{Rew}			-0.02	0.02	-.23
BIS			-0.01	0.01	-.09

Notes: BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report;

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

3.5. Discussion

The present research aimed to examine the relationship between reward and punishment traits and antisocial behaviour (ASB) in an adolescent sample. The between group analyses indicated that adolescent offenders showed increased levels of BAS (reward traits) and lower levels of BIS (punishment traits) compared to non-offenders. The results of the regression analyses demonstrated that high BAS (Drive and Fun) was associated with increased psychopathy, conduct problems, proactive aggression and offence rate. Surprisingly, BAS Reward Responsiveness (the positive response/reactivity to and anticipation of rewards) was negatively associated with aspects of ASB. Finally, in terms of the punishment system; BIS was negatively associated with the unemotional component of psychopathy. The evidence appears to suggest that compared to BIS traits, BAS reward traits are more robust predictors of ASB and may underlie a range of different ASB types rather than being a risk factor for one specific type.

These results provide support for the role of the Reinforcement Sensitivity Theory (RST) in ASB and they are consistent with past research suggesting that increased sensitivity to reward and decreased sensitivity to punishment/fear are associated with ASB (e.g., Steinberg, 2008; Raine, 1993). The between group analyses support the notion that adolescent male offenders may be motivated to engage in ASB as a result of a combination of an increased drive to seek out rewards and perhaps a reduced fear of the negative consequences of their actions. The findings also support the idea that although adolescence may be a time of increased reward seeking, adolescent offenders are more extreme on this dimension.

The analyses within the whole group are consistent with evidence suggesting that BAS is implicated in a range of different conceptualisations of ASB, including clinical

conceptualisations such as conduct disorder and psychopathy, legal approaches such as offence rate and also aggression (e.g., Colder & O'Connor, 2004; Franken & Muris, 2006; Hasking, 2007; Hundt et al., 2008). Perhaps as argued by Hundt et al. (2008), BAS reward sensitivity constitutes a biological substrate for externalising behaviour in general. The results further reveal associations that underscore the importance of examining multiple dimensions of both reward sensitivity and ASB.

Elements of BAS (Fun seeking and Drive) were positively associated with each of the psychopathy factors, while BIS was negatively associated with the unemotional component only. This is consistent with evidence and theory suggesting that BAS represents a vulnerability factor for both the core as well as the secondary antisocial components of psychopathy and partially supports the argument that BIS is associated with the primary (containing emotional and interpersonal components) aspects of the disorder (Bijjtebier et al., 2009). The findings reported here are consistent with the notion that punishment cues fail to inhibit extreme reward seeking tendencies in psychopaths.

BAS Drive was also positively associated with the aggression measure. Reward processing and aggression are related in many ways, for instance from an adaptive perspective, aggression often involves the protection and acquisition of resources of value such as territory and social status; they both involve approach behaviour; and similar brain structures (e.g., striatum) and neurotransmitters (e.g., dopamine) are implicated in both reward and aggression (Beaver et al., 2008). The regression analyses indicated that reward Drive was only predictive of proactive aggression as opposed to reactive aggression; this makes intuitive sense given that proactive aggression is used instrumentally to achieve a goal (e.g., rewards such as money, status, possessions). However, it provides further support for the importance of making the distinction between proactive and reactive aggression which is

becoming increasingly central to theories of the development of ASB and in particular the clinical disorder of psychopathy (Blair et al., 2005).

To the authors' knowledge, this is the only study to have investigated BIS/BAS in relation to offence rate in an adolescent sample and the finding of a positive association with BAS Fun Seeking encourages the use of these scales in understanding ASB. BAS Fun is associated with impulsive reward seeking, this scale also predicted the impulsive antisocial aspects of psychopathy and it therefore appears that these aspects of ASB are associated with disinhibited reward approach behaviour. Nevertheless, reward processing was not associated with offence severity, suggesting that reward related traits may be less important in relation to this dimension of delinquency, but further research is required to explore these associations.

Of particular interest are the diverse associations between the BAS dimensions and ASB. The drive/pursuit of rewards (Drive) and impulsive reward seeking (Fun Seeking) were positively associated with ASB outcomes as expected, generalizing results described for adult samples. Surprisingly, the Reward Responsiveness subscale, conceptualised as the positive response and anticipation of reward (including positive affect), was negatively associated with all ASB measures and this reached significance for conduct problems and the secondary antisocial components of psychopathy. This was also the only reward subscale to be positively associated with BIS, suggesting that those with an attenuated reward response were also low in responsiveness to punishment. It appears that low reactivity to stimuli (rewards or punishments) is associated with ASB, which is consistent with the underarousal often exhibited by antisocial individuals. This is accounted for by both fearlessness and sensation seeking theories of ASB (Raine, 1993), with the former suggesting that antisocial individuals are able to engage in such behaviour because of a lack of fear and the latter suggesting that

ASB is a form of sensation seeking where underarousal represents a non-optimal state and intense sensations are required to reach a more optimal level of functioning.

Also informative here are the opposing hypotheses about the increased reward seeking seen during adolescence, that is, being the result of a hypofunctioning (e.g., Bjork et al., 2004; Spear, 2000) or a hyperfunctioning (e.g., Galvan, et al., 2006) of the reward system. The former suggests that more intensely or more frequently rewarding stimuli are necessary to achieve the same level of activation as in adults (see Galvan, 2010). Support for this hypothesis comes from a range of studies showing adolescents experience positive situations as less pleasurable compared to adults (e.g., Watson & Clark, 1984), experience increased negative affect (e.g., Rutter et al., 1976), that sugar is experienced as less pleasant than in children (DeGraff & Zandstra, 1999) and adolescents generally attain less positive feelings from rewarding stimuli such that they pursue new rewards through an increase in reward seeking behaviour (Spear, 2000). This is consistent with the notion that individuals who display higher levels of ASB (reward seeking behaviour) experience reduced levels of positive affect to rewarding stimuli (i.e., reduced BAS Reward Responsiveness).

Other studies (e.g., Hasking, 2007; Roose et al., 2011) have also found that BAS Reward Responsiveness behaves in a different way to the other BAS scales. Although BAS was not operationalised as multidimensional, research supports this argument. Corr (2008) speculates that BAS contains distinct motivational and consummatory components, the former being mediated by the pursuit of reward goals, while the latter is involved in the enjoyment of such goals. These components also appear to have distinct brain processes (Carver, 2005; Roose et al., 2011). The evidence here suggests that many aspects of ASB are associated with a heightened motivational component, while some aspects may also be related to reduced consummatory processes. It is interesting to note here that it is also possible to make comparisons with Berridge and colleagues'(e.g., Berridge & Robinson,

1998; Berridge & Robinson, 2003; Robinson & Berridge, 2003) distinction between the motivational 'wanting' and hedonic 'liking' of rewards although the different components of reward do not map as clearly as could be expected from the terminology.

Considering the various dimensions of reward functioning and how these are associated with ASB is novel. Further, the use of multiple measures of ASB facilitated not only their comparison in a single study, but also the exploration of the heterogeneity of ASB and their risk factors. Examining these traits in an adolescent sample extends a literature that relies heavily on adult samples. The assessment of reward and punishment traits in a sample with a wider variation in frequency and severity of ASB has provided a novel extension of previous research, that has typically relied on non-offending and often undergraduate student samples and therefore facilitates the greater application of these personality measures. The notion that adolescents who engage in ASB may be more motivated by rewards and less responsive to punishment should be informative when considering the design of interventions for vulnerable young people.

There are limitations to this study; clearly the BIS/BAS questionnaire and some of the ASB measures are self-report. This means that the findings reported here may be confounded by common method variance. It is, however, interesting to note that the BAS questions do not contain any mention of ASB and therefore there is no reason to consider question overlap as a likely explanation for any of the reported associations. Future research might adopt behavioural measures of BAS and BIS to counter this. While professional clinical diagnoses of conduct disorder and psychopathy would have been useful in assessing the relationship between RST and ASB, both the YSR and YPI are reliable proxies that yield strong external validity (e.g., Achenbach and Rescorla, 2001; Campbell, Doucette, & French, 2009; Poythress, Dembo, Wareham, & Greenbaum, 2006).

Furthermore, there have been substantial revisions to the RST theory and the BIS, in particular, has come under scrutiny for being underspecifed (Poythress, Skeem et al., 2008; Poythress, Edens et al., 2008). Questionnaire measures have yet to be developed that accomodate these criticisms. The BIS scale of the Carver and White (1994) scales reflects punishment sensitivity and anxiety, both of which may have different biological bases and may be differentially related to external correlates. Future research should aim to separate out these dimensions (some interesting research is emerging in this area e.g., Roose et al., 2011). Clearly, our research focussed only on male adolescents (because of a scarcity of females offenders) and therefore generalisations to female adolescents are unwarranted. Finally, the present research is cross sectional and so cause and effect can not be established; focussing on younger samples before ASB is fully established is required in order to more fully understand the relationship between reward and punishment sensitivity and ASB.

In conclusion, the findings of the present research provide support for the role of reward and punishment traits and more broadly Gray's (1970) Reinforcement Sensitivity Theory in the understanding of ASB. The evidence suggests that although behavioural inhibition has a role to play in ASB, the behavioural approach system is particularly useful in explaining a wide range of ASB dimensions. The results also argue for the importance of examining dimensions of reward processing, with reward seeking and response/reactivity showing diverse relations with ASB.

Chapter Four - Executive functioning, reward processing and antisocial behaviour.

4.1. Introduction

Executive function (EF) deficits are implicated in the impulsive and risk taking behaviours exhibited by antisocial individuals. This research mostly focuses on global EF deficits rather than specific functions, such as reward processing. Reward seeking is heightened during adolescence and this contributes to a typical increase in impulsive risk taking behaviours during this developmental stage (Steinberg, 2004; 2010). However, it is not clear to what extent reward processing biases are a general characteristic of adolescence or particularly implicated in those who engage in antisocial behaviour (ASB). The present study therefore compared EF and reward processing biases in male adolescent offenders and matched non-offending adolescents using both a global EF measure and two measures sensitive to reward and punishment processing.

Frontal lobe and therefore EF deficits are typically observed in individuals who exhibit ASB (Gorenstein, 1982; Moffitt, 1993; Morgan & Lilienfeld, 2000; Raine, 1993). The mechanism linking EF deficits and ASB involve several regulation deficits including reduced behavioural inhibition, an inability to anticipate the consequences of behaviour and systematic biases in estimating subjective reward and punishment values (Giancola, 1995; Ogilvie, Stewart, Chan, & Shum, 2011). While such EF deficits are consistently observed in those who display ASB, this research has not considered the functional variation known to exist in the prefrontal cortex and therefore different facets of EF (Blair, Mitchell, & Blair, 2005). Clearly, this is a difficult task given that any measure of EF is unlikely to be entirely specific to a specific region of the prefrontal cortex or indeed the frontal lobes themselves (Morgan & Lilienfeld, 2000). Nevertheless, certain measures have more consistently been localised to specific frontal regions, for instance the Wisconsin Card Sort Test (WCST; Heaton, 2005), is a reasonably well validated measure of EF and has long been associated with activity in the dorsolateral prefrontal cortex (DLPFC; Monchi, Petrides, Petre, Worsley,

& Dagher, 2001; Rezai et al., 1993). Indeed, research using positron emission tomography shows that the dorsolateral region of the frontal cortex exhibits increased activity during performance of the WCST (Rezai et al., 1993). Interestingly, this task has been used extensively in antisocial individuals with some positive findings, even though the DLPFC is not strongly implicated in ASB (Blair, et al., 2005; Grafman et al., 1996).

DLPFC lesions usually result in apathy, lack of activity and reduced capacity for sustained attention (Roussy & Toupin, 2000) and evidence for the association between DLPFC functioning and ASB might be explained through the presence of comorbid conditions such as attention deficit hyperactivity disorder (ADHD; Blair et al., 2005). EF deficits are more usually comorbid with ADHD rather than conduct disorder (CD; Pennington & Ozonoff, 1996) suggesting that when investigating the role of EF function in ASB, comorbid conditions such as ADHD should also be considered (Ogilvie et al., 2011). Moreover, performance on EF measures in general and the WCST in particular is associated with IQ and offenders are known to demonstrate reduced IQ compared to non-offenders (on average 8 IQ points lower in young offenders; Moffitt, 1990). Past associations between ASB and WCST performance may therefore be confounded by IQ.

Antisocial individuals often present with risky and disinhibited behaviour; a pattern that is similar to the behaviour of individuals presenting with damage to the ventromedial prefrontal cortex/orbitofrontal cortex (vmPFC/OFC). In contrast to DLPFC lesions, OFC lesions result in impulsivity, behavioural disinhibition, aggression and antisocial tendencies (see Roussy & Toupin, 2000). Damage to this region in humans has resulted in impairments in social decision making that rely on accurately assessing the value of possible behavioural outcomes; an impairment that is referred to as a failure of high-level reward processing (Elliott, 2004). These real life decision making problems have been mimicked in laboratory gambling tasks. Using the classic Iowa Gambling Task, Damasio and colleagues (e.g.,

Bechara, Damasio, & Damasio, 2000; Bechara, Damasio, Damasio, & Anderson, 1994) have demonstrated that patients with OFC lesions appear to be guided by short term rewards at the expense of negative long term consequences.

In addition, lesions in the OFC result in perseverative responding and an inability to achieve response reversal and extinction (Elliot, 2004). Indeed, several studies in monkeys have shown that lesions to the OFC result in perseverative responding on reversal tasks (e.g., Dias et al., 1996; Iversen & Mishkin, 1970). In addition, there are findings in humans in terms of both neuropsychological and neuroimaging evidence that suggests that the OFC is involved in response reversal (Cools et al., 2002; Rolls et al., 1994). Imaging data has implicated Brodman's Area 47 in response reversal (Budhani & Blair, 2005; Cools et al., 2002). Response reversal and extinction tasks require learning to withhold or change a behavioural response when the original response is no longer rewarded but punished. It has been argued that an inability to perform response reversal could lead to frustration, given that the individual is not able to easily adapt their behaviour to achieve their goals. Frustration is a cue for aggression and it has been argued that OFC dysfunction could lead to the heightened aggression seen in psychopathy (Blair et al., 2005).

One EF task that incorporates reward and punishment contingencies and response extinction and is therefore thought to involve the OFC is the Card Playing Task (CPT), originally used by Newman and colleagues to assess behaviour in psychopaths (Newman, Patterson, & Kosson, 1987). The CPT involves establishing a dominant response set for reward by initially providing participants with a high level of reward for their responses. However, as the task progresses the level of punishment increases and reward declines. To be successful participants need to take into account reinforcement changes and interrupt their dominant plan (i.e., stop playing when punishment outweighs reward). Perseveration is said

to occur when the participant plays beyond the point where the rate of punishment outweighs the rate of reward.

Response perseveration on the CPT (or similar measures such as the child modified Door-Opening Task) has been found in a number of antisocial groups, including conduct disordered children (Shapiro, Quay, Hogan, & Schwartz, 1988), conduct disordered children with or without hyperactivity (Daugherty & Quay, 1991; Matthys, van Goozen, de Vries, Cohen-Kettenis & van Engeland, 1998), children with emotional and behavioural difficulties (Fisher & Blair, 1998), juvenile delinquents (Fonseca & Yule, 1995), adolescents with histories of physical aggression (Seguin, Arseneault, Boulerice, Harden, & Tremblay, 2002), non-anxious psychopathic children (O'Brien & Frick, 1996) and adolescent substance users (Martin, Rayens, Kelly, Hartung, & Leukefeld, 2000). Few researchers have examined CPT performance in non-clinical community adolescents with varying degrees and types of ASB. In addition, the mechanisms underlying the behaviour are unclear; perseveration could be caused by a range of factors including oversensitivity to reward, insensitivity to punishment and/or perhaps a limitation of attention in terms of integrating the information (Newman & Wallace, 1993). The development of new measures that aim to examine reward and punishment sensitivity may be useful for delineating the processes underlying the CPT.

Finally, it is important to note that ASB is a heterogeneous concept and specific subgroups of antisocial individuals may differ in the type and extent of EF and reward processing deficit. For instance, LaPierre, Braun, and Hodgins (1995) found that psychopathic criminals but not those without psychopathy exhibited behaviour that was characteristic of OFC/VmPFC deficits (but there was no deficit on global EF tests e.g., the WCST). Roussy and Toupin (2000) similarly found that juvenile psychopathic and non-psychopathic offenders did not differ on DLPFC measures, but the psychopaths committed significantly more errors on OFC measures requiring inhibition. There is also support for the

notion that more serious offenders may be characterised by more pronounced executive dysfunction (Piquero, 2001; Raine et al., 2005). In addition, an extensive literature links aggression with executive function deficits (Kramer, Kopyciok, Richter, Rodriguez-Fornells, & Munte, 2011; Seguin, Boulerice, Harden, Tremblay, & Pihl, 1999). However, the important distinction between reactive and proactive aggression is rarely made in these studies and may show different relationships with reward processing in particular.

4.1.1. The present study

The present study explores EF including reward sensitivity in young offenders (YOs). YO performance was compared with an age, sex, socioeconomic status and IQ matched non-offending (normal control, NC) group. Comparing performance across similarly aged groups allowed us to explore factors associated with the adolescent developmental stage in general as well as ASB in adolescence in particular. The Card Playing Task (CPT; Newman et al., 1987) was used as an extinction task that corresponds with OFC function. It was hypothesised that young offenders would show increased perseveration on this measure compared to the control group. The Wisconsin Card Sort Test (WCST; Heaton, 2005) was used to assess whether young offenders had a general EF deficit. It was hypothesized that young offenders would not show global executive problems compared to non-offending controls when IQ was controlled for (e.g., Fairchild et al., 2009).

A novel gambling test, the Win-Lose Cardiff Gambling test (Win-Lose), was developed. The Win-Lose measures participants' relative reward and punishment preferences when they are asked to monitor windows on a computer display that show the number of points that might be won or lost on each trial of a game. It was hypothesized that young offenders, who would display stronger reward seeking tendencies, would preferentially monitor the win window over the loss window. Of course adolescents in general are also

considered to be reward seekers and given the novelty of this paradigm, we also compared the data to that collected in an older undergraduate sample.

Finally, to explore the heterogeneity of ASB within the YO group, multiple measures were taken; assessments of frequency and severity of offending behaviour from official records and self-report measures such as aggression, psychopathic traits and conduct symptoms, were used to differentiate within the offender group and explore variations in behaviour and/or personality in relation to neuropsychological functioning. We predicted that impairments in reward processing would be more apparent in more extreme ASB subgroups.

4.2. Method

4.2.1. Participants

The young offender (YO) group consisted of 56 young males aged 13 - 17 years old who were engaged in the criminal justice system. The young people had exhibited delinquent behaviour at different levels of frequency and seriousness. They were recruited from the local youth offending service, in collaboration with their case workers. NCs were 44 age-matched males recruited from local comprehensive schools and were screened for the presence of ASB and involvement in the criminal justice system. Participants were provided with vouchers in compensation for their time. The number of participants who completed each of the measures is shown in Table 4.1 and further participant details can be found in Table 4.2.

Given the novelty of the Win-Lose test another comparison group of male undergraduates was included. The task was piloted on these individuals in the absence of normative data. This group consisted of 30 male undergraduates (mean age = 19.61 years; SD = 2.56) who took part for course credit. All participants were tested individually and the study was approved by Cardiff University's School of Psychology Research Ethics Committee.

Table 4.1 Number of participants who completed each of the measures[a]

Measure	YO n	NC n	UG n
CPT	56	44	
WCST	52	26	
Win-Lose	55	40	30
YPI	56	44	
YSR	55	36	
RPQ	25	28	
Offence Records	54	-	
WASI	55	35	

Notes: YO = Young Offender; NC = Normal Control; UG = Undergraduate; CPT = Card Playing Task; WCST = Wisconsin Card Sort Test; Win-Lose = Win-Lose test; YPI: = Youth Psychopathic traits Inventory; YSR = Youth Self Report; RPQ = Reactive-Proactive aggression questionnaire; WASI = Wechsler Abbreviated Scale of Intelligence.

[a] The numbers who completed each measure differed due to difficulties in participant engagement and time limitations for some individuals with the following exceptions; the RPQ was added to the test battery at a later stage therefore explaining the much reduced numbers; the undergraduates only completed the Win-Lose task.

4.2.2. Measures

4.2.2.1. Card Playing Task (CPT; Newman et al., 1987). This is a computerised version of the Card Playing Task; an extinction task that aims to assess response perseveration in the face of changing reward and punishment contingencies. In this task participants are required to click on a pack of cards to win points. A deck of playing cards is displayed face down on the computer screen against a black background. The pack of cards contains 110 cards in total, some of which are black symbol cards (spades and clubs) and others are red symbol cards (diamonds and hearts). Black cards are associated with winning 10 points, while red

cards are associated with losing 10 points. Cards are turned over one at a time by the participant and are presented in a pre-programmed way such that there is a progressive decline in the probability of obtaining a black card (i.e., a winning card). More specifically, in this task the probability of a winning card appearing decreases by 10 % with each succeeding set of 10 cards. For instance, in the first set of 10 trials, a black winning card appears 10 out of 10 times, then in the next set, a black card appears 9 out of 10 times and a red card appears once, and so on until the last set of 10 trials where 10 out of the 10 trials, result in loss.

At the beginning of every trial a question presented in capital letters appeared at the top of the screen, asking participants whether they want to play i.e. 'DO YOU WANT TO PLAY?' If a winning card is displayed a message stating 'YOU HAVE WON' is presented on the screen, while if a losing card is displayed, the message 'YOU HAVE LOST' appears. Winning and losing are also accompanied by appropriate sound feedback. Participants begin with zero points and the computer calculates the amount of points the participant has after each trial and presents a running total on the screen.

Participants are informed that if they want to play they are required to click on the pack with the mouse button to turn over a card. Participants are also told that they cannot skip any cards and that the order is determined by the computer. In addition, participants are informed about what cards lead to win or loss and that the aim of the game is to win as many points as possible. Participants are not informed of the decline in probability of winning. Crucially, they are told that they can stop playing the game whenever they decide to by informing the researcher. The instructions also emphasize that their final winning amount will be compared to the average scores for participants of the same age and educational background and if the score is favourable they could receive a bonus monetary payment. Each trial is self-paced and the task lasts approximately 10 minutes. The total number of cards played is the outcome variable of interest.

4.2.2.2. Wisconsin Card Sorting Test (WCST; Heaton, 2005). The computerised Wisconsin Card Sorting Test-64 Card Version (WCST-64) was used as a measure of set shifting ability. The task involves the sorting of cards that appear at the bottom of the computer screen with one of four key cards presented at the top of the screen. The stimulus cards contain symbols that differ in colour, shape or number. The participant is required to sort the cards according to one of these three different categories. If a participant matches the card correctly, the following message appears on the screen 'THAT IS RIGHT' and if the participant matches the card incorrectly the message appears 'THAT IS WRONG'. After 10 consecutive correct trials, the sorting rule changes, and the participant is required to sort according to the new rule. The test is completed when all 64 cards have been used, or when 6 categories have been completed. Therefore, each of the three possible categories (colour, shape, and number) can be completed twice successfully.

Participants are told that they are required to match the cards by clicking with the mouse button on the key card that they choose. They are told that the experimenter is unable to tell them how to match the cards and if they are wrong to try to match the next card correctly. They are not informed that the sorting rule changes. There is no time limit on the test, and the task takes approximately 15 minutes to complete.

The following measures were taken to evaluate participant performance: total number of errors made (ranging from 0-64), perseverative errors (errors made when continuing to sort cards according to the rule that was correct for the prior stage of the task; ranging 0-62), non-perseverative errors (range 0-64), number of categories completed (range 0-6), the number of trials to complete the first category (ranging 10-65), and failure to maintain set (when more than 5, but less than 10 correct consecutive trials were made).

4.2.2.3. Win-Lose Cardiff Gambling test (the Win-Lose). This is a computer-based task in which participants make gambling decisions in order to obtain as many points as possible. In

this task, two windows are presented side by side on the computer screen (an example of the screen shot can be found in Appendix E), one of these windows displays the number of points that can be won, and the other shows the number of points that can be lost. The amounts that can be won or lost fluctuate randomly during each trial, and can go up or down (in intervals of 5 points) for both wins and losses. The maximum amount of points that can be won or lost on a single trial is 100 points and the minimum is 0 points.

Each trial lasts up to 20 seconds, during which time the participant is required to press the gamble button to decide when the trial will stop. The participant has no ability to affect whether they win or lose, however the amount of points they win or lose is dependent on the values shown in the win and lose windows at the time the gamble button is pressed. Crucially, it is not possible for the participant to see both the win window and lose window at the same time. In order to see a particular window they must click on the corresponding button. There are 50 trials and the task last approximately 20 minutes.

The following variables were examined: Click Frequency, the total frequency of clicks between the windows. This provides a measure of how much time was distributed across both windows. Win_Time/Total_Time, this shows the proportion of time spent in the win window divided by the total time (range from 0-1). Values above 0.5 reflect a win window preference. The loss preference can be inferred from the remaining proportion.

4.2.2.4. The Youth Psychopathic traits Inventory (YPI: Andershed et al., 2002) is a self-report measure that is used to assess psychopathic traits in young people aged 12 years and above. The YPI is a 50 item measure, with each item rated on a 4 point Likert-type scale that ranges from ‘does not apply at all’ to ‘applies very well’. The scale contains three core dimensions: (1) Grandiose-Manipulative (2) Callous-Unemotional and (3) Impulsive-Irresponsibility; Andershed et al., 2002). The reliability and validity of the YPI have been confirmed in

numerous studies (e.g., Andershed, Hodgins, & Tengstrom, 2007; Skeem & Cauffman, 2003).

4.2.2.5. Youth Self Report (YSR; Achenbach & Rescorla, 2001) is a self-report questionnaire used to assess behavioural and emotional problems in young people aged 11 and 18 years. We were interested in the DSM-oriented scales of conduct disorder (CD) and attention deficit/hyperactivity disorder (AD). Participants rate how true each item is for them now or within the past 6 months on a 3 point scale ranging from 'not true to very true'. Scores are converted to a standardised t score. Higher scores reflect higher levels of problem behaviour. The reliability and validity of the YSR are well established (Achenbach & Rescorla, 2001).

4.2.2.6. Official crime records; Offence rate was obtained by dividing the total frequency of offences by age. Offence severity was calculated by using the seriousness scale developed by the Youth Justice Board (ranging from 1 = minor offences to 8 = serious offences). The median severity scores for each YO's offences were obtained.

4.2.2.7. Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). The WASI provides a brief and reliable estimate of a person's intellectual functioning. The two sub-test form was selected; this contains the vocabulary and matrix reasoning components, which tap into crystallized and fluid abilities.

4.3. Data analysis

Data were inspected for accuracy, outliers and the fit to assumptions of univariate analyses. Outliers on various variables were found to be accurate values and were reduced to one unit above the next non-outlier value. A number of variables were positively skewed; Win-Lose Click Frequency, WCST perseverative errors, proactive aggression and estimated IQ were all logarithmically transformed and subsequent parametric tests were conducted. Descriptive statistics represent non-transformed data for ease of exposition. Independent

samples t-tests were used to examine the differences between the YO and NC groups on the CPT and WCST variables. One-factor analyses of variance (ANOVA) were used to examine Win-Lose test performance across YOs, NCs and UGs, while post hoc Bonferroni tests were used to explore significant group differences. Within YO group analyses included Pearson's correlations that were used to examine the relationships between the EF variables and various measures related to ASB. Effect sizes are reported as Cohen's *d* (small, *d*=.2, medium, *d*=.5, and large, *d*=.8). All analyses were carried out using SPSS 16.0 (SPSS Inc., Chicago, Illinois).

4.4. Results

4.4.1. Demographic information

Data on demographic characteristics were analysed using independent samples t-tests or chi-square tests. Table 4.2 presents the demographic information for each group. There were no differences between the groups in ethnicity [χ^2 (1) = 3.46 p = .061] socioeconomic status [$\chi^2(2)$ = 2.15 p = .341] age [$t(98)$ = 1.97, p = .051] or WASI performance [$t(88)$ = -1.14, p = .259].

Table 4.2 Participant descriptive characteristics

	YO		NC	
Measures	Mean	SD	Mean	SD
Age (years)	15.59	1.28	15.09	1.27
Estimated IQ (WASI)	86.72	11.27	89.69	12.83
Ethnicity[a] (n and %)				
Caucasian	38	67.9	37	84.1
Non white	18	32.1	7	15.9
Socioeconomic Status				
Low	35	62.5	29	65.9
Middle	16	28.6	8	18.2
High	5	8.9	7	15.9

Note .YO = Young Offender; NC = Normal Control; WASI = Wechsler Abbreviated Scale of Intelligence.

[a] YO ethnicity; 38 = White British; 3 = African; 2 = Caribbean ; 2 = Mixed White and Black African; 5 = Mixed White and Black Caribbean; 2 = Indian; 4 = Other. NC ethnicity; 37 = White British; 1 = Mixed White and Asian; 2 = Bangladeshi; 3 =Indian.

4.4.2. Between groups analyses

Table 4.3 shows that the YO group scored significantly higher than the NC group on YPI impulsive-irresponsibility, conduct disorder problems and proactive aggression. There were no differences between the groups on the other psychopathy scale scores, reactive aggression or self-reported ADHD symptom scores.

Table 4.3 Antisocial behaviour measure scores in YOs and NCs

	YO		NC			
	Mean	SD	Mean	SD	t	*p*
YPI Grandiose Manipulative	38.12	12.66	38.91	8.25	-.377	.707
YPICallousness-Unemotional.	34.51	7.67	33.09	6.31	.994	.323
YPI Impulsive-Irresponsible	44.33	7.99	37.64	7.11	4.38	<.001
YSR CD	64.55	10.36	56.83	8.25	3.76**	.001
YSR ADHD	61.36	8.33	58.69	7.95	1.53	.130
Reactive aggression	10.60	4.46	8.68	7.72	1.52	.135
Proactive aggression	5.24	3.73	1.82	2.14	3.09***	.004
Offence rate	0.69	0.63	-	-	-	-
Offence severity[a]	3.41	0.98	-	-	-	-

Note: YO= Young Offender; NC= Normal Control; YPI = Youth Psychopathic traits Inventory; YSR= Youth Self Report; CD = Conduct Disorder; ADHD = Attention Deficit Hyperactivity Disorder.

[a] The median offence severity for each individual was obtained and the overall mean (SD) was calculated as shown in the table. The median = 3(IQR = 1.5).

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

Table 4.4 shows performance on the CPT and WCST for the YO and NC groups. Independent samples t-tests showed that the YO group played significantly more cards than the NC group (p = .001), but the groups did not differ on any of the WCST variables.

Table 4.4 Neuropsychological performance in YO and NC groups

	YO		NC				
	Mean	SD	Mean	SD	t	*p*	Effect Size
CPT $_{\text{Cards played}}$	66.96	27.20	49.39	24.46	3.35**	.001	0.67
WCST $_{\text{Total Errors}}$	20.21	7.28	21.15	10.09	-.472	.638	0.11
WCST $_{\text{Perseverative Errors}}$	9.57	4.10	9.73	5.26	-.142	.888	0.04
WCST $_{\text{Non perseverative Errors}}$	10.63	4.76	11.42	7.15	-.509	.614	0.14
WCST $_{\text{Categories completed}}$	2.81	1.09	2.96	1.14	-.579	.564	0.14

Note: YO = Young Offender; NC = Normal Control; CPT = Card Playing Task: WCST = Wisconsin Card Sort Test.

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

Table 4.5 displays the performance on the Win-Lose test for YOs, NCs and UGs. One-way ANOVAs showed that there were significant differences between the groups on all variables. Post hoc Bonferroni t-tests showed that there were no significant differences between the YOs and NCs, but both groups differed significantly from the UGs, showing less switching behaviour (i.e., lower Click Frequency) and greater reward monitoring (i.e., higher Win_Time compared to the UG's.

Table 4.5 Win-Lose test performance in YOs, NCs and UGs

	YO		NC		UG				
	Mean	SD	Mean	SD	Mean	SD	*F*	Bonferroni	Effect Size
Click Freq	114.18	67.41	123.53	61.98	185.23	104.96	6.13**	ug>yo&ug>nc	0.10
Win_ time	.58	.18	.59	.18	.46	.14	6.45**	ug<yo&ug<nc	0.07

Note: YO = Young Offender; NC = Normal Control; UG = Undergraduate; Win-Lose = Win-Lose Cardiff Gambling Test; Click Freq = Total frequency of clicks; Win_time = the time spent in win window divided by total time spent in both windows. ** = $p < .01$

4.4.3. Within YO groups analyses

Pearson's correlations were used to explore the relation between reward processing; CPT number of cards played and Win-Lose performance (Click frequency and Win_Time) and different approaches to ASB (measures of offence frequency, offence severity [Spearman's rho correlations], psychopathic traits, CD problems, reactive and proactive aggression). The results indicated that there were no significant correlations ($p > .05$; these correlations can be found in Appendix F).

4.4.4. Supplementary Analyses

Secondary analyses also included exploring the relation between the CPT number of cards played and Win-Lose variables and the self-report measure of Behavioural Inhibition System/Behavioural activation System scales described in Chapter 3 for the young offenders and normal controls. The results showed that there were no significant associations between behavioural measures and BIS/BAS scales in the young offender group, but there were the following positive associations in the control group; BAS Drive and CPT number of cards played ($r = .309$; $p = .044$) and BAS Fun and CPT number of cards played ($r = .350$; $p = .022$) and BAS Drive and Win_time ($r = .443$; $p = .005$; see Appendix G for the results of these analyses).

4.5. Discussion

This study examined EF and reward processing in offending and non-offending matched adolescent males. A global EF measure and two measures that assess reward and punishment processing were used. Results show that the young offenders (YO) and matched non-offending controls (NC) did not differ in global EF as measured by the WCST. However, the young offenders displayed an increased tendency for response perseveration for reward on the Card Playing Task (CPT) compared to the non-offending controls who stopped playing too soon. On the Win-Lose test the adolescent groups did not differ in reward and punishment monitoring. Although both adolescent groups spent more time monitoring the win window and less time monitoring the loss window compared to male students. Finally, analyses within the YO group showed that those who had engaged in more serious patterns of offending also displayed increased perseveration on the CPT.

The results on the CPT indicate that antisocial youths perseverate in the face of decreasing reward and increasing punishment, supporting previous research in other antisocial samples (e.g., Daugherty & Quay, 1991; Matthys et al., 1998; Seguin et al., 2002; O'Brien & Frick, 1996). Whereas the young offenders played too many cards the control group (who were matched for IQ, age and SES) stopped at a point where reward still outweighs punishment. This is interesting given the evidence that adolescents are reward seekers (e.g., Steinberg, 2004; 2010). Past studies have interpreted perseveration on the CPT as evidence of a reward dominant style, whereby greater sensitivity to reward than to punishment contributes to the failure to interrupt goal directed behaviour to evaluate its potential negative consequences (Goodnight, Bates, Newman, Dodge, & Pettit, 2006; Newman & Wallace, 1993). Nevertheless, it is difficult to disentangle whether perseveration on this task is a result of increased reward sensitivity or decreased punishment sensitivity. In

view of this lack of clarity we developed the Win-Lose Cardiff Gambling test, an attempt to further explore reward and punishment processing.

The Win-Lose test failed to show any differences between our groups of adolescent males, but interestingly when both groups were compared to undergraduate male students some significant findings emerged. Firstly, the undergraduates switched significantly more between the win and lose windows and, perhaps this suggests a more rational approach to playing the game, whereby switching between windows and viewing the fluctuating amounts in both windows allows for a more informed decision before pressing the gamble button. The results also showed that the undergraduates spent more time in the loss compared to the win window whereas the adolescent males showed a preference for viewing the win window. These findings appear to demonstrate an increased preference for the monitoring of reward information, potentially increased reward seeking/sensitivity (and a decreased preference for examining loss information) in adolescent males. Clearly, this is the first use of this measure and one must be cautious in interpretation. It is important to mention that the undergraduate students differ from the young offenders and normal control groups not only in age, but are also are likely to differ in terms of other variables such as IQ which may explain the differences. Furthermore, given that the undergraduates did not also complete the other measures (e.g., the CPT) it is difficult to draw firm conclusions about the reward sensitivity of our adolescents versus undergraduates.

Taking the Win-Lose and CPT results together it would appear that although both adolescent groups had a preference for reward, this reward bias only resulted in deficient behaviour on the CPT for the antisocial young people. The antisocial group appeared to have a problem extinguishing/inhibiting their reward seeking when it becomes maladaptive resulting in loss/punishment. Although the normal control group had a preference for reward (as shown on the Win-Lose), they were able to inhibit this when necessary (as shown on the

CPT). Theorists arguing for a deficit in fear in antisocial individuals would contend that this is a result of impaired processing of punishment-related information (Lykken, 1995) perhaps mediated by an insensitive Behavioural Inhibition System (Gray, 1987) whereby cues of punishment would be less likely to activate behavioural inhibition. This explanation does not appear to be the complete picture given the Win-Lose findings which show that the two groups demonstrated similar levels of disinterest in punishment (lose window).

Alternatively, Newman and colleagues (Patterson & Newman, 1993) have described perseveration on the CPT as an inability to shift attention from the goal of responding to gain reward to the peripheral punishment information (the response modulation theory). The early stopping of the normal controls therefore could be interpreted as over-attention to peripheral cues. On the other hand, Blair (2004) devised the Integrated Emotion System (IES) model which implicates both amygdala and orbitofrontal impairment and suggests that the problem lies in the detection of (or alteration of behaviour in response to) contingency change. The IES model is considered to consist of a number of systems one of which involve units that code if a contingency expectation is violated (i.e., if an expected reward does not occur) and a second system that involves preventing responses that are no longer appropriate. The theory argues for the importance of temporal difference errors which are described as 'the difference between the expected value associated with a stimulus/action and the actual value received (Budhani & Blair, 2005; p. 973). Positive temporal difference errors are said to result from unexpected rewards, while absent highly expected rewards induce negative temporal difference errors (Budhani & Blair, 2005). The theory therefore suggests that antisocial individuals are impaired in modifying their behaviour as a function of negative temporal difference errors (Budhani & Blair, 2005).

Although our results do not distinguish between these theories, we are able to show that performance on the CPT does not appear to be as a result of reward seeking or

oversensitivity to reward alone; the two groups differed on the CPT but did not differ on the Win-Lose where both showed a reward preference. The results appear to suggest that it is the inhibition component that is the problem for antisocial individuals and this may result from punishment insensitivity, failure of response modulation or failure in error detection.

As expected our results show that the two groups matched for age, SES and IQ and with similar self-report ADHD symptom levels did not differ in WCST performance; this measure is related to dorsolateral functioning and is often used as a global measure of EF. The finding of impaired performance on the CPT and intact performance on the WCST provides further support that any EF deficit is not a global one, but rather one associated with OFC functioning. Previous associations found in the literature between WCST and ASB may have resulted from a failure to take IQ and ADHD symptoms into consideration.

Contrary to predictions, psychopathic traits, CD symptoms, aggression or offence rate and severity did not explain variations in reward processing, within the YO group. The correlations between the reward processing behavioural measures and BIS/BAS scales show that in the control group , the number of cards played (CPT task) was positively associated with BAS Drive and Fun and similarly the amount of time spent in the win window (Win-Lose task) was associated with BAS Drive. These associations suggest that self-report measures of reward processing are associated with behavioural aspects of reward processing, but only in the non-offenders.

The present research has many strengths; our deliberate attempt at matching our YOs and NCs is important as it allowed us to control for many factors that are associated with ASB and may potentially explain differences in neuropsychological functioning (IQ, SES etc.) and also explore the factors associated particularly with ASB in adolescence as opposed to the adolescent period in general. The fact that we found increased response perseveration

in young offenders compared to NCs suggests that it is a robust finding and an important one in the understanding of ASB.

Nevertheless, some limitations and directions for future research are worthy of mention; the measures of the various clinical disorders such as conduct disorder and psychopathy were self-report. Both the YSR and YPI have demonstrated good external validity; however, clinical diagnoses are superior to self-report and may have allowed for clearer distinctions in performance on the neuropsychological measures. In addition, time limitations meant that a larger battery of neuropsychological tests was not possible; future studies should incorporate other reward related measures such as those involving discounting procedures and the inclusion of time parameters (e.g., immediate reward versus delayed reward) would be an interesting extension of the work. Also, the rewards used in the present study included the winning of points, and to fully explore reward mechanisms in young offenders it would be useful to examine performance with other types of rewards such as positive social feedback. In addition, our results were not able to clearly distinguish between the different theoretical accounts of the Card Playing Task (i.e., fear dysfunction, response modulation and error detection) and further research is required achieve this. Finally, the non-offending group in our study were matched with the young offenders on a number of variables that are related to ASB. The NC group could be considered an 'at risk' sample of young males given their low IQ and poorer social background, yet they did not engage in ASB. It is likely that the NCs had other protective factors that may have prevented them from engaging in ASB. In future, it would be interesting to assess on what social factors these two groups do differ and how these interact with the neuropsychological factors measured here.

In addition, clearly the matched nature of our groups in terms of IQ is a strength of the study. Nevertheless, both groups had relatively low IQ and one must consider that our groups

may not necessarily be representative of the wider sample from which they were drawn. The relatively low IQ of the participants may have impacted on task performance.

It is also important to mention before concluding, the difficulties in studying and measuring EF and in particular the task impurity problem, such that in any measure of EF there is systematic variation attributable to non EF processes (e.g., speed of processing). Miyake and Freedman (2012) also point out that EFs show unity as well as diversity. More specifically, that different EFs correlate with one another, thus tapping some common underlying ability (unity), but they also show some separability (diversity). In effect we must bear in mind before making any firm conclusions that our separate measures of EF (e.g., WCST and CPT) are also likely to share many similar underlying EF processes as well as of course measuring many non EF related processes.

In summary, the results indicate that offenders do not differ from their non-offending counterparts in global executive functioning but have a more specific deficit as evidenced by the CPT. While both adolescent groups showed a heightened preference for reward, this became only deficient on the CPT in the antisocial youngsters, indicating an extinction deficit which is likely to be caused by a deficit in punishment monitoring or sensitivity. Clearly, these findings fit with the behaviour of these individuals with them seeking out the rewards of ASB (peer approval, status, possessions) and not being put off by the negative consequences (official sanctions, parental disapproval). This study adds to the growing body of literature showing altered reward and punishment processing in antisocial individuals and has implications for attempts at behaviour change. One next step for future research is to explore the extent to which individual differences in reward seeking and punishment insensitivity affect the success of interventions focussing on positive and negative reinforcement.

Chapter Five – Psychophysiology, reward processing and antisocial behaviour.

5.1. Introduction

Emotional processing and learning impairments are strongly implicated in explanations of antisocial behaviour (ASB; Blair et al., 2005; Eysenck, 1964; Gray, 1987; Newman et al., 1987; Raine, 1993). Psychophysiological methods assess the relationship between psychological states and processes such as emotion, cognition and arousal on the one hand and bodily responses on the other (Raine, 1993). As such, psychophysiological correlates have offered a potentially more objective approach for clarifying some of the emotional processing and learning impairments associated with ASB. Nevertheless, psychophysiological approaches to ASB have tended to make use of aversive stimuli and focus on negative emotions (particularly fear) and have often neglected the area of reward processing and learning.

The most frequent psychophysiological approaches adopted in relation to ASB include measures of heart rate and skin conductance (SC). HR reflects both sympathetic and parasympathetic autonomic nervous system (ANS) activity and low resting HR has been found to be one of the best replicated correlates of ASB (Ortiz & Raine, 2003; Raine, 1993). Unlike HR, SC is a measure of sympathetic nervous system (SNS) activity only. Skin conductance responses (SCR) are easily generated by aversive stimuli such as loud noises or threatening images such as an angry face. However, they are also activated by other stimuli of motivational significance such as novelty, rewards and winning points (Critchley, 2002).

Studies and reviews examining the psychophysiology of ASB have emphasised low ANS arousal (e.g., low resting HR and SC level as well as reduced SCR in anticipation of and response to aversive stimuli), reduced ANS orienting and reduced ANS fear conditioning as risk factors for ASB (Hare 1978; Lorber, 2004; Raine, 1993; Scarpa & Raine, 1997; van Goozen, Fairchild, Snoek, & Harold, 2007). The evidence for low HR and SC is consistent

with the influential theoretical interpretation that antisocial individuals are chronically underaroused and that the underarousal reflects low levels of fear (Raine, 1993). An alternative interpretation suggests that the underarousal reflects an unpleasant state and antisocial individuals engage in sensation seeking behaviour to raise the non-optimal ANS levels (Zuckerman, 1979).

Poor autonomic fear conditioning has been established as a correlate of ASB in adults (Birbaumer et al., 2005; Flor, Birbaumer, Hermann, Ziegler, & Patrick, 2002; Raine, 1993). In these classical conditioning procedures, a neutral stimulus (the conditioned stimulus or CS) is paired with an aversive stimulus (the unconditioned stimulus or US) often a loud sound. After repeated pairings the initially neutral stimulus elicits a response (CR), similar to that elicited by the US. The key measure in these procedures is the size of the SCR elicited by the CS after the CS-US pairings (Raine, 1993). Larger SC responses are reflective of better conditioning ability. Theories of classical conditioning and ASB suggest conditionability is important for socialisation and development of a conscience. In typically developing children, engaging in a behaviour (e.g., stealing) that results in punishment (US) would result in the feeling of distress (unconditioned response [UCR]). After a number of learning trials the act of stealing would be associated with a feeling of distress (CR) and the child would be motivated to avoid engaging in the behaviour (see Raine, 1993). However, it is argued that in the case of poor conditioning, individuals would not learn the association and therefore not desist from committing the act.

Evidence suggests that the emotional processing impairment may be related to amygdala dysfunction. The amygdala is crucially involved in emotional learning (Everitt, Cardinal, Parkinson, & Robbins, 2003). Neuroimaging studies have confirmed that the amygdala is activated during fear conditioning and lesion studies have shown that the amygdala is critical for the acquisition of fear conditioned responses (Bechara et al., 1995;

Buchel, Morris, Dolan, & Friston, 1998; LaBar, LeDoux, Spencer, & Phelps, 1995). As such, conditioning ability has often been used as a peripheral measure of amygdala dysfunction (Fairchild, van Goozen, Stollery, & Goodyer, 2008).

Reduced fear conditioning in 3-year-old children has been found to predict aggressive behaviour at age 8 years (Gao, Raine, Venables, Dawson, & Mednick, 2010a) and adult crime at age 23 years (Gao, Raine, Venables, Dawson, & Mednick, 2010b), suggesting that fear conditioning indices are early markers of later behavioural problems. Research examining fear conditioning and ASB in young people is scarce, with some noted exceptions; for instance, Fairchild et al. (2008) found impaired differential fear conditioning in adolescent males with early onset or adolescent onset conduct disorder compared to normal controls. Impaired fear conditioning was also found in adolescent females with conduct disorder (Fairchild, Stobbe, van Goozen, Calder, & Goodyer, 2010). A recent study was the first to show that poor fear conditioning is also a correlate of violent offending in male juvenile offenders (Syngelaki, Fairchild, Moore, Savage, & van Goozen, in press**).**

In contrast to research on negative stimuli and emotions there is very little research focussing specifically on the psychophysiology of reward in relation to ASB. Nevertheless, oversensitivity to reward has been implicated in theories of ASB and evidence has been found using neuropsychological and questionnaire measures (Gray, 1970; Morgan, Bowen, Moore, & van Goozen, submitted; Newman, MacCoon, Vaughn, & Sadeh, 2005; Quay, 1993). In addition, a prominent theory speculates that the heightened risk taking behaviour as seen in adolescence is a result of increased reward seeking (e.g., Steinberg, 2004; Casey Getz, & Galvan, 2008). Moreover, neuroimaging evidence supports the notion that hypersensitivity of the reward system (e.g., exaggerated nucleus accumbens activity) in combination with a maturing self-control system are responsible for reward seeking behaviour (e.g., Casey et al., 2008).

In terms of specific psychophysiological responses to reward, the evidence is mixed and research is limited in young people. There is evidence to suggest that psychopathic adults show appropriate suppression of the startle reflex following a positive visual prime (Levenston et al., 2000), which appears to indicate intact processing of appetitive information. Children with conduct disorder and young offenders demonstrate a normal pattern of affective modulation of the startle reflex, even though the startle magnitudes are generally lower across valence categories (Fairchild et al., 2008; Syngelaki et al., in press; van Goozen, Snoek, Matthys, van Rossum, & van Engeland, 2004). With respect to skin conductance, evidence shows reduced SCRs to positive auditory cues in psychopathic adults (Verona, Patrick, Curtin, Bradley, & Lang, 2004), but increased SCRs to positive imagined situations in children with conduct disorder (Garralda, Connell, & Taylor, 1991). Yet other studies failed to find differences in SC activity between children with oppositional defiant disorder (ODD) and controls during a reward and punishment decision making task, although the ODD children did display greater HR reactivity to reward (Luman, Sergeant, Knol, & Oosterlaan, 2010).

In comparison to aversive conditioning, autonomic reward conditioning has been a neglected research area. The gap in the literature may be the result of the difficulty in finding rewarding stimuli that elicit physiological responses similar to aversive stimuli (Martin-Soelch, Linthicum, & Ernst, 2007). However, appetitive conditioning has the same evolutionarily survival value as aversive conditioning and research is required to elucidate to what extent reward conditioning is implicated in different psychopathologies (Martin-Soelch et al., 2007). It is unclear whether antisocial individuals present with a global deficit in emotional learning, or instead have a specific deficit in learning fear responses. In contrast with research on ASB, some limited research has been conducted examining reward conditioning in other psychopathologies, including depression (where deficits are proposed to arise out of failure to form positive associations between normally appetitive unconditioned

stimuli and neutral stimuli) and substance misuse (maintenance of the problem may result from associations between previously neutral environmental cues that induce craving and relapse; Martin-Soelch et al., 2007). In addition, whereas healthy participants develop a conditioned preference for initially neutral stimuli predictive of rewards, patients with amygdala and medial temporal lesions show impairments on conditioned preference paradigms thus implicating amygdala and related structures in the process (Elliot, 2004; Johnstrude, Owen, White, Zhao, & Bohbot, 2000).

5.1.1. The present study

The present study was conducted to further explore emotional functioning in antisocial adolescents by using psychophysiological measures of autonomic nervous system functioning. The study included a fear and reward conditioning paradigm, both of which employed a standard differential conditioning and partial reinforcement procedure comparing visual stimuli previously paired with an unconditioned stimulus to visual stimuli that have never been reinforced. We hoped to extend the literature on fear learning and ASB by focusing on an antisocial group defined from a legal and judicial approach (i.e., community young offenders) as opposed to a clinically defined antisocial group. However, the primary impetus for this research was to examine reward sensitivity and learning in an antisocial group, in order to assess whether antisocial individuals have a general emotional learning impairment, a specific one related to negative emotion or perhaps even a superior ability to condition to reward given their increased reward seeking tendencies. Based on previous research it was predicted that young offenders would show deficits in fear conditioning compared to the normal controls. In terms of reward conditioning, an open hypothesis was justified given the lack of research in the area.

5.2. Method

5.2.1. Participants

The young offender (YO) group consisted of 35 young males aged between 14 and 17 engaged in the criminal justice system. The young people had exhibited delinquent behaviour at different levels of frequency and seriousness. They were recruited from the local youth offending team, in collaboration with their case workers. The normal control (NC) group (n = 40) were young males aged between 13 and 17 recruited from local comprehensive schools, who were not engaged in the criminal justice system. Both participants and their parents or primary carers provided written informed consent. Participants were provided with vouchers as compensation for their time. All aspects of the research reported here were scrutinised and approved by Cardiff University's School of Psychology Research Ethics Committee

Our inclusion criteria for participation were that participants were male (female YOs are rare), and that their IQ, estimated using the vocabulary and the matrix reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999), was greater than 70.

5.2.2. Measures

Skin conductance recording. Skin conductance was recorded bilaterally from the distal phalanges of the index and middle fingers of the non-dominant hand by using a constant voltage system. Silver-silver chloride electrodes with 8mm diameter were used and applied using double-sided adhesive electrode collars. Skin conductance paste (ABRALYT, 2000, chloride free abrasive electrolyte gel, supplied by Falk Minow Services DE-82211 Herrsching) was used to fill the electrodes. Electrodermal activity was recorded using a skin conductance amplifier (PSYCHLAB Contact Precision Instruments, UK).

5.2.2.1. Fear conditioning task. The fear conditioning (FC) experiment replicated the procedure described by Bechara and Damasio (2002). The FC paradigm involved differential conditioning with partial reinforcement. Coloured slides were presented on the screen, one of which (the blue slide) acted as the visual conditioned stimulus (CS), while an aversive, loud white noise sound (99dB) served as the unconditioned stimulus (US). Electrodermal activity (skin conductance response; SCR) was the dependent measure of autonomic conditioning.

Each coloured slide appeared on the screen for 3 seconds, with an inter-stimulus interval of 10 seconds, which consisted of a blank grey screen. The aversive noise was presented binaurally through headphones. When the conditioned stimulus (blue slide) followed by the unconditioned stimulus (the loud sound) appeared on the screen, the white noise was triggered 2 seconds after slide onset and remained on for 1 second.

The measurement and analysis of skin conductance differed from Bechara and Damasio (2002) and instead was consistent with Fairchild et al. (2008) and Syngelaki et al. (in press). The skin conductance response (SCR) was measured as opposed to skin conductance level (SCL). Dawson, Shell, and Filion (1990) refer to the tonic level of skin conductance or resistance as the absolute level of resistance or conductance at a given point in the absence of a measurable phasic response. Superimposed on the tonic level are phasic decreases in resistance (increases in conductance) referred to as SCRs. Essentially, the SCR measures the change in SC to specific stimuli. The presentation of novel and unexpected, significant or aversive stimuli can result in a specific SCR (Dawson et al., 1990).

A positive SCR amplitude exceeding .05 microsiemens (μS) in the 7 second period following slide presentation was considered to indicate an elicited SCR. Although values used in the statistical analyses and shown in the figures reflect absolute changes in skin conductance level within the 7 second analysis window. The slope function was used to

determine the direction of change in the SCR (a positive SCR or negative SCR) this is consistent with Fairchild et al. (2008) and Syngelaki et al. (in press)[3].

Participants viewed 48 coloured slides in total (blue, red, orange and green). The paradigm was divided into four phases; a habituation phase, two acquisition phases and an extinction phase. During the habituation phase (HAB), the four coloured slide stimuli were presented twice on the computer screen without any reinforcement (i.e., without the aversive white noise). The acquisition phase was divided into acquisition phase 1 (ACQ1) constituting four unreinforced blue slides and five reinforced blue slides and acquisition phase two (ACQ2) comprising the same combination but in a different order. Therefore, the blue slide was reinforced 10 times and unreinforced 8 times in acquisition. These eight blues slides that were not followed by the US served as the test conditioned stimuli. During acquisition, the blue slides were mixed with 10 red slides (there was also one green and two orange slides). Extinction comprised presenting the blue slide six times without reinforcement and the red slide a further three times. Slides were presented in a pseudo-random order (i.e., appearing random for each individual participant but in a set order for all). Please see Table 5.1 for a breakdown of the trials used in this task.

[3] Bechara & Damasio (2002) scored each phase by subtracting the average SCR of the red slides from those of the blue slides (positive responses suggest that SCR were larger to blue slides compared to red) they then went on to conduct a 2 (group) x 4 (conditioning phase) ANOVA on the average SCR from the CS (blue) minus unpaired (red) slides. Similarly, our analysis used the average SCR to both red and blue slides in each phase , but presented them separately in figures and used these separate values for later analyses (rather than simply presenting the difference between them) – this subtle difference allowed us to better explore how SCR differed across phase for both blue and red slides and also across group (e.g. how SCR to blue slides in particular or red slides in particular [safety learning] differed across phase for each group). Furthermore, our use of negative SCRs was an additional issue to consider and therefore it appeared necessary to separate out these values rather than take the difference.

Table 5.1 Fear Conditioning Protocol: The number of slides in each phase

Phase	Number of Slides	Number of blue slides	Number of red slides	Other colour slides
Habituation	8	2	2	4
Acquisition 1	17	9	5	3
Acquisition 2	14	9	5	
Extinction	9	6	3	
Total	48	26	15	7

The average change in skin conductance level in response to both reinforced and unreinforced blue slides and red slides were quantified. For the analysis of differential conditioning only changes related to the test blue slides (unreinforced blue slides; hereafter simply referred to as blue slides) and red slides were considered.

To ensure that participants had paid attention during the task, a test was conducted following the procedure which involved asking the participant: how many colours they had seen (a score of .5 for a correct answer), which colours they had seen (.5 for each correct answer), how many slides were paired with the aversive sound (.5 for a correct answer) and which colour of slide was associated with the noise (2.0 for correct answer, 1.0 if they said blue and another colour). A recall score of 1.5 out of 5 was considered appropriate for inclusion (Bechara & Damasio, 2002; Fairchild et al., 2008).

5.2.2.2. Reward conditioning task. The reward conditioning (RC) task was essentially a replication of the fear conditioning procedure. However, coloured slides were black and white shape slides (tree, house, chair, teapot; see Appendix G for these stimuli) and the US was the delivery of a 10 pence coin that participants were allowed to keep. The tree slides

acted as the visual conditioned stimulus (CS), while delivery of money served as the unconditioned stimulus (US). Money was delivered via a specially signed coin box (see Appendix H for an image of the coin box); 1 x 10p coins were delivered each time. SCR was the dependent measure of autonomic conditioning.

Each slide appeared on the screen for 3 seconds, with an inter-stimulus interval of 10 seconds, which consisted of a blank grey screen. The US (money) was triggered 2 seconds after slide onset. Again like the fear conditioning protocol, there were four phases: habituation, acquisition one, acquisition two and extinction. During acquisition, there were 18 tree slides (CS), 10 of which were paired with the US, while 8 were left unpaired (test CS). Ten house shape slides were also presented during acquisition (and also two teapots and one chair shape). The house slide and other shaped slides were not paired with money. The average change in skin conductance level in response to both reinforced and unreinforced tree slides and house slides were quantified. For the analysis of differential conditioning, changes related to the test CS slides (unreinforced tree slides; hereafter referred to simply as tree slides) and control house slides were considered.

Prior to the experimental phase a practice session was included where participants saw 10 x 10p coins delivered from the box and were allowed to keep this money. The attention check questions were again asked subsequent to completing the task. The reward conditioning paradigm was completed first; the fear conditioning paradigm was completed one week later.

Antisocial Behaviour Measures

The following measures of ASB were obtained in both the YOs and NCs mainly for descriptive purposes to better characterise the two groups; The Youth Psychopathic traits Inventory (YPI; Andershed et al., 2002) a questionnaire for the assessment of psychopathy

and the Youth Self Report (YSR; Achenbach & Rescorla, 2001) a questionnaire including a scale on conduct disorder symptomatology. Offence frequency rate (number of offences /age) and offence severity (average severity of all offences) was also obtained for the YO group.

5.2.3. Procedure

For both the FC and RC paradigms the following procedure was followed: prior to the application of the electrodes, participants were required to wash their hands and then dry them thoroughly. Subsequently, they were seated and the electrodes were applied. Participants were asked to sit comfortably and to place their non-dominant hand on the table, and try to keep this hand still throughout the experiment. Participants were told to pay attention to the computer screen and that different colours (pictures in the case of the reward paradigm) would appear on the screen, and that some of the colours (pictures) would be paired with a sound (delivery of money) and some would not. The experimental phases started a few minutes after the instructions were given in order to allow SC to reach baseline prior to commencing.

5.3. Data analysis

Due to technical problems, artefacts from moving the hand, extraneous noise/interruptions and attrition, data were only available and appropriate for use for 33 YOs; 27 completed both the fear paradigm and reward paradigm, 3 the reward only and 3 the fear only; one YO participant failed to obtain a score above 1.5 on the attention task following the reward conditioning paradigm and so their data was removed for that task. Therefore, the reward conditioning data was present for 29 YOs. 32 NC's data was available (all NC participants completed both measures).

To examine possible demographic differences, one-way analyses of variance (ANOVA) or chi-square tests were used. ANOVAs were also used to examine differences

between the two groups in conditioning ability. Dependent measures were SCR amplitudes at each phase of the conditioning paradigms. The SCR data were not normally distributed and normalized using a SQRT (SCR + 3) transformation. Raw values are shown in the figures for ease of interpretation. SCR data from each paradigm were analysed using a mixed two by four by two ANOVA with group (control vs. offender) as a between-subjects factor and conditioning phase (habituation, acquisition 1, acquisition 2, extinction) and slide stimulus type (i.e. test blue vs. red slide in the fear conditioning paradigm and test tree vs. house slide in the reward conditioning paradigm) as within-subjects factors. Separate repeated-measures ANOVAs were also performed. Simple main effects were used for post-hoc comparisons between groups. Sidak's effects test was used to test simple comparisons. Degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity, where assumptions of sphericity were violated. Supplementary analyses involved examining the relationship between reward conditioning and fear conditioning and self-report and behavioural measures from the previous chapters, these analyses can be found in Appendix J. Effect sizes for the skin conductance results are reported as Cohen's *d* (small, *d*=.2, medium, *d*=.5, and large, *d*=.8) and partial eta squared (η_p^2; small≥.01, medium≥.06, large≥.14; Cohen, 1988). Analyses were carried out using SPSS 16.0 (SPSS Inc., Chicago, Illinois).

5.4. Results

5.4.1. Demographic information

The participants' demographic information is summarized in Table 5.1. One-way ANOVAs showed that the NCs had a significantly higher estimated IQ [$F(1,48) = 5.03$, $p = .030$] and were also significantly younger [$F(1,64) = 14.49$, $p < .001$] than the YOs. Estimated IQ and age were not associated with SCRs in the habituation phase in the fear conditioning task (IQ; r = -.153, p = .300; Age; r = -.062, p = .630) or reward conditioning tasks (IQ; r = .096, p = .518; Age; r = .041, p = .752) and so were not regarded as confounding factors and were not accounted for in subsequent analyses.

Analysis of the ethnicity data (using categories of white Caucasian or other) showed that the majority of both YOs were white Caucasian and there was no difference between the groups [$\chi^2(1) = .34$, p = .56]. Socioeconomic status (SES) was estimated using the Office for National Statistics estimates of average household total weekly income based on each participant's post code (Low = £ 0-£520; Middle = £521-£670; High = £671 +) and there was no significant difference between the groups [$\chi^2(2) = 1.98$, $p = .37$].

Table 5.2 Participant descriptive characteristics.

	YO (n=33)		NC(n=32)	
Measures	Mean	SD	Mean	SD
Age (years)	16.18	0.95	15.09	1.33
Estimated IQ (WASI)[a]	83.14	7.69	90.63	14.03
Ethnicity[b] (n and %)	n	%	n	%
Caucasian	26	78.8	27	84.4
Non white	7	21.2	5	15.6
Socioeconomic Status				
Low	19	57.6	22	68.8
Middle	10	30.3	5	15.6
High	4	12.1	5	15.6

Note. YO = Young Offender; NC = Normal Control; WASI; Wechsler Abbreviated Scale of Intelligence

[a] WASI data was only present for 22 young offenders and 27 normal controls.

[b] YO ethnicity; 26 = White British; 1 = African; 1 = Caribbean; 3 = Mixed White and Black Caribbean; 1 = Indian; 1 = Other ; NC ethnicity; 27 = White British; 1 = Mixed White and Asian; 1 = Bangladeshi; 1 = Pakistani; 2 = Indian.

Table 5.2 shows how the YOs and NCs scored on the psychopathy and conduct disorder measures. One way ANOVAs showed that the YOs scored significantly higher than the NCs on conduct disorder symptoms ($p = .003$) and YPI Impulsive-Irresponsibility ($p < .001$). In the YOs we see a mean offence rate of 0.66 (SD = 0.63) and mean offence severity of 3.24 (SD = 0.84).

Table 5.3 ASB measures in YOs and NCs

	YO		NC		
Measures [maximum score]	Mean	SD	Mean	SD	Sig
YPI Grandiose-Manipulative	37.59	11.84	38.66	8.23	
YPI Callous-Unemotional	34.93	7.20	33.69	6.98	
YPI Impulsive-Irresponsibility	45.10	7.61	38.41	6.57	p <.001
YSR conduct score [100]	64.11	9.94	56.73	8.14	p = .003
Offence Rate	0.66	0.63	-	-	-
Offence Severity [8]	3.25	0.84	-	-	-

Note: ASB= Antisocial Behaviour; YO = Young Offender; NC = Normal Control; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report.

5.4.2. Fear conditioning

There were no group differences in average SCR during habituation [$F(1, 60) = 0.54$, $p = .465$, $d = 0.19$] indicating that the two groups had similar baseline SCRs. The effect of time on the US was examined using a repeated-measures analysis of variance (ANOVA) with time as within-subjects factor and group as a between-subjects factor (10 x 2). This revealed a significant main effect of time [$F(4.80, 302.67) = 22.04$, $p < .001$, $\eta_p^2 = .259$] but no effect of group [$F(1, 60) = 0.58$, $p = .449$, $\eta_p^2 = .009$] and no interaction between time and group [$F(4.80, 302.67) = 0.90$, $p = .481$, $\eta_p^2 = .041$], implying that SCRs to the US declined similarly over time in both groups due to habituation and that both groups did not react differently to the US. See Figure 5.1 for SCRs to the US for both YOs and NCs.

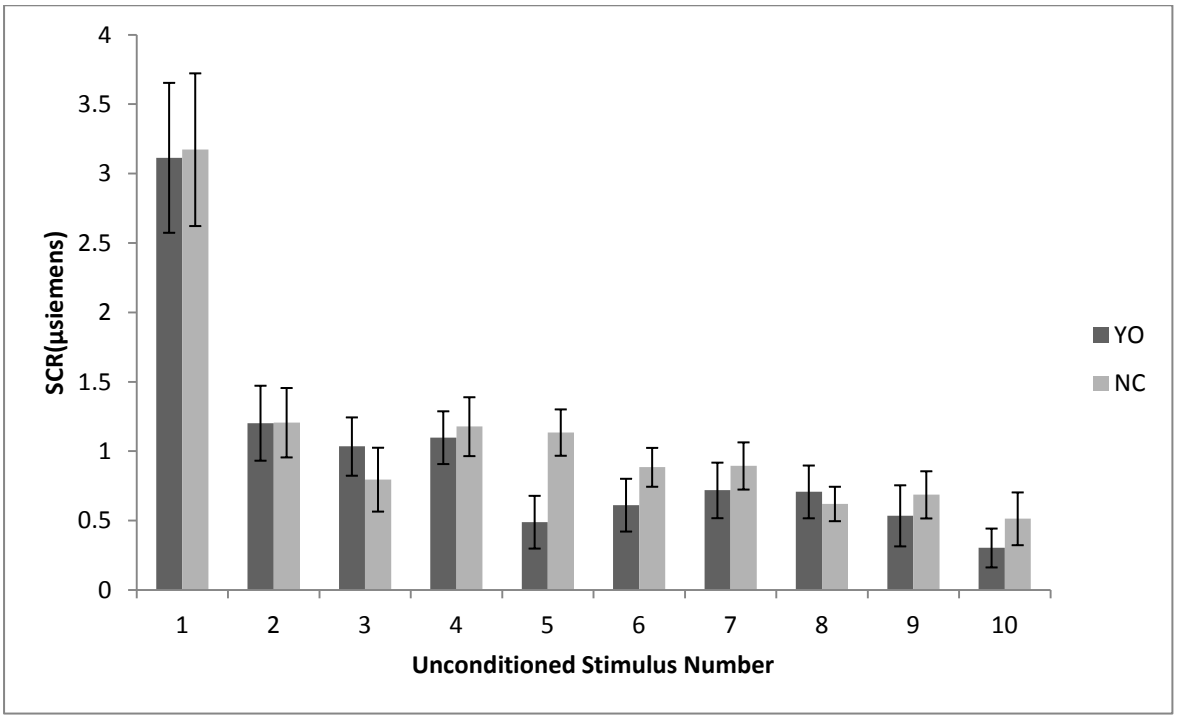

Figure 5.1 Skin conductance responses (SCRs) to the 10 presentations of the aversive unconditioned stimulus (US) in young offenders and normal controls. Error bars are ± standard error. Both groups showed marked habituation of SCRs to the US over time.

A group x phase x slide type (test blue versus red) mixed model ANOVA indicated that there was a significant main effect of slide type [$F(1, 60) = 39.34$, $p < .001$, $\eta_p^2 = .396$], of phase [$F(2.28, 137.06) = 3.73$, $p = .022$, $\eta_p^2 = .058$], and a significant interaction between slide type and phase [$F(2.70, 162.06) = 9.70$, $p < .001$, $\eta_p^2 = .139$]. There was no significant main effect of group [$F(1, 60) = 1.59$, $p = .213$, $\eta_p^2 = .026$], and no interactions between slide type and group [$F(1, 60) = 0.18$, $p = .676$, $\eta_p^2 = .003$], or phase and group [$F(2.28, 137.06) = 1.73$, $p = .177$, $\eta_p^2 = .028$].

There was a marginally significant 3-way interaction between slide type, phase and group ($F(2.70, 162.06) = 2.18$, $p = .099$, $\eta_p^2 = .035$). A two-way repeated measure ANOVA on the NC data revealed that there was a significant main effect of slide type [$F(1, 31) = 17.93$, $p < .001$, $\eta_p^2 = .366$], a main effect of phase [$F(1.94, 60.12) = 4.42$, $p = .017$, $\eta_p^2 = .125$), and a significant interaction between slide type and phase [$F(2.15, 66.67) = 10.70$, $p < .001$, $\eta_p^2 = .257$]. Simple effects tests indicated that there was a significant effect of phase for red slides [$F(3, 29) = 4.6$, $p = .009$, $\eta_p^2 = .324$], but not for test CS blue slides [$F(3, 29) = 1.4$, $p = .251$, $\eta_p^2 = .130$]. Moreover, there was a significant effect of slide type for acquisition phase 1 [$F(1, 31) = 25.38$, $p < .001$, $\eta_p^2 = .450$] and 2 [$F(1, 31) = 12.72$, $p = .001$, $\eta_p^2 = .291$], but not for habituation [$F(1, 31) = 2.42$, $p = .130$, $\eta_p^2 = .072$] or extinction [$F(1, 31) = 0.71$, $p = .406$, $\eta_p^2 = .022$]. Please see Figure 5.2 for the SCR to the blue test slides and red slides in the normal control group.

A two-way ANOVA follow-up analysis on the YO data indicated that there was a main effect of slide type [$F(1, 29) = 21.39$, $p < .001$, $\eta_p^2 = .424$], but no main effect of phase [$F(2.4, 68.73) = 0.41$, $p = .698$, $\eta_p^2 = .014$], and no interaction between slide type and phase ($F(2.34, 67.88) = 1.46$, $p = .239$, $\eta_p^2 = .048$). YO's SC responses for test CS blue slides were significantly higher (mean =1.73) than for red slides (mean = 1.67). Please see Figure 5.3 for the SCR to the blue test slides and red slides in the young offender group.

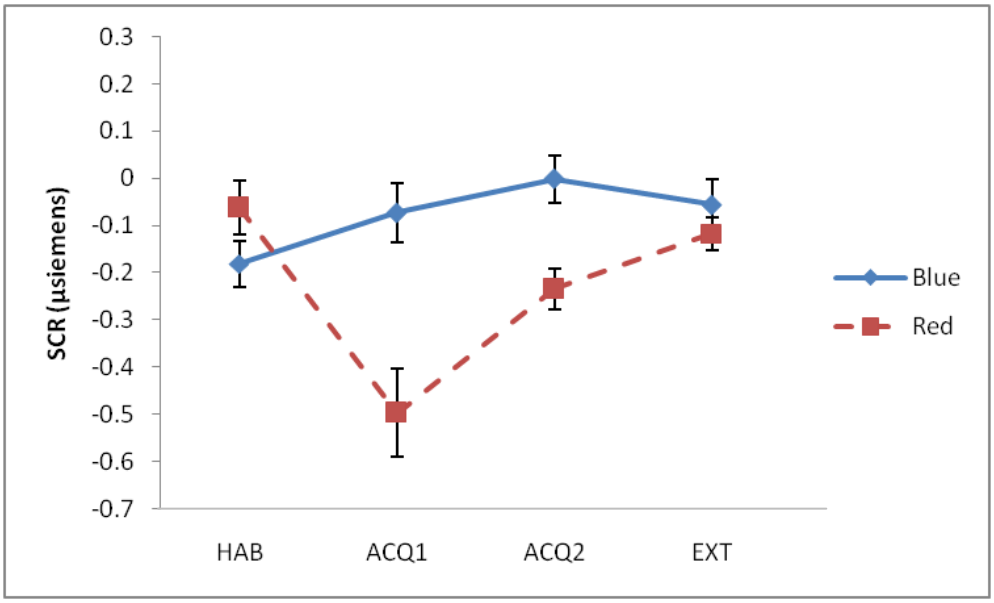

Figure 5.2 Mean skin conductance response to blue test slides (solid line) and red slides (dashed line) across conditioning phases for the normal control group. Error bars are ± standard error. HAB, habituation phase; ACQ1, acquisition 1; ACQ2, acquistion 2; EXT, extinction.

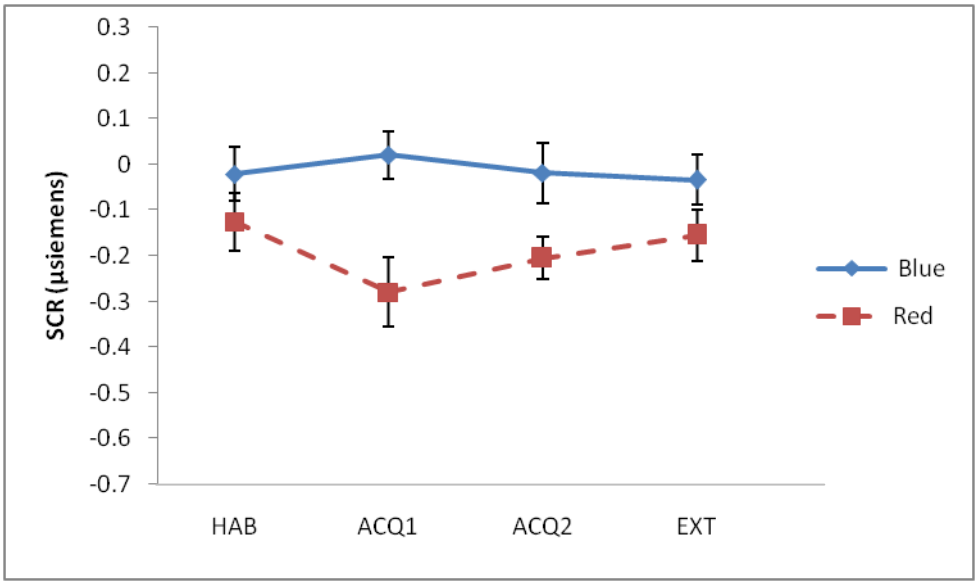

Figure 5.3 Mean skin conductance response to blue test slides (blue slides unpaired with the unconditioned stimulus, solid line) and red control slides (dashed line) across conditioning phases for the young offender group. Error bars are ± standard error. HAB, habituation phase; ACQ1, acquisition 1; ACQ2, acquistion 2; EXT, extinction.

All participants achieved a recall score > 1.5 on the attention task following the fear conditioning paradigm. The mean recall scores for the fear conditioning task for each group were as follows: YO = 3.96 (SD = 0.81) and NC = 3.97 (SD = 0.97). A one-way ANOVA showed that this difference was not significant [$F(1, 56) = .01$, $p = .980$]. The scores in both groups were relatively high and this suggests any impairment in fear conditioning was not as a result of failure to pay attention to the task.

5.4.3. Reward conditioning

There were no group differences in average SCR to the tree slides during habituation [$F(1, 59) = .016$, $p = .901$, $d = 0.03$] indicating that the two groups had similar baseline SCRs. We examined whether SCRs to the US differed over time and by group, using repeated-measures analysis of variance (ANOVA) with time as within-subjects factor and group as a between-subjects factor (10 x 2). There was a main effect of time [$F(5.05, 277.51) = 5.85$, $p < .001$, $\eta_p^2 = .096$], no effect of group [$F(1, 59) = 0.46$, $p = .502$, $\eta_p^2 = .008$], and no group x time interaction [$F(5.05, 277.51= 1.05$, $p = .390=1$, $\eta_p^2 = .019$]. SCRs to the US declined over time in both groups showing a habituation effect, and the groups did not differ significantly in their response to the US.

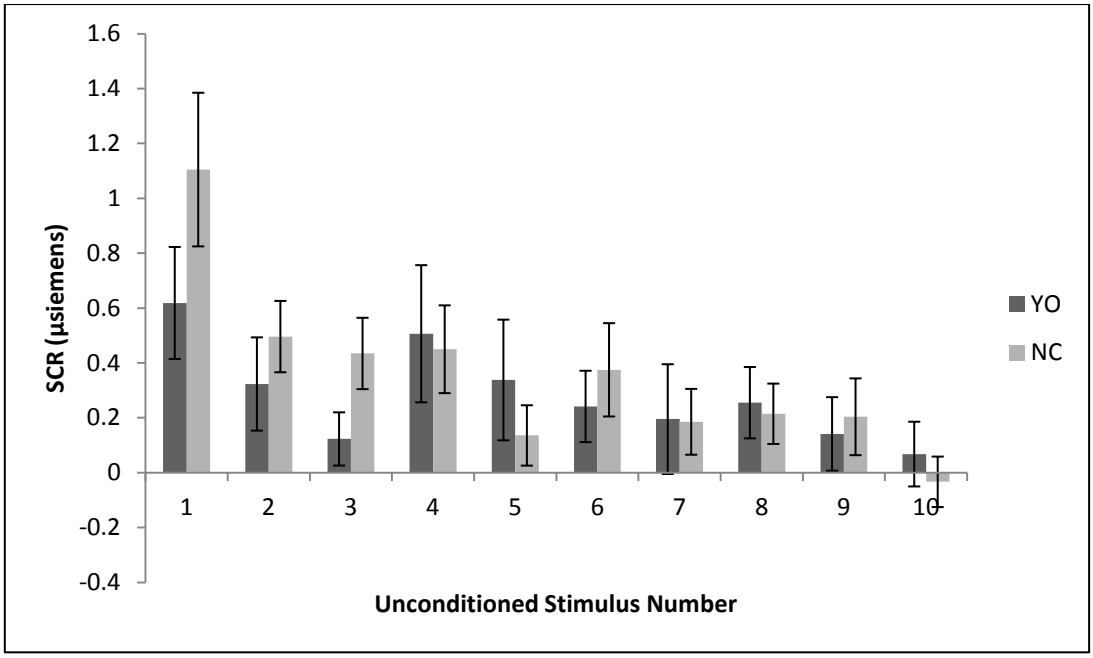

Figure 5.4 Skin conductance responses (SCRs) to the 10 presentations of the rewarding unconditioned stimulus (US) in young offenders and normal controls. Error bars are ± standard error. Both groups showed habituation of SCRs to the US over time.

In order to examine group differences in conditioning ability, a group × phase × slide stimulus type (CS tree versus house slide) mixed-model ANOVA was used. There was a significant main effect of slide type [$F(1, 59) = 7.08$, $p = .010$, $\eta_p^2 = .107$], no effect of phase [$F(2.5, 147.5) = 1.69$, $p = .179$, $\eta_p^2 = .028$] nor of group [$F(1, 59) = 0.0$, $p = 1.00$, $\eta_p^2 = .000$]. The interaction between slide type and phase was marginally significant [$F(2.55, 150.28) = 2.61$, $p = .063$, $\eta_p^2 = .042$]; simple effects tests indicated that there was no significant effect of phase for test tree slides [$F(3,57) = 2.01$, $p = .122$, $\eta_p^2 = .096$] or red slides [$F(3,57) = 0.47$, $p = .704$, $\eta_p^2 = .024$], but there was a significant effect of stimulus slide type for acquisition phase 1 [$F(1, 59) = 6.32$, $p = .015$, $\eta_p^2 = .097$] and 2 [$F(1,59) = 7.75$, $p = .007$, $\eta_p^2 = .116$], but not for habituation [$F(1, 59) = 0.11$, $p = .742$, $\eta_p^2 = .002$] or extinction [$F(1, 59) = 0.0$, $p = .961$, $\eta_p^2 = .000$]. As can be seen in Figure 5.5 and 5.6 the SCRs to test tree slides were higher than for the house slides during both acquisition phases for both the YOs and NCs.

There were no significant interactions between slide type and group [$F(1, 59) = 0.42$, $p = .522$, $\eta_p^2 = .007$], phase and group [$F(2.50, 147.53) = 0.08$, $p = .953$, $\eta_p^2 = .001$], slide type, phase and group [$F(2.55, 150.28) = 0.81$, $p = .475$, $\eta_p^2 = .013$].

As noted previously, one participant (young offender) achieved a recall score of less than 1.5 out of 5 on the attention task following the reward conditioning procedure. The mean recall scores from the attention task for the reward conditioning task for each group were as follows: YO = 3.94 (SD = 0.74) and NC = 3.73 (SD = 0.96) and this difference was not significant [$F(1, 57) = .929$, $p = .339$]. Again, the scores in both groups were relatively high so they appeared to be paying attention to the task.

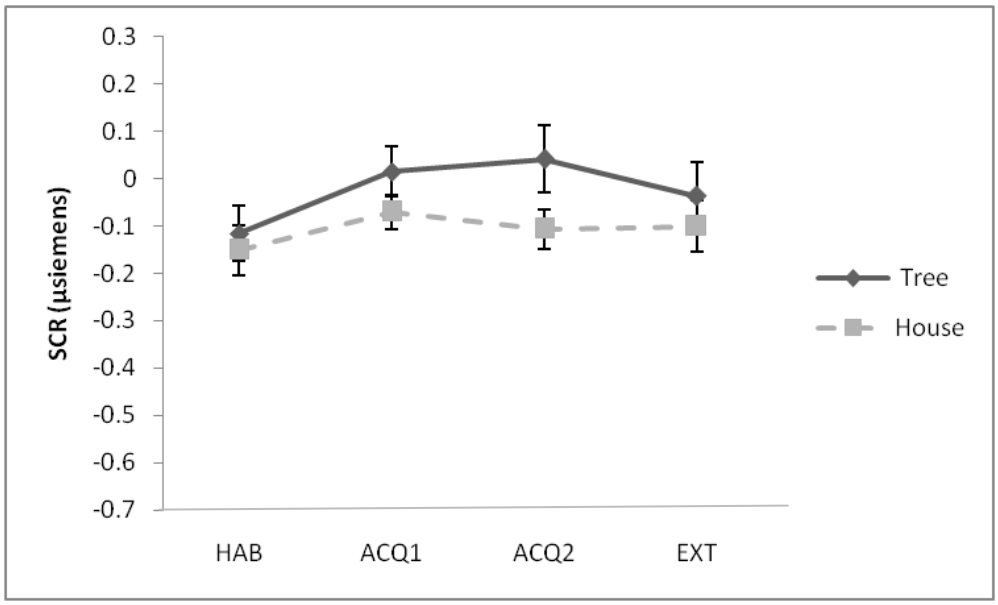

Figure 5.5 Mean skin conductance response to test tree slides (unreinforced tree slides, solid line) and house control slides (dashed line) across conditioning phases for the normal control group. Error bars are ± standard error. HAB, habituation phase; ACQ1, acquisition 1; ACQ2, acquistion 2; EXT, extinction.

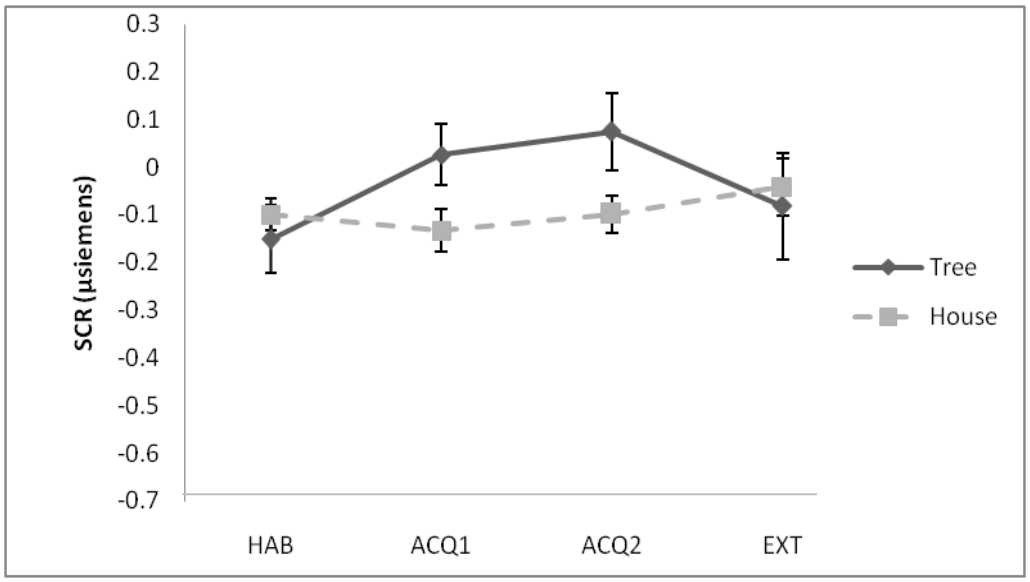

Figure 5.6 Mean skin conductance response to test tree slides (unreinforced tree slides, solid line) and house control slides (dashed line) across conditioning phases for the young offender group. Error bars are ± standard error. HAB, habituation phase; ACQ1, acquisition 1; ACQ2, acquistion 2; EXT, extinction.

5.5. Discussion

The present study aimed to explore emotional functioning in young offenders by examining fear and reward conditioning using psychophysiological methods.

In relation to the fear conditioning, the results show that the young offenders demonstrated differential responding to the test blue and red slide types, but responses did not differ over phase and there was no interaction between slide type and phase. Furthermore, SCRs to both slide types were in the main negative (as can be seen in Figure 5.2), corresponding to a decrease in SCR to the visual stimuli. In normal conditioning one would expect a positive increase in SCR to the test blue slides during acquisition and instead we see a relatively flat line response. They did not acquire an autonomic response during the acquisition phases of the task, reflecting an inability to learn the association between the unconditioned stimulus (US), an aversive white noise, and the visual conditioned stimulus (test blue slide) that predicted the US. Young offenders did show SCRs to the aversive unconditioned stimulus (US) so the reduced SCRs during acquisition were as a result of the inability to form the association. These results are consistent with past findings in antisocial individuals (e.g., Fairchild et al., 2008; Fairchild et al., 2010; Syngelaki et al., in press) and supports the argument that an inability to learn about punishment and fear is implicated in antisocial behaviour (Raine, 1993).

Nevertheless, the normal control group results were unexpected as they performed similarly to the young offender group and did not demonstrate a positive SCR to blue slides that had previously been associated with the aversive noise as would be expected in normal conditioning. However, they did show a markedly decreased SCR to red slides (indicative of safety learning; Fairchild et al., 2008) compared to blue slides and the distinction between the slides increased during acquisition phases suggesting marked differentiation in learning. The

difference between the visual stimuli (blue and red slides) were certainly more evident in the NC group compared to the YO group.

This safety learning response is interesting given the notion that safety itself may be rewarding. Indeed learning theories emphasise mutually antagonistic motivational systems in the brain, the appetitive and the aversive system, with activation of one inhibiting the activity of the other (Josselyn, Falls, Gerwitz, Pistell & Davis, 2005). 'A safety signal that inhibits the aversive system may be perceived [by the animal] as motivationally equivalent to a CS that activates the appetitive motivational system' (p23, Josselyn et al., 2005). It has been argued that the neural components that mediate the behavioural effects of safety signals may overlap with those that mediate appetitive conditioning (Josselyn et al., 2005). Our findings appear to suggest that the NC group show a more extreme response to safety (reduced SCR to reward) finding the red slide more safe than the young offenders. These results are interesting and emphasise the importance of separately examining the SCR to both the test slides and unpaired slides (for instance Bechara & Damasio, 2002 examined the SCR to blue slides minus SCR to red slides and so did not measure this). Nevertheless, the use of negative SCRs is a relatively novel approach (see Fairchild et al., 2008; 2010) and further research is required to feel confident that a negative SCR reflects safety learning.

The results are inconsistent with the pattern found in normal controls in past research using this exact measure of fear conditioning (Fairchild et al., 2008; Fairchild et al., 2010; Syngelaki in press) and casts some doubt on the ability to compare the overall data to this sample, therefore the results must be interpreted with caution. One could tentatively suggest that the very similar levels of emotion related psychopathic traits (a disorder with an established association with emotional dysfunction and deficits in fear processing; Flor et al., 2002; Levenston et al., 2000) in the young offenders and normal controls could imply a

similar level of emotional impairment in both groups and this obscured the findings on the fear conditioning task.

In terms of reward conditioning, the results indicate a significant difference between the visual stimulus types (tree versus house) during the acquisition phases for both the YO and NC groups, but not during habituation or extinction. In contrast to the fear conditioning data, we see that the SCRs to the test slides during acquisition were both positive (above 0) for both groups and the significant difference between stimulus types was not driven by the markedly decreased response of the control slides. Unfortunately, there was no significant difference in phase, (although the pattern is consistent with learning over the task); this is likely to result from the very small SCRs produced to the reward and the variability between individuals in what they perceive as rewarding decreasing the consistency of the findings. Overall, the results are encouraging as a first attempt at the exploration of reward conditioning and would appear to indicate that there was differential responding to the visual stimulus types (tree versus house). This suggests that both adolescent groups were able to develop conditioned SC responses to stimuli previously associated with reward and therefore this sample of young offenders do not display a global emotional learning impairment, but rather it is specific to fear learning.

The strength of the research is the novelty of the reward conditioning procedure and the ability to compare to the fear conditioning data. On the reverse side, a potential limitation is the use of both the reward conditioning and fear conditioning paradigm in the same study which means that the fear conditioning results may have potentially been affected by the previous conditioning procedure. It could tentatively be suggested that the less clear pattern of responding found during the fear conditioning task may be as a result of some carry over effects. For instance, one could argue that the familiarity of the procedure and contingencies could have resulted in the generally reduced SCRs observed in the fear conditioning

paradigm. In addition, in terms of another limitation, although the reward conditioning data are promising as a first step, future research is required that delivers larger rewards (e.g., increased monetary amounts) so that there is an increased likelihood of finding larger conditioned SCRs and a clearer conditioning pattern. In addition, a larger number of participants would have permitted the sub-grouping of the young offender sample based on different dimensions of antisocial behaviour (e.g., psychopathy, conduct symptoms; offence frequency and severity) and allowed for an exploration of emotional functioning in different groups of offenders. Finally, it must be emphasised that the lack of overall group differences between offenders and controls on either task is disappointing and suggests that both groups condition in similar ways which is inconsistent with past evidence and the theory in the area.

In summary, the present findings supports past studies that have found a deficit in fear learning in antisocial adolescents but also provides the novel evidence that these adolescents are not necessarily impaired on reward learning. The latter finding is positive, providing evidence of a strength rather than a deficit in these young people and with further investigation may have important implications for policy and practitioners working with antisocial youngsters. For instance interventions need to capitalise on the strengths of these young people while working on the impairments and therefore emphasise rewards as opposed to punishment as an effective reinforcer for behavioural change. Further research is required to examine how individual differences in these processes affect the effectiveness of intervention/treatment and longer term outcome

Chapter Six – Substance use in young offenders

6.1. Introduction

Antisocial behaviour (ASB) peaks during the adolescent period and a significant proportion of young people begin using drugs and alcohol at around this age (Hellandsjo Bu et al., 2002; Steinberg, 2008). This adolescent increase in risk taking behaviour has been described as partly due to an increase in reward seeking, associated with changes in patterns of dopaminergic activity around this time (Steinberg, 2008). Alcohol and drug use are particularly problematic among young people who demonstrate more extreme antisocial behaviour such as in young offenders (Abrantes et al., 2005). Young offenders have been shown to have five times higher rates of substance use and approximately three times higher rates of substance use disorders in comparison to non-offending young people (Grisso, 2004; Mauricio et al., 2008). Furthermore, ASB and substance use are very closely associated, with some evidence suggesting that substance use facilitates aggression and violence in young people (Welte, Barnes, Hoffman, Wieczorek, & Zhang, 2005) and perhaps even contributes to continued offending (Hussong, Curran, Moffitt, Caspi, & Carrig, 2004; Mauricio et al., 2008). Thus an examination of the extent of substance use in our sample of community adolescent offenders would be useful to further explore the overlap in these proposed reward seeking behaviours.

An association between substance use and ASB repeatedly emerges in the literature (Eklund & Klinteberg, 2009; Mauricio et al., 2008; White, Loeber, Stouthamer-Loeber, & Farrington, 1999). These associations arguably appeal to the notion of an externalising vulnerability (predominantly genetic in origin) for a range of externalising behaviours (Krueger, Markon, Patrick, Benning, & Kramer, 2007). Nevertheless, the extent to which different aspects and patterns of substance use are associated with different elements of offending is an interesting area of research requiring further investigation in young people. For instance, increased substance use has been implicated in more frequent and severe

offending (Eklund & af Klinteberg, 2009; Lennings, Copeland, & Howard, 2003); moreover, different types of substances (e.g., drugs versus alcohol; cannabis versus other substances) may be related to offending variables in different ways.

In addition, the psychopathic offender has also been identified as at risk of substance misuse problems. Clearly the role of psychopathic traits is important in relation to both antisocial behaviour and substance use. Psychopathy and substance misuse tend to co-occur and affect a substantial number of adult offenders (Hare & Neumann, 2009; Hemphill, Hart & Hare, 1994; Hopley & Brunelle, 2012; Rutherford, Alterman, & Cacciola, 2000). However, psychopathy is heterogeneous and dimensional; the evidence suggests that the relationship between substance use and psychopathy is accounted for more by the social deviant/antisocial component as opposed to the emotional interpersonal factors of the construct (Blair et al., 2005; Smith & Newman, 1990; Taylor & Lang, 2006).

Psychopathic traits are becoming increasingly important in young people, with evidence accumulating on the utility of these traits in predicting recidivism (Corrado et al., 2004; Gretton, Hare, & Catchpole, 2004); the limited evidence that exists on the relationship between substance use and psychopathy in adolescents also suggests an association with the antisocial component (Mailloux, Forth, & Kroner, 1997; O'Neill, Lidz, & Heilbun, 2003) but more work is needed in adolescent offenders to elucidate the relationship. Given that both psychopathy and substance use in offenders are risk factors for further offending and are both resistant to therapeutic intervention (Hopley & Brunelle, 2012), further delineating the association between the two is an important area of research

Finally, reward processing is clearly implicated in substance use and personality traits of reward are becoming increasingly important in this context; Gray's Behavioural Activation System (BAS) has been implicated in both the development of substance misuse and ASB more generally. The BAS responds to conditioned and unconditioned signals of reward and

individuals who are high in BAS are proposed to engage in higher levels of approach behaviour and experience heightened positive affect in situations containing reward cues. Furthermore, the neurological basis of BAS (mesolimbic dopaminergic pathways) is similar to the pathways that are responsible for the reinforcing effects of natural rewards such as sex, food and drugs (Dawe, Gullo, & Loxton, 2004).

It is clear that alcohol and drugs have rewarding properties and given that individuals with elevated BAS are considered more reward sensitive it can be argued that increased BAS would be associated with engagement in alcohol and drug use (Franken & Muris, 2006). In addition, those with elevated BAS sensitivity may engage in increased drinking and drug use because of their heightened sensitivity to the positive incentive cues of alcohol and drug related stimuli (e.g., Zisserson & Palfai, 2007). The personality approach of BAS has also been linked with neuroscience developments where changes in the incentive value of rewards have been associated with alterations in neural substrates involved in reward seeking (see Dawe, Gullo, & Loxton, 2004).

There has been support for the role of BAS in substance use in a range of adult samples; drug addicted clinical samples have been shown to have higher BAS scores compared to controls (Franken, Muris, & Georgieva, 2006) and college students' drug and alcohol use (number of illegal substances used, quantity of alcohol use and frequency of binge drinking) was positively associated with BAS (Franken & Muris, 2006). While there is a growing interest in the use of BAS in the examination of alcohol and substance abuse, there are surprisingly few studies that have examined these constructs in adolescents. At least one study, in mainstream Russian youths (aged between 14 and 25) found BAS to be to the best personality predictor of substance use (e.g., Knyazev, Sloboskaya, Karchenko, & Wilson, 2004). Another study failed to find an association between alcohol use and BAS sensitivity in adolescents aged between 12 and 18 from private schools in Australia. The authors argue that

the lack of variance in drinking behaviour in their relatively young sample may be the most likely explanation (Hasking, 2006). Perhaps an examination of alcohol use in an adolescent sample likely to display increased alcohol and substance use would provide more meaningful associations. To the authors knowledge this is the first study to explore BAS and substance use in adolescent offenders.

The aims of this explorative chapter were threefold; firstly, the nature and extent of substance use in a sample of antisocial adolescents was assessed descriptively (and some limited aspects compared to non-offending adolescents); secondly, the relation between substance use and different aspects of ASB was examined in order to assess the extent to which these various behaviours are associated; and finally, the relationship between reward personality traits, psychopathic traits, and substance use was explored. It was hypothesised that drugs and alcohol would be used at high rates in the young offenders and increased use would be associated with increasing levels of offending rate, offending severity, psychopathic traits and reward traits. However, given the heterogeneity of ASB, variation in substance use was predicted to relate differently to different dimensions of the behaviour.

6.2. Method

6.2.1. Participants and procedure

The participants consisted of 66 young male offenders aged between 13 and 17 years old (mean = 16.03; SD = 1.04) who were engaged in the criminal justice system and had exhibited delinquent behaviour at different levels of frequency and seriousness. The majority (66.7%) were British White in ethnic origin. The mean estimated IQ (as measured using the Wechsler Abbreviated Scale of Intelligence) was 85.66 (SD = 10.57). They were recruited from the local community youth offending team, in collaboration with their case workers.

The normal control group were 50 young males aged between 13 and 17 (mean – 15.10; SD = 1.25) that had not engaged in offending behaviour. The mean estimated IQ was 85.5 (SD = 9.88). There was only limited data available for the control group due to ethical approval limitations; data on smoking and alcohol use was present. All participants were provided with vouchers in compensation for their time. All participants completed all questionnaire measures as part of a larger study on adolescent antisocial behaviour; WASI score was missing for 2 offenders and 15 controls.

6.2.2. Measures

6.2.2.1. The Substance Use Report (SURE). A new instrument was developed to examine substance use in adolescents and the items were based on large scale survey methods. More specifically, items were selected from the TRacking Adolescents' Individual Lives Survey (e.g., Ormel et al., 2012) a large prospective population study of Dutch adolescents. Question sections pertained to alcohol use, cannabis use and other illicit substances.

Tobacco Use

The item simply asked whether participants currently smoked and the response option was dichotomous (i.e., yes or no).

Alcohol use

Alcohol items related to the *frequency* (number of times) of drinking in lifetime, past year and month (all ranging from 0 – 40 or more times); lifetime prevalence was also dichotomized (never drank alcohol in life versus have drank alcohol); the *number of drinking days* in the week (Monday – Thursday) and weekend (Friday – Saturday) was obtained; the *quantity* of drinks on a typical weekend night (responses ranging from I don't drink to 10 or more drinks); *drunkenness* in lifetime, past year and month (all ranging from 0 – 10 or more times); *age* of onset of alcohol use (ranging from under 9 years to 17 years old). Other questions pertaining to alcohol use asked about the extent of perceived *problems* as a result of use, including concentration problems, problems with friends and family, problems at school and injuries sustained to self or others as a result of drinking (responses were never, sometimes, often).

Cannabis use

Cannabis items focused on; *frequency* of use in lifetime, past year and month (all ranging from 0 – 40 or more times); lifetime prevalence was also dichotomized to create a variable (never used cannabis versus have used cannabis); *the age of onset* of cannabis use (responses ranged from 9 years or under to 17 years old). Other questions pertained to any *problems* with friends, family, and school as a result of using cannabis (responses included never, sometimes, often).

Other illicit substances

Lifetime *prevalence* of other illicit substances (other than cannabis) including cocaine, amphetamine, ecstasy, tranquilisers and hallucinogens (participants ticked any substance that they had tried in their lifetime) and *current use* of these substances (they selected how often they use currently; responses included never, sometimes and often).

The questionnaire instructed participants to omit completing certain sections that did not apply. That is, if they did not report using a substance they could skip all questions relating to that substance (as such data on certain items are not present for all participants but only those for whom they were appropriate).

6.2.2.2. Fast Alcohol Screening Test (FAST: Hodgson et al., 2002). The FAST is a four item questionnaire that is designed to screen hazardous drinking; according to the authors, hazardous drinking refers to a pattern of drinking that is associated with a high risk of psychological or physical problems in the future. The items concern quantity and frequency of drinking and adverse consequences. The FAST was developed from the longer Alcohol Use Disorders Identification Test (AUDIT) and validated in over 3000 patients in various medical settings. Total scores range from 0 to 16, with a cut-off score for hazardous drinking at 3. This cut off score was used in this study to make use of a well validated categorical approach to the examination of alcohol use. The measure has good internal (Cronbach's alpha = 0.77), test-retest reliability (>.80) and has demonstrated good sensitivity and specificity at identifying hazardous drinkers (see Hodgson et al., 2002). Please see Figure 6.1 for the exact wording of the four items.

1)	How often do you have eight or more drinks on one occasion?
2)	How often during the last year have you been unable to remember what happened the night before because you had been drinking?
2)	How often have you failed to do what was normally expected of you because of drinking?
4)	In the last year has a relative or friend or doctor or other health worker been concerned about your drinking or suggested you cut down?

Figure 6.1 Fast Alcohol Screening Test items.

6.2.2.3. The Youth Psychopathic traits Inventory (YPI: Andershed et al., 2002) is a self-report measure that is used to assess psychopathic traits in young people aged 12 years and above. The three scale scores were utilized; Grandiose-Manipulative; Callous-Unemotional and Impulsive-Irresponsibility.

6.2.2.4. Official crime records; Both offence frequency rate (the number of offences committed divided by age) and offence severity (calculated by using the seriousness scale developed by the Youth Justice Board) were used.

*6.2.2.5. The Behavioural Inhibition System/Behavioural Activation System Scales (BIS/BAS scales; Carver & White, 1994).*The BIS/BAS scales consist of a 24 item self-report questionnaire for the assessment of reward and punishment sensitivity. We were interested in the BAS subscales; BAS Drive, BAS Fun Seeking and BAS Reward Responsiveness.

6.3. Data Analysis

Descriptive data are presented on the nature of the substance use in the sample. Non-parametric tests were selected given the ordinal nature of the response items and non-normal data. Spearman rho correlations were utilised to examine the relation between substance use, offence frequency rate, offence severity and psychopathic and reward traits. Subgroup analyses (i.e., FAST cut off score) were examined using Mann-Whitney U-tests.

6.4. Results

6.4.1. Descriptive Statistics

Tobacco use

The majority of the young offender group (80%; 53 individuals) were currently smokers, compared to 13 non-smokers. Conversely, the majority of normal controls (94 %; 47 individuals) were non smokers. A chi square test showed that this difference was significant $x(1) = 62.90$, $p < .001$.

Alcohol Use

The majority of young people (93.9 %; 62 individuals) reported having tried alcohol in their life and of those individuals, 53.2 % had drank alcohol more than 40 times in their life and 24.3 % had drank alcohol more than 40 times in the last year.

The frequency (number of times) young people had drank alcohol in the last month is shown in Table 6.1. It can be seen that just over a third of the sample (37.1 %) stated that they had not consumed any alcohol during the last month; just over another third (37.1 %) reported that they had drank alcohol 1 to 4 times during the last month; the remaining individuals reported frequency at between 5 and 39 times.

Table 6.1 Frequency of alcohol use in the last month (n = 62)

Frequency of use in last 4 weeks	n (%)
Never	23 (37.1 %)
1-4 times	23 (37.1 %)
5-10 times	6 (9.7 %)
11-19 times	7 (11.3 %)
20-39 times	3 (4.8 %)
40 or more times	0

Note: The modal response categories were 'Never' and '1-4'times. The median was 1- 4 times.

In terms of number of drinking days, Table 6.2 shows the number of days that the young people reported drinking in an average week (Monday -Thursday) and on the weekend (Friday -Sunday). The majority (74.2 %) state that they do not drink alcohol during the week; the majority (81 %) also report that they drink on at least one day of the weekend; the average (modal response) was one drinking day during the weekend.

Table 6.2 Number of drinking days in week and weekend (n= 62)

	Week (Mon-Thurs) n (%)	Weekend (Fri- Sun) n (%)
0 days	46 (74.2%)	12 (19.4%)
1 day	8 (12.9%)	25 (40.3%)
2 days	6 (9.7%)	20 (32.3%)
3 days	2 (3.2%)	5 (8.1%)
4 days	0	-

Note. The mode and median in the week was 0 days; the median and mode was 1 day on the weekend.

The quantity of drinks (1 drink = 1 unit) consumed in one weekend night is shown in Table 6.3. The average (modal) response was 10 or more drinks in one night, with 37 % of the young people reporting this. As shown in Table 6.4 the majority of the sample reported being drunk 10 or more times in their life; similarly, the majority reported being drunk 10 or more times in the last year; 5 % report being drunk 10 or more times in the past month, with the average response being that they had not been drunk in the last month.

Table 6.3 The quantity of drinks consumed on average weekend day/night (n= 62).

Number of drinks	n (%)
I do not drink during weekend	12 (19.4 %)
1 drink per day	3 (4.8 %)
2-3 drinks per day	3 (4.8 %)
4-5 drinks per day	8 (12.9 %)
6-7 drinks per day	4 (6.5 %)
8-9 drinks per day	9 (14.5 %)
10 or more drinks	23 (37.1 %)

Note: The modal response was 10 or more drinks per day; the median response was 8-9 drinks per day.

Table 6.4 The frequency of drunkenness in lifetime, past year and past month (n=62).

	Frequency		
	Lifetime n (%)	Year n (%)	Month n (%)
Never	3 (4.8 %)	8 (12.9 %)	27 (43.5 %)
Once	3 (4.8 %)	9 (14.5 %)	10 (16.1 %)
2-3 times	5 (8.1 %)	10 (16.1 %)	11 (27.7 %)
4-5 times	6 (9.7 %)	4 (6.5 %)	4 (6.5 %)
6-7 times	5 (8.1 %)	3 (4.8 %)	3 (4.8 %)
8-9 times	1 (1.6 %)	4 (6.5 %)	2 (3.2 %)
10 or more times	39 (62.9 %)	24 (38.7 %)	5 (8.1 %)

Note: The modal category in lifetime and last year was '10 or more times' and for the last month the modal category was never. The median for lifetime was 10 or more times; for the past year the median was between 4 and 7 times, while in the last month the median was once.

The age of onset of alcohol use is shown in Table 6.5; a minority of young people report beginning alcohol use before the age of 9. The average (modal) age category is between age 14 and 15 years old.

Table 6.5 Age of onset of alcohol use (n = 60[a])

Age	n (%)
9 years or younger	4 (6.1 %)
10-11 years old	7 (10.6 %)
12-13 years old	22 (33.3 %)
14-15 years old	24 (36.4 %)
16-17 years old	3 (4.5 %)

Note: The modal response was 14-15 years old; the median response was between 12-13 years old.
[a] 2 missing responses;

In terms of the problems of alcohol use on an individual's life, 75.8 % reported that they had never had concentration problems; 74.2 % reported never having had problems with friends or family that were probably caused by drinking of alcohol; 87.1 % reported no problems in terms of performance at school/work; 54.5 % reported that they had never felt guilty about their alcohol use, whereas 36.4 % said they felt guilty sometimes. In addition, 60.6 % reported that they had never injured themselves or someone else as a result of drinking, 31.8 % reported that this had happened sometimes and 4.5 % stated that this had happened often.

The median score on the Fast Alcohol Screening Test for the young offender group was 3 (IQR = 5); 35 young people scored in the hazardous alcohol use range on the FAST (>3) and 31 scored below. The median score on the FAST for the normal control group was 1 (IQR = 3); 11 young people scored in the hazardous alcohol use range and 39 scored below. A Mann-Whitney U test showed that there was a significant difference between the groups in the level of hazardous drinking $U = 1076.50$; $p = .001$.

Cannabis use

The majority of participants (83.3 %; 55 young people) reported having used cannabis in their life. Of those reporting having ever used cannabis 81.8 % reported having used cannabis in the last month and 32.7 % reported having used cannabis more than 40 times in the last month (see Table 6.6 for the extent of use in the past month). Table 6.7 shows the age of onset of cannabis use. A small number reported beginning to use cannabis under the age of 9, the average (modal) age of onset being aged between 14 and 15 years old.

Table 6.6 Frequency of cannabis use in those reporting having ever used in the last four weeks (n = 55.)

Frequency of use in last 4 weeks	n (%)	
Never	10	(18.2 %)
1-4 times	8	(14.5 %)
5-10 times	5	(9.1 %)
11-19 times	7	(12.7 %)
20-39 times	7	(12.7 %)
40 or more times	18	(32.7 %)

Note: Modal response = 40 or more times; Median response = 11-19 times

Table 6.7 Age of onset of cannabis use in those reporting ever to have used it (n=55)

Age	n (%)	
9 years or younger	4	(16.7 %)
10-11 years old	10	(6.1 %)
12-13 years old	18	(27.3 %)
14-15 years old	20	(30.3 %)
16-17 years old	3	(4.5 %)

Note: The modal age category is 14-15 years old; Median response = 14-15 years.

Young people also provided their perception on the nature and extent to which they felt cannabis resulted in various problems in their life (all questions answered in terms of never, sometimes or often). The majority did not report any problems; 66.7 % suggested that

they never had concentration problems after using; 74.5 % reported never having problems with friends and family as a result of cannabis use; 69.1 % felt that cannabis did not affect their performance at school and 69.1 % did not feel guilty about their cannabis use.

Other Illicit Substances

The lifetime prevalence for other illicit drugs in the sample was as follows: 30.3 % had used cocaine; 21.2 % tranquilisers (e.g., benzodiazepines such as valium); 19.7 % amphetamine; 7.6 % ecstasy; 3 % hallucinogens; 0 % had used crack cocaine or heroin. Table 6.8 shows the current use of these substances (for only those reporting ever used that substance). The results show that few young people are using these substances often.

Table 6.8 Current use of substances in those reporting ever to have used each substance.

Substance	Never $_{\text{use now}}$ n	Sometimes $_{\text{use now}}$ n	Often $_{\text{use now}}$ n	Total (% ever tried of whole sample)
Cocaine	9	11	0	20 (30.3 %)
Tranquilisers e.g. benzodiazepines)	9	4	1	14 (21.2 %)
Amphetamine	8	4	1	13 (19.7 %)
Ecstasy	4	1	0	5 (7.6 %)
Hallucinogens	2	0	0	2 (3 %)

Non-Substance Use Measures

Table 6.9 shows the descriptive statistics for the offence history variables (frequency, rate and severity), Youth Psychopathic traits Inventory and BAS scales.

Table 6.9 Descriptive statistics for psychopathic traits, reward traits and offence history.

Measure	Mean	SD	Median[a]	IQR
Offence Frequency	10.68	8.77	9.00	10.00
Offence Rate	0.67	0.57	0.53	0.69
Offence Severity	3.50	0.85	3.32	1.04
YPI Grandiose-Manipulative	38.53	11.94	37.00	17.00
YPI Callous-Unemotional	35.62	7.31	36.00	8.25
YPI Impulsive-Irresponsible	43.73	7.30	44.00	10.00
BAS Drive	11.15	2.70	11.00	4.00
BAS Fun	12.29	1.73	12.00	2.00
BAS Rew	15.65	2.60	16.00	2.00

Note: YPI = Youth Psychopathic traits Inventory; BAS = Behavioural Activation System: IQR = Interquartile range.
[a] Median reported for consistency with the categorical/ordinal averages presented for substance use items

6.4.2.Correlational analyses

Substance use and offence history

Table 6.10 shows the relationship between alcohol variables and drug variables (variables chosen on the basis of consistency with previous research in the area e.g., Franken & Muris, 2006) and offence history (frequency and severity of offending). Spearman correlations revealed a positive association between offence rate and the number of illicit drugs used (r = .393, p = .002), cannabis use in past month (r = .426, p = .001) and the quantity of alcoholic drinks on an average weekend night (r = .265, p = .038). Conversely, offence severity was negatively associated with illicit drug use (r = -.270, p = .035), alcohol frequency in past month (r = .300, p = .019) and the frequency of drunkenness during the last month (r = -.411, p = .001).

Table 6.10 Spearman correlations between substance use and offence history

	Offence rate	Offence Severity
1. Number of illicit drugs used (at least once).	.393**	-.270*
2. Frequency - number of times used cannabis in past month	.426**	-.158
3.Frequency –number of times drunk alcohol in past month	.052	-.300*
4.Quantity of alcoholic drinks consumed on average weekend night	.265*	-.196
5.Frequency of drunkenness during last month	.013	-.411**

Note:

*p < .05 **p < .01

Substance use and psychopathic traits

Table 6.11 shows the relationship between substance use variables and psychopathic traits. The correlations show a number of positive associations between the YPI Impulsive-Irresponsible dimension and substance use variables (number of illicit substances $r = .327$, $p = .007$; frequency of cannabis $r = .380$, $p = .002$ and alcohol $r = .253$, $p = .040$) in the past month). However, there were no significant associations between the YPI affective and interpersonal dimensions and substance misuse.

Table 6.11 Spearman correlations between substance use and psychopathic traits

	YPI Grandiose	YPI Callous	YPI Impulsive
1. Number of illicit drugs used (at least once).	-.105	-.114	.327**
2. Frequency-number of times used cannabis in past month	-.048	.083	.380**
3. Frequency-number of times drunk alcohol in past month	.037	.053	.253*
4. Quantity of alcoholic drinks consumed on average night	.103	-.017	.187
5. Frequency of intoxication during last month	.047	.041	.180

Note:

*p < .05

** p < .01

Substance use and reward traits.

Table 6.12 shows that there are positive associations between BAS Drive and alcohol use, specifically the frequency of alcohol consumption in last month (r = .337, p = .006) and the number of times they had become drunk in the last month (r = .277, p = .026), but there were no relationships between other BAS scales and any measure of drug or alcohol use.

Table 6.12 Spearman correlations between substance use items and reward traits

	BAS Drive	BAS Fun	BAS Reward
1. Number of illicit drugs used ever (at least once).	.074	.065	-.168
2. Frequency - number of times used cannabis in past month	.173	.093	-.063
3. Frequency –number of times drunk alcohol in past month	.337**	.057	.112
4. Quantity – number of drinks on one weekend night	.146	.159	.164
5. Frequency of Intoxication during last month	.277*	.082	.128

Note: BAS = Behavioural Activation System;

*p < .05

** p < .01

Fast Alcohol Screening Test and offence variables, psychopathic traits and reward traits

Mann-Whitney U-Tests showed that those scoring in the hazardous drinking range on the FAST (n = 35) scored significantly higher on BAS Drive (U(65) = 745.50, p = .003) and BAS Fun (U(65) = 694.50, p = .023) compared to those scoring in the non-hazardous alcohol range (n = 31). However, these two groups did not differ on offence history variables or in psychopathic traits.

6.5. Discussion

The present study aimed to examine (1) the extent and nature of substance use (SU) in an adolescent offender sample, (2) the relationship between SU and different aspects of ASB, and (3) the role of reward and psychopathic traits in SU.

The findings indicated that drugs and alcohol were frequently used in the young offender sample. The results showed that alcohol use was particularly common (93.9 % had ever tried it), with 81 % reporting that they drink on an average weekend and 37 % stating that they drink 10 or more drinks on an average weekend night. In addition, 53 % of the young offender sample drank at a hazardous level according to the Fast Alcohol Screening Test, compared to 22 % of the normal control group.

The results also indicated that a substantial number of adolescent offenders had engaged in drug use, with cannabis being the most commonly used drug; 81.8 % reported having used it in the last month and 32.7 % reported using it more than 40 times in the last month. Other illicit substances had been tried by a smaller number of individuals with cocaine being the most frequently used substance after cannabis, but few young people were using these other substances at the time of questionnaire completion.

Interestingly, in terms of the problems reported by young people, the majority did not feel that cannabis in particular was causing any problems in multiple areas of their life. This is consistent with evidence showing that while substance misuse in young people is rising, the perceived risk of using these substances is low (Crowley, Macdonald, Whitmore, & Mikulich, 1998).

We next examined the association between different aspects of substance use and offence history. The evidence showed that in relation to some aspects of substance use a positive association was found with offence rate; the number of illicit drugs used, the

frequency of cannabis use and the quantity of drinks used on a single day were all positively associated with offence rate. This supports our predictions and past research on the relation between substance use and offence frequency, but extends this knowledge to adolescent offenders.

However, interestingly there were negative associations between aspects of substance use and offence severity, suggesting that more severe offending is linked with reduced substance use. This is inconsistent with expectations and past research; however, we must consider the nature of our sample of offenders. Past research has often taken place in adults who have committed more severe crimes or in young people with a lower frequency of crimes and this is perhaps important in considering this finding. Our offenders, although generally low level in terms of severity, were quite frequent offenders. We found that offence rate was actually negatively associated with offence severity ($r = -.276$ $p = .034$). So the more frequent offences in this young sample were also the less severe ones, and we know that offence rate was positively associated with substance misuse in this study.

Thus it would seem that the more frequently committed, less serious crimes are the ones that are associated with substance misuse in our sample. Clearly the exact nature of the relationship between substance use and antisocial behaviour has not been completely specified; many explanations exist but some evidence suggests that some offending is committed to fund drugs and alcohol use (McMurran & Cusens, 2005). The less severe, more frequent offences tend to be acquisitive and property type offences and therefore provides support for that argument.

In relation to psychopathy we see that the association between psychopathic traits and substance use was related to the YPI Impulsive-Irresponsible dimension rather than the affective and interpersonal components. This supports past research on the role of substance use in psychopathy (Blair et al., 2005; Mailloux, Forth & Kroner, 1997; Smith & Newman,

1990; Taylor & Lang, 2006). As noted, the higher order factors of the YPI are thought to relate to the interpersonal, affective and behavioural components identified using the PCL-R in adults (Cooke & Michie, 2001); the YPI Impulsive-Irresponsible dimension is thought to relate to the behavioural dimensions of psychopathy reported in the adult literature. The similarity of findings in adults and our adolescent sample support the validity of these factors and provide important information on the relation between psychopathy and substance use in adolescence. Substance use in adult psychopaths is thought to be symptomatic of general social deviance (Cleckley, 1976; Smith & Newman, 1990); we show that this association already exists at an earlier age.

Finally, we assessed the relation between BAS and substance use and found that only aspects of alcohol use as opposed to cannabis or other illicit substances were associated with reward traits. In addition, it was BAS Drive in particular that was associated with various aspects of ASB. These findings are consistent with past studies that have found that BAS personality traits are related to alcohol use (Loxton & Dawe, 2001), but they are inconsistent with evidence that has shown an association with drug use (Knyazev et al., 2004). This evidence suggests that BAS may be a useful personality factor for the studying of individual differences in alcohol use, but not illicit substances in young offenders.

Clearly this investigation is a very preliminary investigation into the relationship between substance use and antisocial behaviour; it makes an important initial step in elucidating the important factors in an area of research that desperately needs more attention. There are a number of limitations; primarily the reliability of self-report data on substance use has been contested for some time (e.g., honest responding, accurate recall of specific details of substance use); however, it must be noted that previous research has concluded that when participants' anonymity is assured, substance use self reports have acceptable reliability (Murray & Perry, 1987). Furthermore, although the substance use questions were obtained

from a larger scale survey (Tracking Adult Lives Survey; e.g., Ormel et al. in press) with demonstrated validity and reliability, we utilised individual questions from this scale and so the validity and reliability of our new measure as a whole was not assessed and can not therefore be assured. Nevertheless, numerous studies use individual questions to tap into details of substance use and as such appears to be usual practice (e.g., Franken & Muris, 2006).

Future research could further explore the reasons for the association between antisocial behaviour and substance use; perhaps focussing on questioning the reasons that young people give for engaging in substance use and how they fund their use. For instance, do they engage in antisocial behaviour to obtain substances? In addition, longitudinal research exploring the trajectories of offending in these young people could allow us to assess the dynamics of the relationship and whether early onset substance use leads to more frequent offending in the longer term. Finally, the externalising spectrum model (Krueger et al., 2007) provides an interesting integrative framework for further exploring the relation between substance use and antisocial behaviour; the model argues that there is a broad underlying vulnerability (mainly genetic in origin) for externalising behaviours along with specific aetiological factors that lead to the distinctive phenotypic expression of each disorder. Research should further explore the broad dispositional factor that these disorders have in common as well as the unique variance associated with each; the use of electrocortical measures are one methodological approach that shows potential in elucidating the brain processes underlying variations in genetic externalising vulnerability (Hall, Bernat, & Patrick, 2007; Patrick et al., 2006).

Chapter Seven - General Discussion

The present thesis aimed to explore biobehavioural factors in general and reward processing in particular, in relation to antisocial behaviour (ASB) in adolescents. ASB peaks during the adolescent period and poses a significant problem for society and the individuals themselves; exploring risk factors for this behaviour is an important research endeavour. Oversensitivity to reward and increased reward seeking have been implicated in antisocial behaviour, particularly in clinically defined groups and in adults (Newman, Patterson, & Kosson, 1987; Quay, 1993). Recent theories of adolescent development have emphasised normative increases in reward seeking during this period (e.g., Steinberg, 2008). However, the extent to which reward processing is implicated in adolescent offenders has been given insufficient attention. Biobehavioural factors (e.g., neurobiologically informed personality models, neuropsychological functioning, psychophysiological processes) have been identified as important in explaining individual differences in ASB. But rarely are these methodological approaches incorporated into one project or importantly the role of reward processing given the necessary prominence.

I wanted to elucidate the extent to which reward seeking is implicated in ASB, to explore different facets of reward processing using multiple approaches to measurement and assess reward in relation to different approaches to the definition and measurement of ASB. In addition, given that reward seeking is proposed to be heightened during the adolescent period, this research was placed in a developmental context, with emphasis on the extent to which adolescent offenders differ from non-offending adolescents on these reward processing assessments. Finally, the focus was on community adolescent offenders who varied in their frequency and severity of offending so that factors related to different levels of offending

could be examined. The current chapter will present an overview and integration of the main findings, discuss the possible implications, and identify areas for future research.

7.1. Overview and integration

To achieve the aims, a multi-method approach was adopted where aspects of reward processing were measured using a self-report questionnaire (the Behavioural Inhibition System/Behavioural Activation System [BIS/BAS] scales; Carver & White, 1994), neuropsychological behavioural assessments (Win-Lose test, Card Playing Task [CPT]; Newman et al., 1987) and psychophysiological procedures (autonomic nervous system [ANS] reward conditioning). In addition, other biobehavioural measures and assessments implicated in ASB were examined, including IQ functioning, Wisconsin Card Sort Test [WCST] performance and ANS fear conditioning procedures. ASB and related constructs were assessed in community young offenders involved in the criminal justice system using official records of offence history (offence severity and frequency) and self-report measures of psychopathic traits, aggression, and clinical symptomatology as well as substance use measures.

There were a number of hypotheses at the outset; primarily that (1) antisocial young people would be characterized by altered reward processing compared to the normal control group. More specifically, that young offenders would demonstrate (a) increased levels of traits associated with reward on self-report personality measures (i.e., behavioural approach, reward drive, fun seeking, reward responsiveness); (b) neuropsychological impairments on tasks involving reward processing (i.e., response perseveration, increased monitoring of rewards; executive function deficits related to reward processing and the OFC) and (c) intact/superior autonomic reward conditioning in comparison with fear conditioning on psychophysiological measures. (2) In terms of within groups analyses, it was predicted that

adolescents would demonstrate variation in personality, neuropsychology, psychophysiology and substance use and that these factors would explain variations in ASB and related constructs (e.g., offending history, severity, psychopathic traits, clinical symptomatology, aggression).

Study one as reported in Chapter three examined the relation between reward and punishment traits and ASB in male adolescents. Gray's Reinforcement Sensitivity Theory (1987) is a prominent neurobiological theory of personality that has been used as a framework for the understanding of a range of psychopathologies. Nevertheless, BAS and BIS dimensions have rarely been explored in offenders, let alone adolescent offenders, and therefore we do not know the role these traits play in offending behaviour during this time. As such, we compared BIS/BAS Scale (Carver & White, 1994) scores in adolescent offenders and non-offenders and explored the relation between BIS/BAS traits and multiple measures of ASB within the whole group of adolescents as well as offending rate and severity in the offenders. In support of the hypotheses, between group analyses indicated heightened BAS (reward traits, specifically reward Drive) and lowered BIS (punishment traits) in the offender group compared to the non-offenders (see pp. 65-66). Furthermore consistent with expectations, regression analyses indicated that traits associated with greater reward seeking behaviour predicted the majority of ASB dimensions (p. 70-72). However, contrary to predictions, Reward Responsiveness (described as the positive response/reactivity to and anticipation of rewards) was negatively associated with psychopathic traits and conduct problems (pp. 70-71).

Study two as reported in Chapter four examined Executive Functioning (EF) and reward and punishment processing in young offenders and normal controls using neuropsychological measures. Neuropsychological investigations of ASB have often focussed on global EF deficits rather than specific functions such as reward processing. The

WCST, CPT, and a novel measure of reward and punishment processing; the Win-Lose test were administered. As predicted, young offenders displayed increased perseveration for reward on the CPT (a measure related to OFC functioning) compared to the normal controls and there were no differences on the WCST (a measure associated with DLPFC functioning; see p 94 for detailed results). Analyses on the Win-Lose test suggested that both adolescent male groups showed an increased preference for examining reward information compared to punishment information, thus contrary to predictions the young offenders were not heightened compared to their age matched normal controls (p. 95). Within the young offender group analyses evidenced no role of psychopathic traits or conduct disorder symptoms (p. 96).

Study three was reported in Chapter five and examined emotional learning in young offenders by measuring skin conductance responding (SCR) during both a fear conditioning paradigm and a novel reward conditioning paradigm. It was noted that although fear conditioning had been studied frequently in adults and increasingly so in adolescents, reward conditioning had never been studied in adolescent offenders. Consistent with past research, young offenders failed to show a conditioned SCR to visual stimuli that preceded an aversive stimulus. In contrast, young offenders developed a conditioned SCR to stimuli associated with reward (see p. 125). These findings suggest that young offenders may have a specific emotional learning impairment associated with fear but not reward.

Study four as reported in Chapter six extended the examination of antisocial behaviour to the inclusion of substance use, a behaviour with particular links to reward processing. In a primarily descriptive study the extent to which elements of offending behaviour were associated with aspects of substance use was explored. It was reported that alcohol and cannabis use was common among offenders and that elements of substance use

were related to offence rate, psychopathic traits and reward drive traits, possibly indicating an overlap in underlying aetiology.

So taking these results together, firstly we see that biobehavioural factors are important in relation to ASB; young offenders differed from adolescent non-offending controls in terms of personality traits postulated to be associated with particular biological substrates (BIS/BAS), neuropsychological and emotional functioning. They demonstrated higher levels of reward traits, lower levels of punishment traits, deficits on a measure related to OFC functioning that employed reward and punishment contingencies and some limited differences in psychophysiological fear conditioning. The young offenders and controls were similar in age and IQ (although there were some significant differences) and SES background, making these results even more salient and suggests that these biobehavioural factors are important in the understanding of ASB in particular.

Secondly, the evidence suggests that altered reward processing is implicated in adolescence and in adolescent offenders in particular; the reward seeking, BAS Drive variable was significantly heightened in offenders compared to controls and was consistently associated with different manifestations of ASB, including substance use. Similarly, behavioural response perseveration for reward on the CPT was elevated in offenders compared to controls (although this task involves punishment processing as well as reward processing; see later discussions). Both offenders and controls demonstrated an increased preference for reward monitoring relative to punishment monitoring in comparison with undergraduates on the Win-Lose measure. Furthermore, offenders conditioned appropriately to reward, whereas their fear conditioning was impaired, suggesting that their emotional functioning deficits do not extend to reward processing.

This evidence is consistent with the wider literature on the role of reward in ASB; in terms of suggesting an oversensitivity to reward, including studies using a range of

methodologies such as behavioural and self-report measures (e.g., Fairchild et al., 2009; Hasking, 2007). However, the use of a multi-method approach to the examination of reward is an advantage and allows us to be more confident in the robustness of our findings. In addition, given that adolescence is a developmental period where risk taking is heightened and increased reward seeking has been implicated, it is notable that any differences were obtained between the two adolescent male groups. We ascertain then that reward seeking is heightened in adolescent male offenders compared to male adolescents in general.

In addition, the results support past evidence and theory on the role of the BAS in particular in ASB; antisocial individuals are postulated to demonstrate increased BAS sensitivity resulting in elevated appetitive motivation in the presence of conditioned and unconditioned rewards and this has been found in a range of primarily adult antisocial samples (e.g., Bijttebier, et al., 2009; Hundt et al., 2008; Newman et al., 1987; Ross et al., 2007). This study used a questionnaire measure of BIS/BAS and also a behavioural measure from which BAS sensitivity has often been inferred in past research (i.e. the CPT; e.g., Matthys et al., 1998). By examining these variables in adolescence it provides an important and necessary extension to the literature (Bijttebier, et al., 2009).

Crucially, the results emphasise the importance of examining different components of reward processing and using multiple approaches to measurement. We see that on the newly developed Win-Lose test both adolescent groups demonstrated a reward preference and this was significantly different from the undergraduate students, although there were no differences between the adolescent groups. The heightened reward monitoring behaviour seen in the youngsters could be explained given that adolescence is widely recognised as a developmental period of increased reward seeking (Steinberg, 2004, 2008). However, one must consider why the CPT and the BAS questionnaire distinguished between the adolescent groups and yet the Win-Lose did not.

The CPT is an extinction task and participants are required to extinguish a response that leads to punishment when it was previously associated with reward; essentially stopping/inhibiting your goal oriented action. It has been argued that the CPT corresponds to a combination of both BAS and BIS functioning (Goodnight et al., 2006) and is essentially a measure of disinhibition. When considering BAS and BIS separately (in study one, Chapter three) BAS was heightened and BIS was lowered, the CPT is a behavioural measure that combines both BAS and BIS functioning and it appears that when both are activated in a context where a dominant response set for reward is established, the punishment processing is particularly important in distinguishing between offenders and non-offenders.

With regards the Win-Lose test there is no inhibition necessary to achieve the overall goal. The goal is to win, the chance of winning or losing is random, focussing on the win window does not increase or decrease the chance of winning or losing and therefore for the non-offending adolescents there is no need to take into consideration the punishment information and to inhibit their reward seeking; the punishment does not interrupt the reward seeking goal and is also not salient. Essentially, although adolescents in general are reward oriented as evidenced by the Win-Lose, the antisocial individuals are heightened on this (as demonstrated by increased BAS) and importantly are less able to interrupt their plans even when punishment gets in the way and is salient. This suggests that reward seeking in combination with a problem with punishment processing is particularly implicated in ASB in adolescents. Extinguishing/ inhibiting reward seeking when provided with cues for punishment is a particular problem for these individuals. The evidence of reduced trait BIS (Gray's system that causes inhibition to cues of punishment) and also impaired fear conditioning is also consistent with the argument that problems with punishment processing are implicated in ASB adolescents.

A particularly interesting finding that emphasises the importance of multiple facets of reward processing was the negative association found between the BAS Reward Responsiveness subscale, conceptualised as the positive response and anticipation of reward (including positive affect), and all of the ASB measures and this reached significance for conduct problems and the secondary antisocial components of psychopathy (see pp 65-69 for detailed results). This was also the only reward subscale to be positively associated with BIS, suggesting that those with an attenuated reward response were also low in responsiveness to punishment. It appears that low reactivity to stimuli (rewards or punishments) is associated with ASB, which is consistent with the underarousal often exhibited by antisocial individuals. This is accounted for by both fearlessness and sensation seeking theories of ASB (Raine, 1993), with the former suggesting that antisocial individuals are able to engage in such behaviour because of a lack of fear and the latter suggesting that ASB is a form of sensation seeking where underarousal represents a non-optimal state and intense sensations are required to reach a more optimal level of functioning.

Nevertheless, these findings are not completely consistent with the psychophysiological evidence (see p. 115); in the main, offenders demonstrated reduced psychophysiological responding to the aversive US as would be expected, but this was not significant and there were no differences in the SCR to the rewarding US. Past evidence has found reduced SCRs to aversive stimuli in antisocial individuals and underarousal is a robust finding and so one could argue that the explanation for the contradictory evidence potentially lies in a factor associated with our comparison sample. It could tentatively be suggested that the similar psychopathy levels in both offenders and controls could have contributed to the failure to find differences between the groups (given that psychopathy is strongly associated with emotional dysfunction in the literature including deficient fear conditioning (Birbaumer et al., 2005: Blair et al., 2005), the abnormal fear conditioning results of the control group

also call into question the normality of this group. In addition, we can see that the underactivity of BAS Reward Responsiveness and BIS were particularly associated with psychopathy in study one (Chapter three) and it would have been interesting to examine the psychophysiology data in relation to different aspects of ASB, but the low numbers on these measures precluded within group analyses. However, this does not distract from the important finding that young offenders did not condition to fear, but did condition to reward which was the main factor of interest.

Overall the evidence suggests that offenders are motivated to pursue rewards and this may drive elements of their offending behaviour. Extrapolating from the data one could imagine that they may find a number of things rewarding such as the peer approval or the increased status in the hierarchy gained by engaging in ASB, the excitement and sensations of the acts themselves or perhaps the objects/possessions/money obtained (e.g., through stealing); the receipt of these rewards encourage the reoccurrence of the behaviour. Things associated with the behaviour (cars, shops etc.) could also become cues for reward and increase approach behaviour. This increased drive for reward is likely to occur alongside problems in learning from punishment, not fearing the consequences of their actions and not being able to inhibit their reward seeking tendencies when they become instead punishing (e.g., official sanctions, parental disapproval). We find that a reduced reward response associated with positive affectivity and pleasure may be associated with some aspects of ASB. This could lead antisocial individuals to seek out more intense and frequent rewards to achieve an adequate level of stimulation. On a similar note, the seeking out of rewards could be a way of increasing the chronic underarousal of antisocial individuals.

7.2. Strengths, Limitations and Future Research

There are a number of strengths to the present study; the nature of the sample is of course a substantial strength of the study; young offenders in the community are a very difficult sample to recruit and test, and we have added to the limited body of research in the area. The research has extended knowledge on the factors associated with ASB defined from a criminological perspective as opposed to the often clinical approach utilised. In addition, our research has investigated a range of factors associated with ASB in young people who had exhibited delinquent behaviour at different levels of frequency and seriousness, rather than investigating incarcerated offenders who are more extreme in their offending behaviour. Furthermore, by using both official records of offending as well as self-report measures of psychopathy and clinical symptomatology it allowed for a greater understanding of the different dimensions of ASB.

A key strength of the study is the novelty of the focus on reward processing in this group. The vast amount of research on offenders tends to refer to punishment sensitivity and fearlessness and negative emotion in general, with altered reward processing often implicated but not fully investigated. We used multiple approaches to the measurement of reward (self-report, neuropsychological and psychophysiological) to examine how different measures related to different aspects of ASB. Our different measures also aimed to examine different components of reward processing such as reward response/sensitivity, reward seeking and reward learning. Our supplementary analyses, exploring the relation between different measurement approaches, have further emphasised that reward is a multi-faceted construct. In the young offender sample there was no relation between the BIS/BAS scales and neuropsychological behavioural measures. However, in the normal control group, there were positive correlations between BAS scale self-report and performance on the CPT and Win-Lose measures, suggesting some element of consistency in self-report and behaviour in the

control sample. Similarly, the psychophysiology findings suggest a complex reward processing construct as our reward conditioning measures were not associated with self-report or other behavioural measures in either group.

In addition, by recruiting a non-offending control group from the area in which the young offenders live and by matching for socioeconomic status we were able to examine factors that were specifically associated with ASB. However, the discussion of the control group leads to the necessary consideration of the limitations of the project. The selection of the control group in the current project was not only a strength but also a limitation. The matched nature of the groups (e.g. the similar social backgrounds [in terms of area from which they were drawn and parental income], IQ levels, psychopathic traits), means that between group differences may have been more difficult to obtain. This could potentially explain our limited between group differences in the psychophysiology study (Chapter five).

Nevertheless, one might have expected that given the group's similarity, their psychophysiology would have been a distinguishing factor, therefore explaining the differences in antisocial behaviour. Some studies have demonstrated that psychophysiology presents as a protective factor in at risk groups (Brennan et al., 1997). Our research has shown that personality factors (reward and punishment traits) and neuropsychological measures (Card Playing Test performance) are important in distinguishing between the groups. It could be speculated that other social background features not analysed in the present study (e.g., intactness of home; parenting style) may have served as protective factors for the non-offending control group.

In terms of other limitations, it is clear that we did not find any consistent relation between reward measures and any particular ASB assessment; a significant goal was to explore the relationship between reward processing and the heterogeneity of ASB. In general, we expected that more extreme reward seeking/sensitivity would be associated with more

severe/extreme ASB. It is the case that BAS traits were associated consistently with most aspects of ASB, yet behavioural response perseveration and Win- Lose failed to associate with any ASB measure; but conversely there was no measure of ASB that was consistently associated with reward processing across our methodological domains (e.g., psychopathic traits or conduct problems were not associated with personality and behavioural reward processing).

It could be argued that perhaps the self-report nature of the majority of these instruments (i.e., psychopathy, aggression and clinical symptomatology) may have hindered our ability to find clear relations between particular ASB constructs and reward processing. Clinical diagnoses may have allowed for clearer subgroups to be obtained that may have differed in a consistent way on reward measures. Nevertheless, it is important to note that both the YPI and YSR have demonstrated good validity in a number of studies (Achenbach & Rescorla, 2004; Andershed et al., 2002; Skeem & Cauffman, 2003). Unfortunately, it could also be argued that the predominance of self-report questionnaires contained in the methodology of study one (BIS/BAS and ASB; Chapter three) inflated the common method variance. However, it must be noted that offence rate, a non questionnaire assessment also showed an association with BAS dimensions. Furthermore, the questions contained in the ASB self-report focussed on antisocial behaviours and were very different from those in the BAS questionnaire which focussed on non-specific goals. Items were also reverse scored in a number of places, so the correlations were not necessarily the result of some consistent response set across questionnaires. Therefore, an alternative explanation is that the behavioural assessments were less sensitive to the reward processing that is important for the understanding of different aspects of ASB. Future research should further explore different behavioural measures of reward processing and also clinician rated ASB (PCL-R [Hare,

2003] diagnosed psychopathy and clinical diagnoses of CD) to more fully explore the relation between reward processing and ASB types.

The main limitation involves the number of participants who were available for testing; recruitment was an extremely difficult endeavour and although a substantial proportion of all those young people engaged in the youth offending team were approached to take part in the study, many refused to take part. Still, a large number of participants had been recruited, but participants frequently failed to attend scheduled sessions and/or did not want to complete all of the tests in the battery. Although, the number of tests included was necessarily reduced in size to prevent boredom, there were still a considerable number of tests that took up a substantial amount of time and some participants became fatigued and sometimes lost interest. However, I think that most measures were completed in sufficiently large numbers of participants and provide us with interesting and novel information on the factors associated with ASB in young people.

Nevertheless, the different number of participants in each study results in differences in statistical power and this may impact on null findings. The effect size measures show us that the Card Playing Test shows a medium effect size whereas personality and psychophysiology measures are in the main small effects (Cohen's *d)*. A post-hoc power analysis suggests that in the psychophysiology study with the effect size obtained (d = 0.1) nearly 800 participants would be needed to detect a significant effect.

It is also worth noting that we recruited a number of female participants, but these were in such low numbers that it was difficult to complete any meaningful comparisons between the genders and it seemed a mistake to combine into one whole group given evidence that female and males differ in some developmental factors associated with ASB (e.g., Lewin, Davis, & Hops, 1999; van Lier, Vitaro, Wanner, Vuijk, & Crijnen, 2005).

In addition, our behavioural measures focussed on limited types of reward and in future research it will be important to explore reward processing in young offenders using a variety of rewards including social rewards such as positive social feedback (e.g., smiling faces and praise) to assess the specificity of this reward sensitivity. Arguably, the study of reward processing is a difficult endeavour in comparison to the study of negative emotions and studies frequently utilise financial rewards and points as they are easy to manipulate and tend to be universally rewarding to participants. Nevertheless, it is likely that young offenders are motivated by and respond very differently to financial rewards as opposed to social rewards from individuals such as parents, other authority figures and peers. Knowledge on the different types of rewards that motivate pro-social behaviour in these young people is essential for designing effective interventions aimed at behavioural change.

Furthermore, in terms of different types of rewards an examination of peer influence appears an exciting avenue for future research. Adolescent risk taking behaviour, including the committing of crimes, is far more likely to occur in groups than in comparison to adult risk taking (Steinberg, 2008). Furthermore, the nature of peer's substance use is one of the strongest predictors of an adolescent's own substance use (Chassin et al., 2004). Steinberg proposes that the presence of peers activates the same neural network that is involved in reward processing and as such makes potentially rewarding and risk taking behaviour even more rewarding (Gardner & Steinberg, 2005; Steinberg, 2008). These views are yet to be explored in antisocial adolescents.

In addition, future studies could benefit from the inclusion of reward measures such as those included in the present study, in combination with neuroimaging procedures and this may provide more specific information about the brain areas involved in different components of reward processing in the context of ASB. For instance, research has made use of fMRI and cognitive measures to dissociate brain regions associated with anticipatory

(motivational) versus outcome (consummatory) components of reward processing (Bjork et al., 2004). This research could be illuminatory in view of the opposing theories on the hyper and hypofunctioning of the motivational (striatal) system during adolescence and it's relation to reward seeking.

In addition, the distinction between 'wanting' and 'liking' in the reward literature is an important one; BAS Drive and Reward Responsiveness dimensions appear to have overlap with the 'wanting' and 'liking' components; Berridge describes an animal as 'liking' a reward when they have a hedonic experience and 'wanting' a reward when they are driven to behave in a way that will result in its consumption (e.g., Berridge, Robinson, & Aldridge, 2009; Hickey, Chelazzi, & Theeuwes, 2010). BAS Drive has been conceptualised as similar to 'wanting' (Hickey et al., 2010) and Reward Responsiveness appears to relate to the 'liking' component. Research has made it clear that the reward system is multifaceted and the dissociation of reward components appears informative in relation to various psychopathalogies and antisocial behaviour is likely to be no exception.

7.3. Implications

The present research has demonstrated that adolescent offenders are able to learn appropriately about financial reward and do not have a global emotional deficit, they also focus on reward compared to punishment to a greater extent that older participants, they demonstrate increased reward perseveration and self-report higher levels of reward drive (reward seeking traits) compared to non-offending adolescents. Furthermore, at least in terms of self-report, many different aspects of ASB appear to be associated with reward seeking in a positive direction including an association between fun seeking (an impulsive form of reward seeking which is closely associated with sensation seeking) and offence rate, suggesting that for some adolescent offenders their offending behaviour is sometimes a form

of reward/sensation seeking. The findings of reduced punishment sensitivity as evidenced by lowered BIS scores, increased perseveration on the CPT and impaired fear learning suggest a robust punishment processing deficit perhaps related to fearlessness that also needs to be considered. These findings would appear to have potential implications for policy and practitioners working with young offenders. It is important to examine individual risk factors for antisocial behaviour as it can provide avenues for more effective and potentially tailored intervention (Fishbein et al., 2009). Often intervention programs have been developed without an adequate understanding of the individual risk factors involved with the consequence of wasting limited resources (Moffitt, 2005).

Our results would seem to suggest that interventions should capitalise upon the ability to learn about rewards, the increased focus on rewards and the reward seeking drive of these individuals. Clearly, if this reward seeking is a stable and enduring personality trait it could be difficult to modify, but potentially funnelling towards prosocial reward seeking activities may be one possible route for change (Zuckerman, 2008). This supports the inclusion of diversionary activities for young offenders which provides individuals with the opportunity to obtain rewards, sensations, thrills, by socially acceptable means. Young offenders report and evince higher levels of drive for their rewards (BAS and CPT respectively) and pursue them despite negative consequences; potentially increasing opportunities to focus on positive goals as opposed to antisocial ones may elicit a drive for these rewards also.

The home office has funded the positive futures policy (http://www.posfutures.org.uk). And this initiative has been described by the crime and security minister has having the aim of "supporting young people to achieve their full potential and divert them away from crime and substance misuse." The programme incorporates diversionary activities such as sport and physical activities, arts and education to engage young people and provides opportunities for young people to reach their goals though

education and employment. This policy is an initial step in the right direction and suggests that there is a governmental shift in emphasis on to the focus on reward.

Another possibility is the provision of incentives/vouchers for positive behaviour. Our reward conditioning data imply that these young people as a group are able to learn the association between stimuli and rewarding consequences. Of course as noted previously further research needs to include an investigation on whether different types of reward have an effect on behaviour; whether offenders are able to learn about delayed rewards and do they motivate behaviour and also whether providing rewards for positive behaviour leads to any change in the antisocial behaviour.

Contingency management methods (systematic reinforcement of desired behaviour) such as voucher programmes are more frequently used in the United States particularly in relation to adult substance users and include the incorporation of vouchers for abstaining from substances, adhering to treatment plans etc. (Petry, Martin, Cooney, & Kranzler, 2000). We showed that in adolescent offenders, as well as being able to learn effectively about rewards, and being reward seeking, they also frequently use alcohol and drugs; substance use was associated with aspects of offending, implying similar reward seeking type behaviours. Perhaps it is time to make a concerted effort to research the effectiveness of these contingency programmes in the UK with an emphasis on adolescent antisocial behaviour in general as opposed to substance users specifically. One recent study in adolescent substance users found support for the feasibility of a family-based contingency management model to treat substance use and conduct problems (see Kamon, Budney, & Stainger, 2005). Research such as ours on individual differences in reward sensitivity could be important for assessing who would benefit most from reward based treatments.

Our research shows that as well as being reward oriented, these young offenders demonstrated reduced punishment sensitivity (e.g., lowered BIS, reduced observation of Win-

Lose punishment windows, poor fear conditioning). The criminal justice policy tends to focus on deterrence and punishment and these results would imply that antisocial individuals as a group are less responsive to these tactics. In addition, it has been argued that as a result of poor conditioning, antisocial individuals may find it more difficult to learn the associations between negative emotions and harmful actions (Marsh & Blair, 2008). Perhaps pointing out these associations more clearly might help to overcome some of these difficulties; restorative justice may be one particular route in which this can occur.

Of course, implementation of interventions that do not involve punishment and focus only on rewarding the individual are unrealistic and likely to face opposition given the criminal justice system's reliance on it and societal expectations about the necessary course of action. But an understanding of how personality traits associated with reward and punishment can influence behaviour and therefore potentially affect intervention response is an important endeavour. Finally, encouraging the use of positive incentives for positive behaviour and avoiding punishment is not a new idea and is simply the application of basic principles of psychological behavioural change. However, with accumulating evidence suggesting that young offenders demonstrate increased levels of reward seeking and reduced levels of punishment sensitivity , they appear to be a group that would particularly benefit from these psychological principles; the increasing knowledge on this would suggest a need for change in policy and practice.

7.4. Conclusions

In conclusion, this research has focussed on reward processing in antisocial behaviour in a young offender sample involved in the criminal justice system. The evidence from self-report, behavioural and psychophysiology suggest that young offenders have the capacity to learn about rewards and in certain circumstances a proclivity for heightened reward seeking

and a relatively reduced sensitivity to punishment. This research has provided a contribution to the relatively small literature on BIS/BAS in ASB in adolescent offenders, evidenced the specificity of neuropsychological problems implicated in ASB and to the authors knowledge is the first study to explore reward conditioning in offenders. The research has emphasised the importance of reward processing in the context of ASB but also highlighted that there is much more work to be done on different facets of reward processing, reward types and their relation to different aspects of ASB. An improved understanding of these processes may potentially facilitate the development of more targeted and effective interventions.

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Appendix A - Youth Justice Flowchart

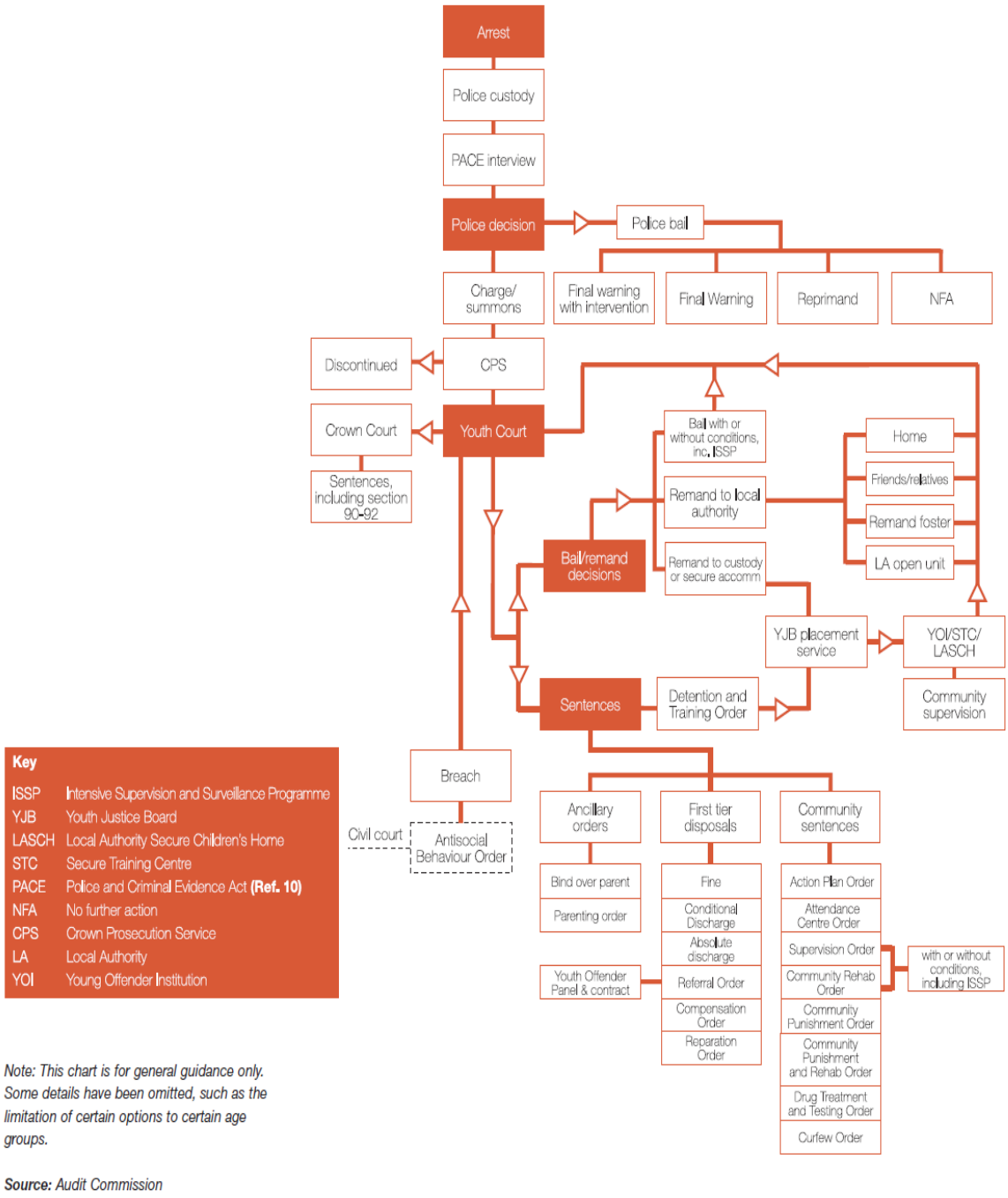

Figure A.1. A flow chart of the process through the youth justice system. Adapted from Audit Commission. (2004). Criminal Justice National Report: Audit Commission.

Appendix B - Youth Justice Board Offence Categories and Severity

Section 8: Annexes

CODE	CATEGORY	SCORE	'SERIOUS OFFENCE' (ISSP)
01	VIOLENCE AGAINST THE PERSON		
0101	**Abduction/Kidnapping**	7	
	Abduction of female by force		Serious
	Child abduction		
	False imprisonment		Serious
	Hijacking		Serious
	Kidnapping		Serious
0102	**Assault police officer (common assault)***	3	
	Assault with intent to resist arrest or assaulting a person assisting a police constable		
0103	**Common assault***	3	
	Assault & battery		
	Assault by beating		
0104	**Grievous Bodily Harm (wound or inflict)***	6	
0105	**Manslaughter***	8	Serious
	Child destruction, infanticide or manslaughter due to diminished responsibility		
0106	**Murder***	8	Serious
	Attempted murder		
0107	**Indictable firearms offences**	5	
	Possessing a real or imitation firearm at the time of committing or being arrested for an offence specified in Schedule 1 of the Firearms Act 1968		
	Possession of real or imitation firearms/explosives with intent to commit an indictable offence – including resisting arrest		Serious
	Possession of real or imitation firearms/explosives with intent to cause violence		
0108	**Other wounding***	4	
	Administering poison with intent to injure or annoy		
	Assault occasioning actual bodily harm (ABH)		
0109	**Possession of an offensive weapon**	3	
	Having an article with a blade or point in a public place		
0110	**Threatening, abusive or insulting words or behaviour**	3	
0111	**Threat or conspiracy to Murder**	5	Serious
	Soliciting to commit murder		
0112	**Wounding or other act endangering life***	7	
	Attempting to choke, suffocate with intent to commit an indictable offence (garrotting)		Serious
	Burning or maiming by explosion		
	Creating danger by causing anything to be on the road, or interfering with a vehicle or traffic equipment		
	Causing explosions or casting corrosive fluids with intent to do grievous bodily harm		Serious
	Endangering life or causing harm by administering poison		
	Endangering railway passengers (by placing anything on railway, taking up rails, changing points and signals or by throwing anything at railway carriages)		Serious
	Causing danger to road users (throwing stones etc.)		
	Possession of firearms with intent to endanger life or injure property		Serious
	Using chloroform to commit or assist in committing an indictable offence		Serious
	Using firearms or imitation firearms with intent to resist arrest		Serious
0113	**Wounding with intent to cause grievous bodily harm (section 18)***	7	Serious

CODE	CATEGORY	SCORE	'SERIOUS OFFENCE' (ISSP)
0114	Other/unspecified violence against the person	4	
02	SEXUAL OFFENCES		
0201	Buggery*	7	Serious
0202	Gross indecency with a child*	5	
0203	Incest*	7	
	Incest with a female under 13		Serious
	Inciting a girl under 16 to have incestuous sexual intercourse		
0204	Indecent Assault*	5	
0205	Indecent behaviour/exposure	4	
0206	Rape*	8	Serious
	Assault with intent to commit rape or buggery		
	Attempted rape		
	Conspiracy to rape		
0207	Unlawful sexual intercourse with female under 13*	4	Serious
0208	Unlawful sexual intercourse with female under 16*	3	
0209	Other/unspecified sexual offences*	5	
03	DEATH OR INJURY BY DANGEROUS DRIVING		
0301	Death by dangerous driving*	8	Serious
	Causing death by aggravated vehicle taking		
	Causing death by dangerous driving when under the influence of drink or drugs		
0302	Injury by dangerous driving*	5	
	Causing injury by aggravated vehicle taking		
	Causing injury by dangerous driving when under the influence of drink or drugs		
04	MOTORING OFFENCES		
0401	Dangerous Driving	5	
0402	Driving under the influence of drinks/drugs	3	
0403	Driving whilst disqualified	5	
0404	Interfering with a motor vehicle	3	
0405	Refusing to give breath test	4	
0406	Road traffic/Additional Offences	2	
	Driving without due care and attention		
	Driving on a footpath or/and common land		
	Driving defective motor vehicle		
	Exceeding speed limit		
	Failure to wear a seatbelt		
	Failure to comply with a road traffic sign		
	Failure to give particulars after an accident		

CODE	CATEGORY	SCORE	'SERIOUS OFFENCE' (ISSP)
	Failure to produce documents		
	Failure to report an accident		
	Failure to stop when requested by a constable		
	Failure to stop after an accident		
	Forge vehicle records/licence		
	No insurance		
	No L plates		
	No licence		
	No MOT		
	Not wearing protective headgear		
	Not well maintained indicators/stop/hazard and light reflectors		
	Pedal cycle offences		
0407	**Other/unspecified Motoring offences**	3	
05	**ROBBERY**		
0501	**Robbery***	6	**Serious**
	Assault with intent to rob		
	Conspiracy to rob		
06	**DOMESTIC BURGLARY**		
0601	**Aggravated burglary of a dwelling***	7	**Serious**
	Burglary with violence or threat of violence		
0602	**Burglary in a dwelling**	6	**Serious**
	Conspiracy to commit burglary of a dwelling		
0603	**Other/unspecified domestic burglary**	6	
07	**NON-DOMESTIC BURGLARY**		
0701	**Aggravated burglary of a non-dwelling***	7	**Serious**
	Burglary with violence or threat of violence		
0702	**Burglary in a non-dwelling**	4	
	Burglary with intent		
	Conspiracy to commit burglary of a non-dwelling		
0703	**Found on enclosed premises**	3	
0704	**Other/unspecified non-domestic burglary**	4	
08	**VEHICLE THEFT/UNAUTHORISED TAKING**		
0801	**Aggravated vehicle taking***	5	
	Injury to person, damage to property or car		
0802	**Being carried***	3	
	Being carried (aggravated)	4	
0803	**Vehicle taking**	4	
	Theft of motor vehicle		
	Unauthorised vehicle taking (TWOC/TADA)		
0804	**Other/unspecified vehicle theft/taking**	4	

CODE	CATEGORY	SCORE	'SERIOUS OFFENCE' (ISSP)
09	THEFT AND HANDLING STOLEN GOODS		
0901	**Handling stolen goods**	3	**Serious**
	Receiving stolen goods		
	Undertaking or assisting in the retention, removal, disposal or realisation of stolen goods, or arranging to do so		
0902	**Theft**	3	
	Extracting electricity		
	Making off without payment		
	Going equipped for stealing		
	Intent to steal		
0903	**Other/unspecified theft & handling**	3	
10	FRAUD AND FORGERY		
1001	**Forgery**	3	
	Forgery, or use, of false prescription		
1002	**Fraud**	3	
	Acting as a peddler without certificate		
	Counterfeiting		
	Conspiracy to defraud		
	Fraudulent use of documents		
	Obtaining pecuniary advantage by deception		
	Obtaining property by deception		
1003	**Public/private service vehicle and rail fare evasion**	1	
1004	**Other/unspecified fraud and forgery**	2	
11	ARSON		
1101	**Arson endangering life**	6	**Serious**
	Arson reckless as to whether life is in danger		
1102	**Arson not endangering life**	5	**Serious**
1103	**Other/unspecified arson**	5	
12	CRIMINAL DAMAGE		
1201	**Criminal damage endangering life**	6	**Serious**
1202	**Other Criminal Damage Over £2000**	3	
	Equipped with intent to commit criminal damage		
	Threat to commit criminal damage		
1203	**Other Criminal Damage Under £2000**	2	
	Equipped with intent to commit criminal damage		
	Threat to commit criminal damage		
1204	**Other/unspecified criminal damage**	3	
13	DRUGS		
1301	**Permitting use of premises for use of Class B or Class C drug**	3	**Serious**

CODE	CATEGORY	SCORE	'SERIOUS OFFENCE' (ISSP)
1302	**Possession – Class A drug**	3	
1303	**Possession – Class B drug**	2	
1304	**Possession – Class C drugs**	2	
1305	**Supply – Class A drug**	6	Serious
	Possessing a class A drug with intent to supply		
	Offering to supply a class A drug		
1306	**Supply – Class B drug**	4	Serious
	Possessing a class B drug with intent to supply		
	Offering to supply a class B drug		
1307	**Supply – Class C drug**	4	
	Cultivation of cannabis		Serious
	Possessing a class C drug with intent to supply		
	Offering to supply a class C drug		
1308	**Unlawful importation or exportation of a controlled drug**	5	Serious
1309	**Other/unspecified drug offence**	2	
14	PUBLIC ORDER		
1401	**Affray**	4	
1402	**Bomb Hoax**	5	
	Supplying false information about the presence of bombs		
	Dispatching articles to create a bomb hoax		
1403	**Breach of the Peace**	2	
	Behaviour likely to cause breach of the peace		
1404	**Drunk and Disorderly**	1	
1405	**Other Public Order Act offences**	2	
	Section 4 Public Order Act 1986 (fear or provocation of violence)		
	Section 4a Public Order Act 1986 (intentional harassment, alarm or distress)		
	Section 5 Public Order Act 1986 (harassment, alarm or distress)		
	Placing people in fear of violence		
1406	**Rioting**	6	
1407	**Violent disorder**	5	
1408	**Other/unspecified public order offence**	2	
15	OTHER		
1501	**Other specified offences**		
	Absconding from lawful custody	5	
	Air weapons offences	3	
	Blackmail	5	Serious
	Cruelty to animals or unlawful killing of animals	3	
	Firearms Act Offences (e.g. no firearm licence)	2	
	Interfering with witness/perverting justice	5	
	Obstruct police or fire service	3	
	Public nuisance (common law offence)	2	
	Resisting arrest	2	
	Sending indecent/offensive articles	4	
	Trespassing on a railway	2	

CODE	CATEGORY	SCORE	'SERIOUS OFFENCE' (ISSP)
1502	**Other minor offences**	1	
	Abusive language		
	Begging		
	Consuming alcohol under the age of 18 in a public place		
	Concealment of birth		
	Cycling in pedestrian area		
	Failure to make children attend school		
	Infuriating an animal (Section1 (1) (a) Protection of Animals Act 1911)		
	Inciting a child away from Local Authority care		
	Littering		
	Nuisance on educational premises		
	Urinating in a public place		
	Vagrancy		
	Making hoax/abusive or malicious telephone calls		
	Non-payment of financial penalty		
	Purchasing alcohol under the age of 18		
	Wasting police time		
1503	**Other/unspecified offence**	3	
16	RACIALLY AGGRAVATED		
1601	**Criminal damage – racially aggravated**	3	**Serious**
1602	**Other wounding – racially aggravated***	3	
	Actual bodily harm		
	Common assault		
	Intentional harassment alarm or distress		
	Putting people in fear of violence		
	Threatening, abusive or insulting words or behaviour		
1603	**Wounding or other act endangering life – racially aggravated***	6	**Serious**
	Wounding with intent to do grievous bodily harm		
1604	**Other/unspecified racially aggravated offence**	3	
17	BREACH OF CONDITIONAL DISCHARGE – this only applies where the breach has resulted in an additional substantive outcome. Where a young person has been re-sentenced, please refer back to the original offence for the seriousness.		
1701	**Breach of conditions of discharge**	1	
18	BREACH OF BAIL – this only applies where the breach has resulted in an additional substantive outcome. Where a young person has been re-sentenced, please refer back to the original offence for the seriousness.		
1801	**Breach of conditions of bail**	2	
19	BREACH OF STATUTORY ORDER – this only applies where the breach has resulted in an additional substantive outcome. Where a young person has been re-sentenced, please refer back to the original offence for the seriousness.		
1901	**Breach of Order or license conditions**	4	

Appendix C - BIS/BAS Scales

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being 'consistent' in your responses. Choose from the following four response options:

1 = very true for me
2 = somewhat true for me
3 = somewhat false for me
4 = very false for me

Please circle the appropriate number below each question.

---

1. A person's family is the most important thing in life.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

3. I go out of my way to get things I want.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

4. When I'm doing well at something I love to keep at it.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

5. I'm always willing to try something new if I think it will be fun.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

6. How I dress is important to me.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

7. When I get something I want, I feel excited and energized.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

8. Criticism or scolding hurts me quite a bit.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

9. When I want something I usually go all-out to get it.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

10. I will often do things for no other reason than that they might be fun.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

11. It’s hard for me to find the time to do things such as get a haircut.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

12. If I see a chance to get something I want I move on it right away.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

13. I feel pretty worried or upset when I think or know somebody is angry at me.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

14. When I see an opportunity for something I like I get excited right away.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

15. I often act on the spur of the moment.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

16. If I think something unpleasant is going to happen I usually get pretty 'worked up.'

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

17. I often wonder why people act the way they do.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

18. When good things happen to me, it affects me strongly.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

19. I feel worried when I think I have done poorly at something important.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

20. I crave excitement and new sensations.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

21. When I go after something I use a 'no holds barred' approach.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

22. I have very few fears compared to my friends.

1	2	3	4

Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

23. It would excite me to win a contest.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

24. I worry about making mistakes.

1	2	3	4
Very true for me	Somewhat true for me	Somewhat false for me	Very false for me

That is the end of the questionnaire
Thank you very much for your time.

Appendix D - Pearson's correlations between BIS/BAS, psychopathy and ASB in the young offenders and normal controls.

Table D.1 Pearson's intercorrelation matrix for BIS/BAS, psychopathy and antisocial behaviour measures for the young offenders only (n= 85)

	BAS Drive	BAS Fun	BAS Rew	BIS	YPI Grandiose	YPI Callousness	YPI Impulsive	YSR Conduct	Reactive Aggression	Proactive Aggression
BAS Drive	1	.664***	.551***	.105	.339**	.311**	.396***	.331**	.117	.083
BAS Fun		1	.556***	.159	.186	.156	.406***	.175	.148	-.069
BAS Reward			1	.496***	.196	-.063	.019	-.1123	.008	-.190
BIS				1	.083	-.249*	-.062	-.073	-.075	-.161
YPI Grandiose					1	.434***	.439***	.474***	.141	.436*
YPI Callous						1	.444***	.317**	.154	.441*
YPI Impulsive							1	.529***	.267	.424*
YSR Conduct								1	.431*	.769**
Reactive Aggression									1	.524**
Proactive Aggression										1

Notes: BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report ; * $p < .05$, ** $p < .01$, *** $p < .001$

Table D.2 Pearson's inter-correlation matrix for BIS/BAS scales, psychopathy and antisocial behaviour measures for the normal controls only (n= 50)

	BAS Drive	BAS Fun	BAS Rew	BIS	YPI Grandiose	YPI Callousness	YPI Impulsive	YSR Conduct	Reactive Aggression	Proactive Aggression
BAS Drive	1	.546***	.466**	.068	.254	.277	.341*	.294*	.365*	.368*
BAS Fun		1	.506***	.243	.179	.082	.415**	.076	.340	.328
BAS Reward			1	.373**	.106	.034	.118	-.055	-.110	-.030
BIS				1	-.326*	-.553***	-.249	-.228	.054	-.149
YPI Grandiose					1	.476***	.549***	.427**	.267	.432*
YPI Callous						1	.481***	.305*	.177	.259
YPI Impulsive							1	.507**	.502**	.556**
YSR Conduct								1	.374	.679***
Reactive Aggression									1	.620***
Proactive aggression										1

Notes: BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report ; * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix E - Screen Shot of the Win-Lose test windows

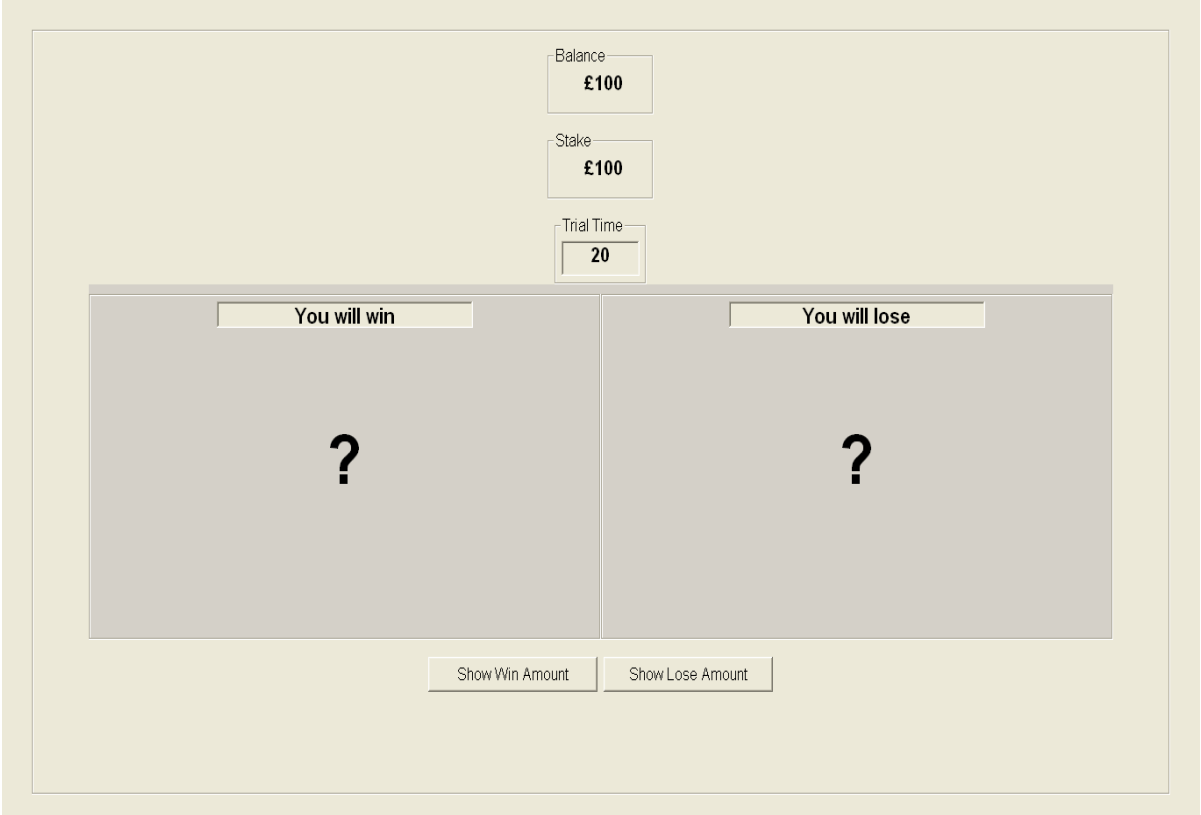

Figure E.1. Screen shot of the Win-Lose display screen.

Appendix F - Relationship between neuropsychological reward measures, psychopathy and antisocial behaviour measures.

Table F.1 Pearson's correlations between reward processing behavioural measures, psychopathy and antisocial behaviour in the young offender group.

	CPT	Win-Lose Click Freq	Win-Lose Win_Time
YPI Grandiose-Manipulative	-.060	-.030	-.129
YPI Callousness-Unemotional	-.047	.089	-.188
YPI Impulsive-Irresponsible	-.046	-.010	-.072
CD (YSR)	-.154	.047	-.138
Reactive Aggression (RPQ)	-.306	-.380	.169
Proactive Aggression (RPQ)	-.074	-.169	.150
Offence Rate	-.094	.075	-.009
Offence Severity[a]	.110	-.192	.034

Note: CPT = Card Playing Task; YPI = Youth Psychopathic traits Inventory; YSR = Youth Self Report; RPQ = Reactive Proactive Aggression Questionnaire; FAST = Fast Alcohol Screening Test

[a] Spearman's rho correlations conducted given ordinal nature of offence severity.

Appendix G- Relationship between the Card Playing Task, Win-Lose and Behavioural Inhibition System/Behavioural Activation System scales in Young Offenders and Normal Controls.

Table G.1 Pearson's correlations between reward neuropsychology measures and BIS/BAS scales in Young Offenders

	BAS Drive	BAS Fun	BAS Reward	BIS
CPT	-.223	-.100	-.071	.079
Win_time	.108	.057	.066	.200
Click Freq	.216	.028	-.106	-.249

Note: CPT = Card Playing Task; Win-Lose = Win-Lose Cardiff Gambling Test; Win_time = the time spent in win window divided by total time spent in both windows; Click Freq = Total frequency of clicks; BAS = Behavioural Activation System; BIS = Behavioural Inhibition System.

Table G.2 Pearson's correlations between reward neuropsychology measures and BIS/BAS scales in Normal Controls.

	BAS Drive	BAS Fun	BAS Reward	BIS
CPT	.309*	.350*	.184	-.205
Win_time	.443**	-.020	.181	-.243
Click Freq	-.040	.012	.272	.002

Note: CPT = Card Playing Task; Win-Lose = Win-Lose Cardiff Gambling Test; Win_time = the time spent in win window divided by total time spent in both windows; Click Freq = Total frequency of clicks; BAS = Behavioural Activation System; BIS = Behavioural Inhibition System.

** p = < .05 **p = < .01*

Appendix H - Reward conditioning visual stimuli

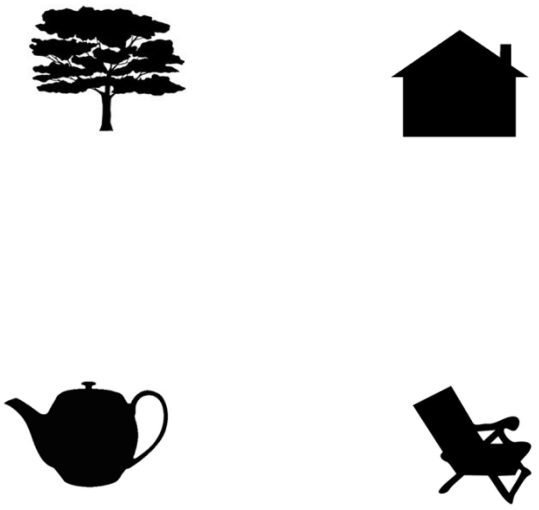

Figure H.1. Reward conditioning stimuli.

Appendix I - The reward coin box used in the reward conditioning paradigm.

Figure I.1. Photograph of the reward coin box used in the reward conditioning paradigm.

Appendix J – Psychophysiology Supplementary Analyses

5.4.4. Supplementary Analyses

Additional analyses were conducted in order to examine the relationship between the fear conditioning and reward conditioning paradigms and also to explore the relationship between psychophysiological measures and self-report measures and behavioural reward measures.

Fear Conditioning Responses

Using the transformed (SQRT+3) data, the values of the test blue slides for acqusition phases were collapsed (added) and the habituation phase was taken away (larger values indicate a larger increase in SC from habituation to acquision). The resulting value was termed Fear Response 1. For the young offender group; mean = 1.74; SD= 0.15 and for the normal control group; mean = 1.76; SD= 0.20 an independent samples t-test showed that this difference was not significant (t = -.548 , p = .586; d = 0.11) . In addition, the values for test blue slides and red slides were compared (red slide values substracted from blue slide values) during acquisition to examine the differential conditioning (larger values indicate a larger differential conditioning). The resulting value was termed Fear Response 2. For the young offender group; mean = 0.15; SD= 0.19 and for the normal control group; mean = 0.20; SD = 0.23. Again this difference was not significant (t = 1.10, p = .276; d = 0.24).

Reward Conditioning Responses

Similarly, using the transformed (SQRT+3) data the values of the test tree slides for acqusition phases were collapsed (added) and the habituation phase was taken away (larger values indicate a larger increase in SC from habituation to acquision). The resulting value was termed Reward Response 1. For the young offender group; mean = 1.80; SD = 0.26 and

for the normal control group; mean = 1.78; SD = 0.20 an independent samples t-test showed that this difference was not significant (t = .401, p = .690; d = 0.09).

In addition, the values for test tree slides and house slides were compared (house slide values substracted from tree slide values) during acquisition to examine the differential conditioning (larger values indicate a larger differentiation). The resulting value was termed Reward Response 2. For the young offender group; mean = .09; SD = 0.23 and for the normal control group; mean = .06; SD = 0.15. An independent samples t-test showed that this difference was not significant (t = .579, p =.565; d = 0.16).

Spearman's rho correlations were used to compare the the fear conditioning and reward conditioning responses with the self-report BAS scales of the BIS/BAS questionnaire, the Card Playing Test (number of cards played) and the Win-Lose (Win-time) variables in both the young offender and normal sample. We also analysed the relationship between the reward conditioning and fear conditioning values. In the young offender sample, the results indicated that Fear Conditioning Response 1 (the increase in SCR from habituation to acquisition for test blue slides) was positively associated with Reward Conditioning Response 2 (the differentiation between test tree slides and house slides at acquisition) (r_s = .389, p = .049). In the control group there was no association between the fear conditioning and reward conditioning responses.

In relation to other self-report and behavioural measures, the results indicated that in the young offender group Fear Conditioning Response 1 was negatively associated with YPI impulsive-irresponsibility (r_s = -.468 , p = .016). However, in the normal control group, Fear Response 1 was positively associated with YPI impulsive-irresponsibility (r_s = .375, p = .034). In addition, Fear Response 2 (the differentiation between test blue slide values and red slides at acquisition) was negatively assocated with the number of cards played on the Card Playing Task (r_s = -.464, p = .009). There were no other significant correlations.

Table J.1. Spearman's correlations between fear conditioning, reward conditioning and self-report and behavioural reward prcoessing measures in young offenders.

	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*
1.FC response 1		*.434**	*.114*	*.389**	*-.046*	*-.018*	*.247*	*-.286*	*-.115*	*-.288*	*-.090*	*-.468**
2.FC response 2			*-.138*	*.282*	*-.176*	*-.127*	*.135*	*-.319*	*.241*	*.020*	*-.126*	*-.224*
3.RC response1				*.663**	*.051*	*-.068*	*-.231*	*-.168*	*.227*	*-.236*	*-.040*	*.071*
4.RC response 2					*-.137*	*-.048*	*-.340*	*-.016*	*.348*	*-.274*	*-.125*	*-.098*
5.BAS Drive						*.640***	*.583***	*-.227*	*.140*	*.396***	*.263*	*.330**
6.BAS Fun							*.636***	*-.200*	*.078*	*.164*	*.080*	*.272*
7.BAS Reward								*-.169*	*.013*	*.234*	*.053*	*-.020*
8.CPT									*-.040*	*-.100*	*.041*	*-.049*
9.Win-Time										*.081*	*.032*	*.054*
10.YPI Grandiose											*.526***	*.507***
11.YPI Callous												*.402***
12.YPI Impulsive												

Note: FC = Fear conditioning; RC = Reward conditioning; BAS = Behavioural activation system; CPT = Card Playing Task, number of cards played; Win-Time = Win-Lose time spent in win window divided by the total time spent; YPI = Youth Psychopathic traits Inventory;

* $p < .05$

** $p < .001$

Table J.2. Spearman's correlations between fear conditioning, reward conditioning and self-report and behavioural reward prcoessing measures in normal controls.

	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*
1.FC response 1		*.411**	*-.269*	*.095*	*.042*	*.237*	*-.253*	*-.123*	*-.339*	*.269*	*.096*	*.375**
2.FC response 2			*-.265*	*-.021*	*.088*	*.191*	*-.059*	*-.464***	*-.135*	*-.020*	*-.102*	*.114*
3.RC response1				*.235*	*.111*	*.159*	*.022*	*.067*	*.148*	*-.094*	*-.067*	*.193*
4.RC response 2					*-.002*	*-.156*	*-.213*	*-.312*	*-.176*	*.042*	*-.274*	*.010*
5.BAS Drive						*.566***	*.420***	*.242*	*.370**	*.176*	*.248*	*.424***
6.BAS Fun							*.516***	*.183*	*.022*	*.115*	*-.128*	*.512***
7.BAS Reward								*.122*	*.123*	*.049*	*.052*	*.151*
8.CPT									*.283*	*.153*	*.179*	*.235*
9. Win Time										*-.164*	*.035*	*.177*
10.YPI Grandiose											*.437***	*.444***
11.YPI Callous												*.337**
12.YPI impulsive												

Note: FC = Fear conditioning; RC = Reward conditioning; BAS = Behavioural activation system; CPT = Card Playing Task, number of cards played; Win-Time = Win-Lose time spent in win window divided by the total time spent; YPI = Youth Psychopathic traits Inventory;

* $p < .05$ ** $p < .001$