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Screening for Autism Spectrum Disorders and an Examination of Social Cognition in Prisoners

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MEDICINE MD

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DECLARATION

I declare that I composed this thesis.

I have made a substantial contribution to this work, and this work has been clearly indicated in the text.

The work has not been submitted for any other degree or professional qualification.

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Abstract

Prisoners have high rates of physical and mental morbidity and of re-offending. There have been concerns that autism spectrum disorders (ASDs) may be over-represented and under-diagnosed in this population.

The aims of this study were to examine the effectiveness of an instrument which was developed to screen for ASDs in prisons and to establish whether male Scottish prisoners differ from community controls with respect to facial emotion recognition, as measured by behavioural testing, and differ on a neural basis while performing complex social judgements, as measured using functional magnetic resonance imaging (fMRI). A total of 2458 prisoners (approximately 40% of the convicted prison population) were examined using the screening tool, of whom a further 127 were interviewed in depth and were assessed for facial emotion recognition ability. FMRI was used to examine haemodynamic changes in a small sample of liberated prisoners (9) during a social judgement (approachability) versus control (gender judgments) task.

The screening tool had poor sensitivity (28.6%) and specificity (75.6%) and was not effective or useful in screening for ASDs in this population. Significant deficits in negative facial emotion recognition were found in the prisoner group in comparison with age- and sex-matched community controls. Region of interest analysis of fMRI data in the bilateral amygdala revealed significantly greater activation in the left amygdala in ex-prisoners versus controls during the social judgement task. The identification of these abnormalities in facial emotion recognition and social judgement are in keeping with current literature on antisocial populations. They may offer the opportunity for development of interventions aimed at reducing re-offending in the future.

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1. Introduction

This thesis focuses upon an examination of prisoners in Scotland. Their study can be challenging, in part because prisons do not easily lend themselves to research, being crowded and with frequent movement of prisoners. However, prisoners have high rates of physical and mental morbidity, substance misuse and social problems, and high re-offending rates (Prison Reform Trust, 2014). A greater understanding of this group is required to reduce morbidity and offending rates, improving quality of life for prisoners and society.

This research took place within a research team at the University of Edinburgh. My personal contribution to this work will be indicated throughout.

Research Questions

The aim of this research was to address the following questions:

1. Is a tool that has been designed to screen for autism spectrum disorder effective in the Scottish prison population and should it be used?
2. Do Scottish prisoners differ from community controls with respect to facial emotion recognition, as measured by behavioural testing?
3. Do Scottish prisoners differ from community controls in neural activation during a complex social judgement task, as measured by fMRI?

Structure of the thesis

There have been concerns, particularly by charities and relatives' groups, that autism spectrum disorders (ASDs) may be over-represented in prison populations. There have also been concerns that such individuals are often undiagnosed in this environment (Browning and Caulfield, 2011). This has led to the development of a brief screening instrument designed to identify individuals in prisons who are likely to have an ASD. This thesis will introduce this subject area, including the relevant

literature, and a study evaluating the screen in a sample of Scottish prisoners. The study will be described. Results of the study and their implications will then be discussed.

We already know that antisocial groups such as prisoners differ from control groups on biological measures. Differences in brain function have been demonstrated behaviourally and using imaging techniques such as functional magnetic resonance imaging (fMRI)(Yang and Raine, 2009a). Although a causal link with offending has not been demonstrated, some biological differences have been shown at a young, pre-offending age (Gao et al., 2010).

Studies of biological differences in antisocial groups are not always easy to interpret. The majority have focused upon psychopaths, a small subgroup of antisocial individuals. Others have considered groups defined by antisocial personality disorder, or groups defined by antisocial behaviour, such as prisoners. It is difficult to apply findings from studies of psychopaths to the Scottish prison population, where psychopathy is relatively rare (Cooke and Michie, 1999). However, an understanding of any such differences could have significant implications in understanding and treating the basis of offending.

‘Social cognition’ refers to ‘processing that is elicited by, about, and directed towards other people’ (Kennedy and Adolphs, 2012). The ASD screening study allowed the examination of one type of social cognition in Scottish prisoners, recognition of facial emotional expressions. There is existing research to show that this is impaired in antisocial groups (Marsh and Blair, 2008), and it has been hypothesised that such dysfunction relates to antisocial and violent behaviour (Blair, 2010a). Social cognition in offenders and the rationale for studies in this area will be introduced. A literature review in the area of facial emotional recognition in antisocial groups will be described. An account of a study using facial emotion data from prisoners will follow, and the results discussed.

Brain imaging techniques can be used to examine neural correlates of social judgement. Background to this subject will be described, including a literature review of functional imaging studies of emotional tasks in antisocial groups. A study using functional imaging techniques to assess liberated prisoners while performing a social judgement task will be introduced and described. Results will be presented and discussed. The implications of the facial emotion recognition study and the neuroimaging study will be considered.

Final conclusions will then be drawn.

2.1 Autism Spectrum Disorders

Introduction and Review of the Literature

Autism spectrum disorders (ASDs) are neuro-developmental disorders that form part of a group of lifelong conditions known as pervasive developmental disorders. ASDs are all characterised by deficits in three areas (the ‘triad of impairments’), social interaction, communication, and imagination, and associated with narrow, repetitive activities and interests (Wing and Gould, 1979).

The term ‘autistic’ was coined by Bleuler in 1911 to describe self-centred and isolated thought processes in schizophrenia (in McGlashan (2011)). However, ‘early infantile autism’ was first described by Kanner (Kanner, 1943). He documented a syndrome of ‘inborn autistic disturbances of affective contact’ which he differentiated from childhood schizophrenia. Key features of these children were an inability to relate themselves to others, abnormal (non-communicative) language, repetitive behaviour, an ‘obsessive desire for the preservation of sameness’, and ‘good cognitive potentialities’.

A further syndrome, ‘autistic psychopathy of childhood’, conceived of as a disorder of personality, was described by Asperger (Asperger, 1944). Although some cases were similar to those of Kanner, others showed more well-developed language and intelligence while showing abnormal behaviour and communication (Pearce, 2005). Asperger’s work did not reach a great deal of the scientific community until Wing broadened the diagnostic scope of autism, describing Asperger’s syndrome (Wing, 1981) in children who had normally developed language and grammar and were socially interested in others. Wing also introduced here the concept of a continuum of severity of impairment, giving rise to the construct of an autism spectrum. Wing and Gould described the clustering of a triad of impairments - abnormal social interaction, abnormal social communication, and abnormal social imagination with repetitive activities replacing imaginative activities - in 1979 (Wing and Gould, 1979). However, Wing considers that the main impairment in ASDs is the loss of ‘social instinct’ (Wing et al., 2011).

Classification

Both international classifications, International Classification of Diseases (ICD) and DSM (Diagnostic and Statistical Manual of Mental Disorders), include autism-related disorders (American Psychiatric Association, 2013b, WHO, 1992). They both require more than one specific area of impairment for diagnosis. ICD-10 includes impairments in three areas- social interaction, abnormalities in communication, and restricted, repetitive patterns of behaviour, while DSM-5 describes two domains, social communication and interaction and restrictive repetitive patterns of behaviour. ICD-10 classifies the ‘pervasive developmental disorders’ as disorders of psychological development. They include childhood autism (age of onset earlier than three years, deficits in all three areas), atypical autism (differs in age of onset or doesn’t meet all criteria), Asperger syndrome (no cognitive deficit and no language delay, deficits in three areas), and Pervasive Developmental Disorder- Unspecified (WHO, 1992).

DSM made changes to its criteria in the recent fifth edition in order to reflect research and current understanding of these disorders (American Psychiatric Association, 2013a). The terms ‘Autistic Disorder’, ‘Asperger Disorder’, and ‘Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS)’ were replaced by ‘autism spectrum disorder’. Current severity (Levels 1-3), and accompanying intellectual or language impairment are also specified. Age of onset must be from early childhood, although diagnosis is not required at this age, and symptoms must cause clinically significant impairment in functioning (American Psychiatric Association, 2013b).

ICD-10 uses a categorical system with cut-offs between those with and without autism related conditions, while DSM-5 considers autism in a more dimensional manner. Both classifications use functional impairment to define that a disorder is present. However, autistic traits may be found in the less-impaired population, and are particularly likely to be found in those in affected families who have increased genetic liability. This has been described as the ‘broader autism phenotype’ (Losh and Piven, 2007).

As a group, therefore, ASDs are behaviourally heterogeneous. The sub-categories are based on behaviour alone and it is not clear that these distinctions are particularly meaningful or reliable (Rutter, 2011, Lord et al., 2012).

Clinical associations

ASDs were initially found to be strongly associated with intellectual disability. In one study 75% of individuals with autism showed such impairment (Baird et al., 2003). However, this has changed with increasing diagnosis of non-cognitively impaired individuals with ASD. While estimates vary, many suggest that fewer than 50% of cases are associated with intellectual disability (Chakrabarti and Fombonne, 2005). IQ is lowest for those falling within narrow definitions of childhood autism (Baird et al., 2006).

ASDs, particularly autistic disorder, show a clear association with particular medical conditions, for example tuberous sclerosis and Fragile X. Estimates vary but these known medical conditions account for approximately 10% of ASDs (Fombonne, 2003). Such a known organic cause does not exclude a diagnosis of ASD, as it would in other mental disorders such as schizophrenia.

Epilepsy is particularly over-represented in ASD, present in approximately one fifth of those with autistic disorder (Volkmar and Nelson, 1990). Epileptiform EEG activity has been found in up to 60% of cases (Spence and Schneider, 2009). Developmental regression and savant skills (isolated talents in particular domains, found in approximately a third of cases) are particularly associated with autism, although the causes are unknown (Rutter, 2011, Howlin et al., 2009).

Individuals with ASDs show deficits in social cognition (Baron-Cohen et al., 1999). Social cognition can be defined as brain *processing that is elicited by, about, and directed towards other people* (Kennedy and Adolphs, 2012). In particular they have been shown to be impaired in inferring and understanding the mental state of others, known as theory of mind (Baron-Cohen et al., 1985). They also show particular cognitive deficits. These include deficits in executive function (Ozonoff and Jensen,

1999), and weak central coherence, which is a focus on detail at the expense of meaning (Happé and Frith, 2006). Psychiatric co-morbidity is common in individuals with ASD, particularly ADHD and mood disorders (Abdallah et al., 2011a).

Diagnosis

Diagnosis of ASDs is important in order to allow access to services, support for carers and diagnosis of co-morbidities. Diagnosis is clinical and solely based upon behaviour and developmental patterns. It requires a developmental history, direct observation and exclusion of differential diagnoses. Medical investigations for any underlying cause and assessment of co-morbidity are required (Levy et al., 2009).

Diagnostic instruments have been developed for research studies and are often used to aid diagnosis although they are not required for this (Le Couteur, 2011, Scottish Intercollegiate Guidelines Network, 2007). Instruments helping to structure developmental histories taken from carers include the Autism Diagnostic Instrument-Revised (ADI-R) (Lord et al., 1994), which takes 2-3 hours to complete (Le Couteur, 2011) and is applicable in the diagnosis of autistic disorder only. The Diagnostic Interview for Social and Communication Disorders (DISCO) (Wing et al., 2002) is based upon carer interview. This takes around three hours to complete and requires specialist training (Le Couteur, 2011). The Developmental Diagnostic and Dimensional Interview (3di) (Skuse et al., 2004), for children only, requires training and is computerised, lasting around an hour and a half. The Asperger Syndrome (and High Functioning Autism) Diagnostic Interview (Gillberg et al., 2001) is more brief and is also completed with a carer. Observation-based instruments include the Autism Diagnostic Observer Schedule – Generic (ADOS-G) (Lord et al., 2000) which is also lengthy and requires specialist training.

Evidence based diagnostic guidelines have been produced. These have previously focused mainly upon children and young people, for example the Scottish Inter-Collegiate (SIGN) Guideline 2007 applies to children up to the age of 18 (Scottish Intercollegiate Guidelines Network, 2007) and the National Institute for Health and Care Excellence (NICE) Guideline (NICE, 2011) includes those up to the age of 19.

SIGN recommend use of international diagnostic criteria and multidisciplinary assessments focusing upon developmental history and observation of behaviour. Both sets of guidelines stress the importance of early diagnosis for access to services and support for carers.

The National Institute for Health and Care Excellence has also published guidelines regarding diagnosis in adults (NICE, 2012). After a review of 22 assessment instruments designed to support diagnosis no one tool was recommended for routine use, but several were recommended as possibly useful. These included the ADI-R, ASDI, and ADOS-G. Overall these guidelines recommend comprehensive assessment, history and observation, and suggest that use of a structured tool should be considered. Parents often have concerns about their children for a long period before a formal diagnosis is made. In autistic disorder, there are, on average, parental concerns at around 18 months while mean age at diagnosis is approximately three years. Parental concerns begin, on average, at 30 months for Asperger's Syndrome, with mean age of diagnosis at 11 (Howlin and Asgharian, 1999). Asperger's in particular may not be recognised in childhood, and in adulthood such individuals in the community are often socially disadvantaged and undiagnosed (Brugha et al., 2011a). Adults with autism in general appear to welcome diagnosis as providing access to services and understanding of difficulties, while a lack of diagnosis in adulthood can mean that appropriate care is not provided and co-morbidities not managed (NICE, 2012).

Although there is concern about under-recognition of ASD, particularly in adults (NICE, 2012), general population screening for ASDs is not recommended for adults or children (NICE, 2012, Scottish Intercollegiate Guidelines Network, 2007). However, a number of instruments have been developed for the purpose of identifying individuals likely to have an ASD once concern has been raised about them. Those identified in a review by NICE (NICE, 2012) were:

- the Autism-Spectrum Quotient (AQ) (Baron-Cohen et al., 2001), a self-report tool for identification of high functioning autism/Asperger's, of which there are several versions;
- the Social Communication Questionnaire (SCQ) (Rutter et al., 2003) a parental-report tool based on the ADI-R and specific to autistic disorder only;
- the Autism Behavioural Checklist (ABC) (Krug et al., 1980) an informant-based tool which can identify cases across the whole spectrum;
- the Pervasive Developmental Disorder in Mental Retardation Scale (PDD-MRS) (Kraijer and de Bildt, 2005) for those with learning disability.

NICE recommends the use of the AQ to support referrals to specialist assessment in adults without learning disability (NICE, 2012).

Aetiology

Historically, ASDs have been attributed to differing environmental causes. Bettelheim's 1967 model of cold and distant maternal parenting style ('refrigerator mothers') was influential for a period although it is no longer considered applicable (Baker, 2010). A theory implicating the MMR (Measles, Mumps and Rubella) vaccine (Wakefield et al., 1998) was influential for a period before being discredited.

ASDs have been known to have a strong genetic component for decades (Folstein and Rutter, 1977). However, although there are associations between particular genetic abnormalities and ASD, there is no universal autism 'gene' and the genetic abnormalities found are also associated with other mental disorders (Murphy et al., 2011, Guilmatre et al., 2009). A genetic diagnosis is not therefore possible. There is some evidence for a role of early environmental risk factors (Gardener et al., 2011) and evidence that raised paternal age is a risk factor (Cantor et al., 2007).

Overall it appears likely that ASDs are aetiologically heterogeneous, with contributions from many abnormal genes and environmental factors resulting in a 'final common phenotype' (Geschwind, 2011).

Epidemiology

Estimates of prevalence have increased since the 1960s, when autism was considered to be a rare condition. A 1966 study found a prevalence of 4.5 per 10,000 children (Lotter, 1966) while more recent studies report higher rates. A UK study found that 116.1 per 10,000 children had ASDs, and that the prevalence of childhood autism was 38.9 per 10,000 (Baird et al., 2006).

This increase in estimates of prevalence may reflect a trend in identifying more cases, inclusion of the broader spectrum of disorders, pressure for diagnosis in order to access specialist services and resources, or may reflect a true increase in rates of the disorder (Levy et al., 2009). A community study in adults in England estimated ASD prevalence at 9.8 per thousand (Brugha et al., 2011b), which is approximately one per cent. This is similar to prevalence estimates in children and suggests that broader diagnostic criteria are responsible for the upward trend in measured prevalence rather than a true increase in cases. More males are diagnosed with ASDs than females. An average ratio of males to females of 4.2:1 across all ASDs was found in an international meta-analysis (Fombonne, 2009).

An increase in people seeking diagnosis has reflected increased awareness of ASD. A national assessment service for adults with ASD reported that the number of people seen increased by approximately 5 times between 2005 and 2010. Despite prior screening by primary care and psychiatry, a large proportion of this group were found not to have an ASD (Murphy et al., 2011).

Neuroimaging

Research in ASD neuroimaging has been limited by methodological shortcomings. The most important issue is the heterogeneity of the subjects used. Subjects are recruited from across the diagnostic spectrum, with differing co-morbidities and levels of cognitive impairment. This increases the likelihood of differing aetiology and brain differences within samples. This difficulty is particularly marked in the field of autism, where classifications don't exclude underlying medical conditions. For example, definitions of schizophrenia, both traditional and operational, exclude

organic causes. As this is not the case in ASDs, such cases are more likely to be associated with particular brain differences.

Where subjects are not matched for IQ, studies are likely to find differences relating to IQ (Spencer et al., 2005). In addition, epilepsy, commoner in cognitively impaired groups within ASD, is associated with imaging abnormalities itself (Spencer et al., 2011). The use of standardised instruments reduces the problem of heterogeneity somewhat, but even here a variety of instruments are used. In practice, most subjects in imaging studies of ASD are non-learning disabled and male, and findings are not necessarily applicable to other groups (Spencer et al., 2011, Philip et al., 2012). Age matching is also important, particularly in children due to age-related changes even in healthy developing brains (Giedd et al., 2009).

Results of brain imaging studies in the ASDs are overall heterogeneous, and are not useful at present in diagnosis or differentiating between sub-categories (Anagnostou and Taylor, 2011). However, there is evidence of brain overgrowth early in childhood and a later reduction in growth rate (Courchesne et al., 2011). There is some evidence of abnormalities in the ‘social brain’ (amygdala, fusiform facial area, superior temporal sulcus, orbitofrontal cortex) (Spencer et al., 2011). There is also evidence from structural and functional imaging of abnormal connectivity across brain regions and types of task (Spencer et al., 2011, Philip et al., 2012), including fMRI tasks of social cognition (Di Martino et al., 2009).

Management

ASDs are lifelong conditions and there is no ‘cure’. Early identification is important so that access to appropriate services is available and carers are supported. All staff working with adults with autism should offer support and care and be educated about autism and the effects of the environment on them, particularly personal space, visual supports, lighting and noise – due to hyper and hypo-sensory sensitivities which can occur in autism (NICE, 2012).

Effective interventions for ASD in adults are psycho-social in nature. These include social learning programmes for those with problems in social interaction (NICE, 2012). NICE recommend anger management interventions where adults have problems with anger and aggression, and anti-victimisation interventions for adults at risk of victimisation. Employment support is also recommended where appropriate. There is no strong evidence base for any biomedical treatment for autism. Any co-morbid conditions should be managed as they would be in any other individual. (NICE, 2012).

ASD and forensic populations

Where offending occurs, it is likely to be in individuals with autism who have a mild learning disability or no learning disability. Although autism can be associated with challenging behaviour in those who also have a moderate to severe learning disability, such individuals are less likely than others to come into contact with the criminal justice system (Lyall et al., 1995). There is evidence that suggesting within the learning disability population those with ASD may be less likely to be prosecuted than others (Esan et al., 2015), but it has also been speculated that individuals with ASD be more likely to receive a prison sentence (Archer and Hurley, 2013).

ASD and offending

Lorna Wing described "bizarre anti-social acts" in 4 out of 34 cases of Asperger's Syndrome, and ascribed them to lack of empathy (Wing, 1981). Following this, a series of case studies were published which suggested both increased risk of offending in individuals with ASDs and that core features of ASDs may be relevant where offending occurs. These features included a lack of awareness of the effect of behaviour on others due to poor theory of mind (Baron-Cohen, 1988), inability to recognise social cues (Murrie et al., 2002, Haskins and Silva, 2006), pursuit of particular interests, for example an interest in fire relating to arson (Barry-Walsh and Mullen, 2004); concern only with one's own preoccupations (Murrie et al., 2002); response to distressing sounds (Mawson et al., 1985), and well as vulnerability to being exploited by others due to lack of social understanding.

Despite these case reports, there is no evidence that in general individuals with ASDs are more likely to offend than those without (Mouridsen, 2012). In fact, it has been suggested that they are at lower risk of offending than the rest of the population. A UK community study, although not a prevalence study, found lower rates of offending in individuals with a diagnosis of ASD than in a comparison group (Woodbury-Smith et al., 2006).

When offending does occur in ASD it appears to be associated with particular types of offending including stalking (Stokes et al., 2004) and fire-setting (Mouridsen et al., 2008). Risk factors for offending in ASD include a diagnosis of Asperger's syndrome in particular, being male, substance misuse and psychosis (Langstrom et al., 2009).

Prevalence in forensic populations

There has been little research into ASDs in the criminal justice system. An examination of referrals of young offenders for forensic psychiatric assessment in Stockholm found that 3% met criteria for Asperger's Syndrome and 12% for PDD-NOS (Siponmaa et al., 2001). This level is higher than that of the general population, but this was a sample about which there were psychiatric concerns and is unlikely to have been representative of young offenders.

Individuals with ASD are, however, found in excess in high-security psychiatric settings in the UK (Scragg and Shah, 1994, Hare et al., 1999, Crocombe et al., 2006). The point prevalence of Asperger's Syndrome in the male population of Broadmoor, a special hospital, was found to be 1.5% (2.3% including borderline cases) (Scragg and Shah, 1994). Using the same criteria, Ehlers and Gillberg had found a prevalence in children of 0.55-0.64% in 1993, although it should be noted that this is below current estimates of prevalence (Ehlers and Gillberg, 1993). A study in the three high-secure (then described as 'special') hospitals in England (Hare et al., 1999) found a rate of 2.4% for ASDs, and an unpublished study of a female high-secure population found a rate of 11% (Crocombe et al., 2006).

There have been few studies in prisons. A study asking staff in the Scottish Prison Service about cases of ASDs of which they were aware yielded 19 people with an established diagnosis of learning disability and/or ASDs across 16 prisons (Myers, 2004). This did not take into account undiagnosed cases or those where the diagnosis was not known to staff, and was not intended as a measure of prevalence.

ASD in prisons

The relatively high levels of ASDs found in high-security psychiatric settings have led to concerns that individuals with ASDs are not being recognised in the criminal justice system (Browning and Caulfield, 2011). Without such recognition, it may be difficult to make sense of their offence and assess criminal responsibility in order to allow an appropriate defence. While in prison these individuals may be particularly vulnerable to bullying or exploitation (Allen et al., 2008). They are at increased risk of psychiatric co-morbidity, particularly ADHD and mood disorders (Hofvander et al., 2009, Abdallah et al., 2011b). In addition, they may present management problems as a consequence of poor social and communication skills. Their early identification in prison would allow appropriate care to be provided and risk of future offending to be more effectively assessed and managed.

These concerns led groups including relatives' support networks and autism charities, such as Research Autism, to become interested in the issue of individuals with ASD in prisons. In particular, there was an interest in numbers of individuals affected and the range of difficulties and impairments they might experience.

Scottish Prisons

At the time of this study, the Scottish Prison Service had 13 publicly-run and two privately-run prisons. There were two Young Offenders Institutions (HMYOI Polmont and HMYOI Cornton Vale). Women were held in several of the prisons following overcrowding at the previous women's prison, HMP Cornton Vale. There was one maximum security prison. Sex offenders were held at HMP Peterhead and HMP Dumfries. The prison estate has since increased, and young and female

offenders are now also provided for in the new HMP and YOI Grampian. HMP Peterhead has now closed.

The Scottish prison population in August 2014 was 7828, of whom 1350 were on remand and 438 were women (Scottish PrisonService, 2014), while in England the total prison population was 85,401 (Ministry of Justice, 2014). There has been an upward trend in the size of the Scottish prison population since 1980, and this reached a peak in 2012 at 8178 (The Scottish Government, 2012a). The rate of imprisonment in Scotland is 146 per 100,000 population, having reached a peak at 150 per 100,000 in 2012. It is comparable to the rate in England and Wales of 149 per 100,000 and of Northern Ireland 101 per 100, 000 (International Centre for Prison Studies, 2014). These figures contrast with international figures such as 707 per 100,000 in the USA and 81 per 100,000 in France.

Management of healthcare in Scottish prisons transferred to the NHS in November 2011. Forensic psychiatric staff work closely with the prison services, and the Mental Health (Care and Treatment) (Scotland) Act (2003) and Criminal Procedure (Scotland) Act (1995) allow the assessment and treatment of mentally-disordered offenders throughout the Criminal Justice System.

Prevalence of mental disorders in prisons

Prison populations have high rates of psychiatric morbidity, suicide and self harm (Fazel and Baillargeon, 2011, Fazel and Danesh, 2002). An international systematic review of mental disorder in prisons suggested that prevalence of psychosis was 4%, major depression 10-12%, and personality disorder 40-70%. Substance abuse and dependence are also common, and screening for such disorders on admission has been recommended (Fazel et al., 2006). Studies carried out in the 1990s estimated rates of psychosis at 7% in male convicted prisoners in England and Wales and 10% in the male remand population. Forty (sentenced) to 59% (remand) of male prisoners were estimated to have a neurotic disorder, while 63% (sentenced) and 76% (remand) of women prisoners were estimated to have neurotic disorders. Sixty three per cent of remand and 58% of sentenced male prisoners were estimated to have alcohol abuse

problems (Singleton et al., 1998). This was lower in women prisoners, where the rate of alcohol abuse problems was estimated as 36% in remand and 39% in sentenced prisoners.

A more recent study of psychosis in prisons in England and Wales found rates of 52 per thousand in comparison with a community rate of 4.5 per thousand (Brugha et al., 2005). A study in the remand population of Scottish prisons found somewhat lower rates of 2.3% of psychosis, 24.8% for neurotic disorder, 22% for alcohol abuse or dependence, and 73% for drug abuse or dependence (Davidson et al., 1995). Such high rates of mental disorders in prisons may reflect an association between mental disorder and crime, a lack of psychiatric provision in the community, poor identification and diversion of mental disorder in the criminal justice system (Fazel and Baillargeon, 2011) or an association between offending and a higher risk of being caught for criminal behaviour. The reason for the particularly high morbidity of the remand population is not known. The apparent lower prevalence of mental disorders in Scottish prisoners is thought to be a result of greater diversion from the prison system in Scotland (Fraser et al., 2007).

All prisoners are briefly assessed for mental and physical disorder on reception into prison. Screening tools for severe mental illness have been used in prisons (Birmingham and Mullee, 2005) and magistrates' courts (Shaw et al., 2003) but are not currently in use in Scotland.

ASD diagnosis in prisons

Diagnosis of ASDs usually requires a neurodevelopmental history and a clinical assessment. Obtaining a neurodevelopmental history is difficult in these adults, many of whom were brought up in the care system or have no contact with their family. No screening tool has been used in prisons.

Screening for ASDs

Screening is a process carried out in order to identify individuals with a particular condition who are asymptomatic or whose symptoms are not recognised (Wilson and

Jungner, 1968). It is not a diagnostic process and those with a positive test should be referred for further assessment. Traditionally the aim of screening is early detection and cure of disease while reducing resources such as the time of highly-trained staff (Wilson and Jungner, 1968).

Screening tools must be assessed before they can be used. 'Validity' is a measure of the frequency with which the result of the screening test is confirmed by a diagnostic procedure, which is usually the 'gold standard' diagnostic investigation (Wilson and Jungner, 1968). It is a measure of the ability of the test to separate those who have the condition sought from those who do not. A screening test can be described as valid if 'it detects most people with the target disorder (high sensitivity) and excludes most people without the disorder (high specificity), and if a positive test usually indicates that the disorder is present (high positive predictive value)' (Greenhalgh, 1997).

The use of a screening tool leads to four categories of results. These are true positives and negatives, and false positive and negatives. The ideal test would identify all true positives and not identify any negatives as positives. This is measured by sensitivity (ability to classify those with the condition as positive) and specificity (ability to classify those without the condition as negative). Sensitivity measures false negatives and specificity false positives. Sensitivity and specificity will co-vary depending upon the cut-off level set on the test (Wilson and Jungner, 1968). Receiver operating characteristic curves (ROC Curves) are used to demonstrate the pattern of sensitivities and specificities at different diagnostic cut-offs.

Reliability of both the method and the tester are also important in the use of a screening tool. In addition, the yield, which is the amount of previously unrecognised disease identified by the test (Wilson and Jungner, 1968), relates to prevalence in the population and current levels of diagnosis. It is highest in prevalent, poorly-diagnosed conditions.

Other outcomes of testing are also important. With respect to test results, the emotional and social impact on the person must be considered as well as the clinical management. False positive results can lead to unnecessary treatment and distress, while false negatives reassure inappropriately and lead to missed diagnoses. The impact of the test itself, including financial cost and physical and psychological effects is important. Such considerations are important as the cost of the test is likely to represent diversion from elsewhere (Segal, 2012).

Evaluating a screening tool for ASDs in prisons brings particular challenges. The gold standard diagnostic method is a clinical one, based upon observational and developmental history. The structured tools used in research studies for diagnosis, such as the ADOS-G, are too lengthy to be used in large numbers in a prison setting. Prison routines do not allow lengthy interviews and cannot guarantee appointments can be kept. In addition interviews with parents, even where possible, are unlikely to be able to continue for several hours.

2.2 Study 1. Evaluation of a Screening Tool for ASD in Prisoners

Introduction

Due to concerns that there may be a large number of un-diagnosed prisoners with ASDs, and the lack of a useful method of their identification, a screening instrument was devised by the UK-based autism charity, Research Autism (Wing L. et al., 2008) (see Appendix A). This screening tool is designed to be completed for each prisoner by a prison officer who knows that prisoner well. Responses are based on behaviours that the officer will have observed to be present or absent during the time that they have known the prisoner. The instrument was designed to be used without training.

The 20-question tool was based upon the Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI) (Gillberg et al., 2001). The ASDI is a structured interview relating to neurodevelopmental history and behaviour, which is conducted with a relative. The screening tool was designed to be completed for each prisoner by a prison officer who knows that prisoner well. Responses are based on behaviours that the officer will have observed as part of their professional role. No training is required to use the instrument.

A small pilot study within Her Majesty's Prison La Moye, Jersey, was undertaken by the UK charity Research Autism (www.researchautism.net). It was found that the questionnaire took on average only 1.5 minutes to complete (personal communication, Richard Mills, Research Autism). This was an important demonstration of the feasibility of completion of the questionnaire in a prison setting. However, there is considerable variation between individual prisons. Research Autism were concerned that the small HMP La Moye which has a maximum capacity of 174 prisoners, is not representative of UK prisons as a whole. Results of this pilot study have not been published.

The aim of this study was to evaluate this tool in the much larger, Scottish prison population. The screening instrument was evaluated by comparing it against two assessments which are used commonly by mental health professionals in diagnostic assessments for ASDs (the study was completed before the publication of DSM-5). It was also compared against an objective measure of social cognition which is known to be impaired in individuals with ASDs (Philip et al., 2010).

My personal contribution to this study included managing the day-to-day running of the study including writing the ethics application, training and recruiting the team of interviewers, liaising with the Scottish Prison Service and individual prisons, as well as participation in its design and collection of data as part of a team. I also conducted the interviews with relatives and analysed and interpreted the results.

2.3 Methods

Ethical Approval

All study volunteers provided informed consent and the study was approved by the Scottish Prison Service Ethics Committee and the Multicentre Research Ethics Committee (MREC). Written information about the study was displayed in areas agreed with individual prisons or given to prisoners. Prisoners could choose to opt out of the screening process. Further participation in the study included receiving written information about the research 24 hours before being asked to take part in an interview, and written informed consent. Participant information and consent sheets were approved by the ethics committee for prisoners and for family members, as was an information sheet for prison officers.

MREC stipulated that only convicted, and not remand, prisoners could be included in the study. They were concerned that remand prisoners might use a diagnosis of an ASD in their defence in court. This was despite the fact that this study was not a

diagnostic study. In addition, it would appear that should an individual have a mental disorder, it is appropriate that they should be able to use that in their defence should they choose to do so. They also considered that remand prisoners were ‘innocent’ and therefore should not be included in the study. This is despite the evidence discussed above that remand prisoners are at least as likely as convicted prisoners to experience mental disorder. This ethical stipulation therefore led to a significant reduction in the population of prisoners assessed.

As this was a validation rather than a screening study, the ethical issue of potentially large numbers of false positive cases was not addressed. This is however an important ethical issue when considering all screening tools, where advantages of identifying possible cases should be considered to be greater than any harms from false positive cases (Moynihan et al., 2012).

Participants

After obtaining approval from the Scottish Prison Service, all 12 publicly-operated closed prisons in Scotland were invited to take part in the study. The Open Estate was not included in this study for practical reasons- prisoners in open prisons are less likely to be available for interviews than those confined to prison. Visits were made to the prisons to present information and explain the rationale for the study to senior prison staff.

The tool stipulates that the tool must be used by officers on prisoners whom they know well. After discussion with prison staff it was agreed that this would be assumed that prison officers would have a knowledge of prisoners’ presentation after at least one week. The screening tool was completed by prison officers on convicted prisoners whom they had known for at least a week, during a specified one-week period. Papers were collected at the end of that week and scored by LR. Each screening form identified prisoners by prison number only.

Reliability

Although reliability is not required for validity, information on reliability is of use when determining the practical value of a screening test. To this end, after a further week, subgroups of officers were asked to rescore prisoners they had scored the previous week, and other subgroups asked to score prisoners previously scored by others. These screening papers were collated by a named co-ordinator within the prison and collected by a member of the research team.

Scoring

The instrument was designed with seven areas for scoring purposes. These comprise the six areas of the ASDI, and a seventh area, represented by question number 20 (about noise/bright lights) reflecting sensory hypersensitivities. The scoring method is described in Appendix A.

The original aim was to interview participants scoring above the proposed cut-off of five on the tool, and an equal number of age and sex-matched controls scoring below five. However, as few prisoners scored above five during the initial prison visit, participants scoring above zero on the tool were invited to participate in interviews, along with age and sex-matched controls who scored zero.

Interviews

Interviews with prisoners were carried out in prison a week after the collection of the screening tools. This was in order to minimise the period during which prisoners could be liberated or transferred. Interviews were performed by a team of psychiatrists trained in the measures used and blind to screening status.

All prisons where screening had taken place except HMP Shotts gave permission for assessments on a sample of the prisoners who had been screened. One hundred and three participants scoring above zero on the screening instrument were invited for interview along with an equal number of age and sex-matched participants scoring zero.

Background information was obtained from participants, including age, date of admission and estimated date of liberation from prison. Forensic, substance misuse, past medical and psychiatric, educational and employment histories were taken. Participants provided accounts of past offending. Current IQ was estimated using the Quick Test (Ammons and Ammons, 1962), a brief, standardised measure of intelligence that can be used in non-readers. Reading age was measured using the Schonell Graded Word Reading Test (Schonell and Schonell, 1960).

Mental health screen

Participants in whom the initial assessment by a psychiatrist suggested possible current mental disorder were fully clinically screened with a standardised instrument, the Clinical Interview Schedule (Goldberg et al., 1970). Prisoners were invited to consent for a relative to be contacted in order to conduct a telephone interview and to be being contacted after liberation regarding a future study.

Measures used

Adult Autism Spectrum Quotient (AQ)

The AQ is a 50 item self-report questionnaire that measures a range of mild autistic traits in a relatively brief and simple format. An initial study demonstrated excellent sensitivity and specificity in the identification of participants with ASDs (Baron-Cohen et al., 2001). In the general population, 80% of adults of normal intelligence meeting criteria for an ASD would be expected to score 32 or above in the test (sensitivity), in comparison with 2% of controls. The AQ is one of the formal assessment tools suggested by NICE for use in diagnosis and assessment of adults (NICE, 2012).

The AQ was not devised for antisocial groups. Some of the questions refer to aspects of life unfamiliar to many prisoners, such as visits to theatres and museums. Unfortunately, all of the self-report measures available have similar references, and the AQ was felt to be the most socially appropriate. Good sensitivity and specificity in identifying individuals with ASDs has been demonstrated in a forensic psychiatric sample (Murphy, 2011). Due to anticipated low literacy levels in the study

population each question was read aloud to the participant by the interviewer. The AQ has not been validated in this manner. However, no other tool which is validated when read to subjects was identified. It was considered that too many participants might be loss and bias added if it were not read out.

Ekman 60 Faces Test

This neuropsychological test of basic facial emotion recognition consists of a battery of photographs of faces drawn from the Ekman and Friesen series (Ekman and Friesen, 1976). Sixty photographs, comprising ten representing each of six basic emotions (happiness, surprise, disgust, fear, anger and sadness), are separately displayed upon a computer screen in a pseudo-random order for five seconds each (Figure 1). Pseudo-randomisation ensures that the stimuli are not presented in a predictable way, although the order is pre-determined, thus reducing any effect of the order of the stimuli affecting the outcome. The participant is required to identify which of the six emotions each photograph represents. The names of the six emotions were at the bottom of the screen, and this was available throughout the test. Participants received no feedback on task performance. This test has been used successfully to characterise deficits in emotion recognition displayed by adults with ASDs (Philip et al., 2010) and adults with schizophrenia (Hall et al., 2004) in comparison with healthy controls. This test is less language dependent than other tests and so is useful in populations with poor literacy skills



Figure 1. Example of one of the images presented during the Ekman 60 Faces Test

Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI)

This structured clinical interview was developed as a diagnostic tool to include a range of aspects of behaviour typically affected by ASDs (Gillberg et al., 2001). It is designed for use with a first-degree relative who has known the individual well since their childhood. There are 20 items which map to Gillberg's six diagnostic criteria for Asperger Syndrome (Gillberg 1991 in Gillberg et al., 2001), which do not coincide with criteria in DSM or ICD classifications. Only two ratings of each item are possible. The interview has been shown to have good inter (kappa 0.91) and intra-rater reliability (kappa 0.92) and validity (Gillberg et al., 2001). NICE recommend that it should be considered in the diagnosis and assessments of adults (NICE, 2012).

Relatives of prisoners who had provided consent and for whom contact details were available were contacted in writing where possible, and the ASDI was carried out by telephone.

2.4 Results

In total, 2458 convicted prisoners were screened using the tool. The convicted prisoner population at that time was 6156 (Scottish Prison Service, 2009), therefore 39.9% of the convicted population in Scotland was screened. This proportion was limited by numbers of prisoners suitable for screening (known to a prison officer for at least one week) and numbers of prison officers taking part.

Prisons included local and long-stay prisons, one male Young Offenders' Institution (YOI) and the one women's prison and YOI. Twenty seven of the prisoners screened were women. Fifteen prisoners from Inverness were screened at the health centre due to staff concerns that they might have ASDs; all other prisoners were screened by staff on the prison halls (main living areas). Some prisoners opted out of the screening process in HMP Peterhead, but the number opting out is not known.

The following prisons took part in this study. Screening and interviews took place between February 2008 and September 2009. The populations described are as at the time of the study.

HMP Edinburgh	(male, short-term prisoners)
HMP Aberdeen	(male, short-term prisoners)
HMP Greenock	(male, short and long-term prisoners)
HMP Perth	(male, short and long-term prisoners)
HMP Barlinnie	(male, short and long-term prisoners)
HMP YOI Cornton Vale	(female adults and young offenders)
YOI Polmont	(male young offenders)
HMP Glenochil	(male, long-term prisoners)
HMP Dumfries	(male, short-term prisoners and national offence-related protection prisoners)
HMP Peterhead	(male sex offenders)
HMP Shotts	(male, long-term prisoners)
HMP Inverness	(male, short-term prisoners)

Scores on the screening tool

In total, ninety seven prisoners (4.0%) scored 5 or more, the cut-off suggested for the screening tool when it was designed (Table 1). Minimum score on the tool was 0, maximum score was 7. Median score across all prisons was 0, (interquartile range 0-2). Median score from those prisoners attending Inverness Health and Learning Centres was 4 (n=15, IQ range 2-4). It is possible that those prisoners had higher rates of mental illness or learning disability. When those from the health centre in Inverness were excluded from the total sample of prisoners screened, median score remained 0 (0-2) (n=2443).

Score	Frequency	Percent
0	1256	51.1
1	514	20.9
2	275	11.2
3	179	7.3
4	137	5.6
5	73	3.0
6	21	0.9
7	3	0.1
Total	2458	100.0

Table 1. Distribution of scores across the total screened prison population

A description of scores for each prison is shown in Table 2. The distribution of scores for the total prison population and that of the prison population excluding Inverness Health and Learning Centres are shown in Figures 2 and 3.

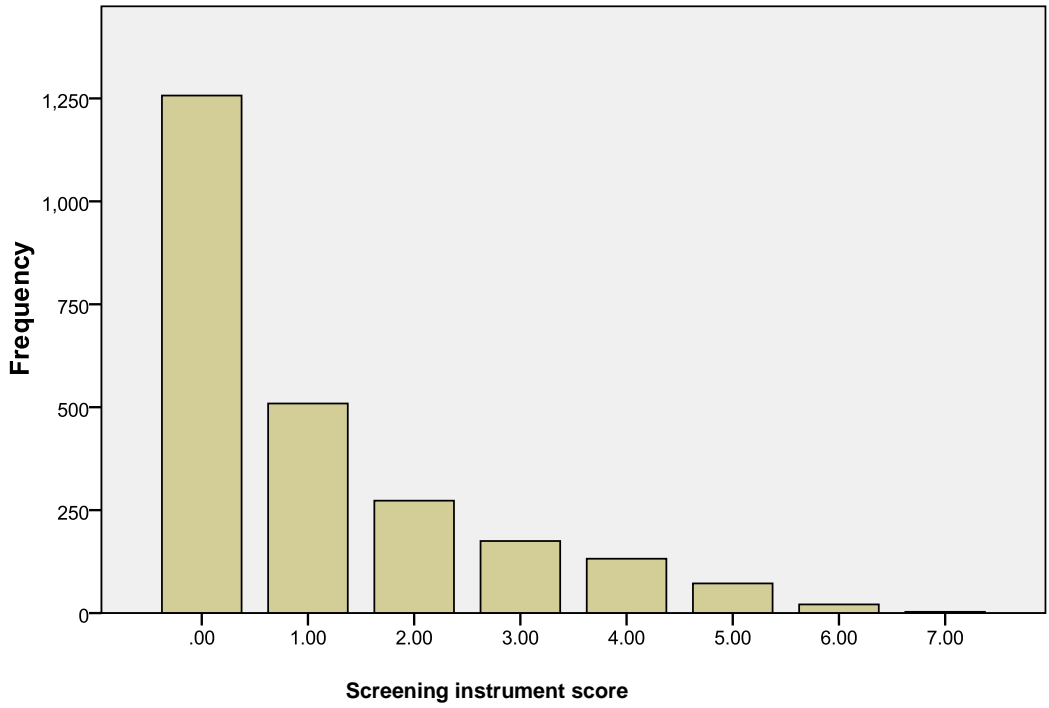


Figure 2. Distribution of scores across the prison population, all of those screened (n=2458)

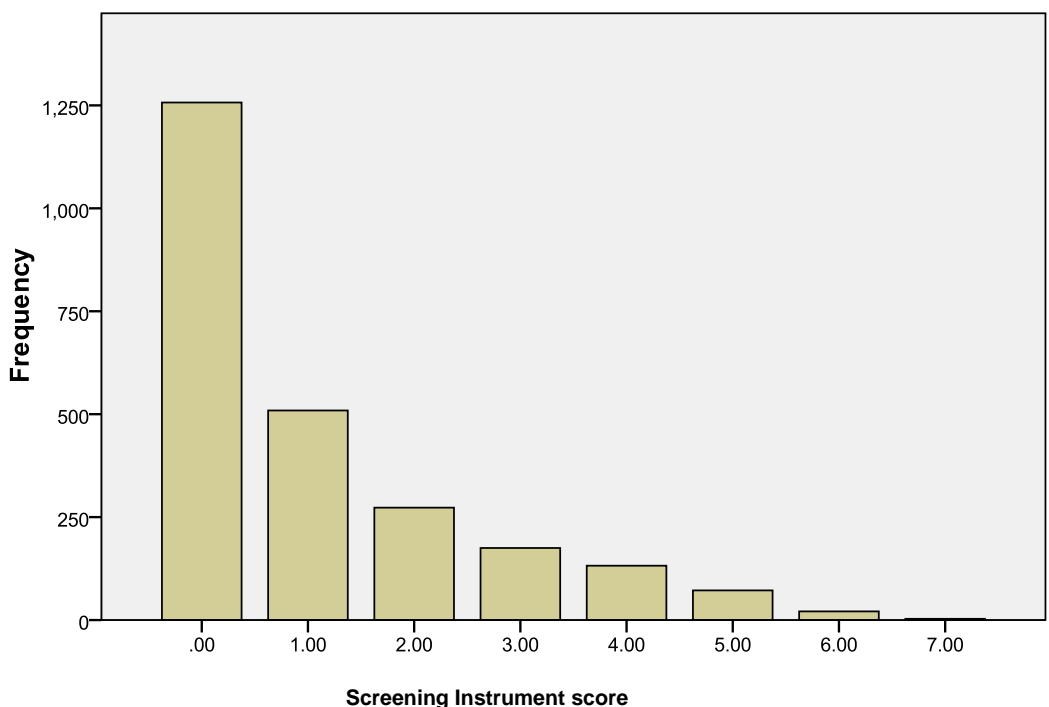


Figure 3. Distribution of scores across prison population (excluding Inverness Health and Learning Centres) (n-2443)

Prison (N)	Median score (interquartile range)
Edinburgh (340)	2 (1-4)
Barlinnie (574)	1 (0-3)
Perth (143)	0 (0-1)
Shotts (371)	1(0-2)
Greenock (61)	2 (0-4)
Dumfries (121)	1 (0-1)
Peterhead (280)	1 (0-1)
Polmont (226)	0 (0-1)
Cornton Vale (127)	1 (0-2)
Aberdeen (113)	0 (0-1)
Inverness (67)	0 (0-1)
Glenochil (35)	0 (0-2)
Total 2458	0 (0-2)

Table 2. Scores on screening tool by prison

On comparison of the distribution of scores between prisons, the Kruskal –Wallis one-way analysis of variance test is significant beyond the .01 level: chi-square (11) =197.97; $p < .01$, meaning that there are statistically significant differences between the prisons. It is clear that Greenock has a slightly different distribution of scores from the others. It is not possible to suggest an explanation for this from these data, and it is possible that they reflect a true difference in population screened. Despite

the inclusion of a group from the Health and Learning Centres at Inverness, which showed a different pattern of distribution of scores, there was not a difference found between the total scores at Inverness and those elsewhere. This is likely to reflect the relatively low number of individuals from the Health and Learning Centres in the Inverness total sample.

Reliability

The co-ordinators in the prisons reported that they were unable to persuade prison officers to repeat the exercise, with the exception of in HMP Peterhead, where it was possible to obtain data on intra-rater reliability only. The reasons for this are not known. It may be because officers already felt that they had completed the study, and because the rationale for the repeat scoring exercise may not have been well explained to them.

Intra-rater reliability

Nine prisoners were re-scored after a week had elapsed by the officer who had first scored them. Median score for the 9 prisoners for the first screen was 0, (interquartile range 0-2), and for the repeat screen was 2 (interquartile range 1-4.5). There was no significant correlation over time between the ratings of the same prison officer for the same subject ($ICC < 0$), and intra-rater reliability was therefore poor for this sample. The small size of the sample used for reliability means that these conclusions are limited.

Results: Interviews

All prisons where screening had taken place except HMP Shotts gave permission for assessments on a sample of the prisoners who had been screened. HMP Shotts did not provide a rationale for this, and we were obliged to accept this decision by the prison. HMP Shotts was a higher security prison than the others we visited and it is possible that it was not felt by the prison Governor that security could be maintained during our visit and interviews.

Initially, participant numbers of those scoring 5 or above and of controls were sent to the prisons. Prison staff were asked to identify which of those prisoners was still in prison and to give them written information about the study and invite them to attend for interview. This is a part of the study over which I had little control and is a source of potential bias. Prisons were also sent controls scoring 0 and asked to select an equal number of controls, of the same age as the subjects, and also provide them with information and invite them to the interviews. Due to concerns over low numbers of participants scoring 5 or above, this group of 'positives' was changed to include participants scoring over 0.

1202 participants scored more than 0 on the screen. As Shotts did not take part in the interviews (where 17 prisoners scored more than 0 including 1 scoring 5), 1185 prisoners were identified to the prisons to be given information about the study and invited to participate. Those scoring 5 or above were identified within this group to the prisons as those prisoners whom we were particularly interested in interviewing. 1185 prisoners scoring 0 were identified to act as controls and to be matched by age. Of the 1202 subjects, 97 scored 5 or above.

One hundred and three participants scoring above zero on the screening instrument were identified by prisons as available and interested in coming for interview on the day of our visit. An equal number of age and sex-matched participants scoring zero were invited.

Fifty one of the 103 scoring above 0 (49.5%) participated, of whom 32 had scored five or above on the screen (the cut-off). Twenty seven refused 17 were unavailable (at court, liberated or transferred), and for eight the reason for not attending is not known. Seventy six (73.7%) of those invited and scoring zero on the tool chose to participate and were available. The reasons for non-attendance in this group are not recorded, and this is a limitation of this study, as potential bias at this point cannot be evaluated. In total, 127 prisoners who had been scored with the screening tool attended for interview, and 126 took part in all of the further assessments. Seven of those interviewed were women.

Prisoners were interviewed from the following 11 prisons:

Barlinnie (57)

Dumfries (4)

Edinburgh (7)

Perth (8)

Polmont (6)

Greenock (5)

Glenochil (12)

Inverness (6)

Cornton Vale (7)

Peterhead (7)

Aberdeen (8)

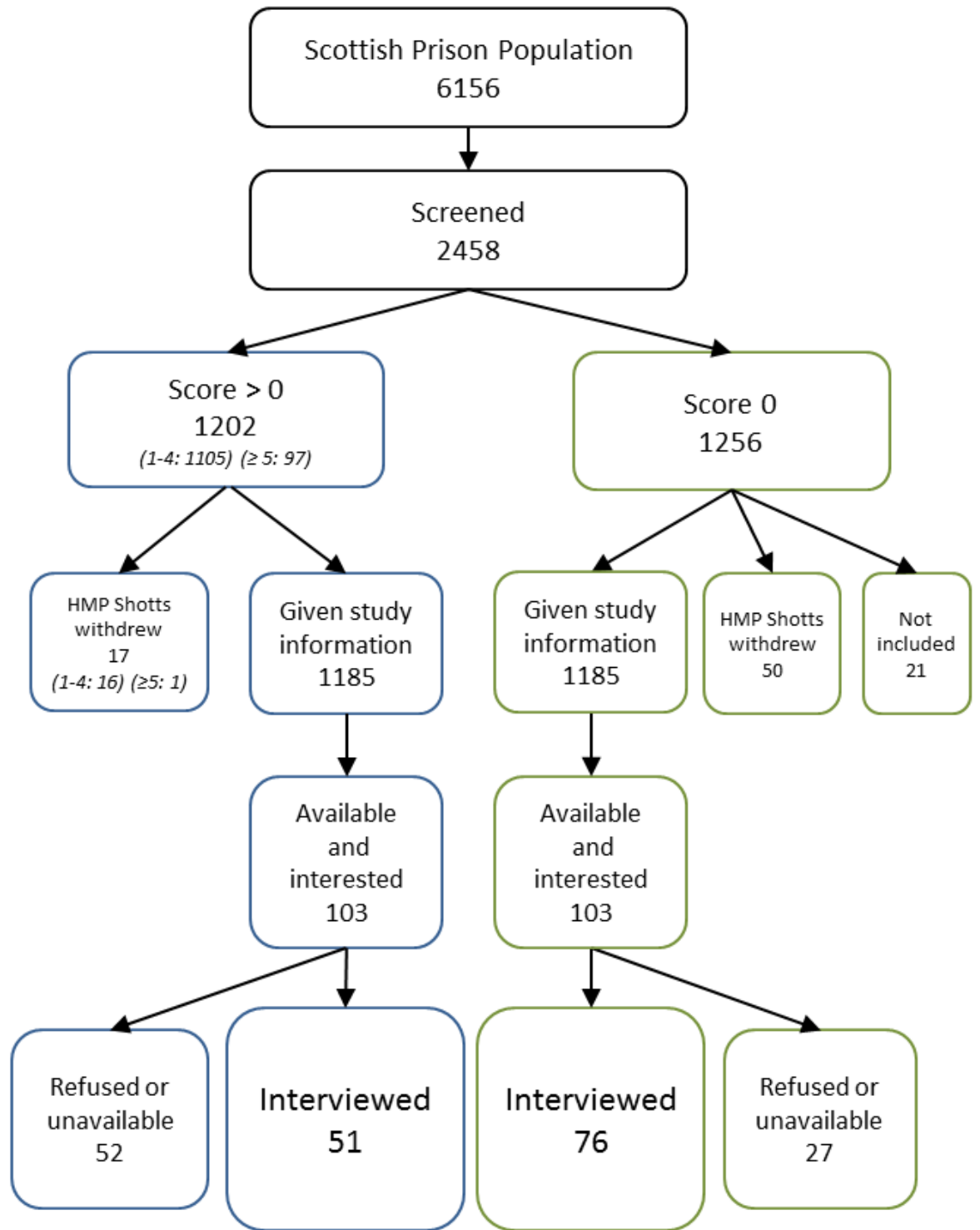


Figure 4. Flowchart demonstrating numbers at different stages of the screening study

Participant Characteristics

IQ/ reading age

Age, IQ and reading age are shown in Table 3. On the Quick Test one participant's score was too low to allow calculation of IQ. IQ was estimated at less than 70 in six participants.

	N	Mean (range, standard deviation)
Age (years)	126	35.2 (17.7-65.7; 11.3)
IQ	125	92.5 (45-130; 15.4)
Reading Age (years)	125	12.6 (6.8-15; 1.8)

Table 3. Demographic characteristics of participants

Health/Substance Use

Mean estimated alcohol intake in the week before prison admission was 91.1 units. Mean estimated intake in that week for males was 91.5 and for females 83.4. The range for the total group was between 0 and 595 units per week. One hundred and two (81%) participants had ever used illegal drugs, and 46 (36.5%) had used drugs while in prison (see Table 4 for type of drug used). Forty two of those interviewed (33%) had a history of intravenous drug abuse. At that time new psychoactive substances, 'legal highs', were not in common use.

Drug	Ever used n (% of total sample)
Cannabis	71 (56.3)
Heroin	61 (48.4)
Cocaine	49 (38.8)
Crack	16 (12.7)
Amphetamine	34 (27.0)
Solvents	9 (7.1)
Benzodiazepines	29 (23.0)
Dihydrocodeine	4 (3.2)
LSD	14 (11.1)
Magic mushrooms	5 (4.0)
Ecstasy	30 (23.8)
Ketamine	2 (1.6)
Methadone	17 (13.5)
Morphine	1 (0.8)

Table 4. Reported illegal drugs used

Sixty nine (54.8%) had a history of head injury leading to hospital admission or loss of consciousness. Seventy four (58.7%) were being prescribed medication, 22 of whom were prescribed methadone. Seventy seven (61.1%) had ever seen a psychiatrist and 17 (13.5%) stated that they had been detained under the Mental Health Act in the past. Six reported past diagnoses of schizophrenia or psychosis, 13 depression, 6 substance misuse problems, 5 PTSD, 6 ADHD, and one possible ASD. Two had received assessment or treatment for anger management, and 43 gave a history of deliberate self harm.

Forensic Characteristics

114 (90.5%) prisoners had previous convictions and 94 (74.6%) had served previous prison sentences. Table 5 shows type of offence for which the prisoner was serving a sentence.

Offence Type	N (%)
Violent	86 (68.3)
<i>of which sexual</i>	22 (17.5)
<i>of which homicide</i>	14 (11.1)
Drug-related	16 (12.7)
Theft	9 (7.1)
Breach of the Peace	5 (4.0)
Other	10 (8.0)
Total	126 (100)

Table 5. Offence for which prisoner was serving sentence (index offence), by type

Education/Employment

Thirty six (28.6%) of prisoners had received special educational support at school. Forty three (34.1%) stated that they had difficulty with reading at school; 41 of the 125 (32.8%) who answered this question had had difficulty with writing at school. Eighty five (67.5%) had been excluded from school and 47 (37.3%) had obtained formal educational qualifications. One hundred and fourteen (90.5%) said that they can read and write. One hundred and seven (84.8%) had ever been employed.

Mental Illness Screen

The initial assessment by a senior psychiatric trainee, based upon the information given and clinical presentation, suggested possible current mental disorder in seven prisoners. They were examined by Consultant Psychiatrists using a formal mental illness screen, the Clinical Interview Schedule (Goldberg et al., 1970). Three had no symptoms, two had symptoms of depression and anxiety, one had dissociative symptoms, and one had symptoms suggestive of an organic brain syndrome.

Autism Quotient (AQ)

Mean AQ score was 20.1 (range 6-41, standard deviation 7.3) (Figure 5). Seven of the 126 participants (5.7%) scored 32 or above, the cut-off at which further investigations for ASDs are recommended by the authors of the test (Baron-Cohen et al., 2001).

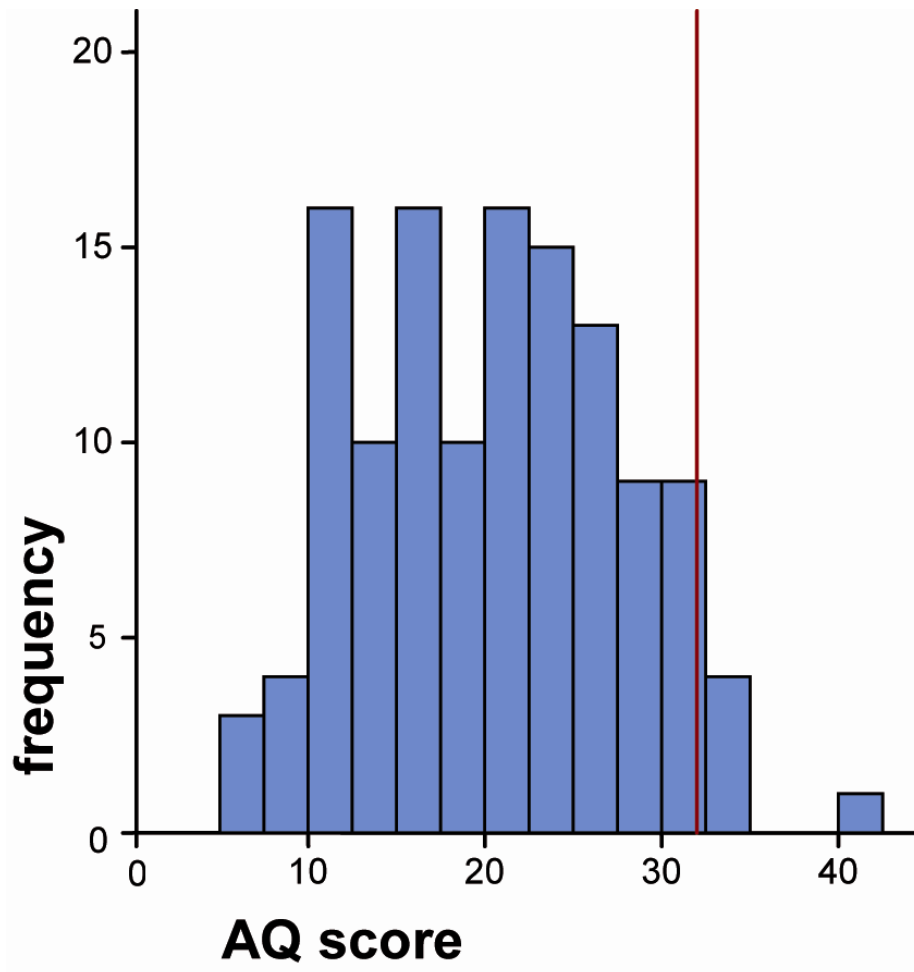


Figure 5. Distribution of AQ scores, showing cut-off of 32

Asperger Syndrome (and high-functioning autism) Diagnostic Interview (ASDI)

An ASDI was carried out with 44 of the prisoners' relatives (3 female and 41 male prisoners). No participant reached the cut-off score of 5 (median score was 0, interquartile range 0-1.75) (Figure 6).

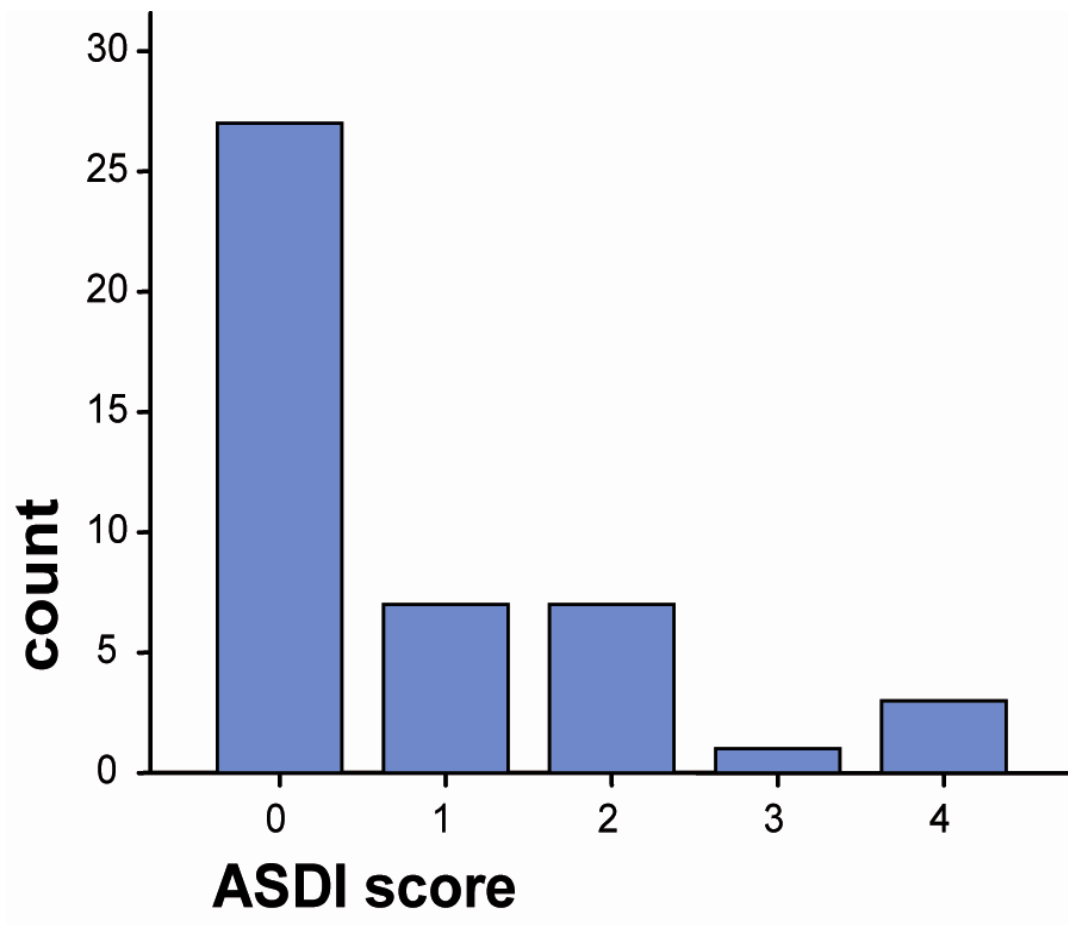


Figure 6. Distribution of ASDI scores

Ekman 60 Faces Test

This test provides a score out of 10 for each of the 6 emotions (happiness, sadness, disgust, fear, anger, surprise) and a total score out of 60. One hundred and twenty six screened prisoners were examined. The mean score total score was 41.1 (range 24-55, standard deviation 7.3). Distribution of the total scores is shown in Figure 7.

Performance was not consistent across emotion type, with prisoners performing best at recognising happiness (mean score 9.8) and worst at fear (mean score 4.2). Scores for each emotion are shown in Table 6.

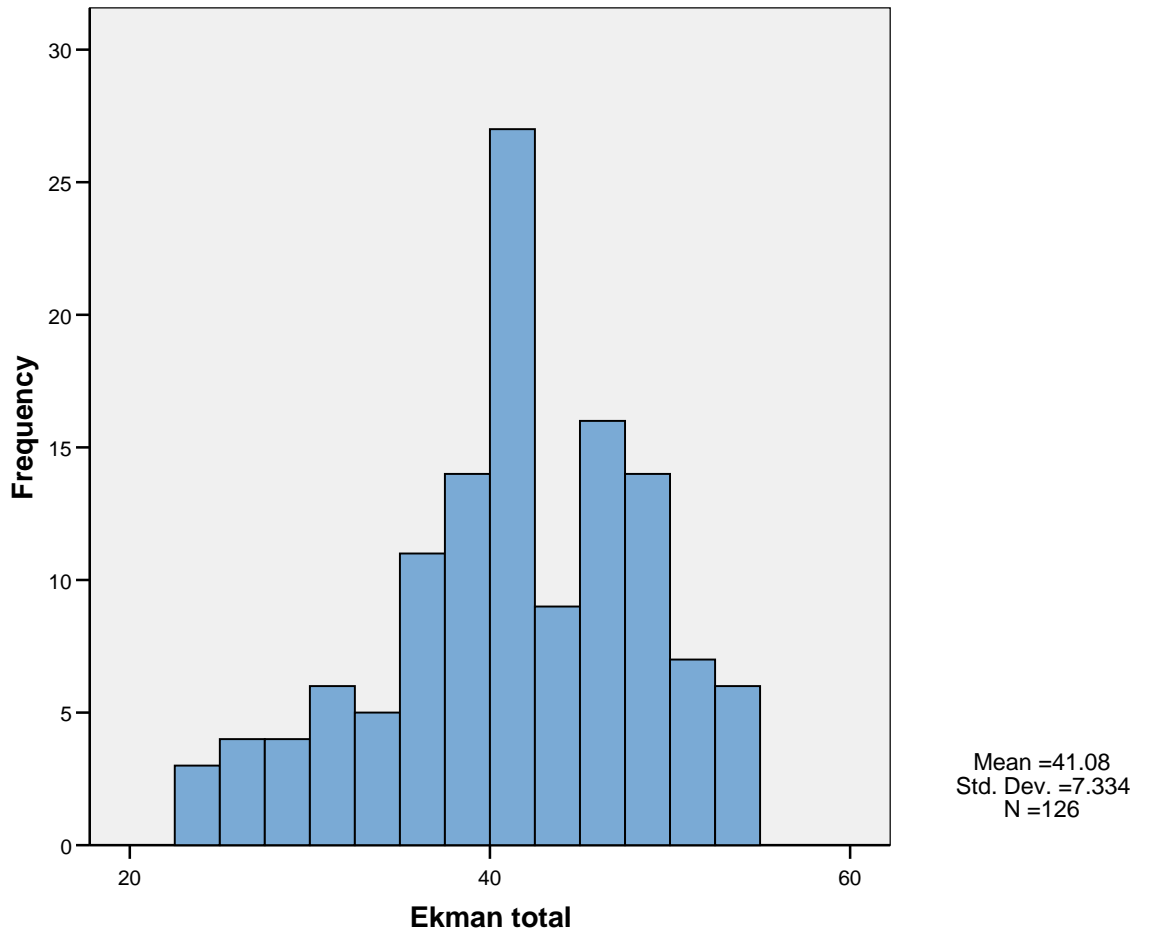


Figure 7. Distribution of Ekman 60 total scores

Emotion	Mean score	Range
Anger	6.3	0-10
Disgust	5.71	0-10
Fear	4.22	0-10
Happy	9.83	3-10
Sad	6.71	1-10
Surprise	8.26	0-10

Table 6. Scores for individual emotion recognition

Female prisoners

Seven women prisoners were interviewed. The mean age of female participants was 32.0, mean IQ was 91.6, and mean reading age was 13. Two women scored above zero on the screening instrument, of whom only one reached the cut-off of 5. Five scored 0 on the screening instrument. Mean AQ was 18.9. Three ASDIs were performed with relatives. None reached the cut-off of five on this instrument. Two scored 0 on the ASDI and one scored two.

Mean units of alcohol drunk in the week before prison was 83.4, with a range between zero and 210. Six of the seven had a history of use of illegal drugs. Four of the seven had a violent index offence.

A mental illness screen was performed on three of the women, two of whom had symptoms of depression and anxiety. Six had been seen by a psychiatrist in the past and four had a history of deliberate self harm.

Relationship between measures and screening tool scores

AQ

A statistically significant association was found between scores on the screening tool and AQ score ($\rho=0.177$, $p=0.047$).

ASDI

A statistically significant correlation was found between the screening tool score and ASDI ($\rho=0.37$, $p=0.012$).

Ekman 60 Faces Test

There was no statistically significant correlation between score on the screening tool and Ekman 60 Faces Test score ($\rho=0.21$, $p=0.41$).

Relationship with IQ

The screening tool score did not correlate significantly with IQ ($\rho=0.05$, $p = 0.579$). In addition, there was no significant association between the screening tool score and reading age or whether an ASDI was performed or not.

Relationship between measures

AQ and ASDI scores ($\rho=0.35$, $p=0.018$), and AQ and IQ scores ($\rho=0.25$, $p=0.006$), showed significant correlations. IQ and Ekman 60 Faces Test scores were also significantly correlated ($\rho=0.35$, $p<0.001$). There was no significant association between IQ and ASDI score. While AQ and Ekman scores showed a significant correlation ($\rho=0.25$, $p=0.005$), this becomes non-significant when IQ is used as a covariant.

Although AQ and ASDI scores showed a statistical correlation, suggesting that both tools may measure autistic traits, no ASDI performed reached a score of 5 the cut-off score for this instrument. This was despite some individuals scoring above the cut-off score for the AQ and being scored on both tools. These results highlight the differences between the two instruments in particular, and between self-report and collateral information in general. Both sources of information can be biased (Murphy et al., 2011). Neither self-report nor developmental history alone can be used for diagnosis, and an accurate developmental history and clinical observation are always required. The differences in outcomes from different instruments illustrate that overall diagnosis and the 'gold standard' must still be clinical judgement, informed by a range of sources of information.

Characteristics of the screening tool

In the tool design, a score of 5 was designated as the cut-off (i.e. individuals scoring 5 or above were screened as positive).

Comparison against AQ results

In this analysis, a score of 32 or above on the AQ was used to represent a case. This is the score at which the authors suggest that further assessment should be carried out

and that there are clinically significant levels of autistic traits (Baron-Cohen et al., 2001). It should be noted, however that the AQ does not provide a diagnosis in itself and that all of the three participants who scored 32 or above on the AQ who were also assessed using the ASDI did not reach the diagnostic threshold on that measure.

The rate of a score of 32 or above was 5.5% in this sample. The relationship between AQ score status and screening instrument status is shown in a contingency table (Table 7). The probability associated with the chi square statistic of 0.80 suggests that the relationships could be explained by chance.

		AQ cut off reached (case)	AQ cut off not reached (not case)	Total
5 or above on screen	yes	2	29	31
	no	5	90	95
Total		7	119	126
Chi Square p=0.80		0.063		

Table 7. Contingency table for screening tool cut off against AQ cut-off (chi-square=0.063, p=0.80)

Sensitivity and specificity of the screening instrument

Sensitivity was 28.6% and specificity 75.6%. A ROC curve was plotted (Figure 8). Area under the curve is 59.6% (where a figure close to 100% suggests a good screening measure and a figure of 50% indicates that it is no better than chance). Significance is 0.44, meaning that the probability that the test performs better than random chance is low. Regardless of the cut-off score chosen, sensitivity in particular is low (Table 8).

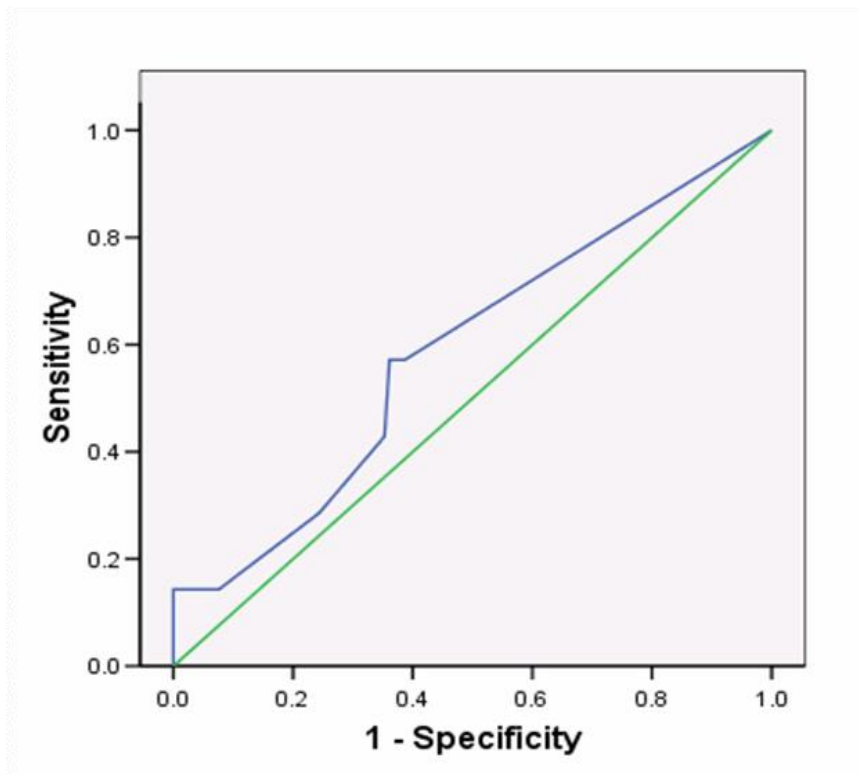


Figure 8. ROC Curve showing sensitivity and 1-specificity

Screen score	Sensitivity	Specificity
0	1.0	0.00
1	0.57	0.61
2	0.57	0.62
3	0.57	0.62
4	0.43	0.65
5	0.29	0.76
6	0.14	0.92
7	0.14	1.00

Table 8. Sensitivity and specificity of screening tool at different cut –off scores

Positive predictive value (PPV) (proportion of cases with a positive test result which are truly positive) was 6.5%; and negative predictive value (NPV) was 94.7%.

Likelihood ratio for a positive test (how much more likely a positive screening result

is to be found in someone with the disorder than without) is 1.17, and likelihood ratio for a negative test is 0.94. Unlike PPV and NPV, likelihood ratios, which are derived from sensitivity and specificity, are not affected by prevalence.

Alternative scoring method

An alternative scoring method may be used, where ‘yes’ or ‘maybe’ for question 11 (‘popular with other prisoners; a ringleader’) leads to a total score on the tool of 0 (see Appendix for scoring method). This led to a change in score to 0 for 5 individuals who had scored above 0. Their original scores are shown in Table 8.

Screening tool score	Frequency
1.	1
2.	1
3.	1
4.	2
Total	5

Table 9. Scores on the screening tool which were changed to ‘0’ by the alternative scoring method.

None had originally scored the ‘cut off’ of 5 for the screening tool, and so were always screen ‘negatives’. None of these prisoners scored 32 or above on the AQ, that is all were ‘negative’ cases. The alternative scoring method had no effect on the results of the screen and no effect on the properties of the instrument.

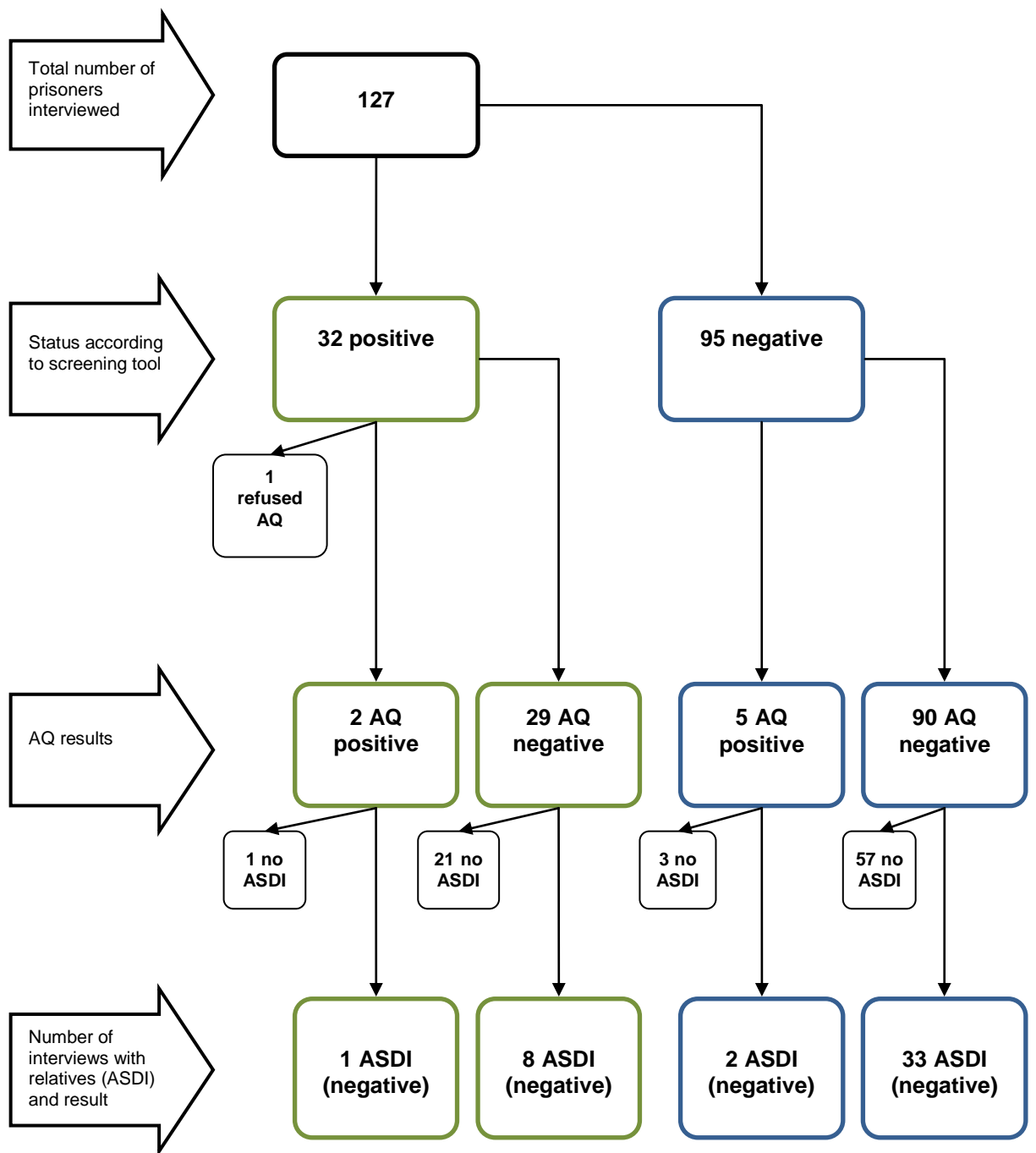


Figure 9. Summary of Study Results.

AQ Adult Autism Spectrum Quotient

ASDI Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview

2.5 Discussion

This study examined an instrument designed to be completed by prison officers with the aim of screening for ASDs in prisoners. A total of 2458 prisoners across 12 prisons were screened, accounting for 40% of the sentenced prison population. 127 were interviewed, 126 completed the AQ and 44 ASDIs were completed with relatives. The tool proved to measure autistic traits as measured by the AQ but showed poor sensitivity in particular. In addition, although only a small sample of prisoners were rated twice, those data suggest that intra-rater reliability was poor. Inter-rater reliability could not be measured.

In order to be valuable, a study of a screening tool must have used a blind comparison with a gold standard test and results must be generalizable to the population in which it is intended to be used (Lawrie et al., 2000).

Diagnostic Tool

Where possible, tests should be compared with a diagnostic gold standard which will give a true account of whether the diagnosis is present. A true diagnostic gold standard for ASD in adults requires clinical assessment, history and a third party developmental history. Structured clinical interviews, for example the ADOS (Lord et al., 2000) are often used as gold standards in evaluation of diagnostic tests in psychiatry, although they can not be used to make a diagnosis. This study did not use such an instrument.

The ADOS and similar instruments take several hours to perform. The constraints of the prison environment including periods of time allowed with individual prisoners would not have allowed significant numbers of prisoners to be assessed using such an instrument. Instead, briefer, more practical measures were used covering several areas of diagnosis as the best tests available. These included patient self report in a validated reliable instrument (the AQ (Baron-Cohen et al., 2001), a structured third party developmental history (the ASDI) (Gillberg et al., 2001), and an objective measure of social cognition (Ekman Faces Test (Young et al., 2002a). In practical

terms, the best tests that could be used were used. This ensured that it was possible to carry out a study of this type at all, while still producing useful and important results. In addition, assessments were carried out blind to the participant's screening status.

Generalizability

It is important that any screening tool is examined in an appropriate population (Lawrie et al., 2000). This tool was evaluated in a large sample of convicted prisoners that included both sexes and range of ages. Scores on the Quick Test can be compared with those obtained during a survey of the prison population of England and Wales (Singleton et al., 1998). In that sample 24% of male sentenced and 16% of female sentenced prisoners scored 41 or more (equivalent to an IQ of 100 or more). In the current, Scottish, sample 40% of males and 29% of females scored 41 or more. The sample in this study therefore appears to have a relatively larger proportion of individuals with an IQ score above 100 than that of England and Wales. Both however do not reach the expected population average of 50%. With respect to low IQ, a study of both remand and sentenced prisoners in England and Wales (Hassiotis et al., 2011) found that 4% scored 25 or less on the Quick Test (indicating an IQ of less than or equal to 65) and also had no educational qualifications. Similarly, in the current sample, 6 prisoners (4.7%) met both of these criteria. The high levels of substance misuse and head injury in this sample are in also keeping with other prison populations (Fazel et al., 2006) (Williams et al., 2010).

Although there was considerable past psychiatric contact, there was no evidence of high rates of current major mental illness. This contrasts with data from other sentenced prisoner populations. For example, rates of current psychotic illness have been estimated as 7% of male sentenced prisoners (Singleton et al., 1998) (Brugha et al., 2005), and 14% of female sentenced prisoners in England and Wales (Singleton et al., 1998). Results from this study are in keeping with prevalence studies in remand populations which suggest that levels of major mental illness in prisons may be lower in Scotland, (2.3%), than in England and Wales (10%) (Davidson et al., 1995) (Singleton et al., 1998), possibly as a result of greater diversion from the prison system in Scotland (Fraser et al., 2007).

The prison population used in this study was therefore similar to other UK prison populations although rates of mental illness were lower than expected.

Validity of the Test

As was stated on page 17, a screening test can be described as valid if ‘it detects most people with the target disorder (high sensitivity) and excludes most people without the disorder (high specificity), and if a positive test usually indicates that the disorder is present (high positive predictive value)’ (Greenhalgh, 1997). Evaluation using the AQ showed low sensitivity (28.6%) and specificity of 75.6% at a cut-off of 5. However, sensitivity remained low at different cut-off scores. Positive predictive value was low (6.5%). The likelihood ratio for a positive test indicates the how much more likely that a positive result will occur in someone with the disorder than that it will come from someone without the disorder. In this case the likelihood ratio for a positive test was 1:17, a low result suggesting that the test would not be clinically useful. It can be concluded therefore that the test is not valid, despite appearing to measure autistic traits.

Although the test was practical to administer, requiring little time to complete and no training, it is not valid. In addition, although limited, the data suggest poor reliability. The poor intra-rater reliability may relate to individual characteristics of this tool. However, it is possible that it may reflect more general difficulties in a design using prison officers to complete assessments. Prison officers were asked to devote extra work time in order to complete the tools, and although they were informed about the background to the study, may have been poorly motivated to complete the forms correctly. They also may not have known the prisoners well enough to comment on their social behaviour. It is not possible to make comparisons with similar studies as the author of this thesis is unaware of any other studies which have relied upon assessment by prison officers in this way.

Prevalence

This study was not designed to estimate ASD prevalence. However, it is the first study to examine screening for ASDs in a prison setting and there have been no

prevalence studies of ASD in prisons (Underwood et al., 2013). Large numbers of individuals with high self-report scores of autistic traits were not identified. In addition, no developmental history taken was suggestive of an ASD. This may be because individuals with ASDs did not take part in assessments (selection bias). It is possible that the particular tools used did not identify individuals with ASDs in this population. However, few individuals with high levels of autistic traits may have been identified because levels of ASDs in this prison population are in fact low. This might be due to diversion of such individuals early in the criminal justice process, or because prisoners with ASDs may not tolerate a prison environment resulting in transfer to hospital once admitted to prison (these explanations could explain the relatively high rates of ASDs identified in the high-secure hospitals). It is also possible that individuals with ASDs are less likely to offend, and therefore would be under-represented throughout the criminal justice system (Woodbury-Smith et al., 2006).

This study demonstrated that a prison is a unique environment in which to conduct research. The primary concern of the prison is staff and prisoner safety, and strict regulations and routines have been devised to ensure this. They are rarely flexible regardless of research needs, and this research was conducted within these constraints. This meant that lengthy diagnostic instruments or interviews could not be used. Frequent movement of prisoners meant that the delay between completion of screening instruments and further assessments had to be minimised. Despite having developed relationships with each prison, it was not possible to return to one of them at all after completing the screening in order to interview prisoners. It was not possible to establish the reasons for this.

Limitations

There are several limitations to this study of a screening tool for ASD in prisoners. Remand prisoners were excluded from this study by the guidance of the multicentre ethics committee. Remand prisoners are different from convicted populations and in particular have higher rates of mental disorders (Singleton et al., 1998). It is therefore possible that there would have been more cases of ASD had remand prisoners been

included in the study. However, it is unlikely that the performance of the screening instrument would have been affected and this would not therefore alter the conclusions of this study.

Although most prisoners took part in the screening, fewer took part in interviews (49.5%). This may reflect the fact that prisoners were required to actively opt out of the screening process. In order to take part in the interviews they had to spend time which meant giving up work or leisure time. This would lead to some choosing not to participate. In addition, a group of prisoners had already moved in the week since the screening took place. Such loss is inevitable in the prison system in which prisoners are frequently transferred and liberated, often without warning. However, fewer of those screening positive than negative on the screening instrument chose to take part in interviews. As the screen has been shown to provide some measure of autistic traits, this may reflect selection bias, meaning that individuals with ASDs were less likely to take part in the interviews. However, again this is unlikely to have altered the overall assessment of the tool.

It did not prove possible to obtain data on inter-rater reliability, and data on intra-rater reliability were limited. We were reliant upon the co-operation of prison officers to obtain these, and reasons for the difficulties may have included constraints on their time or an inadequate explanation on our part to officers for the reasons for repeat screenings. These data are important, however. Those we do have suggest poor reliability. This suggests that the screen would be of limited use regardless of its other characteristics. Although it is unlikely that this screen will be used, this is an important consideration in the design of other screening tools completed by prison officers.

A gold standard diagnostic assessment was not performed. As discussed above, diagnosis of this condition is complex and particularly difficult in a prison environment, with its rapid turnover and frequent and unannounced movement of prisoners. It appears likely, therefore, that using a full clinical assessment would have led to lower numbers of participants in the study.

2.6 Conclusions

This is the only study of a screening tool for ASDs in a prison that has been carried out to date. Although specificity was good, the sensitivity of this tool was poor in this convicted Scottish prisoner population and the tool is not valid. These results, along with poor reliability, suggest strongly that the tool should not be used in its current form to screen for ASDs in prisoners.

The difficulties inherent in prison research limited the methods used. Such difficulties may explain why there have been no previous studies of assessment or prevalence of ASD in prisons (Underwood et al., 2013). Prison officers in this study considered that they knew prisoners well enough to complete a screening instrument for many of them, while this is not necessarily the case elsewhere. For example, prison officers in London have reported that they do not interact enough with prisoners to be able to provide this type of information (Underwood et al., 2013). This perhaps reflects the smaller size of the Scottish prison service. Families of at least some prisoners could be contacted and were willing to take part in the study. Again, this does seem to be the case elsewhere (Underwood et al., 2013). Despite the limitations described above, this study provided important information for prison healthcare policy makers and managers as well as mental health professionals working in the criminal justice system.

Although this was not a prevalence study, there was no evidence to suggest that ASDs are common in this population. In addition, there was no evidence suggesting elevated rates of current major mental illness in this population. However, there were high levels of head injury and substance misuse. The extremely high self-reported levels of alcohol use in particular (average intake for men more than 4 times the recommended weekly limit, and for women almost six times) are a significant problem in this population. At present alcohol misuse is not routinely screened for in Scottish prisons and it is likely that many individuals with alcohol misuse disorders are not identified by prison staff (MacAskill et al., 2011). This means that alcohol withdrawal may be missed soon after admission. In addition, an opportunity to

address other health risks associated with high alcohol intake and to deliver appropriate psychological interventions may also be missed.

It is important that individuals with ASDs are identified within the criminal justice system. This will allow an assessment of their needs to be made which may include additional support. Such individuals are otherwise at increased risk of suggestibility during police interview and court proceedings, and their manner may be interpreted as arrogant which can affect treatment by the criminal justice system (Woodbury-Smith and Dein, 2014). It will also allow their offending to be properly understood and allow criminal responsibility to be assessed and the option of a hospital rather than a criminal justice disposal. Regardless of disposal, diagnosis of ASD allows risk of re-offending to be addressed in an appropriate manner for that individual.

Although the results of this study suggest that rather routine screening for ASDs in prison should not be recommended, other methods of identifying individuals with ASDs should be sought. Although there is no evidence that they are able to identify individuals with ASDs, staff should be encouraged to raise concerns about all individuals struggling to cope in prison.

3.1 Social Cognition in Antisocial Groups

Introduction

The second part of this thesis developed from the results of the facial emotion testing in the prison study already described. The prison population which was examined showed deficits when performing a task asking them to recognise six facial emotions. Facial emotion recognition is a form of social cognition.

Here, I will discuss some of the theoretical background to studies on antisocial populations before a discussion on social cognition. Databases searched for this information included OVID Medline, psycARTICLES, AMED, Embase, Medline in process and Psychinfo. This will provide a context for both a literature review on facial emotion recognition in antisocial groups and the study of facial emotion recognition in Scottish prisoners which will be described.

Aggression

Aggression and violence are common and these terms encompass a large range of behaviours. They describe behaviour carried out with the intent of verbal or physical harm to others. Following a tradition developed in animal research and more recently applied to humans, including forensic populations (McEllistrem, 2004), aggression and violence are commonly divided into two types, 'reactive' and 'instrumental' (Weinshenker and Siegel, 2002).

1. Reactive aggression, also described as 'affective' aggression (Meloy, 2006) occurs in response to threat or frustration and leads to an unplanned angry attack (physical or verbal). It is preceded by autonomic arousal. It can have an adaptive defensive function (Meloy, 2006) and can be healthy or pathological.

Groups characterised by increased rates of maladaptive and inappropriate reactive aggression, but not increased instrumental aggression, are thought to include Antisocial Personality Disorder (without psychopathy), intermittent explosive disorder (IED), post-traumatic stress disorder (PTSD), and borderline personality disorder (Blair, 2010b).

2. In contrast, instrumental ('proactive', 'predatory') aggression is planned and goal directed (Meloy, 2006). Autonomic arousal is absent and the perpetrator has either no emotional awareness or experiences positive feelings (Weinshenker and Siegel, 2002). An association with instrumental aggression is thought to be characteristic of psychopathy, a disorder in which there is also an increased risk of reactive aggression (Cornell et al., 1996, Woodworth and Porter, 2002). However, instrumentally aggressive behaviour is also seen in non-psychopaths.

Disorders Associated with Antisocial Behaviour

Diagnostic classification systems the International Classification of Diseases -10 (ICD-10 (WHO, 1992)) and the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (American Psychiatric Association, 2013b) describe several disorders that relate to antisocial behaviour and violence.

Personality Disorders

Personality disorders are mental disorders in which, according to DSM-5, the essential features are impairments in personality functioning and the presence of pathological personality traits. For diagnosis, there must be significant impairments in self and interpersonal functioning; the impaired personality functioning and expression of personality traits must be stable across time and consistent across situations; and the personality expression is not better understood as part of development or culture (American Psychiatric Association, 2013b). The sub-categorisations into separate personality disorders in DSM-5 and ICD-10 do not imply any particular model of aetiology or development.

Antisocial Personality Disorder (ASPD)

During the development of DSM 5, a dimensional approach to personality disorder classification was considered. However, the categorical approach was retained without altering the personality disorders that are included. ASPD is described in DSM-5 and forms part of the Cluster B grouping of dramatic or flamboyant personality disorders. It has not changed from DSM-IV. According to this classification, ASPD is characterised by a *pervasive pattern of disregard for and*

violation of the rights of others that begins in childhood or early adolescence and continues into adulthood, as indicated by three or more of:

- 'failure to conform to social norms with respect to lawful behaviors;
- deception,
- impulsiveness or failure to plan ahead;
- irritability and aggressiveness;
- reckless disregard for safety of self or others;
- consistent irresponsibility;
- lack of remorse.'

The individual must be aged at least 18, and there must be evidence of conduct disorder with onset before age 15 years (American Psychiatric Association, 2000). Individuals within this category may therefore differ in which of the criteria they meet, meaning that this is likely to be a heterogeneous group in presentation and possibly in aetiology.

An alternative model in DSM-V (section III, Emerging Measures) is based more on personality functioning rather than antisocial behaviour. Criteria which must be met are:

'A. Significant impairments in personality functioning manifest by:

1. Impairments in self functioning (a or b):

a. Identity: Ego-centrism; self-esteem derived from personal gain, power, or pleasure.

b. Self-direction: Goal-setting based on personal gratification; absence of prosocial internal standards associated with failure to conform to lawful or culturally normative ethical behavior.

AND

2. Impairments in interpersonal functioning (a or b):

- a. Empathy: Lack of concern for feelings, needs, or suffering of others; lack of remorse after hurting or mistreating another.
- b. Intimacy: Incapacity for mutually intimate relationships, as exploitation is a primary means of relating to others, including by deceit and coercion; use of dominance or intimidation to control others.

B. Pathological personality traits in the following domains:

1. Antagonism, characterized by:

- a. Manipulativeness: Frequent use of subterfuge to influence or control others; use of seduction, charm, glibness, or ingratiation to achieve one's ends.
- b. Deceitfulness: Dishonesty and fraudulence; misrepresentation of self; embellishment or fabrication when relating events.
- c. Callousness: Lack of concern for feelings or problems of others; lack of guilt or remorse about the negative or harmful effects of one's actions on others; aggression; sadism.
- d. Hostility: Persistent or frequent angry feelings; anger or irritability in response to minor slights and insults; mean, nasty, or vengeful behavior.

2. Disinhibition, characterized by:

- a. Irresponsibility: Disregard for – and failure to honor – financial and other obligations or commitments; lack of respect for – and lack of follow through on – agreements and promises.
- b. Impulsivity: Acting on the spur of the moment in response to immediate stimuli; acting on a momentary basis without a plan or consideration of outcomes; difficulty establishing and following plans.
- c. Risk taking: Engagement in dangerous, risky, and potentially self-damaging activities, unnecessarily and without regard for consequences; boredom proneness and thoughtless initiation of activities to counter boredom; lack of concern for one's limitations and denial of the reality of personal danger.

C. The impairments in personality functioning and the individual's personality trait expression are relatively stable across time and consistent across situations.

D. The impairments in personality functioning and the individual's personality trait expression are not better understood as normative for the individual's developmental stage or socio-cultural environment.

E. The impairments in personality functioning and the individual's personality trait expression are not solely due to the direct physiological effects of a substance (e.g., a drug of abuse, medication) or a general medical condition (e.g., severe head trauma).

F. The individual is at least age 18 years.'(American Psychiatric Association 2013)
Should such a definition replace the current one in use, it is likely that fewer individuals would receive a diagnosis of ASPD.

Dissocial Personality Disorder

This personality disorder is described in ICD-10 as 'usually coming to attention because of a gross disparity between behaviour and the prevailing social norms'. It is characterized by:

- 'Callousness unconcern for the feelings of others
- irresponsibility and disregard for social norms, rules and obligations;
- incapacity to maintain enduring relationships, though having no difficulty in establishing them;
- very low tolerance to frustration and a low threshold for discharge of aggression, including violence;
- incapacity to experience guilt or to profit from experience, particularly punishment;
- marked proneness to blame others, or to offer plausible rationalizations, for the behaviour that has brought the patient into conflict with society' (WHO, 1992).

There may also be persistent irritability as an associated feature. Conduct disorder during childhood and adolescence, though not invariably present, may further support the diagnosis. This definition specifically includes 'psychopathic personality

disorder' (WHO, 1992). Unlike ASPD, it does not include concepts of deceitfulness, impulsivity or recklessness, although low tolerance of frustration is mentioned.

Definitions of ASPD (DSM version IV and 5) and of Dissocial Personality Disorder therefore overlap, including concepts of irritability and aggressiveness, lack of remorse and irresponsibility. However, they are not identical. For example, ICD-10 refers to lack of emotional empathy (unconcern for the feelings of others) and incapacity to maintain relationships, while DSM mentions repeated lying and conning, impulsivity and reckless disregard for the safety of self and others. Childhood conduct disorder is required for DSM.

Prevalence of ASPD/Dissocial Personality Disorder

Estimates of the prevalence of these personality disorders vary. This variation is likely to reflect differing study methodologies as well as possible real differences across populations (Coid et al., 2006b). An interview-based study in the UK found a community prevalence of ASPD of 0.6% (Coid et al., 2006b), while a self-report study showed a community prevalence of 4% (Coid et al., 2006a). Both showed a higher prevalence in men than in women.

Surveys of offender populations find high rates of personality disorder, particularly the antisocial disorders. In one systematic review across several countries, 47% of male prisoners were estimated to have ASPD while amongst female prisoners the rate was 21% (Fazel and Danesh, 2002). 63% of male remand, 49% of male sentenced, and 31% of female prisoners were estimated to have ASPD in England and Wales (Singleton et al., 1998). A study in one Scottish prison estimated that more than 80% of the male prisoners had the disorder (Bartlett et al., 2001).

Studying the antisocial personality disorders

Dissocial personality disorder has been less researched than ASPD (De Brito and Hodgins, 2009), but studies of both of these disorders are made difficult by the fact that individuals with antisocial personality disorders are less likely to take part in

research than the rest of the population (Hodgins et al., 2007). Such studies are also complicated by psychiatric comorbidity. Substance misuse and anxiety in particular are common in this group.

Comorbidity

A lifetime prevalence of anxiety of 54% for the 3.3% of adults in the community with ASPD was estimated from the National Comorbidity Survey, a community epidemiological study (n=5,877) in the United States. Adults with ASPD and comorbid anxiety had significantly higher levels of comorbid major depression, alcohol dependence, and substance dependence and significantly higher rates of lifetime suicidal ideation and suicide attempts compared to adults with ASPD or anxiety disorders alone or with neither disorder.(Goodwin and Hamilton, 2003). Using DSM III criteria, a study of men with ASPD in US prisons found that two-thirds had a lifetime anxiety disorder, of whom 50% had early onset of the anxiety disorder (under 16 years old). Offenders with ASPD and comorbid anxiety disorder had more ASPD symptoms, more substance misuse symptoms, more suicidal ideation and attempts, and more had been convicted of ‘serious crimes involving interpersonal violence’ (Hodgins et al., 2010).

The frequent comorbidity between substance misuse disorders and ASPD was demonstrated in a large (N=43093) epidemiological study in the United States. In the 3.6% of adults with ‘adult antisocial disorders’ which included ASPD (DSM-IV), conduct disorder without antisocial behaviour (a childhood precursor of ASPD) and ‘adult antisocial behaviour’, the prevalence of alcohol use disorders was 30% (42% in men, 19.5% in women) and drug use disorders was 10%(Compton et al., 2005). Such strong associations led the authors to suggest a common aetiology for ASPD and substance misuse disorders.

Relationship with offending

ASPD is strongly associated with antisocial behaviour, violence and criminal recidivism. A large international meta-analysis found, for example, an odds ratio of 12.8 for violent outcomes in ASPD (Yu et al., 2012). A self-report UK community study (Coid et al., 2006a) also found strong associations between a diagnosis of ASPD and repetitive violence causing injury towards strangers, family members and police. However, to have ASPD is not necessarily to be violent. In the same UK study, although more than 25% of those with the diagnosis reported having injured someone violently in the last 5 years, half did not report any violence in that period. A strong relationship between ASPD and offending is reflected in the high prevalence of ASPD in prison populations (Singleton et al., 1998), and the relationship between ASPD and violence is particularly strong in women (Yu et al., 2012).

Although studies of ASPD usually focus on harm to others, ASPD is also harmful to those with the disorder. These individuals are more likely to be injured than the rest of the community (Coid et al., 2006a) and have higher mortality rates than the population even when controlling for age and gender (Black et al., 1996).

Psychopathy

Psychopathy is a mental disorder with affective, interpersonal and consequent behavioural components which was described in non-forensic psychiatric patients by Cleckley (Cleckley, 1941). The concept of psychopathy is old and transcultural. A 'moral' form of insanity was described by Pritchard 1835, and a pattern of personality traits and behaviours resembling psychopathy has been recognised across cultures, for example in the Inuit and the Yoruba of Nigeria (Murphy, 1976).

The label is used to describe individuals who are 'impulsive sensation seekers, cold, lacking in remorse and the ability to learn from experience (respond to punishment), grandiose, insincere, unconscientious and antisocial' (Bishopp and Hare, 2008).

Cleckley described 'poverty of affective reactions', as he considered based upon observations that psychopaths do not experience the normal range and intensity of emotions (Pham and Philipot, 2010) .

Psychopathy is at present conceptualised as a form of personality disorder. Included under dissocial personality disorder in ICD-10, it is not specifically mentioned in DSM IV or V (although the alternative model of ASPD in DSM-V is thought to be closer to the concept of psychopathy as it describes some of the same personality characteristics (Glenn et al., 2013)).

PCL-R

A method of measuring psychopathy, the Psychopathy Check List-Revised (PCL-R) (Hare, 2003), was developed on criminological samples using the Cleckley criteria (Hare and Neumann, 2006) and is in wide use both in clinical practice and research.

The PCL-R measures both personality traits and criminal behaviours, and was originally divided into two subfactors. - 1. 'selfish and callous' is affective and 2. 'socially deviant' is behavioural (Hare, 1991). Individuals scoring above 30 in North America are considered for research purposes to be psychopathic (Hare and Neumann, 2006). However, other cut-off scores are commonly used. In Europe a score of 25 is often chosen.

Further factor analysis of the PCL-R has led to three- and four-factor models of the instrument which separate the antisocial behaviour component from the affective (lack of emotion/affect, lack of remorse or guilt, shallow affect, callous/ lack of empathy, failure to take responsibility for own actions) and interpersonal (glibness, manipulateness, grandiose) aspects. While some consider that antisocial behaviour is essential to the construct of psychopathy (poor behavioural controls and severe versatile antisocial behaviour) (Hare and Neumann, 2006) others see antisocial behaviour as a common consequence of the core features of the personality (manipulative personal style and affective deficits) (Cooke et al., 2004). This analysis has led to the concept of the 'non-criminal' or 'successful' psychopath.

These individuals have a psychopathic personality structure but do not have a criminal lifestyle (Gao and Raine, 2010). It has also been argued that psychopathy should be a dimensional concept, like other personality disorders, best seen as consisting of a cluster of personality traits on a continuum of severity (Edens et al., 2006). This argument has allowed the study of psychopathic traits in non-criminal healthy populations such as university students.

Although the PCL-R dominates the field of assessment of psychopathy other measurements have been developed. These include the Psychopathic Personality Inventory (PPI) a self-report instrument (Lilienfeld and Widows, 2005), and derivations of the PCL-R such as the Psychopathy Checklist: Screening Version PCL:SV (PCL: SV) (Hart et al., 1995); and Youth Version (PCL:YV) (Forth et al., 2003).

The factor structure of these assessment tools means that a particular score can be reached in more than one manner. In the two factor model for example a relatively high score can be achieved through either scoring highly on antisocial behaviour or on affective characteristics. This is a reason for using only those scoring above diagnostic cut-offs as a 'psychopathic' group in studies.

Relationship between psychopathy and the antisocial personality disorders

The relationship with ASPD is unclear. A subgroup of those with antisocial personality disorders will also meet criteria for psychopathy, but many will not, while most individuals with a high score on the PCL-R will meet criteria for the personality disorders (Hare, 2003). ASPD is strongly associated with Factor 2 (socially deviant) and weakly with Factor 1 (affective and interpersonal) of the PCL-R and it is argued that they are not therefore not the same phenomenon (Hare and Neumann, 2006), although ICD-10 includes more Factor 1 traits. A cluster analysis in a sample of offenders with ASPD suggested that there were four subtypes, one of which was described as 'non-psychopathic ASPD' (Poythress et al., 2010). There is some structural (Gregory et al., 2012) neuroimaging evidence of differences between men with ASPD and psychopathy and ASPD without psychopathy. However, others

consider psychopathy to be a severe form of ASPD with the same underlying pathology, as is implied in DSM and ICD (Coid and Ullrich, 2010).

This debate is important for studies of ASPD and psychopathy. Studies of ASPD which do not also assess psychopathy may be studying heterogeneous groups which include some psychopathic individuals and some without psychopathy. It is possible that studies of ASPD have in fact found differences from healthy populations solely due to the effects of the psychopaths in the sample, or that studies of psychopaths are in fact studies of severe ASPD.

Prevalence of psychopathy

In the UK 7.7% male and 1.9% female prisoners in England and Wales were estimated to have psychopathy, using a PCL-R cut off of 30 (Coid et al., 2009b). This contrasts with an estimate of prevalence in US prisoners of 39% (Cooke and Michie, 1999). Psychopathy is rarer in the community, estimated to affect less than 1% of the household population in the UK (Coid et al., 2009a). As with the antisocial personality disorders, this measure finds a higher prevalence in men.

{Cooke, 1999 #118}

Relationship with violence/ offending

Studies of the relationship between psychopathy and violence and offending are carried out mostly in offender populations. Within offender populations, psychopathy has a strong relationship with both instrumental and reactive violence (Cornell et al., 1996). PCL-R scores predict violence and violent and general recidivism (Hare et al., 2000) and are used clinically as a violence risk assessment instrument.

Conduct Disorder

Conduct disorder is a disorder of childhood, recognised in DSM as a pattern of repetitive and persistent behaviour characterized by the violation of the rights of others or of major age-appropriate norms. Criteria are subdivided into categories of aggression to people and animals, destruction of property, deceitfulness or theft, and serious violations of rules (American Psychiatric Association, 2013b), and into early

and late onset types. DSM –5 also adds a descriptive specifier of ‘a more severe form of the disorder with limited prosocial emotions’ in which individuals show more serious behaviour, have a callous and unemotional inter-personal style and show little empathy. It suggests that this group will show a different response to treatment. ICD-10 describes the conduct disorders, and notes that in some cases conduct disorders ‘may proceed to dissocial personality disorder’ (WHO, 1992). Conduct disorder is commoner in boys, and prevalence in the UK is estimated at 7.4% of boys and 3.2% of girls (Meltzer et al., 2000).

Children and adolescents with antisocial behaviour and poor impulse control, who meet criteria for conduct disorder, are often separated for research purposes into those in whom callous-unemotional (CU) traits are additionally present or absent. This is now reflected in DSM’s descriptive specifier. Children with callous-unemotional traits show low empathy, shallow affect and callous use of others and are at higher risk of extreme antisocial behaviour (Frick and Dickens, 2006). CU traits are often treated as the equivalent of psychopathic traits for research purposes, they show high heritability (Viding et al., 2013) and show stability across several years, (Frick and White, 2008) while conduct disorder is more heterogeneous.

Aetiology of the antisocial personality disorders

Causes of antisocial behaviour, conduct disorder, ASPD and psychopathy continue to be proposed and debated. It has long been clear that crime runs in families (Farrington et al., 2001) (Frisell et al., 2010), but the relative roles of genetic and environmental factors in this have been less clear. Antisocial behaviour appears to be heritable to some extent (Rhee and Waldman, 2002) , and some genes have been identified in ASPD although many are involved (Kendler et al., 2012). Environmental risk factors in studies are often confounded by the antisocial nature of parents (gene environment correlations). There is also a role for genotype-environment interaction. For example, boys with a genotype for low levels of the enzyme MAO-A were more likely to develop antisocial behaviour than boys with

other alleles, but only when exposed to childhood maltreatment (Caspi et al., 2002). However, some environmental factors such as childhood maltreatment also appear to independently increase risk of lifetime antisocial behaviour (Jaffee et al., 2012).

Several models of psychopathy have been proposed, based upon the characteristics of psychopathy and investigations that have demonstrated differences between groups with psychopathy (and children with callous unemotional traits) and those without. Some models have included a focus upon difficulties in attending to peripheral information (response modulation theory) (Baskin-Sommers et al., 2011). Others have examined emotional processing deficits in psychopathy. Emotional processing deficits are demonstrated by reduced autonomic response to others' pain or distress, reduced recognition of facial expressions, reduced aversive conditioning, and difficulties in reinforcement based decision making (Blair, 2013b).

Early theories, such as that of Lykken (Lykken, 1957), cited in Fowles and Dindo (2007), concentrated upon the lack of response to or fear of punishment in psychopaths. This was based upon studies showing a lack of fear conditioning in psychopaths, and was thought to suggest that a socialisation process did not correctly occur (Fowles and Dindo, 2007). The 'Paralimbic Hypothesis', based upon cognitive and linguistic abnormalities, as well as functional imaging data, suggests dysfunction in amygdala, orbitofrontal cortex, cingulate cortex, parahippocampus and insula in psychopathy, as well as regions of the temporal pole (Kiehl, 2006).

An alternative model, 'Integrated Emotions Systems' (IES), described by Blair (Blair, 2005), is based upon imaging data and altered function of brain regions. It focuses upon the amygdala, which has been shown experimentally to be dysfunctional in psychopathy (Patrick et al., 1993). The amygdala is required for aversive conditioning and processing facial expressions, particularly fear. Blair suggests that the lack of emotional empathy in psychopathy (responding to the emotions of others) is a result of amygdala and ventromedial prefrontal cortex (vmPFC) deficits.

According to Blair's model, in healthy individuals perception of distress cues will activate the amygdala. This will lead to increased arousal and will increase attention to the cue, and an association will be made with objects in the environment, such as the negative response of a care giver. This is required for normal socialisation and development of guilt. In psychopaths or callous unemotional children the amygdala shows a reduced response to distress cues such as fearful faces, and does not facilitate the learning to associate them with negative outcomes. Thus the appropriate associations with environmental feedback are not developed and antisocial behaviour is not avoided in the future. Blair also suggests that the increased risk of reactive aggression that is found in psychopathy results from a different mechanism to the increased risk of reactive aggression found in other reactively aggressive groups, such as those with ASPD. In psychopathy, he suggests, reactive aggression is results of decision-making deficits associated with ventromedial prefrontal cortex and striatal abnormalities (Blair, 2013a). In contrast, he suggests, increased risk of reactive aggression in mental disorders such as ASPD is a result of hyper-arousal of the amygdala to threat. Such hyper-arousal may be a result of environmental influences, such as abuse, during childhood as well as deficits in the prefrontal cortex's normal role of reducing activation in the amygdala..

Other disorders associated with antisocial behaviour

Other mental disorders are also associated with offending behaviour and violence. Risk of violence in substance misuse is similar to that of ASPD (Fazel et al., 2009b). To a lesser extent, schizophrenia (Fazel et al., 2009a), bipolar disorder (Fazel et al., 2010) and personality disorders other than ASPD are also associated with increased risk of violence, although the role of co-morbid substance use appears to be significant (Yu et al., 2012). Intermittent Explosive Disorder has been studied less frequently, but it has been suggested that rates of aggression and violence are higher than in ASPD (Coccaro, 2012).

Social Cognition

There is a great deal of interest among neuroscientists and psychologists in understanding the biological processes underlying social processes. Within the discipline of social cognitive neuroscience, neuroimaging and neuropsychological testing have been used to examine such processes (Lieberman, 2007). Social cognition refers to ‘processing that is elicited by, about, and directed towards other people’ (Kennedy and Adolphs, 2012). These processes allow us to infer other peoples’ intentions, feelings and thoughts and may be uniquely human (Adolphs, 2009).

Several types of social cognition have been identified. These include social perceptual processes (including facial recognition and processing and interpreting others’ intentions) attributional processes (explaining and understanding others’ behaviour, including theory of mind, empathy) and social categorisation processes (including schemas and stereotypes) (Forbes and Grafman, 2010).

Processing of facial emotions

Making judgements about the faces of others is an important aspect of social cognition. Such judgements include facial identity, complex social judgements such as intelligence, and emotion recognition. There are thought to be six basic emotions which are universally displayed and recognised across cultures: happiness, sadness, anger, fear, surprise and disgust (Ekman, 1993). Recognition of these emotions requires both the perception of a particular configuration of facial features, and recognition of their emotional meaning (Adolphs, 2002).

Emotional facial signals convey significant social information to others. This information not only relates to the individual’s internal mental state, but provides important information about threat (Frith, 2009). A fearful expression suggests a possible environmental threat, while anger suggests a direct threat to the perceiver from the individual (Marsh et al., 2005). Experimentally, in healthy subjects, facial expressions of anger act as an aversive stimulus, (a stimulus leading to avoidance-

based behaviour), while a fearful expression leads to approach-related behaviour in the perceiver, despite the suggestion of local threat in the environment (Marsh et al., 2005).

Facial emotion processing is complex and involves many neural structures (Adolphs, 2002). Lesion studies have suggested particular brain areas might be associated with deficits in facial emotion recognition. For example, individuals with amygdala lesions have shown deficits in fear recognition and sometimes also in anger, disgust, and sadness (Adolphs, 2002). However, they have also shown the ability of individuals with large brain lesions to continue with apparently unaffected emotional functioning. Functional imaging studies have demonstrated increased activation in several parts of brain during facial emotional processing tasks, and it is concluded that all are involved in processing emotional faces. These include visual, limbic, tempero-parietal and prefrontal areas, putamen and cerebellum (Fusar-Poli et al., 2009). Different patterns of activation have been described for processing different emotions, with happy, fearful and sad faces specifically activating the amygdala, and disgust and anger, the insula, although there is a considerable degree of overlap in these patterns across studies and these data do not demonstrate that these particular regions are necessary for the processing of these particular emotions (Barrett and Satpute, 2013). Differences in regional activation depending upon whether the processing is implicit (without conscious awareness) or explicit, and the age and sex of the subject have also been described (Fusar-Poli et al., 2009).

Studies of facial emotional processing where individuals are explicitly asked to identify facial emotions often use standardised facial stimuli sets such as those by Ekman and Friesen (Ekman and Friesen, 1976). Such studies have demonstrated that on average females are better than males at identifying facial emotion (Thayer and Johnsen, 2001).(Hall and Matsumoto, 2004). Explicit facial affect recognition ability in healthy controls appears to relate to IQ (Mukherjee et al., 2011) and to aspects of general cognitive ability, such as information processing speed, impulsivity/inhibition and working memory capacity (Mathersul et al., 2009). It is

also affected by age, with adolescents and young adults performing more accurately than children and older adults (Williams et al., 2009).

Impaired facial emotion recognition has been demonstrated in diverse clinical conditions, including schizophrenia (Marwick and Hall, 2008) and Huntington's disease (Sprengelmeyer et al., 1996). There are studies suggesting deficits in facial emotion recognition in autism spectrum disorders (Philip et al., 2010), but others showing no deficit (Jones et al., 2011). In addition, deficits in emotion recognition have been related to particular genetic polymorphisms, for example *met* allele carriers for the BDNF gene in healthy controls are impaired in explicit recognition of facial fear (Mukherjee et al., 2011). Deficits associated with clinical conditions may be across all facial emotions. However, recognition of particular emotions only may be impaired, such as disgust in Huntington's disease, (Sprengelmeyer et al., 1996). This is likely to occur because recognising individual emotions each requires activity in a specific brain regions which may affected by a particular condition.

Social cognition in antisocial groups

Antisocial individuals interact with the social world around them in ways different to the rest of the population. Their social behaviour, with consequent distress and financial cost to others, has led to an interest in the examination of how such individuals perceive and interpret social signals and make decisions relating to their own actions and behaviour.

The suggestion that the brains of antisocial individuals may differ from others is longstanding, as evidenced by the case of Phineas Gage. In this nineteenth century case one individual reportedly developed personality change, in particular becoming more antisocial while continuing otherwise to function adequately, following injury to prefrontal cortices of his brain, (Damasio et al., 1994).

At an experimental level, differences between antisocial and control groups have been demonstrated behaviourally, on physiological testing (discussed below), and using neuroimaging (for review of this literature see Chapter 3.5). In addition, our

understanding of the influence of genetics in accounting for variance in antisocial behaviour continues to improve (Moffitt, 2005).

An interest in measuring social cognition in antisocial groups in comparison with controls comes from two broad perspectives, criminology and clinical science: and both in the context of knowledge that a small number of individuals are responsible for a large proportion of violent crime (Farrington et al., 2001).

The criminological study of violent offenders comes from a tradition primarily interested in how characteristics of antisocial individuals relate to offending, and therefore are risk factors for violence or offending. Biological factors, including deficits in social cognition, are considered along with other characteristics including relationship, social, cultural and environmental factors (Gannon, 2009). The underlying goal of this work is to predict and prevent offending and violence.

Typologies of offenders have been described which are categorised by their patterns of offending. One example of this is a developmental taxonomy (Moffitt, 1993) which separates offenders into life-course persistent offenders (in whom it is hypothesised that neuropsychological deficits interact with environmental factors) and adolescence-limited offenders who are peer influenced and do not offend as adults (hypothesised to show demonstrate fewer neuropsychological deficits). Offenders are also categorised by offence type. An example of this is a model in which individuals who offend sexually against children are likely to lack empathy or social cognition skills (Marshall et al., 1995).

The second tradition associated with investigating the social cognition of antisocial groups is associated with the clinical and behavioural sciences of neuroscience, psychology, and psychiatry. This perspective has focused upon the relationship between clinical syndromes and deficits in social cognition, in order to further understand the underlying pathology. It is informed by the study of other disorders such as autism, and there is a particular emphasis in the literature on psychopathy. Aims of such studies include understanding the development of these disorders in

order to identify preventative strategies, therapeutic targets, or biomarkers for treatment monitoring.

Studies of social cognition in antisocial groups

Studies of social cognition, including facial emotion processing, have been constructed depending upon which tradition the authors follow. Criminologists have studied groups defined by social and behavioural labels, such as ‘offenders’ or ‘prisoners’. Such groups have therefore usually both been violent and been convicted under criminal law. They may divide subjects into categories by the type of offence committed such as ‘sex offenders’, ‘child molesters’, ‘non-sexually violent offenders’.

In contrast, those from the clinical sciences divide subjects by diagnosis. Such studies are therefore of groups meeting diagnostic criteria for, for example, psychopathy or dissocial personality disorder. Alternatively, they may examine healthy populations in which levels of personality traits such as those relating to psychopathy are measured.

These differing approaches are reflected in the research literature, and as a result studies of social cognition are heterogeneous in methodology and theoretical background. In practice, the study groupings overlap, as many offenders have personality disorders or psychopathy and many individuals with antisocial personality disorder or psychopathy will be violent and/or offenders.

Many such studies draw their subjects from institutions such as prisons or hospitals. A problem common to all such studies is that non-criminally convicted or non-custodially sentenced antisocial or violent individuals are under-represented. To be an offender requires detection and conviction as well as antisocial behaviour, and the mentally ill, learning disabled, and ‘unsuccessful’ criminals who are more likely to be caught are likely to be over-represented in research samples. Other limitations are differing concepts of antisocial behaviour and differing definitions for commonly-used terms such as ‘violence’ and ‘aggression’.

Studies of facial emotion recognition in antisocial groups

A literature review was completed in order to identify studies which examined facial emotion recognition in antisocial groups, including groups defined by either diagnosis or behaviour.

Electronic databases used: OVID Medline, psycARTICLES, AMED, Embase, Medline in process and Psychinfo Searches were completed in November and December 2011.

Limits: English language, humans

Keywords:

Facial emotion	Offender
Social cognition	Antisocial
Ekman	Psychopath(y)
Facial expression	Dissocial
Emotion	Prisoner
Fear recognition	Violent
Callous	Criminal
Conduct disorder	

4125 records were identified through database searching, and 767 remained after deduplication. 723 records were excluded or ineligible through hand sorting.

Forty six papers were included. Forty four individual studies and two meta-analyses were reported. A repeat search was performed in 2014 which identified two further relevant papers. These studies are summarised in Appendix B and discussed below.

Individual Studies

Samples

14 studies examined groups of adults defined using behavioural criteria; 14 groups using diagnostic criteria, and 18 in total examined children and adolescents, defined either behaviourally or with diagnostic tools.

The studies are extremely heterogeneous. The studies defining groups by their behaviour include groups of violent offenders, sex offenders, non-violent offenders, prisoners, 'child molesters', 'abusive mothers', 'aggressive mentally-retarded patients', and 'Intimate-Partner-Violent' men of different types. These groups are often not clearly defined. There are particular issues about definition in sex offenders, as sex offences are often classified as violent offences and so sex offenders may be included in a violent offender group (Hoaken et al., 2007) or examined separately (Hudson et al., 1993).

The studies defining groups clinically all use a diagnostic instrument. This means that the exact nature of the choice of participants is clearer. However, again the studies are heterogeneous in this regard. Antisocial personality disorder (DSM) and dissocial personality disorder (ICD) are used, and different studies use different iterations of the classifications systems. Psychopathic groups are defined by PCL-R in several cases, but diagnostic cut-off scores chosen vary, meaning that the groups may not be directly comparable. Psychopathy is also measured in studies using the PCL: SV and BIS-BAS scales (Carver and White, 1994). Several self report instruments are used to measure psychopathy, such as Levenson's Self Report Psychopathy Scale (LSRP) (Levenson et al., 1995) and the Hare Self report of psychopathy III (SRP-III) (Paulhus et al., 2009). These studies include highly psychopathic populations such as North American prisoners, and low-psychopathy groups such as university students separated into groups by levels of self-report psychopathic traits. These differences can mean that one study's psychopath would be in another's control group.

Studies of children and adolescents are equally heterogeneous in their selection criteria. While none include adult personality disorder, groups include those diagnosed with conduct disorder (using ICD or DSM criteria) and those with or without callous unemotional traits.

Most of the studies are on men, however some are of women or girls, and some are mixed. Sex is important in this context both because females overall are more accurate at recognising facial emotions as discussed above, and because psychopathy and antisocial behaviour are likely to be expressed differently in women from men (Snowden et al., 2013, Kreis and Cooke, 2011)

Several of the studies do not measure or account for IQ in their analysis. There is a positive association between low IQ and antisocial behaviour (Hodgins, 1992), and individuals with low IQ are over-represented in forensic populations (Singleton et al., 1998). Lack of accounting for IQ in antisocial populations is likely to lead to confounding, as low IQ is associated with poorer facial emotion recognition ability as above.

In addition, many of the studies include or do not assess for individuals with other mental disorders known to affect facial emotion recognition. For example, traumatic brain injury is also commoner in forensic populations (Shiroma et al., 2012) and associated with deficits in facial emotion recognition (Radice-Neumann et al., 2007), and few studies account for this. Schizophrenia is another disorder over-represented in forensic populations (Fazel and Baillargeon, 2011) and associated with deficits in facial emotion recognition (Hall et al., 2004). Not addressing this factor can also lead to misleading results when comparing forensic groups with community controls.

Maltreatment and facial affect recognition deficits are addressed in one study. There is some evidence that severely abused children differ in facial emotion perception from matched controls, for example in over-identifying anger (Pollak and Kistler, 2002). In addition it is known that childhood physical maltreatment predicts antisocial behaviour and appears likely to have a causal role in this (Jaffee et al.,

2004). In addition, studies of male prisoners with psychopathy have shown that they are more likely to have experienced abuse as children (Marshall and Cooke, 1999). In girls with conduct disorder, Pajer et al (Pajer et al., 2010) found an association between abuse and fear recognition but not a diagnosis of conduct disorder. Callous unemotional traits were not examined.

Tasks

The tasks used vary across studies. The commonest task used is Ekman and Friesen's Pictures of Facial Affect (Ekman and Friesen, 1976) which shows six emotions in a forced choice task. However, some of the tasks used extend or reduce this range of emotions. Others use different intensities of emotions. Some tasks use different stimuli including children's faces and cartoons of faces, and allowed open-ended responses. Again, this heterogeneity makes meaningful comparison of the studies difficult.

Finally, most sample sizes are small, and many studies are likely therefore to be underpowered.

Results of individual studies

Given the many heterogeneities across these studies it is unsurprising that the results are also heterogeneous. Among adults there are results which suggest that violent and sexual offenders are worse at recognising a range of emotions, and also studies suggesting that they are better at emotion recognition than controls. Studies suggest that adults with ASPD may be worse than controls at facial emotion recognition, and studies of psychopathy vary in their results. Child and adolescent studies also show heterogeneous results. A study on female adult psychopaths demonstrated a worse performance on emotion recognition than controls, in keeping with studies on male psychopaths (Eisenbarth et al., 2008), while a study of *abusive mothers* demonstrated difficulties in labelling anger and fear on the faces of babies (Kropp and Haynes, 1987).

Some studies have attempted to differentiate between ASPD and psychopathy, or in children and adolescents, conduct disorder and callous-unemotional traits. Dolan and Fullam (Dolan and Fullam, 2006) measured both dissocial personality disorder and psychopathy in a sample of offenders, finding that dissocial personality disordered men performed worse than controls in total facial recognition ability, and that psychopathy was associated with a deficit in recognising sadness. Several studies separate conduct disorder from callous unemotional traits, for example Woodworth and Waschbusch (Woodworth and Waschbusch, 2008), Fairchild (Fairchild et al., 2009) (Fairchild et al., 2010) and Dadds (Dadds et al., 2006), again with heterogeneous results.

Dadds' 2006 study (Dadds et al., 2006) further examines the nature of the fear recognition deficit he identifies in children with callous unemotional traits, finding that the recognition deficit disappears when the children are instructed to look at the eyes of the face, but remains when they are instructed to look at the mouth (as is also the case in individuals with amygdala lesions (Adolphs et al., 2005)). Dadds has since demonstrated that young children with high levels of callous unemotional traits do not make normal eye contact with mothers in comparison with children with low levels of these traits (Dadds et al., 2012a). The authors suggest that the underlying cause of the abnormal eye gaze which leads to the recognition deficit is amygdala dysfunction, and argue that this supports a hypothesis that lack of attention to the eyes of attachment figures is an early developmental characteristic of children with callous-unemotional traits and leads to abnormal development of empathy and conscience.

Iria and Barbosa (Iria and Barbosa, 2009) examined 4 groups of men: criminal psychopaths as defined using PCLR-SV (Hart et al., 1995); non-criminal psychopaths; criminal non-psychopaths and non-criminal non-psychopaths. Age and years of education were controlled for. A deficit in facial fear recognition was found in psychopaths in both groups, in comparison to non-psychopaths. Criminals were worse than non-criminals among psychopaths and among non-psychopaths (ie criminal psychopaths > non-criminal psychopaths > criminal non-psychopaths > non-criminal non-psychopaths). They concluded that a deficit in the ability to recognise

fear was ‘not a decisive condition for the development of criminal behaviour’ as it was found in the non-criminal psychopaths also, and that the deficit in fear recognition was psychopathy specific.

Meta-analyses

A meta-analysis of 20 studies of processing facial affect in antisocial populations, both defined behaviourally and by a range of clinical instruments incorporated 1244 participants (Marsh and Blair, 2008). The authors concluded that there is a ‘robust link’ between antisocial populations and impaired recognition of facial fear expressions (also sadness, but the fear deficit was significantly larger). They did not find reliable impairments in surprise, happiness, anger or disgust. The authors also concluded that the fear deficit did not result from task difficulty, as the antisocial groups differed significantly from controls. The deficit did not have a relationship with measures of psychopathy, age or gender. The authors speculated that the deficits described may relate to amygdala dysfunction.

A separate meta-analysis (Wilson et al., 2011) examined 22 studies (published and unpublished) on facial affect recognition. This study examined psychopathy only, and included both institutional and community samples. This study also sought to examine why some studies reported no deficit in facial emotion recognition in psychopathic groups. It aimed to examine two neurobiological models of psychopathy a model of amygdala dysfunction (Blair, 2005) and a model of deficits in left hemispheric activation (Hare and Jutai, 1988). The authors investigated whether response style affected outcome, suggesting that studies using a verbal response would show poorer affect recognition in psychopaths, as this style is dependent on left hemispheric linguistic activity (Wilson et al., 2011). This meta-analysis found very small deficits in recognition across all emotions in psychopaths. The deficit was larger for fear and for sadness, with a larger again deficit in verbal responses for fear, anger and sadness (emotions processed in the amygdala). The authors stated that the findings that emotion recognition deficits are present in psychopathy and that for some emotions (those processed in the left amygdala) verbal processing can exacerbate this deficit did not fully support either model.

Authors' interpretations of the study results

Interpretation of the literature describing facial emotion recognition in antisocial groups in general is made according to the authors' tradition. The dominant model for the clinical sciences, where one is referred to by the authors of these studies, is Blair's Integrated Emotional Systems model, as described above. This is the case whether the authors suggest that their results support the model, for example Dolan and Fullam (2006) and Montagne et al. (2005) or contradict it (Glass and Newman, 2006, Pham and Philipot, 2010). The authors of one study suggest that their results support Kiehl's model also (Kosson et al., 2002). However, criminologists and some clinicians refer to the model of hostile attribution bias described by Crick and Dodge (1994), for example Hall (2006) and Dadds et al. (2006).

This model (HAB) directly relates social cognition to aggression and violence. Findings on social cognition are placed within a model of social information processing (SIP)(Crick and Dodge, 1994), in which children perform a series of mental operations when processing social information including interpreting stimuli, setting goals, formulating and evaluating responses and enacting behaviour. According to this model a characteristic SIP style demonstrates selective attention to hostile cues and ambiguous cues are perceived as threatening (hostile attributional style- HAS). Individuals with an aggressive response evaluation and decision (RED) style expect positive outcomes from social responses such as aggression and violence, (Dodge et al., 1986). (Crick and Dodge, 1994) (Fontaine et al., 2009). HAS is hypothesised to relate to reactive aggression while aggressive RED style correlates with instrumental aggression (Crick and Dodge, 1996). It is hypothesised that early maltreatment, peer rejection, exposure to relationship violence and genetic factors contribute to this form of social information processing (Dodge, 2011). The model was developed in children and adolescents but has been applied to adult offenders and psychopaths (Vitale et al., 2005). A meta-analysis (41 studies) of relationship between HAS and aggression in children found heterogeneous results but a significant relationship between this attribution style and aggressive behaviour (Orbio de Castro et al., 2002).

Studies which describe their results as supporting a HAB model include those demonstrating poor overall facial emotion recognition, as well studies relating antisociality to the misattribution of anger to neutral faces, for example Dadds et al. (2006).

More complex social judgements from faces

There is evidence of abnormal abilities to make more complex social judgements from faces, such as approachability and trustworthiness, in disorders such as schizophrenia ((Hall et al., 2004), (Baas et al., 2008)) and ASD, and in individuals with bilateral amygdala damage (Adolphs et al., 2001). Despite these groups also showing facial emotion recognition deficits, fewer studies have been carried out on facial judgements other than facial emotion in antisocial groups.

Patients with bilateral amygdala lesions and patients with schizophrenia and with ASD have difficulty in making judgements of trustworthiness (Adolphs et al., 1998) (Adolphs et al., 2001) (Hall et al., 2004). Trustworthiness judgements are known to activate bilateral amygdala, orbito-frontal cortex and superior temporal cortex on fMRI (Winston et al., 2005).

One study examined 19 age- and IQ-matched psychopathic (30 and above on PCL-R) and 19 non-psychopathic men (20 or below on PCL-R) from a forensic institution in making judgements of facial trustworthiness (Richell et al., 2005). A subgroup (11, 11) of the men also rated emotional faces (angry, fearful, happy, and sad). Ratings of trustworthiness did not differ between the psychopaths and non-psychopaths. In both groups trustworthiness judgements correlated negatively with judgements of anger. This finding related this complex judgement of trustworthiness to the judgement of a basic emotional expression. The authors therefore suggested that the lack of relative deficit in trustworthiness judgements in this psychopathic group is because of the lack of an anger processing deficit in psychopathy.

In conclusion, there is clear evidence for deficits in facial emotion recognition in antisocial groups. There is no evidence for behavioural deficits in complex social

judgements, but only one such study has been described. These studies are heterogeneous in their methods, types of subjects, or findings. Their results have been used to argue for several theoretical models for aggression and violence, none of which is entirely proved or disproved by evidence described above.

3.2 Study 2. Facial Emotion Recognition in Prisoners

Introduction

The ASD screening study described in Chapter 2 provided data on emotion recognition in a sample of Scottish prisoners. It was noted that scores on the emotion recognition task appeared low, particularly for negative emotions such as anger and fear. There was no evidence that individuals with ASDs, who are known to have facial emotion recognition deficits,(Philip et al., 2010), were over-represented in this group. However, antisocial groups such as prisoners have been shown to differ from controls in such judgements. In order to investigate the hypothesis that this offender group show similar deficits to other antisocial groups, scores were compared with age, sex and IQ-matched community controls. Since this group is defined by its criminal history, offending characteristics were also examined. As reported in section 3.1 , there is some evidence that offenders' ability to recognise facial emotion varies with offence type (Hudson et al., 1993, Gery et al., 2009).

My personal contribution was in designing the experiment and conducting the statistical analysis, as well as managing the prison study during which the data were collected and training the research team in the use of the tests used. The behavioural testing was conducted by a research team of which I was part.

Methods

As described in Section 2.3, participants were recruited from publicly-run Scottish prisons. The Ekman 60 Faces Test (Young et al., 2002b) (an established method for measuring this aspect of social cognition) was employed to establish basic facial emotion processing ability. Photographs of the faces of 10 people were taken from the Ekman and Friesen series (Ekman and Friesen, 1976). For each face, there were poses corresponding to each of six basic emotions (happiness, surprise, fear, sadness, disgust, and anger), giving a total of 60 photographs (10 for each emotion). These were shown on a computer monitor one at a time in pseudo-random order, for 5 seconds each. The task involved deciding which of the emotion names (happiness, surprise, fear, sadness, disgust, or anger) best described the facial expression shown.

The names of the six emotions were at the bottom of the screen, and this was available throughout the test. Participants received no feedback on task performance.

Healthy community control participants were recruited in Germany and the UK by a collaborator (Reiner Sprengelmeyer, University of St Andrews). IQ in the control group was measured using the NART (Nelson, 1982) and an abbreviated German version of the WAIS (Wechsler, 1999). This dataset was already held by Dr Sprengelmeyer, allowing recruitment of a further control group not to be necessary. Controls were matched to participants (also by Dr Sprengelmeyer) on age and sex to reduce bias resulting from differences between the groups on these characteristics. Subjects were not matched at an individual level, but the control group was made equivalent using frequency matching. This technique allows the use of more of the control data and reduces the risk of controls being unrepresentative of the population from which they were drawn (Stuart, 2010).

Statistical analysis was carried out in SPSS version 14.0 for Windows (SPSS Inc., USA). Mean differences between the prisoner and control groups on Ekman facial recognition were investigated using t tests. Repeated-measures analyses of variance (ANOVAs) were used for each task of emotion recognition with emotion as the within-subject variable and group as the between-subject factor. Following this the effect of group was investigated for each emotion separately using univariate ANOVA. Within-prisoner analysis was conducted using repeat-measures ANOVA with emotion as the within-subject variable and group as the between-subject factor- using subgroups of prisoners with a history of prison sentences, and with histories of and an index offence of violent offending and sexual offending, history of head injury, detention under the mental health act, having ever seen a psychiatrist, being prescribed medication and illegal drug use. There was no relationship within the group on facial emotion recognition ability and alcohol intake. Following this the effect of group was investigated for each emotion separately using univariate ANOVA.

3.4 Results

A total of 127 prisoners were assessed using the Ekman 60 Faces Test. Sixty eight per cent of the group were violent offenders. The population has been described earlier in this thesis. Overall results are shown in Table 10.

Emotion	Mean score (SD)
Total (/60)	41.1 (7.3)
Happiness	9.8 (0.7)
Surprise	8.3 (1.8)
Anger	6.3 (2.2)
Sadness	6.7 (2.1)
Disgust	5.7 (2.8)
Fear	4.2 (2.6)

Table 10. Prison sample scores on the Ekman 60 Test (n=127).

Comparison with community controls

Results from males and females were analysed separately as there are known to be gender differences in facial emotion recognition ability (Hall and Matsumoto, 2004). The small size (7) of the female group meant that comparison with a control group could not be made with sufficient statistical power. They are included in the tables for completeness. Age, IQ and Ekman 60 Faces Test scores for prisoners and controls are shown in Tables 11 and 12.

	Male prisoners (N=120)	Male controls (N=56)	Female prisoners (N=7)	Female controls (N=74)
Mean age (SD)	35.3 (4.9)	36.5 (13.7)	32.0 (9.7)	36.4 (13.9)
Mean IQ (SD)	92.4 (15.2) Quick test	101.3 (13.7) NART/WAIS	91.6 (17.7) Quick test	101.6 (8.9) NART/WAIS

Table 11. Mean Age and IQ of prisoners and controls

Emotion	Mean score (SD) male prisoners (N=120)	Mean score (SD) male controls (N=56)	Mean score (SD) Female prisoners (N=7)	Mean score (SD) Female controls (N=74)
Total test score (/60)	40.8 (7.4)	51.5 (4.29)	45.00 (4.40)	52.30 (5.34)
Happiness	9.8 (0.7)	9.9 (0.4)	10.0 (0.00)	9.9 (0.3)
Surprise	8.2 (1.8)	8.6 (1.32)	9.3 (0.76)	9.0 (1.2)
Anger	6.3 (2.3)	8.5 (1.3)	6.6 (2.15)	8.5 (1.7)
Sadness	6.7 (2.1)	8.7 (1.4)	6.4 (2.30)	8.6 (1.9)
Disgust	5.6 (2.7)	8.0 (1.9)	7.7 (2.75)	8.7 (1.7)
Fear	4.2 (2.6)	7.8 (1.6)	5.0 (1.29)	7.6 (2.3)

Table 12. Scores on facial emotion recognition in prisoners and controls

Scores from male prisoners and controls were analysed using repeat measures ANOVA. There was a significant between subject effect ($p < 0.001$), indicating an overall significant difference between the groups. Within subjects there was also a significant interaction (with emotion ($p < 0.001$)) and emotion by group ($P < 0.001$). These data were therefore analysed using GLM (General Linear Model) univariate ANOVA in SPSS. This model uses least squares regression where there is more than one predictor variable (ie for more than one way ANOVA). . There were statistically significant differences in total score, $F = 101.247 = p < 0.001$, anger $F = 51.451 = p < 0.001$; fear $F = 89.114 = p < 0.001$; sadness $F = 41.838 = p < 0.001$; and disgust $F = 36.38 = p < 0.001$.

Age and IQ-controlled males

Age and IQ were controlled in order to make a more meaningful comparison between the groups. This was due to the potential confounding effects of age and IQ on facial emotional recognition (Williams et al., 2009, Mukherjee et al., 2011). In the prisoner group, males with IQ of less than 70 or with no measure of IQ were excluded. 116 prisoners remained in this group (mean IQ 93.5 (standard deviation (SD) 14.12), mean age 35.6 (SD 11.4)). Male controls were matched by IQ and age by hand so that they did not differ statistically from the prisoners. There were 19 controls in this male matched IQ group. Mean IQ was 93.5 (SD 7.8) and mean age was 37.2 (SD 10.3). Repeated measures ANOVA showed a trend towards significance in difference between subjects ($p = 0.06$), significant effect of emotion ($p < 0.001$) and significant group by emotion interaction ($p = 0.01$). Comparison of data using univariate GLM/ANOVA is shown in Table 13. Differences in Ekman total score, anger, fear and sadness remained significant at $p < 0.001$, while difference in disgust was significant at $p < 0.05$ (Fig. 10). There were no statistically significant differences in recognition of happiness or surprise between the groups.

Emotion	Male prisoners (IQ 70 or above) score (SD) N=116	Low-IQ male control group score (SD) N=19	ANOVA/GLM group/emotion
Total (all emotions)	41.1 (7.3)	50.8 (3.9)	F=32.02 p<0.001**
Anger	6.3 (2.2)	8.6 (1.2)	F=20.12 P<0.001**
Disgust	5.7 (2.7)	7.3 (2.55)	F=5.86 p=0.017*
Fear	4.2 (2.61)	7.7 (1.2)	F=31.90 P<0.001**
Happy	9.8 (0.76)	9.8 (0.51)	F=0.001 p=0.98
Sad	6.8 (2.1)	9.0 (1.3)	F=19.33 P<0.001**
Surprise	8.3 (1.67)	8.5 (1.2)	F=0.132 p=0.72

* p<0.05 ** p<0.001

Table 13. Facial emotion recognition scores for male prisoners and age/ IQ-matched controls.

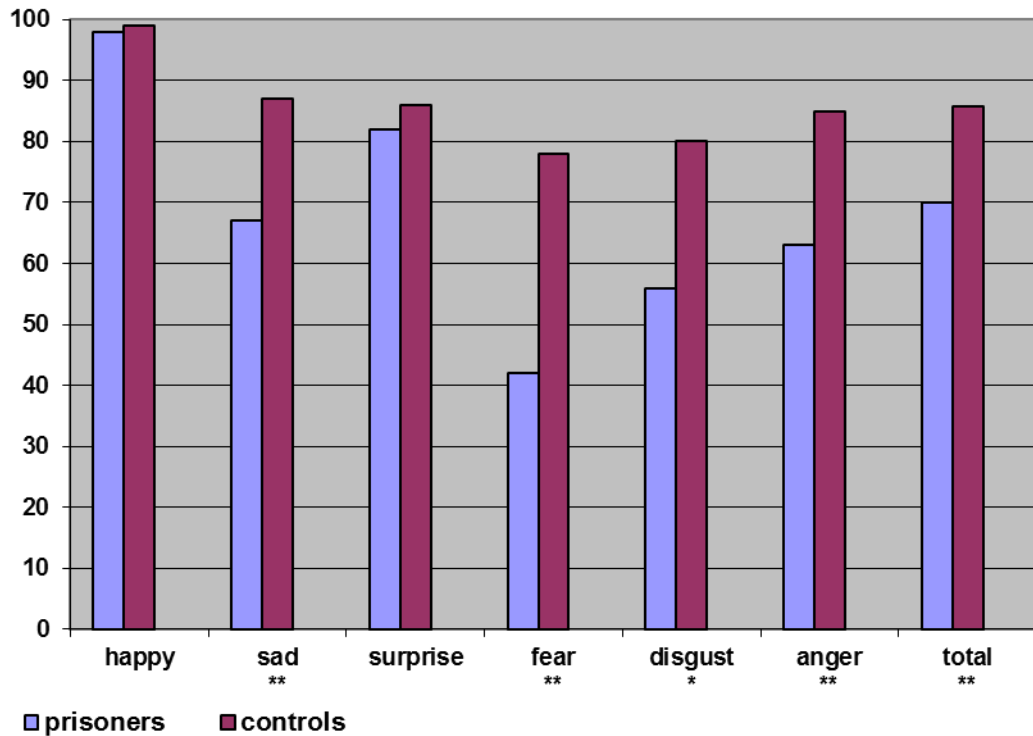


Figure 10. Facial emotion recognition in age and IQ-matched male prisoners and controls
X axis shows emotion type, Y axis facial emotion recognition score, shown as percentage correct.
 * $p < 0.05$ ** $p < 0.001$

Control for autistic traits

Due to the nature of the recruitment of the prisoner group, it is important to establish that deficits in this group are not a result of higher levels of autistic traits.

Where all male prisoners scoring 32 or more on the AQ in the IQ and age-matched group were removed leaving 110 prisoners (mean AQ 19.3, sd6.6) and compared with the age and IQ matched control group there were still significant deficits in prisoners on fear, sadness and anger recognition ($p < 0.001$) and disgust ($p < 0.05$).

In a further analysis, the IQ and age-matched male prisoner sample included only those prisoners who had been included as controls in the original study sample (scoring 0 on a screen for ASD and thought likely to have low levels of autistic

traits) (mean AQ 19.5). Of this group, those scoring 32 or above on the AQ (diagnostic cut-off) were also excluded. When this prisoner group (n=67, mean AQ 18.72 SD 6.4) was compared with the age, sex and IQ matched controls described above, deficits in prisoners in recognising anger, fear, and sadness remained statistically significant at $p < 0.001$, and disgust at $p < 0.05$.

Within-prisoners analysis

Offending

Tests of effects within the prisoner sample were performed using a univariate analysis of variance with IQ as covariant. Forensic history might be expected to be associated with a more 'antisocial' pattern of face recognition. On repeat measures ANOVA covarying for IQ there was no overall significant difference between the group with a history of previous prison sentences and those without ($p = 0.05$). However, there was a significant emotion by group interaction ($p = 0.016$), and individual analysis of emotion found that this factor was significantly associated with a more severe deficit in fear recognition (($F = 10.9$), $p = 0.001$, mean difference -1.167).

Repeated measures ANOVA found no significant difference in emotion recognition between or within subjects with a violent conviction or those with a violent index offence in comparison with offenders without. Here, violent crime included all offences where force was used or threatened. It included all sexual offences. Prisoners whose index offence was sexual (n=22) showed no overall significant difference between groups. However interaction of emotion by group was significant ($p = 0.013$). This group performed better at recognising sadness ($F = 4.06$, $p = 0.046$, mean difference 1.06) and worse at recognising surprise ($F = 7.97$, $p = 0.006$, mean difference 1.03) than the rest of the prisoner group.

Background factors

A relative deficit in total score was found in those prisoners who said that they had ever been detained under the mental health act ($F = 4.76$, $p = 0.031$) and in those with a history of head injury which had led to loss of consciousness and/or admission to hospital ($F = 4.34$, $p = 0.039$). Prisoners who had ever seen a psychiatrist ($F = 5.7$,

p=0.018) and those being prescribed medication were worse at recognising fear (F=5.79 p=0.18) than other prisoners.

A history of illegal drug use was significantly associated with a relative deficit in surprise recognition (F=26.18, p=0.021). There were no significant associations found between facial emotion recognition and level of alcohol intake immediately before admission to prison.

3.5 Discussion and Conclusions

This study has demonstrated deficits in recognition of facial emotion in a large sample of convicted prisoners in Scotland. Male prisoners were significantly less able to recognise negative emotions of sadness, anger, fear (all $p < 0.001$) and disgust ($p < 0.05$), in comparison with age, sex and IQ-matched controls. This is consistent with other studies on antisocial populations as discussed previously and does not appear to relate to autistic traits, IQ or current major mental illness.

In addition, within the group of convicted prisoners a relative deficit in fear recognition was associated with a history of previous prison sentences. A history of sex offences was associated with relative deficit in recognition of surprise and a relative superior ability to recognise sadness.

With respect to background factors, there were abnormalities associated with history of head injury, detention under the mental health act, having ever seen a psychiatrist, being prescribed medication and illegal drug use. There was no relationship within the group on facial emotion recognition ability and alcohol intake.

The deficits in recognising negative emotions here are in keeping with other studies on antisocial populations. The cause is not known. This will be explored further later during this thesis. It is plausible that these abnormalities are of relevance to offending, either through influencing social interactions directly or as a result of their effects on early development (Blair, 2010b). It is not possible for this study to conclude this however, as we do not know when such deficits first presented, and

such deficits may be a result of experiencing a prison environment. However, we do know that other neurobiological abnormalities in antisocial groups are present at a young and pre-offending age (Gao, Raine, Venables, Dawson, & Mednick, 2010).

The association between relatively poorer fear recognition within prisoners and previous prison sentences again does not demonstrate a causal relationship. Those with previous sentences have had both more exposure to prison in addition to having presumably committed more frequent or more serious offences, perhaps indicating more antisocial traits. It is of interest however, that deficits in fear recognition in particular have been associated with antisociality and that accurate recognition of fearful faces has been demonstrated experimentally to predict prosocial behaviour (Marsh, Kozak, & Ambady, 2007).

The particular pattern of facial emotion recognition shown by sex offenders in comparison with other prisoners is of interest. It is, of course, scarcely surprising that individuals who commit sex offences may view other people in a different way to those who commit other crimes, but the pattern of difference is not easily understood on a 'common-sense' basis. They show a relative deficit in an emotion, surprise, which has not been consistently associated with antisocial populations, and a relative superiority in recognising sadness. This differs, therefore, from a 'typical' antisocial pattern.

Given that deficits in social cognition are associated with a number of psychiatric conditions, the deficits in prisoners with history of contact with psychiatric services, head injury or prescribed medication is not surprising. Finally, the observed associations between drug use and particular deficits are of interest but not easy to interpret. Illicit drug use may be a cause of particular impairment or be associated with causes of social cognition impairment such as head injury. However, it is also possible that this result reflects the strong association between illicit drug use and antisocial behaviour.

Limitations

The sample of prisoners was not random. As described above, they were recruited as part of a study in Scotland investigating autistic traits in prisoners. This resulted in autistic traits in the sample being higher than would be expected in the Scottish prison population. However, the difference in the level of autistic traits between subjects and controls is unlikely to account for the Ekman task differences reported, because these differences were found to be robust to the exclusion of subjects with high scores on the AQ.

This study defined the antisocial group studied by behaviour. The prisoners were clearly an antisocial group. However, diagnostic assessments for disorders such as antisocial personality disorder or psychopathy were not conducted. Such clinical information would have been of interest and perhaps useful in attempting to elucidate the cause of the abnormalities found. Such long assessments would have been difficult to perform in a prison environment in such a large sample, however, due to the practical constraints of the environment.

Although we obtained measures of IQ for both subjects and controls, different measures were used to assess IQ within these groups, and that therefore these IQ scores cannot be assumed to be equivalent. However this is unlikely to affect our main findings because IQ was measured in order to control for its effects only rather than as a main independent variable of interest. In addition, some of the controls were from Germany rather than the UK, potentially introducing another source of bias. It is not clear however what the bias would be. I am unaware of any evidence suggesting that there are differences in facial emotion recognition across Europe.

Offending histories were based on self report by prisoners. It has been assumed that the offenders have given a truthful account of their offending history. However, as data were anonymised it is likely that that pressure on the prisoners to provide a false account was minimised. A further limitation is that the offending history of the control group is not known. We can not therefore quantify the degree of 'antisociality' in the control group.

Finally, prisoners and controls were not selected on the basis of their rates of substance abuse or head injury. Inevitably, therefore, such factors are likely to be over-represented within the offender group and it is possible that these factors relate to the emotion recognition deficits that were found. However, any sample of prisoners without head injury or substance misuse may be at risk of being unrepresentative as there are such strong associations between head injury, substance misuse and antisocial behaviour, as discussed in the introduction.. In addition, controlling for the effects of IQ means that it is therefore unlikely that any substance abuse or head injury-related reduction in IQ with could account for these findings

Neuroimaging of Social Cognition in Antisocial Groups

4.1 Introduction and Review

Evidence of abnormal brain function in groups at high risk of antisocial and violent behaviour, for example abnormal social cognition, has led to further investigation of their brain structure and function using neuroimaging techniques. The aim of such investigation has been to identify regions implicated in this behaviour with a view to understanding any underlying pathology and, ultimately, treatment or prevention. Here, I will provide background information regarding the neuroimaging of social cognition in antisocial groups. Sources of information included *OVID Medline*, *psycARTICLES*, *AMED*, *Embase*, *Medline in process* and *Psychinfo* were searched, although a record of all searches was not kept. Examples of search terms used included *social cognition*, *facial emotion*, *facial recognition*, *offenders*, *prison(er)*, *violent*, *sex offender*. This provides context and information for a literature review of fMRI studies of facial emotion recognition in antisocial groups, and the neuroimaging study in an antisocial group described in the following chapter.

Neuroimaging has been used in the investigation of psychiatric disorders since the early 20th century. Structural and functional abnormalities have reliably been demonstrated in mental disorders such as schizophrenia (Lawrie and Abukmeil, 1998) (Hall et al., 2008).

Before the use of neuroimaging, evidence from patients with brain lesions suggested relationships between particular areas of the brain and antisocial behaviour. One such case was of Phineas Gage, who in 1848 was injured when a tamping iron penetrated his skull damaging prefrontal brain areas (Damasio et al., 1994). He survived with full consciousness but with significant personality change. Such studies demonstrated a correlation between loss of an area of brain and an alteration in brain function.

Damage to the orbitofrontal cortex has been shown to be associated with antisocial behaviour, and to lead to a behavioural syndrome known as ‘pseudo-psychopathy’ – or ‘acquired sociopathy’, characterised by reactive aggression, poor decision making,

lack of social responsibility and inability to sustain relationships, but without a global intelligence deficit. This is a behavioural pattern similar to that seen in ASPD. However, there is no association known with the lack of empathy, remorse and instrumental aggression associated with psychopathy (Damasio et al., 1990, Blair and Cipolotti, 2000). Temporal lobe damage in general, and amygdala damage in particular, are also associated with aggression in animals and humans (Kiehl, 2006, van Elst et al., 2000)

Although lesion studies are useful in identifying brain areas without which there is a lack of function, they do not illuminate the function of the non-lesioned brain in life, nor the interaction of neural regions. Neuroimaging allows us to investigate further.

Neuroimaging: background

Neuroimaging techniques include Computed Tomography (CT), developed in 1971 (Hounsfield, 1973). Based upon the use of X-rays, it is used extensively in a clinical context to provide structural images. However, research use is limited due to its reliance upon potentially harmful radiation.

Functional brain imaging measures neuronal activity indirectly through blood flow and brain metabolism. Single-photon emission computed tomography (SPECT) and positron emission tomography (PET) are nuclear-based techniques using radiotracers administered intravenously which are then recorded, thus allowing measurement of cerebral blood flow and also neurotransmitter turnover (PET). Again, use of these tools in research is limited because of the health risks to subjects associated with exposure to ionizing radiation.

Magnetic resonance imaging:

Nuclear magnetic resonance (NMR) relies upon the phenomenon in which some atomic nuclei in a magnetic field can be made to absorb and re-emit electromagnetic radiation. This was first reported in 1946 by Bloch (Bloch et al., 1946) and Purcell (Purcell et al., 1946). The first image was published in 1973 (Lauterbur, 1973).

In humans the most abundant of these nuclei are the hydrogen nuclei (protons) found in water. Each nucleus has a small magnetic field which is usually cancelled out by others in the tissue. During the imaging process, a uniform external magnetic field is applied by the magnet in the machine. The hydrogen nuclei align to the external field, leading to net magnetisation in the long axis of the patient. Resonant radio-frequency waves (excitation pulses) are then applied via a coil around the patient. This rotates the alignment of the nucleus which then returns gradually to the main magnetic field. This process ('relaxation') releases energy, which is detected and encoded as an electric signal by a receiver coil. Longitudinal relaxation (in the long axis of the patient) is characterised by the time constant T1, and transverse relaxation is characterised by T2.

Although there are clear advantages to this technique, which is non-invasive and does not use ionizing radiation, there are hazards associated with MRI. Due to the powerful nature of the magnets, objects such as ferromagnetic aneurysm clips may be dislodged. The procedure is relatively lengthy (around an hour) and is noisy. The subject must lie in a small space where they are unable to see anyone else. This can lead to anxiety and some subjects are unable to tolerate the process.

Diffusion tensor MRI imaging (DT-MRI)

This technique uses MRI to measure restriction of water diffusion in white matter tracts *in vivo* (Bastin and Lawrie, 2004) and estimate direction of water molecule flow. It allows inference to be made about the structure and integrity of the tissue, and is measured using indices of diffusivity such as fractional anisotropy (FA) and mean diffusivity (MD) (Whitford et al., 2011).

Functional magnetic resonance imaging (fMRI)

Functional imaging aims to investigate spatial and temporal patterns of brain activity during a specific cognitive task. fMRI is a technique which allows the examination of these neurobiological processes *in vivo* in a non-invasive, safe manner. This is a significant advantage over other methods of imaging function such as positron emission tomography (PET) which use ionizing radiation. An unlimited number of

scans per individual are possible, allowing longitudinal studies, and groups such as children and pregnant women may be safely examined. It is a relatively new technique, the first human study being published in 1991 (Belliveau et al., 1991).

The commonest technique used in fMRI is blood oxygen level dependent (BOLD) imaging. The different magnetic properties of oxygenated and deoxygenated haemoglobin (Pauling and Coryell, 1936) mean that the relative proportions of deoxyhaemoglobin to oxyhaemoglobin affect the MR signal (Amaro and Barker, 2006). Neural activity is then measured indirectly by measuring haemodynamic change.

It is assumed that increased blood flow, and therefore the increase in BOLD signal (increased oxyhaemoglobin in activated brain area), is a response to increased neuronal activity ('neurovascular coupling') (Logothetis et al., 2001). Such increased demand can be caused by excitation or inhibition at the synapse, and therefore the particular event which underlies 'activation' is not clear. 'Deactivation' is thought to correlate with reduced metabolic demand and therefore a lack of neuronal events.

The haemodynamic response function (HRF) describes changes in the BOLD signal response over time in response to a stimulus: Vascular change is not instantaneous at the time of neural activity, and this is known as the 'haemodynamic delay'.

Following an initial dip in BOLD effect there is a peak, where increased oxygenated blood concentration leads to an increased signal (Amaro and Barker, 2006).

In addition to the safety of fMRI in comparison with other functional imaging methods, there is reduced cost, and importantly fMRI has better spatial and temporal resolution in comparison with PET. Its sensitivity means that meaningful data can be obtained from one subject alone. However, the low signal to noise ratio (changes in signal in response to a cognitive activity in comparison with background activity) often requires many scans to be collected during a task, allowing the calculation of an averaged response to reduce this ratio.

Disadvantages include those for all MRI scanning techniques, including the contraindication of subjects with metal implants. In addition, the small enclosed space and noise causing anxiety in the subject can not only lead to termination of the scan, but may affect emotional responses and therefore the task and subsequent measurement itself.

FMRI studies

FMRI experimental examinations of cognitive functions are usually case control in design. A stimulus is presented and BOLD response recorded. The structure of experiments varies, particularly in the use of comparison strategies. Cognitive subtraction strategies assume that different elements of a cognitive task are additive ('pure insertion'), and that activation from a control condition can be subtracted from an active condition, leaving the activation associated with the difference between the two tasks. This approach has been criticised, as it assumes that there is no interaction between cognitive components of the task (Friston et al., 1996). However, it is commonly used and effective. Alternatives include factorial and parametric (where cognitive demand of a task is altered) comparisons.

A variety of stimulus presentation strategies are also used, such as blocked and event-related (Amaro and Barker, 2006). Blocked designs use blocks of stimulation and blocks of rest allowing task states to be compared against non-task states, and results to be averaged across trials to improve the signal to noise ratio. This method does not allow the examination of a particular trial within a block. Event-related design allows data to be recorded regarding one particular trial or event and variations in type of task to be used in one experiment.

A limited range of responses to tasks are available to investigators during fMRI scanning. Verbal responses are not possible as the subject is isolated from investigators in a noisy environment. In addition this may cause head movement. Even small subject movements can affect the data obtained.

Image analysis

Imaging data must be statistically analysed to convert raw data into maps of structure, or to relative brain activation by task between groups. Data can be analysed either using pre-specified regions of interest (ROI) or voxel- based analysis.

Structural analysis

Analysis of structural scans was initially confined to ROI methods. In this method, an individual hand traces structures of interest, sometimes assisted by semi-automated methods. Later, voxel-based methods (see below) were also used.

Functional analysis

Voxel-based methods (VBM) such as Statistical Parametric Mapping (SPM) (Frackowiak et al., 2004) are used in functional image analysis. Data are realigned to correct for head movement, then go through processes of spatial normalisation (fitting the brain image of an individual to a standard template), and spatial smoothing. Where two groups are compared, a t test statistic is calculated for each voxel (unit of volume). This produces a three dimensional map of t values- a statistical parametric map. A correction for multiple statistical tests is then made.

Functional Connectivity

As brain regions are known to interact rather than function in isolation, there has been increasing interest in imaging the networks which underlie cognitive processes (Rowe, 2010). Functional connectivity represents the covariance over time of neural events, while effective connectivity measures the effect of one region on a second region. While functional connectivity could be a result of a third factor, effective connectivity uses mathematical models to demonstrate how the areas connect (Steele and Lawrie, 2010).

Brain imaging studies in antisocial groups: background

Neuroimaging has been used to investigate the neurobiological mechanisms behind increased propensity to violence and antisocial behaviour. As with other studies of antisocial groups, the majority of neuroimaging studies have been on criminals and psychopaths. Here, structural MRI studies will be briefly reviewed, followed by a

review of fMRI studies on facial emotion processing in antisocial groups (shown in Appendix C), and an outline of how these results have been interpreted in the literature.

Structural and functional studies of antisocial groups of children have been excluded from this review. Although both types of study have been carried out, their conclusions are limited and it is difficult to extrapolate the results to adult populations. Limitations to imaging studies in particular include the heterogeneous nature of the groups examined, for example conduct disorder/callous unemotional traits/ oppositional defiant disorder/ behaviourally disturbed children. Of these children it is not possible to easily predict which will become significantly antisocial as adults (although CU traits in adolescence have been shown to predict antisocial behaviour in young adults to an extent (McMahon et al., 2010)). In addition, developing brains change over time. Even with age matching, there is significant variation in brain structure within healthy groups of children (Giedd et al., 2009).

Structural MRI

Many subjects in these structural studies have substance misuse disorders (SUDs). This is unsurprising as there is a strong association between substance use and antisocial behaviour, ASPD and psychopathy (Neumann and Hare, 2008). Many antisocial individuals are therefore likely to have had exposure to substances over a long period. Substance use is associated with grey matter volume reductions, particularly in prefrontal cortex (Fein et al., 2002) and temporal regions (Agartz et al., 1999). However, many structural studies have not controlled for use of substances.

Psychopathy

Differences in several brain regions have been found in comparisons of psychopaths and non-psychopaths using structural MRI, by both VBM and ROI methods. However, numbers of subjects are usually small and the PCL-R cut-offs used are not consistent between studies. In addition, some studies have differentiated between 'successful' and 'unsuccessful' psychopaths, where successful psychopaths

were defined as those with high psychopathy scores without criminal convictions, and “unsuccessful” psychopaths had high psychopathy scores and convictions (Yang and Raine, 2009b).

Prefrontal areas were first highlighted as an area of interest by lesion studies. Reductions in prefrontal grey matter have been reported in unsuccessful psychopaths in comparison with successful psychopaths and controls (Yang et al., 2005) and in community psychopaths (Yang et al., 2009a). Reduced grey matter volumes in psychopaths have also been shown in temporal areas such as right superior temporal gyrus (Muller et al., 2008) and anterior temporal cortex (Yang et al., 2009a).

Structural differences between psychopaths and non-psychopaths have also been demonstrated in the limbic system. Amygdala deformations and bilateral volume reductions correlating with PCL-R score have been demonstrated (Yang et al., 2009b, M et al., 2011).

Structural hippocampal asymmetry has been shown between unsuccessful psychopaths and both successful psychopaths and controls (Raine 2004). Increased striatum volume has been demonstrated (Glenn et al., 2010a), and anterior cingulate volume has been shown both to be reduced (Muller et al 2008) and not to differ from controls (Glenn et al., 2010b). In addition, increased corpus callosum white matter volume and reduced thickness have been described in psychopaths (Raine et al., 2003).

Cortical thinning in psychopathic prisoners has been shown in comparison with non-psychopathic prisoners in left insula and dorsal anterior cingulate cortex, bilateral precentral gyri, bilateral anterior temporal cortices, and right inferior frontal gyrus (substance disorder controlled) (Ly et al., 2011).

Antisocial Personality Disorder

Reduced prefrontal grey matter has been reported in men with ASPD in comparison with substance using and healthy control groups (Raine et al., 2000).

Reduced orbitofrontal, middle frontal and rectal gyral volumes were found in men with ASPD with psychiatric comorbidity in comparison with substance using and psychiatric controls (Raine et al., 2011). The groups did not differ on whole-brain or prefrontal white matter volumes. Low orbitofrontal and middle frontal grey volumes were associated with antisociality in both male and female samples (Raine et al., 2011). Males had lower orbitofrontal and middle frontal volumes than females and ‘controlling for middle frontal, orbitofrontal and rectal gyral volumes largely abolished the gender difference in antisocial behaviour, reducing it by 77.3%’. The authors suggested that sex differences in antisocial behaviour between male and females generally may be explained by reduced OFC volumes in men.

A study of male community psychiatric patients with ASPD, some of whom met criteria for psychopathy, showed fronto-temporal and limbic grey matter reductions (de Oliveira-Souza et al., 2008). Associations with ASPD have also been described with respect to reduced whole brain and temporal, and increased putamen volume (Barkataki et al., 2006), and medial frontal cortical thinning (Narayan et al., 2007). However, a study of personality-disordered men in special secure hospitals found no difference in temporal or frontal lobe volume from healthy controls (Dolan et al., 2002)

Studies of ASPD taking psychopathy into account

Violent offenders with ASPD and substance misuse showed larger white matter volumes in bilateral occipital and parietal lobes, and in left cerebellum, and larger grey matter volume in right cerebellum than controls (Tiihonen et al., 2008). These volumes were not associated with psychopathy or substance abuse. The offenders also showed reduced grey matter in bilateral post-central gyri, fronto-polar cortex, and orbitofrontal cortex in comparison with controls. The subgroup of offenders who met PCL-R criteria for psychopathy showed greater grey matter loss in these areas.

Violent male offenders with ASPD and psychopathy in comparison with matched violent offenders with ASPD without psychopathy, and matched healthy non-

offenders, had reduced grey matter volumes in prefrontal cortex and bilateral temporal poles (Gregory et al., 2012). When subjects using substances were excluded, however, only differences at bilateral anterior temporal cortex remained. There were no differences between the group with ASPD without psychopathy and controls.

Offenders

A meta-analysis of prefrontal structure in antisocial individuals, which included 12 structural studies, found significantly reduced prefrontal grey matter volume, particularly right orbitofrontal cortex, right anterior cingulate cortex, and left dorsolateral prefrontal cortex (Yang and Raine, 2009b). Results were not moderated by psychopathy.

Structural MRI of 38 incarcerated sex offenders found that 44.7% showed a structural brain abnormality, unrelated to measures of violence, anxiety and aggression (Eher et al., 2000). A study of male non-violent paedophilic offenders without a history of substance misuse found reduced right amygdala volume relative to non-IQ matched male controls (Schiltz et al., 2007). Abnormal hippocampal shape has been described in violent offenders with alcohol dependence (Boccardi et al., 2010).

A study of 254 male prisoners found that psychopathy (PCL-R) was associated with reduced grey matter in paralimbic and limbic areas including bilateral parahippocampal, hippocampal areas, bilateral temporal pole, posterior cingulate cortex and orbitofrontal cortex (where substance misuse was included as a covariate) (Ermer et al., 2011).

Studies of brain developmental abnormalities

In a community sample, individuals with *cavum septum pellucidum* were more likely to meet criteria for psychopathy, ASPD, and to have a history of offending (Raine et al., 2010).

Substance use disorders

An investigation comparing men with SUDs (substance use disorders) and a history of violence, violent offenders without such disorders, non-violent men with SUDs, and non-offender men without SUDs (Schiffer et al., 2011) found that in comparison with non-offenders, violent offenders had larger grey matter volume in bilateral amygdala, left nucleus accumbens and right caudate, and reduced grey matter volume in the left insula. Amygdala, left nucleus accumbens and right caudate volumes correlated positively with PCL-SV scores, while left insula correlated negatively with these scores. Scores for aggressive behaviour correlated positively with bilateral amygdala and caudate head volume. Men with SUDs had smaller grey matter volume in orbitofrontal cortex, ventromedial prefrontal cortex (vmPFC) and premotor cortex than men without SUDs. This study suggests that the frontal grey matter volume loss reported in violence and psychopathy may reflect the substance use in these groups.

DTI

Psychopathy

Two DTI studies in men with high psychopathy scores demonstrated lower structural integrity in right uncinate fasciculus (connection between vmPFC and anterior temporal lobe) than those with lower scores (Craig et al., 2009) (Motzkin et al., 2011).

Antisocial personality disorder

Men with ASPD in comparison with matched controls showed reduced structural integrity in corpus callosum, uncinate fasciculus, fronto-occipital fasciculus, anterior corona radiata and internal capsule, which showed a negative correlation with psychopathy scores (Sundram et al., 2012).

In summary, structural MRI studies of antisocial groups are limited by small numbers, co-morbidities and differing inclusion criteria. There is evidence of reduction of grey matter, particularly in frontal, temporal and limbic areas. However, these results, particularly relating to frontal regions, may in part be a reflection of

environmental factors, particularly co-morbid substance misuse. In addition there is some evidence of reduced integrity of white matter tracts between prefrontal and other regions including temporal and occipital and between hemispheres.

Functional Imaging in Antisocial Groups

PET studies

Studies using this method to investigate antisocial populations have shown lower glucose metabolism in temporal and frontal lobes in violent groups (Seidenwurm et al., 1997),(Volkow et al., 1995). A PET study of male and female murderers pleading not guilty by reason of insanity found reduced glucose metabolism during a continuous performance task in the prefrontal cortex, superior parietal gyrus, left angular gyrus, and the corpus callosum. Abnormal asymmetries of activity (left hemisphere lower than right) were also reported in amygdala, thalamus, and medial temporal lobe in comparison with controls (Raine et al., 1997). When the sample of murderers was categorised by nature of violence, either ‘predatory’, that is instrumental or ‘affective’, that is reactive, affective murderers relative to controls had lower bilateral prefrontal functioning, higher right subcortical functioning, and lower right prefrontal/subcortical ratios. Prefrontal functioning in instrumental murderers was closer to controls, while right subcortical activity was higher (Raine et al., 1998). The not guilty by reason of insanity plea suggests that psychiatric co-morbidity is likely in this sample.

SPECT

A SPECT study of impulsively violent offenders versus healthy controls demonstrated hypo-perfusion in frontal and temporal regions (Soderstrom et al., 2000), while a separate study of violent offenders (male and female with a range of DSM-IV diagnoses) found negative correlations between interpersonal features of psychopathy (particularly Factor 1) and frontal and temporal perfusion (Soderstrom et al., 2002).

FMRI

Functional MRI in antisocial groups has sought to examine brain activity associated with particular tasks. Tasks often involve emotional processing, including viewing

emotional faces, and fear conditioning. In terms of methodology they often focus on ROI related to emotion.

Non-emotion related fMRI studies

Differences between antisocial groups and controls have been demonstrated in fMRI studies using non-emotional tasks in a variety of brain areas including frontal, limbic, temporal and parietal. Kumari *et al* showed relatively reduced activation in men with ASPD in left frontal gyrus, ACC and precuneus on a working memory task (Kumari *et al.*, 2006). Studies of response inhibition have shown an association between reduced thalamic activity and violence (Barkataki *et al.*, 2008). A study using a Prisoner's Dilemma task demonstrated reduced amygdala activation in subjects with high psychopathic traits (Rilling *et al.*, 2007), while studies of reversal learning have demonstrated abnormal vmPFC function in psychopathy (Budhani *et al.*, 2007).

A meta-analysis of prefrontal functional studies and antisociality including ASPD and psychopathy (Yang and Raine, 2009b) which included 31 functional studies on antisocial samples found overall reduced function in the prefrontal cortex. Antisocial individuals showed a significant decrease in prefrontal functioning in right orbitofrontal cortex, left dorsolateral prefrontal cortex and right anterior cingulate cortex. These areas were found to be structurally abnormal (reduced) in the concurrent meta-analysis of structural studies. No moderating effect of violent versus non-violent samples, psychopathic versus non-psychopathic samples, institution or community-based samples, age or gender were found. The authors concluded that their findings were consistent with prefrontal regions hypothesised to be impaired in antisocial/ psychopathic groups by Blair and and Kiehl's models, as well as other, older models of antisocial behaviour which focused solely upon prefrontal deficits. They also noted that their findings did not support the Left Hemisphere Activation Hypothesis of Psychopathy, which ascribed abnormalities in psychopathy to left hemispheric deficits (Hare and Jutai, 1988).

Functional connectivity

A study comparing men with poor fear recognition ability with men with normal fear recognition ability in the normal population demonstrated relatively increased connectivity between amygdala and anterior temporal cortex in the normal fear recognition group (Corden et al., 2006).

Abnormal resting functional connectivity in psychopathic prisoners in comparison with control prisoners has been demonstrated. Reduced resting functional connectivity between vmPFC and amygdala, and vmPFC and medial parietal cortex (Motzkin et al., 2011) and reduced resting functional connectivity between left insula and left dorsal anterior cingulate cortex (Ly et al., 2011) have been shown. A study in which adolescents with conduct disorder viewed pain demonstrated reduced prefrontal-amygdala functional connectivity (Decety et al., 2009).

Functional imaging: emotional tasks

An emotional Stroop task on 10 male violent spouse abusers for the contrast of aggressive versus neutral words found relative under-activation of areas including frontal cortex, anterior cingulate, lingual and fusiform gyrus, and temporal cortex; and over-activation of amygdala, hippocampus, insula, right middle occipital gyrus, right fusiform gyrus, right superior and middle temporal gyri, right caudate nucleus, left middle cingulate gyrus, and left precuneus (Lee et al., 2008).

Affective memory tasks

A study using an affectively neutral and negative words memory task on prisoner psychopaths, non-psychopathic prisoners and healthy controls analysed the contrast of emotional versus neutral. Relative under-activation of right amygdala and anterior cingulate differentiated psychopaths from prisoners and controls, while left amygdala and parahippocampal gyrus and superior temporal gyrus under-activation in comparison differentiated both prisoner groups from controls (Kiehl et al., 2001).

Fear conditioning

A study of men with ASPD and high PCL-R scores found greater activity in the amygdala and dorsolateral prefrontal cortex during the conditioning than in

controls (Schneider et al., 2000). However, a further study of fear conditioning: (Birbaumer et al., 2005) in male psychopathic offenders (6 of whom also had ASPD) found that psychopaths showed relatively reduced activation in areas including left amygdala, left middle and right anterior insula, anterior cingulate, and right OFC. A study of threat of electric shock comparing violent and non-violent men with schizophrenia, violent men with ASPD and healthy controls, found that the ASPD group showed relatively reduced activity in the thalamus and striatum in comparison with violent men with schizophrenia (Kumari et al., 2009).

Studies viewing affective pictures:

In a study of 10 male violent spouse abusers viewing affective images, for the contrast of aggressive threat versus neutral, subjects relatively over-activated parietal, temporal, occipital and left posterior cingulate cortex and right thalamus. When the pictures showed a female victim of the violence subjects over-activated frontal, parietal, temporal, and occipital regions (Lee et al., 2009).

A study of male psychopaths compared with controls for contrast of negative pictures versus other pictures found that psychopaths over-activated temporal, occipital, parietal and frontal regions, right anterior cingulate, and right amygdala, and under-activated right cingulate, temporal, occipital and parahippocampal regions (Muller et al., 2003).

A study using emotional induction and a cognitive task found that in psychopathy there was a significant task X emotion interaction in right insula and right claustrum, while in controls a significant task X emotion interaction in medial frontal gyrus, left inferior frontal gyrus, left supramarginal gyrus and left precuneus. A subgroup from this sample were analysed for a contrast of viewing negative pictures, although the analysis used is not described. This analysis found that psychopaths showed relatively reduced activation in right superior temporal gyrus (Muller et al., 2008).

Functional imaging of facial emotion recognition tasks

There is evidence to suggest that several brain regions are likely to be relevant to risk of antisocial behaviour and associated disorders. Deficits in facial emotion recognition are among many behavioural indicators of amygdala dysfunction in these groups (see Chapter 3.1 for detail). Lesion and structural imaging studies (discussed above) as well as neuropsychological deficits, for example on response reversal and gambling tasks in psychopathy (Blair, 2007), suggest that frontal and temporal areas may also be important.

With respect to individuals predisposed to reactive aggression, it has been suggested that underlying abnormalities are found in a neural circuit regulating emotion are, particularly, orbitofrontal cortex, amygdala, and anterior cingulate (Davidson et al., 2000).

Blair considers that the primary deficit in reactively aggressive groups is in inappropriately increased amygdala response to threat (Blair, 2007). The amygdala functions as part of the threat response system and is normally regulated by the prefrontal cortex (Blair, 2004). It is suggested that a circuit mediating response to threat includes amygdala, medial hypothalamus and periaqueductal grey, and that both amygdala and orbitofrontal cortex have input into the system with the effect of modulating response to threat (Blair, 2004).

Blair suggests that regulation of the amygdala by the prefrontal cortex is impaired in reactively aggressive groups, leading to over-reaction to perceived threat. He therefore predicts increased amygdala activation and reduced prefrontal activation to threatening stimuli, such as fearful faces, in these groups (Blair, 2010a). In contrast, in instrumentally violent groups (psychopaths) Blair considers the key deficits to be in maladaptive decision making leading to poor assessment of risks and benefits of antisocial behaviour, as well as in impaired processing of distress cues having led to impaired development of understanding of the social impacts of behaviour that harms others (by stimulus-reinforcement learning). He suggests that this deficit is secondary to prefrontal, striatum (prediction error signalling) and amygdala (stimulus

reinforcement learning, distress signals) impairment (Blair, 2013a), and that instrumentally violent groups will therefore show reduced activation in these areas during emotional tasks (Blair, 2010a). He also suggests that the elevated risk of reactive aggression in psychopathy comes not from under-regulation of amygdala function leading to amygdala over-activity in the context of threat, but from an increased risk of frustration secondary to impaired stimulus-reinforcement learning and reversal learning, as a result of prefrontal (vmPFC) dysfunction (Blair, 2010b).

Functional neuroimaging can be used to investigate the function of these potentially relevant areas. Visual facial processing has been demonstrated to be associated with activation of visual (fusiform gyrus, inferior and middle occipital gyri, lingual gyrus), limbic (amygdala and parahippocampal gyrus, posterior cingulate cortex), temporo-parietal (parietal lobule, middle temporal gyrus, insula, posterior temporal sulcus), prefrontal (medial frontal gyrus), and subcortical areas (putamen) as well as the cerebellum on fMRI in comparison with baseline (Fusar-Poli et al., 2009, Zhen et al., 2013). FMRI studies of facial emotion recognition in healthy populations demonstrate that these tasks activate areas of interest such as limbic areas, temporal areas and prefrontal cortex (Fusar-Poli et al., 2009). Different facial emotions appear to be associated with activation of different areas. Fearful faces, for example, in comparison with baseline, are associated with activation of amygdala and fusiform gyrus, cerebellum, parietal and prefrontal areas (Fusar-Poli et al., 2009). Happiness, sadness and fear all activate amygdala, with fear doing so most strongly, while anger and disgust are not associated with amygdala recruitment. Insula is recruited for processing faces showing disgust and anger, and is more sensitive for disgust (Fusar-Poli et al., 2009).

Emotion recognition takes place through both conscious and unconscious processes which are, however, likely to interact (Frith, 2009). Explicit (conscious) versus implicit (non-conscious) processing of emotional faces are associated with differences in areas of brain activation, as are age differences and sex difference between subjects (Fusar-Poli et al., 2009).

Functional Imaging of Facial Emotion in Antisocial Groups: Literature Review

A literature search was completed in order to identify studies which have used functional imaging to examine the neural correlates of facial emotional processing in antisocial groups (using emotional tasks) including groups defined by either diagnosis or behaviour.

An electronic search was conducted in January and February 2012 in the electronic databases OVID Medline, psycARTICLES, AMED, Embase, Medline in process and Psychinfo.

Limits: English language, and humans

Keywords:

FMRI	MRI
Imaging	Conduct disorder
Offen/der/ce	Ekman
Antisocial	Facial expression
Psychopathy	Emotions
Dissocial	Fear recognition
Prisoner	Facial emotion
Violent/ce	Social cognition
Criminal	Callous

5064 records were identified through database searching, and 768 remained after deduplication. 760 records were excluded or ineligible through hand sorting. A further search was performed in 2014. No additional studies were identified.

Eight studies of basic facial emotion processing were identified. They are described in Appendix C and discussed below. No fMRI studies investigating processing of complex social judgements on faces were identified.

Participants

Although children have been excluded from this review as discussed above, studies of adults are also problematic. It is difficult to separate factors directly relating to antisociality from secondary environmental effects on the brain from antisocial lifestyles such as substance misuse and trauma. Even among adults, brain activation in response to emotional faces is modified by age, as discussed above.

Three of the studies used criminal psychopaths, all recruited from inpatient forensic psychiatric institutions. PCL-R cut-offs of 24 (Deeley et al., 2006), and 30 (Howner et al., 2011) were used, and one study included only one psychopathic individual, with a score of 37 (Hoff et al., 2009). One study (Dolan and Fullam, 2009) examined violent men with schizophrenia recruited from a secure forensic psychiatric institution, and separated them into ‘*high*’ and ‘*low*’ psychopathy groups by their relation to the median group score on the PCL:SV (12.5) rather than the standard cut-off for psychopathy on this instrument of 18 (Cooke et al., 1999). . Individuals in the ‘*high*’ psychopathy group in this study would not have met criteria to enter the ‘*psychopath*’ groups in the other two studies.

One study examined individuals with a diagnosis of Intermittent Explosive Disorder, a mental disorder characterised by disproportionate impulsive aggression (Coccaro et al., 2007). Under DSM-IV, used at the time of the study, the aggression was defined as leading to assault or damage to property (Association, 2000). One study examined *chronically violent men* in the community, making the grouping by criminal record, and self and past teacher/parent assessment (Pardini and Phillips, 2010). All participants in this study were also assessed using part of the Self Report of Psychopathy-III (SRP-III) instrument (Paulhus et al., 2009).

Two of the studies (Gordon et al., 2004, Han et al., 2011) examined healthy community subjects. One study used college students and the Psychopathic Personality Inventory (PPI) (Lilienfeld and Andrews, 1996), a self-report measure, to separate them into *high* and *low* groups based upon the median score (Gordon et al., 2004). The second (Han et al., 2011) used subjects recruited from the community via

advertisements, separating them into low and high callousness groups using the cold-heartedness subscale of the Psychopathic Personality Inventory Revised (PPI-R) (Lilienfeld and Widows, 2005). These studies used high-functioning individuals in the community showing relatively high scores on instruments which model psychopathy as a set of personality traits distributed within the general population. This means that extrapolating data from normal population to draw conclusions about violent criminals or psychopaths is of limited value.

The majority of the studies included male participants only. However, two (Han et al., 2011, Coccaro et al., 2007) included male and female participants. This is important because of differences in brain activation by subject's sex when processing facial emotions, as discussed above.

IQ matching was carried out in several studies (Pardini and Phillips, 2010, Howner et al., 2011, Han et al., 2011, Dolan and Fullam, 2009). In addition, one study matched subjects by education (Coccaro et al., 2007). There was a large difference in IQ between groups in one study (Deeley et al., 2006). Two studies did not measure IQ (Gordon et al., 2004, Hoff et al., 2009). This is important because behaviourally, IQ has an effect on performance on facial emotion recognition, and there may therefore be difference in cognitive processing between the groups based on IQ alone, leading to misleading results. Where IQ is measured and the groups differ, the analysis of the data can attempt to control for this difference.

Psychiatric comorbidity is common in these samples. All subjects had schizophrenia in one study (Dolan and Fullam, 2009). Others excluded some but not all psychiatric comorbidities (Deeley et al., 2006, Pardini and Phillips, 2010); while some excluded all Axis I comorbidities (Coccaro et al., 2007, Howner et al., 2011, Han et al., 2011) but included other psychiatric co-morbidities such as personality disorder. One study (Hoff et al., 2009) did not address psychiatric comorbidity in the subjects but screened controls for psychiatric illnesses. Psychiatric co-morbidity is relevant because mental disorders including schizophrenia and depression are associated with different activation in emotion-related areas, including amygdala, in comparison with

healthy controls on facial emotion recognition tasks measured using fMRI (Hall et al., 2008, Stuhmann et al., 2011).

Substance misuse is common in antisocial groups. Substance use was documented in three studies (Deeley et al., 2006, Pardini and Phillips, 2010, Hoff et al., 2009). Two studies did not mention substance use but excluded Axis 1 disorders (Howner et al., 2011, Han et al., 2011) which would include substance misuse diagnoses. Current substance use was not addressed in one study (Coccaro et al., 2007). Substance use is relevant in this context because drugs of abuse are known to alter brain activity, including in frontal and limbic regions (Lingford-Hughes et al., 2003).

Sample sizes in these studies are small. Among the case control studies, numbers of subjects include one psychopath (and 12 healthy controls) (Hoff et al., 2009), and 6 psychopaths (Deeley et al., 2006). Smaller sample numbers are associated with institutionalised psychopathic patients. Community and non-criminal samples reached relatively larger sample sizes. The largest study included 20 chronically violent subjects (Pardini and Phillips, 2010). Smaller sample sizes increase risk of Type II error (failing to reject the null hypothesis) when hypothesis testing.

The small sample size, group heterogeneity, inclusion of psychiatric disorder including substance use disorders, and use of healthy non-criminal populations all reflect the difficulty in recruitment in this subject area. Antisocial individuals are by their nature disinclined to be altruistic and take part in scientific research. In addition, it is difficult in practical terms to conduct an fMRI investigation on an individual who is incarcerated in a prison or forensic hospital as it means managing the legal and security risk of removing the individual from their institution or perhaps taking a scanner into the institution. The issue of substance misuse in these studies is difficult. Antisocial behaviour, ASPD and psychopathy are closely associated with substance misuse and it is extremely common in these groups. Including only subjects with no such history is likely to recruit an unrepresentative sample.

Tasks used to assess facial emotion processing

Explicit versus implicit judgement

Two studies examined explicit processing (Gordon et al., 2004, Han et al., 2011). Of the studies examining implicit processing, several used a gender labelling task (Coccaro et al., 2007, Howner et al., 2011, Dolan and Fullam, 2009, Deeley et al., 2006, Pardini and Phillips, 2010). One used an *n-back* task while viewing affective faces (Hoff et al., 2009). Explicit tasks are likely to recruit different brain areas to implicit tasks, as discussed above, although there is likely to be some overlap. Comparisons between studies examining these two types of task are therefore limited.

Emotion type

Studies varied in the range of emotions included, from only fear and neutral (Jones et al., 2009) to angry, happy, sad, fear, surprise, disgust and neutral (Coccaro et al., 2007). One study used six emotional faces but did not label these faces by emotion type in the paper (Hoff et al., 2009). Three studies used variations in expression intensity in a parametric paradigm (Deeley et al., 2006, Pardini and Phillips, 2010, Marsh et al., 2008).

Stimulus type

Most studies used photographs of actors taken from standardised sets. However, one study modified the pictures by removing eyes or leaving eyes-only as well as full facial pictures (Han et al., 2011). Another used cartoon drawings of facial emotion and scrambled drawings of faces (Hoff et al., 2009).

Comparisons used in analysis

Most studies compared activations associated with specific emotions and/or all emotions versus baseline or neutral expressions. However, Han (Han et al., 2011), using whole-face, eyes-only and without-eyes stimuli made comparisons between those most- and least- socially meaningful by emotion (based on behavioural data). This led to a comparison of *eyes-removed* versus (minus) *eyes-only* for fear. Conversely, for happiness and disgust the comparison was *eyes-only* v *eyes-removed*,

as the authors stated that most social information in these emotions comes from the face.

Results

Results are reported by areas of relative over or under-activation between subject groups and control groups (see Appendix C). Differences between subjects and controls are demonstrated in several brain areas (Table Appendix C). However, the authors and the literature have focused on limbic and frontal areas in particular when considering the implications of the results.

All studies reported differences between groups. Four studies found differences between results for different emotions. One found differences between groups for fear versus baseline, fear versus neutral, happiness versus baseline and happiness versus neutral (Deeley et al., 2006); one between anger versus baseline and happiness versus baseline (Coccaro et al., 2007); one found differences for fear and disgust versus neutral but for not anger versus neutral (Dolan and Fullam, 2009); and one found differences examining fear and happiness using partial face encoding (Han et al., 2011).

Pardini examined more than one emotion but found differences only for happy versus neutral and all faces combined versus baseline (Pardini and Phillips, 2010), Hoff (Hoff et al., 2009) examined six emotions and found a difference between groups for total emotional faces versus neutral, and Gordon only difference for all faces versus baseline (Gordon et al., 2004)

Psychopathy

A reduced amygdala response to fearful faces, and increased amygdala response to disgust was demonstrated in men with schizophrenia and relatively high psychopathic traits (PCL: SV score above the median of the group which was 12.5. A score of 18 on this instrument indicates that further assessment for psychopathy is required) (Dolan and Fullam, 2009). Psychopathy scores correlated negatively with amygdala activation.

Deeley et al (Deeley et al., 2006) demonstrated differences in activation in cerebellar, parietal, frontal and visual areas. In all cases activation was reduced in psychopaths for fear and happiness contrasts with baseline and neutral. In particular, a group by condition interaction was demonstrated for the contrast of fear versus neutral in right cerebellum and fusiform gyrus, where controls increased activation to fear while psychopaths reduced activation, and for happy versus neutral in right lingual, occipital and fusiform cortices, where again controls showed increased activation and reduced response activation to emotion.

A study of psychopathic offenders in comparison with offenders with ASD and non-criminal controls found that all offenders over-activated limbic areas (amygdala, ACC and hippocampus) for the fear versus neutral comparison. Psychopathic offenders versus ASD offenders over-activated anterior cingulate cortex and left insula for this contrast, and ASD offenders over-activated right insula, language areas and left cingulate relative to psychopaths (Howner et al., 2011).

A study of one psychopath compared with healthy controls found over-activation in cerebellum, limbic and frontal areas and substantial nigra to emotional faces in comparison with scrambled drawings in the psychopath, and over-activation of temporal, frontal and parietal areas only in the controls for the same comparison (Hoff et al., 2009).

Healthy subjects

In male students a group with relatively high levels of psychopathic traits showed relative under-activation of frontal areas and right amygdala, and over-activation of visual cortex and dorsolateral prefrontal cortex, for the contrast of emotional faces versus baseline (Gordon et al., 2004) in comparison with controls.

A study contrasting the most socially meaningful versus the least socially meaningful facial stimuli (Han et al., 2011) found that for fear recognition those with high callous traits showed relative under-activation in frontal, parietal areas as well as

right cingulate gyrus and left amygdala The equivalent test for happiness showed that high callous individuals showed under-activation- of fusiform gyrus, temporal gyrus and amygdala.

Violent men

In chronically violent men for the contrast of all emotions versus baseline they showed relative under-activation of prefrontal cortex and ACC, and over-activation of amygdala for the contrast of happy versus neutral faces (Pardini and Phillips, 2010).

Intermittent Explosive Disorder

Individuals with this disorder demonstrated relative over-activity of amygdala and underactivity of OFC in comparison with controls for anger versus baseline, and relative underactivity for OFC to happy versus baseline (Coccaro et al., 2007). Amygdala over-activity to angry faces was noted to relate to measures of lifetime history of aggression. It should be noted that all subjects in this group met criteria for personality disorders which did not include ASPD, providing potential confounding.

Interpretation of Results

A model of findings on fMRI imaging between reactively aggressive groups (such as ASPD) and psychopathic groups was been described by Blair (Blair, 2010a) as discussed above. He suggested that individuals at risk for reactive aggression only would show increased amygdala responses to emotional stimuli and that ‘individuals with psychopathic tendencies’ would show decreased amygdala and orbitofrontal cortex responses to emotional stimuli. Such an increased amygdala response to emotional stimuli has been shown using fMRI in some impulsively aggressive groups such as spouse abusers (Lee et al., 2008) and adolescents with conduct disorder (Herpertz et al., 2008).

Reactively aggressive groups reviewed here include a sample with IED who showed relative amygdala over-activity to anger, and reduced OFC responses (Coccaro et al., 2007). Two studies did not differentiate their samples by psychopathy or type of violence and therefore can not be clearly labelled as reactively or instrumentally

aggressive and used to support or refute Blair's model. A study of chronically violent men found that the violent sample scored significantly higher than the control, non-violent men on a self-report measure of psychopathy (Pardini and Phillips, 2010). The study demonstrated amygdala over-activation to happy faces in the violent group and found that a self-report measure of psychopathy showed no statistical relationship with amygdala activation during emotional face viewing (Pardini and Phillips, 2010).

Results among studies using psychopathic samples vary. Reduced amygdala response to facial fear was found in men with schizophrenia and high psychopathic traits in comparison with a violent group with low psychopathic traits (Dolan and Fullam, 2009). Deeley *et al* found no difference in relative amygdala activation but reduced frontal activity to emotional faces in psychopaths (Deeley et al., 2006). Howner *et al* found no difference in amygdala activation between psychopathic and non-psychopathic subjects (Howner et al., 2011). However, the study found that amygdala over-activation in the criminal group as a whole in comparison with non-criminals. Hoff *et al* found no amygdala activation differences between one psychopath and controls, but found both over and under-activation of prefrontal areas in response to emotional faces (Hoff et al., 2009). Students with high levels of psychopathic traits showed relative under-activation of amygdala and frontal areas to emotional faces (Gordon et al., 2004, Han et al., 2011).

Although the data are not wholly consistent therefore, they are largely in keeping with Blair's model of amygdala over-activity in reactively aggressive groups and under-activity in instrumentally violent groups. Blair suggests that while Deeley *et al* did not demonstrate reduced amygdala activity this is likely to reflect a lack of power (Blair, 2010a) There is less evidence regarding OFC activity, where Blair suggests that OFC activity is not commonly revealed in facial emotion tasks (Blair, 2010a). A further study is relevant here. Healthy male carriers of the low-expression monoamine oxidase (MAOA-L) allele, a gene known to be associated with antisocial behaviour where there is childhood maltreatment (Caspi et al., 2002), making facial emotion judgements, demonstrated significant increased activation of left amygdala

as well as decreased activity in ventral cingulate cortex, left lateral OFC, and left insular cortex in comparison with carriers of the high expression (MAOA-H) allele, as predicted in Blair's model for reactively aggressive groups (Meyer-Lindenberg et al., 2006) .

Other authors have stressed the role of limbic and temporal structures in a model of psychopathy (Kiehl, 2006), in particular orbital frontal cortex, insula, anterior and posterior cingulate, amygdala, parahippocampal gyrus, and anterior superior temporal gyrus. As can be seen from table 1, many of these structures are also identified in the studies but not solely in studies of psychopaths. The cingulate (Pardini and Phillips, 2010), (Hoff et al., 2009, Howner et al., 2011, Han et al., 2011), OFC (Coccaro et al., 2007), hippocampus (Howner et al., 2011) and insula (Howner et al., 2011) (Hoff et al., 2009) have all been reported as differing in activation between antisocial groups and controls in response to emotional face stimuli.

Conclusions

By their nature, antisocial individuals are often reluctant to take part in scientific studies (Hodgins et al., 2007). Difficulty in recruitment has been the most significant limitation on research in antisocial populations and underlies the small sample sizes in many investigations, particularly those requiring lengthy procedures such as MRI scanning. In response to this, studies often use individuals with co-morbid severe mental illnesses such as schizophrenia, or non-offending community samples. This means that any abnormalities found can be difficult to relate to severely antisocial groups.

The most notable feature of this literature is its heterogeneity. This is seen in number and nature of subjects, type of task, and in results. This heterogeneity, as well as leading to possible lack of statistical power in studies with small sample sizes and therefore error, makes it difficult to draw meaningful conclusions from the data.

There is little evidence of a consistent pattern of results, even when relatively similar recruitment criteria and tasks are used. However, the data do suggest abnormalities in the function of emotional circuitry in antisocial groups. Along with small studies performed on antisocial children (Passamonti et al., 2010, Marsh et al., 2008), of which one also measured CU traits (Marsh et al., 2008), and one using high versus low CU trait groups (Jones et al., 2009), and a study on healthy carriers of MAO-A (Meyer-Lindenberg et al., 2006), the studies described above may support a model of amygdala underactivity in instrumentally aggressive groups and over-activity in reactively violent groups. This is far from clear cut, however, and remains a hypothesis to be tested. No studies of complex social judgements from faces have been published. However, such tasks investigate regions of interest and might further illuminate this area of research.

Study 3. Functional Imaging of a Complex Social Judgement in Prisoners

4.2 Introduction

Following the demonstration of significant differences between Scottish offenders and controls in the recognition of facial emotions described in Study 2, it was of interest to examine whether similar differences could be detected at a neural level using fMRI. The studies described in Section 3.1 have demonstrated differences between antisocial groups and controls using fMRI on tasks requiring recognition of facial emotions. However, antisocial groups have not been studied while making more complex social judgements.

Complex social judgements, such as trustworthiness and intelligence, are routinely made from faces. Such judgements are important in social interactions and show reliability between individuals (Todorov et al., 2013). There is evidence that such judgements guide social behaviour by for example affecting a decision regarding which political candidate to vote for, although they are not necessarily accurate (Olivola and Todorov, 2010).

Social judgements such as approachability and intelligence are impaired in mental disorders such as autism spectrum disorders and schizophrenia (Hall et al., 2004) (Philip et al., 2010), disorders in which facial emotion recognition is also impaired. Approachability and trustworthiness judgements, which relate to assessments of threat, are impaired in individuals with complete bilateral amygdala damage (Adolphs et al., 1998). Individuals with orbitofrontal cortex (OFC) lesions show deficits in approachability judgements while being able to recognise facial expressions (Willis et al., 2010).

A relationship between amygdala dysfunction and deficits in social judgements is hypothesised to result from the role of the amygdala in assessing level of threat (Adolphs, 2003). Given the evidence for amygdala dysfunction in antisocial groups, it was hypothesised that differences in amygdala function would be shown on fMRI imaging using an approachability task. Given the relatively low rates of psychopathy and high rates of ASPD likely to be found in our sample of Scottish prisoners (Davidson et al., 1995, Coid et al., 2009b, Singleton et al., 1998) it was further hypothesised that there would be increased amygdala activation associated with performing this threat-related task in an ex-prisoner population in comparison with a control group, in keeping with a hypothesis of amygdala over-responsiveness to perception of threat in reactively violent groups such as those with ASPD.

Given the difficulties inherent in carrying out imaging research in particular on antisocial groups, this study also aimed to examine the feasibility of using fMRI techniques on offenders in Scotland.

My contribution to this study included participating in the design of the study, managing the study including obtaining the necessary permissions, recruiting of participants from prison, interviewing the prisoners including administration of the PPI-R, and interpretation of the results.

4.3 Methods

A task in which subjects are asked to make conscious judgements of the approachability of individuals based upon photographs, in comparison with gender judgements, has been shown in controls to activate a network of prefrontal cortex, superior temporal cortex, cerebellum and amygdala (Hall et al., 2010). The aim of this task was to investigate the interaction between prefrontal cortex and amygdala, likely to be impaired in an antisocial group as discussed above.

Participants

The antisocial group consisted of liberated prisoners recruited following the investigation of convicted prisoners in Scotland which related to the examination of a screening tool for autistic characteristics described in Chapter 2. All 127 prisoners were invited to consent to contact on liberation with a view to further investigations which might include a scan, as it was not practicable to carry out fMRI scanning during their period of imprisonment. All prisoners were aware of their earliest possible date of their liberation. Those who consented provided this information. Most did not have a stable address or telephone number that they maintained while in prison, and often did not think that they would be able to retain information to make contact once they left prison. Where this was the case, again where the prisoner consented, details for someone who would be in contact with them after they had left prison were given by the prisoner. In most cases this was their wife or mother. Such contacts were more likely to have stable addresses and telephone numbers. The prisoners also agreed to inform these individuals that contact would be made with them after the date of liberation in order to arrange the participation of the prisoner in the study if they still wished to do so. When prisoners were contacted, meetings were arranged with them near their home to discuss the study. Reminders were sent a week and a day before they were due to attend. Both overnight accommodation and transport were arranged for participation in the study. Participants were collected and taken to the scanning site if they so wished.

Prisoners recruited into the scanning study were therefore required to have been liberated before the period of this study. They had to have been willing while in prison to be contacted in the future, be contactable on liberation, and still interested in the study. While it is acknowledged that these factors mean that the study sample is unlikely to be fully representative of the prison population as a whole and to have introduced a degree of attrition, this approach to recruitment was considered to be optimum from the ethical stand-point of preventing any possibility of pressure to participate.

Characteristics of this population including chaotic lifestyle, homelessness, mistrust of authority and little tradition of altruism, as well as high early reconviction rates (Scottish The Scottish Government, 2012b), made recruitment challenging.

Controls

Healthy controls were selected from a previous study employing the same social cognition task in the scanner, matched for sex. The control group consisted of typically developing male volunteers who reported no personal or family history (first-degree relative) of a major psychiatric disorder. Seven of the control subjects had a history of illicit drug misuse. None had a history of head injury. There are no data regarding the forensic history of the control group. It was not possible to exactly match controls with prisoners by IQ. Instead an age and sex matched group of controls was chosen.

Clinical assessments, measures of cognitive ability and emotion recognition outside the scanner

Current IQ in the ex-prisoner group was assessed using the Quick Test (Ammons and Ammons, 1962) and in the control group IQ using the Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999). While in prison, all participants had been interviewed by a psychiatrist with no concerns that there was evidence of a major mental illness or a requirement for a full mental health screen.

Psychopathic traits were measured in the ex-prisoner group using the PPI-R (Lilienfeld and Widows, 2005). This is a reliable and valid self-report measure of psychopathy that incorporates four validity scores and for which offender population norms are available. The PPI-R has been sub-divided into three factors (‘Fearless Dominance’ (PPI-I), ‘Impulsive Antisociality’ (PPI-II) and Coldheartedness). It has been shown (Poythress et al., 1998) to correlate with the Psychopathy Checklist

(Revised) (Hare, 2003), the ‘gold standard’ measure of psychopathy which is based on self report, interview and file information.

The Ekman 60 Faces test (Young et al., 2002b) was employed to establish basic face processing ability across all subject groups. Participants were requested to select a textual label to describe the emotion expressed in a face presented on a computer monitor. The stimuli were selected from Ekman and Friesen’s pictures of facial affect series (Ekman and Friesen, 1976). Each face stimulus was presented for 5 seconds and participants had a choice of six emotion labels: ‘happiness’, ‘sadness’, ‘anger’, ‘disgust’, ‘fear’ and ‘surprise’. Ten trials for each emotion were presented in random order and participants received no feedback on task performance.

The ex-prisoner and control groups were assessed using the Autism Spectrum Quotient (AQ), a self-report instrument measuring mild autistic traits (Baron-Cohen et al., 2001). The authors have demonstrated its excellent sensitivity and specificity in the identification of participants with an ASD. However, a potential limitation of the AQ within the prisoner population is that it refers to aspects of life (for example theatre going, museum visiting) that these individuals are less likely to have had the opportunity to experience.

Ethical approval

All study volunteers provided informed consent and the study was approved by the Local Research Ethics Committee. The prison study was approved by the Multicentre Research Ethics Committee (MREC), reference number 08/MRE00/7.

Scanning procedure

Imaging was carried out at the Brain Imaging Research Centre (BIRC) for Scotland on a GE 1.5 T Signa scanner (GE Medical, Milwaukee, USA). The imaging protocol consisted of a localizer scan, followed by a T2-weighted fast spin-echo sequence,

functional imaging paradigms, and finally a structural T1 weighted sequence. The functional acquisition consisted of axial gradient-echo planar images (EPI) (TR/TE = 2500/40ms; matrix = 64 x 64; field of view (fov) = 24 cm) which were acquired continually over two runs. Thirty contiguous interleaved 5-mm slices aligned to the anterior and posterior commissure were acquired within each TR period. Each acquisition consisted of 96 volumes, of which the first four volumes were discarded. The T1 sequence yielded 128 contiguous 1.2 mm coronal slices (matrix = 192 x 192; fov = 24 cm; flip angle 8°).

Experimental paradigm

In the ‘approachability’ task subjects had to decide whether faces appeared ‘approachable’ or ‘not approachable’. The control condition consisted of rating gender from the same faces, counterbalanced across subjects. The same stimuli were used in both conditions meaning that change in regional brain activation was related to the cognitive demands of the task, rather than the features of the individual stimuli. Facial stimuli were selected as described by Hall et al. (2004). Five hundred pictures of faces were shown to volunteer participants and rated for approachability. Faces representing the extremes of each social dimension were then selected as stimuli for the task. Two sets of facial stimuli (A and B) were constructed for each task. The sets consisted of 18 male and 18 female faces, each comprising 9 high and 9 low approachability faces. The use of the stimulus sets was counterbalanced across subjects.

The task was constructed to consist of 2 runs of 6 blocks per run. Blocks of approachability judgement were alternated with blocks of gender judgement and the order of the blocks was counterbalanced across subjects. Each block lasted 25s and blocks were separated by a rest period of 12.5s during which subjects were instructed to fixate on a cross in the centre of the screen. Blocks commenced with a 1s visual prompt relating to the task to be performed (for example “Approachability”). Six faces were then presented in each block with 3.5s stimulus presentation separated by

a 0.5s inter-stimulus interval. Faces were presented in a pseudorandom order with the constraint that no more than 3 faces of one end of the dimension should be presented sequentially. The two response choices ('approachable'/'not approachable' or 'male'/'female') were shown on the screen and subjects had to press a button to indicate which response they felt was most appropriate for each face shown. Responses on the approachability judgement tests were scored according to their agreement with the response most commonly selected in the previous study, with a maximum score of 36 in each category. Stimulus presentation was conducted using Presentation software (Presentation Software, 2011).

Image processing and analysis

Image processing and analysis were completed by Dr Heather Whalley, Division of Psychiatry, University of Edinburgh. EPI and T1 structural images were reconstructed offline into Nifti format using DICOM convert functions available in SPM5 (Statistical Parametric Mapping) (Wellcome Department of Cognitive Neurology and Collaborators, 2005) running in Matlab (The MathWorks). To assess data quality, reconstructed images were examined using 'Art Repair' software ('Art Repair'). Standard SPM5 pre-processing procedures were conducted. Images were corrected for differences in image acquisition time between slices (slice timing) and then realigned to the mean functional image using a two-pass procedure to correct for movement artefact throughout the period of image acquisition. The structural (source) and functional (reference) image were then co-registered and the anatomical image was then segmented, creating grey and white matter images. The spatial normalisation parameters generated from the previous step were then used to normalise the realigned functional EPI data. Finally the slice timed, realigned and normalised images were smoothed with an 8mm full width at half maximum (FWHM) Gaussian filter.

First level analysis

Statistical analysis was performed using the general linear model approach as implemented in SPM5. At the individual participant level the data were modelled with the three conditions (approachability, gender, and baseline) each modelled by a boxcar function convolved with a synthetic haemodynamic response function. Estimates of head movement from the realignment stage of pre-processing were included as additional regressors in the model. Before fitting the model, the participant's data were filtered in the time domain using high pass filter (128 s cut-off) and serial correlations were accounted for by using the autoregressive (AR(1)) model. All pre-processing and analysis was conducted using default settings unless otherwise stated. Contrast images for each participant were constructed representing a subject-specific summary of brain responses to the different conditions, approachability versus baseline, and gender versus baseline.

Second level analysis

Contrast images were entered into a repeated-measures ANOVA using the flexible factorial model option in SPM5. Factors modelled were group (controls, ex-prisoner group), and condition (approachability versus baseline, and gender versus baseline). This model was used to examine within-group activation patterns and group-by-condition interactions (i.e. group differences in the approachability versus gender contrast). Between-group statistical maps were thresholded at a level of $p=0.001$ uncorrected, and regions were considered significant at $p<0.05$ cluster level corrected for multiple comparisons. Based on our prior hypothesis a small volume correction (svc) was used for the amygdala. This was anatomically derived, created using the WFU PickAtlas (Maldjian et al., 2003, Tzourio-Mazoyer et al., 2002). Where significant clusters were found, data were extracted and entered into SPSS version 14.0 for Windows to determine correlations with measures described below. All p values quoted are at the cluster level corrected for multiple comparisons. Coordinates are reported in MNI (Montreal Neurological Institute) convention. All

images are overlaid onto standard brain in MNI space using the Mango software package (<http://ric.uthscsa.edu/mango>).

Correlation analyses:

Correlation with clinical measures

Data were extracted as described above to determine whether any group difference findings related to PPI-R or AQ measures. This was examined by performing correlation analyses between these scores and the degree of activation. Correlations with psychopathy scores (PPI-R) were only performed on the ex-prisoner group.

Examination of potential confounders

We also conducted similar within-group correlation analyses to examine the effects of potential confounding factors on these regional group differences, including the effects of IQ and reported units of alcohol consumed prior to entering prison.

4.4 Results

Participants

Nine prisoners who were able to fully co-operate with the scan were recruited. In a tenth case co-operation with imaging was limited and the scan could not be used. The ex-prisoner group were asked about levels and patterns of alcohol and substance misuse and were asked to refrain from taking any non-prescribed medication prior to the scan.

Characteristics of ex-prisoners

Each of the ex-prisoners had served at least one sentence in prison. The most common index offence (self-reported) was violent in nature (5 of the 9 antisocial men), and 8 of the 9 had ever had a violent conviction. 8 had a previous conviction. The index offence for the individual without previous convictions was Assault to Severe Injury. Index sentence length was between 4 weeks and 3 years, 10 months. Total time spent in prison ranged between 2 months and 17 years. Six had served sentences before the index sentence. Time since liberation ranged between four weeks and 11 months. The offending histories of all nine in this group suggest that this group can be considered 'antisocial' (either violent offences or repeat offences leading to imprisonment). It is not suggested that the entire group necessarily met criteria for antisocial personality disorder. Eight of the 9 subjects had a history of illicit drug use. None had any current symptoms of mental illness, based upon assessment in the screening study (p19). Three had a past history of head injury that had resulted in loss of consciousness. For characteristics of these nine subjects including substance misuse see Table 14.

Ex-Prisoner	1	2	3	4	5	6	7	8	9
Index offence	Serious Assault	Assault/permanent disfigurement	Drug offence	Drug offence	Assault with weapon	Shoplifting	Serious Assault	Breach community service	Assault/severe injury
Sentence length	11 months	17 months	8 months	5 months	12 months	5 months	4 weeks	3 months	3yrs 10 months
Time since liberation	3 months	6 months	11 months	5 months	1 month	1 month	5 months	4 weeks	6 months
Previous offending	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Previous violent offending	Attempted murder	Not known	Conspiracy to murder	Assault	Robbery	No	Serious Assault	Assault	No
Total time in prison excluding index	16 years	0	5 years	2 years	12 years	1 year	0	13 years	0
Alcohol units /week pre-prison	4	15	0	0	40	0	64	120	80
Substance misuse history	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Substances used in the past*	cocaine	cannabis, cocaine, ecstasy	heroin, methadone	cocaine	heroin, BDZ, methadone	cannabis heroin, LSD amphetamines, BDZ, ecstasy, methadone	Nil	cannabis, BDZ heroin, LSD, cocaine, crack amphetamines ecstasy, solvents	cannabis, cocaine, amphetamines, BDZ, ecstasy
PPI percentile	>99	68	2	>99	83	94	55	31	99

Table 14. Characteristics of ex-prisoners who participated in scanning BDZ benzodiazepines

Characteristics of Control Group

The control group consisted of typically developing male volunteers who reported no personal or family history (first-degree relative) of a major psychiatric disorder. Seven of the control subjects had a history of illicit drug misuse, of whom two reported that they were currently using such substances (cannabis) (Table 15).

Control	Ever used illicit substances	Current substance use
1	Cannabis	nil
2	No	nil
3	Cannabis Stimulants Hallucinogens	nil
4	Cannabis	nil
5	Cannabis LSD	nil
6	Cannabis Ecstasy Benzodiazepines Amphetamines Cocaine LSD	cannabis
7	No	nil
8	Cannabis	cannabis
9	Cannabis Ecstasy Amphetamines	nil

Table 15. Control participants' self-reported past and current drug use

None had a history of head injury. Because of the lower mean IQ characteristic of the prison population, it was not possible to exactly match prisoners with controls by IQ. Instead an age and sex matched group of controls was chosen.

Demographic and clinical measures

Demographic and clinical measures for both groups are presented in Table 16. There were no sex differences as both groups were all males. The mean IQ of the ex-prisoner group on the Quick Test (86.94) was lower than the mean IQ score (125.22) for the age-matched control group. IQ effects in relation to the imaging findings are further explored below

There was a significant difference between the group mean in terms of AQ total scores ($p < 0.01$). All sub-measures of the AQ followed the pattern that the ex-prisoner group scored higher than the healthy controls (see table 16). However, none of the ex-prisoner group reached the cut-off score of 32 on the AQ, above which further assessment for the presence of an autism spectrum disorder is recommended. PPI percentiles for the ex-prisoners (range 2 - >99) suggest that levels of psychopathy varied significantly within this group.

Behavioural measures of emotion processing

For the outside-scanner behavioural measures of facial emotion processing (Ekman 60 Test) the ex-prisoner group scored significantly lower than the controls for the emotions anger ($p = 0.01$), fear ($p = 0.04$) and sadness ($p = 0.03$), see Table 16. This is in keeping with behavioural data from the larger prison population from which these ex-prisoners were taken.

For within-scanner behavioural performance both groups had mean percentage correct scores greater than 75% for approachability (although two in the ex-prisoner

group scored around chance level of 50%) and there was no significant difference between the groups. See Table 16.

	Ex-prisoner group (n=9)	Healthy controls (n=9)	p value
Demographic details:			
Mean age (SD)	32.3 (7.68)	30.94 (3.01)	0.62
Mean IQ (SD)	86.9 (8.35)	125.22 (6.01)	n/a
Mean AQ score	23.2 (6.46)	13.9 (4.48)	<0.01
AQ Range	10-31	7-23	n/a
Within scanner performance:			
Approach correct (%)	76.2 (19.8)	80.6 (15.6)	0.61
Ekman 60 test:			
Anger	64 (15.09)	82 (10.93)	0.01
Disgust	72 (24.89)	72 (13.94)	1.00
Fear	58 (21.67)	79 (18.33)	0.04
Happiness	100 (0.00)	99 (3.33)	0.3
Sadness	57 (22.91)	80 (16.58)	0.03
Surprise	84 (16.67)	87 (14.14)	0.76

Table 16. Demographic details, clinical characteristics and behavioural measures.

Within-group activation maps

For the approachability versus gender judgement both groups demonstrated activation in regions typically associated with the task: bilateral superior/medial frontal gyrus, middle frontal gyrus, inferior frontal gyrus and the left middle temporal gyrus (Hall et al., 2010). At the chosen statistical threshold neither group demonstrated significant differential activation of the amygdala for the approachability versus gender judgement. However, examination of approachability versus baseline and gender versus baseline conditions indeed indicated engagement of this region during the task, (controls $p=0.003$, ex-prisoner group $p=0.001$ for approachability versus baseline; controls $p<0.001$, ex-prisoner group $p=0.127$ for gender versus baseline). Within group activation data are shown in Table 17.

Table 17: Within-group activation data (clusters reported where $p < 0.05$)

a. Within-group activation: gender versus baseline contrast (whole brain)

Group	P (corrected)	kE	Z	Peak Height (x,y,z)
Controls	<0.001	9666	5.46	46 -60 -16
	<0.001	947	4.75	6 14 46
	0.004	121	4.75	-18 -66 50
	<0.001	307	4.68	-50 4 48
	<0.001	419	4.40	44 16 24
	<0.001	292	4.33	12 -28 -6
	<0.001	210	4.23	-36 -66 48
	<0.001	260	4.05	-14 -32 -8
	0.002	137	4.01	-12 -22 14
Prisoners	<0.001	5984	5.26	34 -58 -16
	<0.001	335	4.54	34 -46 40
	0.013	157	3.93	2 -62 -42
	0.003	201	3.79	-24 -68 48
	0.045	117	3.77	-30 -68 18
	0.032	127	3.57	44 6 26

b. Within-group activation data: social versus baseline contrast (whole brain)

Group	P (corrected)	kE	Z	Peak Height (x,y,z)
Controls	<0.001	7406	5.73	16 -96 0
	<0.001	608	5.61	-6 10 48
	0.022	84	4.68	44 6 52
	<0.001	162	4.40	-42 14 0
	0.015	91	4.35	14 -24 -10
	<0.001	179	4.14	34 -70 26
	0.005	112	4.07	-8 46 50
	<0.001	270	4.03	-46 22 -16
	0.031	78	4.03	-40 -4 40
	0.001	137	3.90	42 16 24
Prisoners	<0.001	8529	5.37	-34 -52 -18
	<0.001	1474	5.23	-54 20 30
	<0.001	1869	5.04	46 24 28
	<0.001	1189	4.88	2 28 38
	<0.001	409	4.84	36 -56 48
	<0.001	1854	4.47	12 16 4
	<0.001	528	4.39	-40 50 8
	0.001	180	4.25	-40 26 -22
	0.010	114	4.10	18 -70 36
	0.018	17	4.07	-46 -50 12

c. Within-group activation data: gender versus baseline contrast (small volume correction/ amygdala)

Group	P (corrected)	kE	Z	Peak Height (x,y,z)
Controls	<0.001	96	3.82	24 0 -16
	0.003	44	0.01	-28 6 -16

d. Within-group activation data social versus baseline (small volume correction/amygdala)

Group	P (corrected)	kE	Z	Peak Height (x,y,z)
Controls	0.003	44	3.54	22 -6 -10
Prisoners	0.001	77	4.08	16 -6 -16
	0.001	70	4.06	-20 -4 -14
	0.016	23	3.88	-30 6 -22

e. Within-group activation data social versus gender (whole brain)

Group	P (corrected)	kE	Z	Peak Height (x,y,z)
Controls				
Prisoners	<0.001	1253	4.25	-48 -44 2

f. Within-group activation data social versus gender (small volume correction)

Group	P (corrected)	kE	Z	Peak Height (x,y,z)
Controls				
Prisoners	0.056	62	3.08	-22 -10 -16

Between-group activation differences

For the group by condition effect, there was a significant difference in the left amygdala between the groups (ex-prisoner group > controls; $p = 0.021$, $KE = 31$, $Z = 3.78$; $-26 -10 -16$, with small volume correction), see Figure 11

Graphs of the extracted data for this region for the two conditions indicated a greater differential response in the ex-prisoner group, with a relative over-activation in the ex-prisoner group during approachability versus baseline. The analysis was repeated excluding the two subjects who scored at the chance level of performance for the approachability condition, and the same pattern of findings was present; greater activation in the amygdala in the ex-prisoner group versus controls ($p=0.03$).

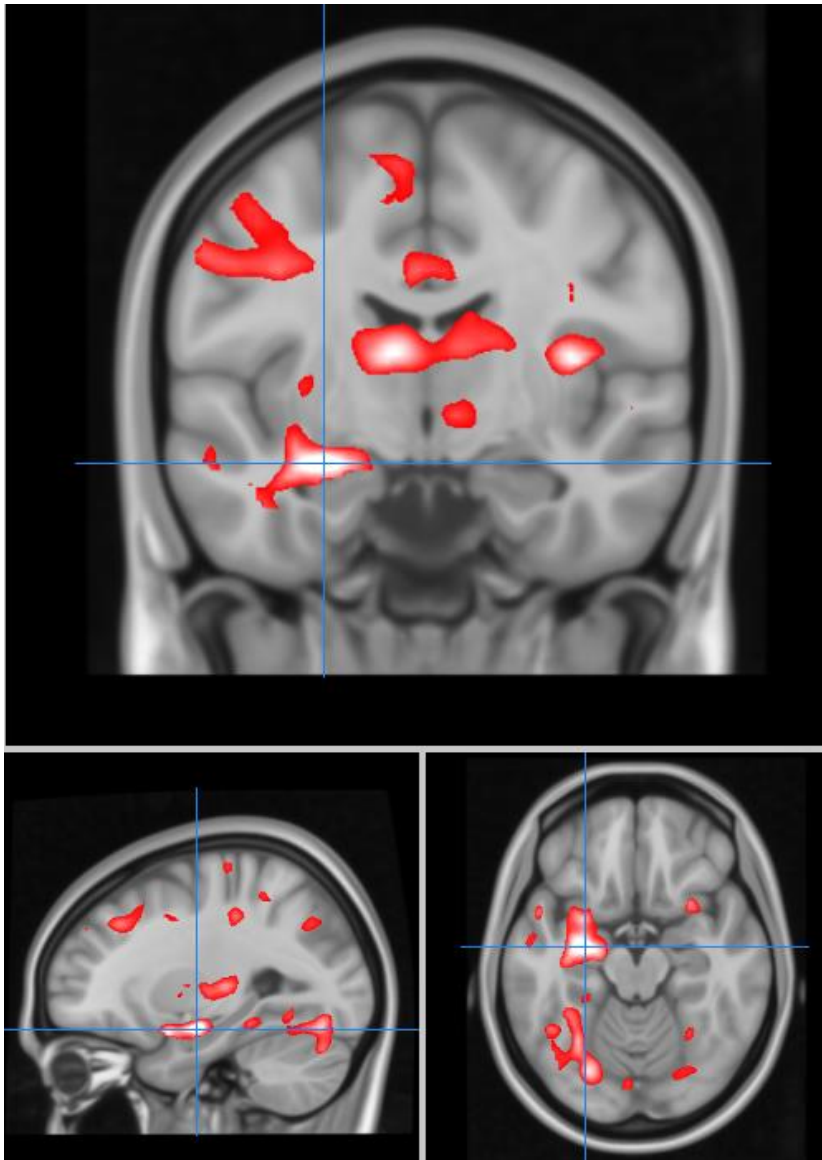


Figure 11. Group by condition effect in left amygdala; Cluster of significant difference in left amygdala $p=0.021$ (corrected), $KE=31$, $Z=3.78$ (-26, -10, -16); controls < prisoners. Map represents T-statistic image overlaid onto standard brain in MNI space using Mango software package thresholded at $T \geq 2.5$ (<http://ric.uthscsa.edu/mango>).

Correlations with clinical measures.

There were no significant correlations between factor scores of the PPI-R measure of psychopathy or the PPI-R total score and the extracted data from the cluster of group difference in the amygdala.

Effects of potential confounders

There were also no significant correlations between the extracted data for the amygdala cluster and AQ measures either across both groups or on examining the groups. There were no significant within-group correlations between IQ measures and data extracted from the amygdala, nor was there any correlation with activation and reported levels of alcohol consumption.

4.5 Discussion

Region of Interest analysis of data in the bilateral amygdala demonstrated significant over-activation in the left amygdala in a group of nine ex-prisoners relative to controls in the approachability versus control (gender judgements) task, a complex social judgement task.

In this approachability task the use of the gender comparison means that any processing deficits based on face processing alone are controlled for. As predicted, activation was found in both groups while judging approachability in comparison with gender in areas known to be activated in social judgements (amygdala, medial frontal gyrus, left posterior frontal gyrus) (J. Hall, et al., 2010). However, significant activation differences between the ex-prisoner group and controls were found in the amygdala for the contrast of approachability versus gender judgement. The results of this study therefore support a hypothesis that there are differences in neural activation, measurable using fMRI, associated with performing social judgement in this ex-prisoner population in comparison with controls.

The pattern of amygdala activity here is consistent with a model of amygdala over-activation in response to emotional stimuli in reactively aggressive groups, as has been discussed earlier (Section 4.1). However, this is the first demonstration of such a response in an antisocial group on a social judgement such as approachability rather than a facial emotion recognition task. This amygdala over-activation may reflect a lack of prefrontal cortical regulatory input (R.J.R. Blair, 2007), although this hypothesis was not examined here.

This result did not show any association with a measure of psychopathy. This is as anticipated, given that there is evidence in the scientific literature of relative amygdala under-activation rather than over-activation to emotional and threat-based stimuli in psychopathic groups and children with callous unemotional traits (Dolan and Fullam, 2009, Gordon et al., 2004, Han et al., 2011) as discussed earlier (Section 4.1, p120).

The difference between the ex-prisoner group and controls was apparent despite similar levels of task performance. This suggests that a lack of evidence for behavioural difference does not necessarily indicate that there is no difference at a neural level. These behavioural data contrast with behavioural differences between the two groups outside the scanner on recognition of basic facial expressions of fear and anger, where the ex-prisoners' performance was significantly worse. However, they are consistent with findings from a behavioural study of psychopaths versus controls in judging facial trustworthiness, another social judgement (Richell et al., 2005).

It should be noted that it is not possible to suggest an underlying cause of the differences between the groups from this study. The ex-prisoner group has had life experiences that differ from the controls, such as spending time in a prison

environment. It may be that environmental factors underlie the differences between groups. Alternatively, such differences may reflect the role of early factors such as genetics in the aetiology of antisocial behaviour (Frisell et al., 2010).

In summary, this study further provides preliminary evidence of differences at a neural level between an antisocial group defined behaviourally, ex-prisoners, and controls. A difference in amygdala activation on a social judgement task has been demonstrated that has not previously been investigated in antisocial groups. This further supports a hypothesis of differences in amygdala function in such populations. In addition, it has demonstrated that it is feasible to recruit antisocial subjects for a scanning study in this population.

Limitations

This study has several limitations. The primary limitation is that the sample was small and not necessarily representative of the prison population as a whole. The small sample size means that statistical power was low. Although low statistical power increases risk of a Type II error (falsely accepting the null hypothesis) rather than a Type I error, a small sample size in this type of study means that individual subjects have a large impact on the findings. The risk of false positives due the effects of outliers is consequently increased. The findings of this study should therefore be regarded as preliminary. This limitation is common in imaging studies of antisocial groups, and numbers in studies discussed earlier in this thesis (Appendix C) were similarly small, the smallest containing one antisocial individual. This reflects the difficulty in recruiting antisocial subjects for studies of this type, which require a time commitment, travel to a scanner, the ability to tolerate boredom or periods of concentration, as well as the ability to make and keep to plans for the future.

One difference between this study and several of those described in this thesis is payment to participants. While in this study participants in the community were given expenses they were not paid. Although prisoners are not permitted to be paid to take part in research projects in prison, payment is possible in the community unless the individual is on probation. Given the characteristics of antisocial groups, including lack of altruism and mistrust of authority, such payments may be required in order to recruit a large enough sample. Although there have been ethical concerns regarding payment for taking part in research studies and risk of coercion (Appelbaum et al., 2011), such payment can also alter the balance of power between researchers and participants and reduce the possibility of participants believing that the research is for their direct benefit (therapeutic misconceptions) (Health Research Authority, 2014). Despite concerns, there is no evidence that payment for participation in research leads to increased use of illicit substances, but there is evidence that recruitment can be improved (Festinger et al., 2005). Use of payments in this study might have increased participation rates and allowed a larger antisocial sample to be recruited.

A second significant limitation was that the control group was taken from a sample of participants already recruited by the university who had completed the task. Access to the sample to carry out further measures such as the PPI-R was not possible, although this would have been of interest. This led to different measures of IQ having been used for the ex-prisoner and the control group. It was not considered to be practical to carry out the WASI on the prisoner group due to the length of the interview the ex-prisoners would tolerate. Limited tolerance of interviews was found to be the case in practice. Although the measures are not directly comparable, the ex-prisoner group had a lower mean IQ. This cannot be ruled out as a factor contributing to the difference in amygdala activation found between the two groups. It should be noted, however, that the left amygdala activation on the task within the ex-prisoner group did not correlate with IQ.

The antisocial group was defined behaviourally rather than by diagnostic means. The advantage of using subjects who have been in prison is that all have exhibited significant antisocial behaviour. It would have been of interest, however, to have information on which other disorders were present, such as ASPD. Psychopathic traits were measured among the subject group, although not among controls using the PPI-R (Lilienfeld and Widows, 2005). Although widely used, this is a self-report measure. Advantages of using this measure included it being shorter to carry out than other measures and not requiring a review of extensive file information. It uses validity scales, and there are no concerns regarding inter-rater reliability. However, this method of assessment is being used in individuals who lie, have no insight into their own psychological problems, and who are poor at labelling their own affective experience (Lilienfeld and Fowler, 2006).

Recruitment was through a study investigating autistic traits in prisoners in Scotland. Recruitment into the imaging study was not based upon autistic traits, however. Autistic traits in the ex-prisoner sample were on average higher than in the control group. However, no subject reached an AQ score of 32 meaning that none had 'clinically significant levels of autistic traits' (Baron-Cohen et al., 2001). In addition, the increased activation in the ex-prisoner group did not correlate with AQ scores, suggesting that the difference found here does not relate to autistic traits.

Individuals with ASDs also perform poorly when asked to make complex social judgements, such as judgement of facial trustworthiness (Adolphs et al., 2001) and approachability (Philip et al., 2010). An fMRI study examining trustworthiness judgements in ASD (Pinkham et al., 2008) found that an ASD group differed from controls with relatively reduced activation of right amygdala, fusiform face area and left ventrolateral prefrontal cortex activation. A comparison of brain activation in males with ASD and matched male controls during the approachability judgement found greater left inferior frontal cortex activation and reduced activation in right anterior cingulate cortex in the ASD group (Hall et al., 2012). A meta-analysis of

studies of children and adults with ASD performing complex social cognition tasks such as approachability indicated abnormal activation in left superior temporal gyrus and right superior temporal gyrus, left inferior frontal gyrus, left pre and post central gyri and left superior temporal gyrus and left claustrum in ASD (Philip et al., 2012). These results also suggest that the difference between the groups in this study was not a result of autistic traits.

Levels of past substance misuse were high in both subjects and controls. Eight of the nine members of the group had a history of illicit drug misuse in comparison with seven of the control group. In this regard the ex-prisoner sample is representative of the prison population from which they were drawn. Given the close relationship between disorders such as antisocial personality disorders and substance use disorders it is rare to find an antisocial sample without a history of substance misuse. Any antisocial sample without a history of substance misuse is likely to be unrepresentative of a wider antisocial population, and so this is an issue for all studies of antisocial groups (Trull et al., 2010). A control group with a high rate of substance misuse may contain an unrepresentatively high number of antisocial individuals. Certainly the rate of illicit drug use in the controls (7 of 9 controls ever used drugs) is higher than the rate of illicit drug use in the Scottish adult population, where 30% report ever having used an illicit drug (The Scottish Government, 2013). Although similar rates of drug use between subjects and controls might be expected to reduce the likelihood of differences between the groups being a result of substance misuse, patterns and types of drug use may have differed significantly between the two groups. A contribution to the result from differences in substance misuse histories between the two groups can not be ruled out

It should be noted, however, that reported alcohol intake did not correlate with amygdala activation on the task in this group. In addition, increased amygdala activation in response to threatening stimuli has been found in adolescents with conduct disorder, a precursor to antisocial personality disorder, but not in a comparison group of adolescents with ADHD and without conduct disorder

(Herpertz et al., 2008) despite an association between both disorders and high levels of substance misuse.

Three of the nine subjects had a history of traumatic brain injury. In the Scottish prison sample from which these subjects were drawn, 54% of those interviewed gave a history of head injury which had required hospital admission and/or led to loss of consciousness. Such injuries are common among prisoner populations, with estimates ranging between 25 and 87% (Shiroma et al., 2012). Traumatic brain injury increases risk of mental disorder (Orlovska et al., 2014) as well as risk of violent crime (Fazel et al., 2011). At the same time, presence of antisocial personality disorder (Hibbard et al., 2000) and substance misuse (Jorge, 2005) increase risk of future traumatic brain injury. Traumatic brain injuries have been shown to affect facial emotion processing, (Radice-Neumann et al., 2007), linked to injuries to prefrontal cortex, limbic system and parietal lobes.

Other environmental factors may also have played a role in these results. The ex-prisoners had all had recent exposure to prison, an unusual and often hostile social environment which might be expected to affect the social judgement of all who experience it. However, an advantage of this study is that the ex-prisoners were no longer in prison at the time of comparison with controls.

I have been asked to address the issue of what might be done with hindsight if the study were being conducted again. It would be helpful to increase the power of the study. Payment for participants would be the most important step as this might improve participation. It is not clear whether ethical approval could be obtained for this as there is not a tradition of paying participants in imaging studies in Scotland.

Recruitment of a new control group would allow the same measure of IQ to be used on both groups allowing a more helpful comparison. It would also allow the PPI-R measure of psychopathy to be used in both groups.

Should levels of recruitment allow, it would be of interest to recruit two offender and control groups. Two groups (one offenders) would have co-morbid substance misuse and (one offenders) would not. This would help to clarify whether there is role for substance misuse in the results of the study.

It would have been of interest to define the groups by diagnosis as well/ instead of by behaviour. Use of the Structured Clinical Interview for DSM Disorders (SCID-5 (Non-patient Edition) (First et al., 2014)) and the SCID 5 for Personality Disorders (SCID-5-PD, due for publication Spring 2015) would allow assessment of current mental illness and of personality disorder. This would require at least two interviews in addition to a scan, and experience on this study suggests that participants might find this too great a commitment. Certainly, participants could not be expected to travel large distances on three occasions. The background and risk associated with some of the offenders in this study meant that home visits would not be suitable even if more than one researcher were to visit. Such a study would therefore be likely to require research premises in the local area. Alternatively, should participants be identified before liberation from prison, interviews could be carried out in prison. This would be likely to mean however that several interviews would be carried out on individuals who did not go on to participate, given the relatively high numbers of prisoners who agreed to take part when in prison in comparison with those who attended for an fMRI scan.

4.6 Conclusions

Recruiting antisocial groups for research is challenging. This study was limited in particular by a small sample size and the inclusion of individuals with substance use disorders. Although we were able to account for IQ differences in the analysis, the groups significantly differed in IQ. However, from this study of male ex-prisoners we can conclude that there are not only differences in social cognition in antisocial groups in comparison with controls, but that differences in brain blood flow can be demonstrated using fMRI on a task involving social judgement. In addition, although this study is limited, these preliminary results suggest that this difference is unlikely to be due to level of alcohol intake, mental illness or autistic characteristics. The next step in investigating this difference would be to use the social judgement task on a larger sample of antisocial men and controls, with diagnostic tests for mental disorder applied as well as psychopathy scores for both groups. However, experience from this study suggests that the method of recruitment used is unlikely to generate a large enough sample.

It is important to note that there are considerable differences between prison populations and the community. Prisoners are more likely for example to have substance misuse problems, to have poor numeracy and literacy skills, to have been unemployed or homeless, or to suffer from a mental disorder (Prison Reform Trust, 2014). It is not possible to conclude here that the neural differences in social cognition observed in this antisocial population are the cause, directly or otherwise, of their offending.

5 Implications of studies 2 and 3

Antisocial behaviour is common (The Scottish The Scottish Government, 2014) and associated with significant morbidity, and cost to the NHS and the criminal justice system (Bellis et al., 2012). Despite interest in treatment for antisocial individuals, treatments have not been wholly successful and management has focused upon treatment of co-morbidities such as substance misuse. Difficulties have included problems in conducting trials due to difficulties in recruitment and engagement of subjects. Antisocial individuals rarely engage or comply with treatment voluntarily and mental health services have traditionally excluded such individuals without psychiatric co-morbidity due to beliefs about untreatability (Salekin et al., 2010). Treatments have been primarily through the criminal justice system rather than mental health organisations.

Within the criminal justice system, treatment has focused on groups defined by behaviour with psychological programmes aimed at, for example, violent or sex offenders. Disadvantages of these treatments are that they are only used in individuals after they have. In addition, there is evidence that non-completion of such treatments can lead to increased risk of re-offending (McMurrin and Theodosi, 2007). Overall, the criminal justice system is poor at preventing reoffending- 46% of adults released from prison in the UK will re-offend within one year of release (Prison ReformTrust, 2014).

Attempts have been made, however, to address the treatment of particular disorders. For ASPD, National Institute of Health and Care Excellence Guidelines (NICE, 2009) note that the evidence for treatment is limited. The Guidelines suggest consideration of group-based cognitive and behavioural interventions. A systematic review of psychological treatments for ASPD concluded, however, that ‘there is insufficient trial evidence to justify using any psychological intervention for adults with ASPD’, and stated that further research was urgently required (Gibbon et al., 2010). An understanding of the development from children into antisocial adults has

led to an interest in interventions in childhood aimed at preventing antisocial behaviour in adulthood. NICE recommend psychosocial interventions for highly aggressive behaviour in high-risk children (NICE, 2013).

Psychopathy has traditionally been considered untreatable, and potential treatments treated with caution. Particular concerns include lack of motivation to change, deception and manipulation, and lack of deep or lasting emotion (Salekin et al., 2010). NICE recommend adapted cognitive and behavioural interventions for psychopathy (NICE, 2009).

New directions

Evidence on the deficits in social cognition found in antisocial disorders has begun to be incorporated into attempts at treatment. Attempts have been made to modify the deficit in facial emotional recognition, with an expectation that this may lead to reduced antisocial behaviour.

In one recently-developed intervention, Mentalization-Based Therapy for ASPD, the rationale refers explicitly to deficits in social cognition, and to amygdala dysfunction, within this group. The therapy includes a focus upon understanding emotional cues and recognition of emotions in others (Bateman et al., 2013). No evidence regarding its effectiveness is currently available.

Brief implicit training on facial affect recognition was evaluated in a trial involving 44 male violent prisoners and 43 matched controls (Schönenberg et al., 2014). Half of each group were trained to look at salient facial regions and to increase sensitivity to facial expressions (sensitivity to emotional expressions training, SEE), while the other half had training to look at salient regions only. The group which received SEE improved their recognition of facial emotions. The authors, referring to evidence of a

fear recognition deficit in psychopathy and to work on psychopathy described by Blair (Blair et al., 2001) and Dadds (Dadds et al., 2006) suggest such improvements in emotion recognition may lead to improved empathy and reduced violent behaviour due to recognition of distress signals, but did not evaluate this.

Bateman and Schonenberg assume that skills in emotional training will be retained over time. They also assume that a deficit in emotional recognition in adults is directly responsible for antisocial behaviour. This is plausible if antisocial behaviour is a result of misunderstanding social cues including distress. The models referred to above by Schonenberg, however, primarily relate to amygdala dysfunction which is measured by facial emotion recognition deficits. They describe hypotheses associating amygdala dysfunction in early life with lack of development of emotional empathy and conscience in later life. According to these models, modification of adult emotion recognition would not treat psychopathy and interventions would be expected to be more effective if used early in life. However, the models do not address the development of non-psychopathic disorders such as non-psychopathic ASPD, which may be more amenable to intervention in adulthood. Certainly, there is some evidence that psychosocial interventions can reduce amygdala hyper-activity to threat in PTSD, although amygdala over-activation to fear predicts poor treatment response in this disorder (Bryant et al., 2008, Felmingham et al., 2007).

Dadds *et al* report a trial of Emotion Recognition Training (ERT) (Dadds et al., 2012b). Children with high levels of callous unemotional traits showed small but significant improvements in affective empathy and conduct problems following ERT at 6 months follow up, although no improvement in facial emotion recognition. Such of improvement was not found for children with high callous unemotional traits who received treatment as usual, or for those with low callous unemotional traits who received ERT. Given that the improvement was not mediated by improved facial emotion recognition, the authors concluded that the value of the training was in fact in its role in intimate relationships.

Penton-Voak et al (Penton-Voak et al., 2013) demonstrated that the perception of ambiguous expressions could be modified in adolescents at high risk of offending and delinquency (of whom 70% were offenders) through computer-based training. Those who received the training showed reduced aggressive behaviour for the following two weeks in comparison with controls. The authors relate the results to the model of hostile attribution bias (HAB) discussed earlier, p152. Although this study does not demonstrate a practical method for long-term treatment of aggressive behaviour it does suggest that modification of perceptions of emotions need not be in very young children to have an effect, and that such modification can have an effect upon aggressive behaviour. It would have been of interest for the aggressive group to have been characterised by diagnosis or presence/ absence of callous unemotional traits. However this is a novel and significant finding which directly translates theoretical knowledge of deficits in facial emotion recognition in antisocial groups into an effective treatment.

It is possible that interventions aimed directly at the amygdala will be developed in the future. Should this be the case, a clinical diagnosis is likely to be required or some other method of establishing whether amygdala hyper or hypo-response to distress cues is the underlying pathology (Blair, 2013a), assuming that amygdala pathology is the cause, directly or otherwise, of antisocial behaviour. Again, according to Blair's model, it is likely that treatment would be required early in development for psychopathy if not for other disorders

A further implication of the improved understanding of the neurobiological nature of antisocial disorders is the identification of biomarkers in the future, in order to provide diagnosis and guide prognosis and future response to treatment as well as potentially monitor treatment effects (Blair, 2013a). Although such evidence at present is lacking, the ability to use an objective measurement in assessment and treatment of groups at risk of not reporting truthfully to clinicians would be extremely valuable. This would raise ethical issues of giving a stigmatising diagnosis

and using preventative treatment on the basis of theoretical risk of offending only rather than in individuals with established adult diagnoses and history of offending.

The study on facial emotion recognition that has been described in this thesis demonstrates that deficits in facial emotion recognition are present in this population of Scottish prisoners and not just highly-selected psychopathic groups. The imaging study suggests that amygdala abnormalities may be present. The implications of these findings include a role for the development and use of treatments for antisocial behaviour based on neurobiology within Scotland.

6. Conclusions

This thesis has described an examination of prisoners in Scotland. Two types of disorder have also been discussed, autism spectrum disorder and antisocial personality disorders. They are, of course, different but have in common deficits in social functioning.

The aim of this thesis was to answer the following research questions:

1. Is an instrument that has been designed to screen for autism spectrum disorder (ASD) effective in the Scottish prison population and should it be used?
2. Do Scottish prisoners differ from community controls with respect to facial emotion recognition, as measured by behavioural testing?
3. Do Scottish prisoners differ from community controls in neural activation during a complex social judgement task, as measured by fMRI?

The first study, described in Chapter 2, aimed to answer the first question. This was the first time that such a study had been carried out in a prison in the UK, and it reflects the methodological difficulties of conducting such a study in a prison environment. A total of 2458 prisoners, including male and female prisoners and young offenders, were screened across 12 prisons in Scotland accounting for 40% of the sentenced population. Following this, 127 prisoners were assessed in more detail. Scores on the instrument were compared against scores from standardised instruments that are commonly used to aid diagnosis of ASD in adults.

Scores on the screening instrument correlated with measures of autistic traits. However, it showed poor reliability. The instrument was not found to be valid when compared against the Autism Quotient (AQ). No evidence of high rates of ASD was found in this population although this was not a prevalence study. Despite the significant limitations of this study in providing an assessment of prevalence, there is little information available on ASD in prisoners at present and therefore it is of value.

This study also found that prisoners showed deficits in facial emotion recognition. High rates of drug and alcohol misuse as well as of head injury were also found in this group of prisoners

The study was limited by the exclusion of remand prisoners. In addition, a small sample of prisoners took part in assessments in comparison with the group screened. There was a low response rate to invitations to take part in interviews (49.5%) potentially leading to biased sampling. Data was not obtained on inter-rater reliability and few data for intra-rater reliability. In addition, a true 'gold standard' diagnostic test including a full clinical assessment was not performed.

Despite the limitations of the study it is possible to conclude that the screening instrument is not effective in the prison population and should not be used. This recommendation was communicated to the Scottish Prison Service in both a formal report and a presentation to prison staff. This result is important because it provides evidence which prevents this screening instrument being used in prisons. As the tool has reasonable face validity there would otherwise be a risk of its use, with consequent poor results, particularly in not identifying those individuals with ASDs. For the paper published following this work please see Appendix D.

The second study, described in Chapter 3, aimed to establish whether Scottish prisoners differed from community controls in their ability to identify facial emotions. Using a large sample, the study demonstrated a significant difference in recognition of negative emotions between male prisoners and age, IQ and sex-matched controls. This study showed that the Scottish prison population shows similar deficits in facial emotion recognition to those found in other antisocial populations. These deficits do not appear to relate to IQ. In addition, prisoners with a history of previous prison sentences and those with a history of psychiatric contact had a more severe deficit in fear recognition, and sex offenders showed unexpected deficits in surprise recognition and superior ability in recognising sadness. This study was limited, however, by the inclusion of prisoners with histories of substance misuse and head injury, which may have influenced their facial emotion recognition.

This is a common difficulty in such studies, as both factors are associated with antisocial behaviour. For the paper published following this work please see Appendix D.

The third study, also described in Chapter 3, aimed to answer the third question. Nine prisoners took part in an imaging study following their release. Haemodynamic changes during a task in which they made judgements about the approachability of faces, in comparison with gender judgements, were compared with controls. An increase in relative amygdala activation was found in the prisoner group.

There were several limitations to this study, the most important being that a small sample was used. This means that results must be seen as preliminary. In addition, there were differences between the prisoners and the control group, for example in IQ (although this was addressed to some extent in the analysis) in history of head injury and to some extent in substance misuse, and meaning that this result can not suggest a cause for the differences on MRI between subjects and controls.. Although limited by sample size and differences between control and participant groups in particular, the results suggest that Scottish prisoners may differ from controls in neural activation during a complex social judgement task as measured by fMRI.

This study was the first to use fMRI to examine brain activity during a complex social judgement task in an antisocial group. As well as the result described above, the study demonstrated that it was feasible to conduct a small imaging study on this antisocial group in Scotland. However, it also demonstrated that it would not be feasible to obtain a larger antisocial sample over the timescale that would be required to conduct a larger similar study. One suggested method of improving recruitment in this difficult-to-study group would be to provide payment for participation in research.

The main result of this study, however, does demonstrate a difference at a neural level between an antisocial and a control group during an emotional task. The over-activity in the amygdala is in keeping with hypotheses described in the literature

regarding the underlying abnormalities in such groups, and is similar to results obtained elsewhere in the world using other emotional tasks such as facial emotion recognition. Both this result and the behavioural deficit identified (Study 2) demonstrate that abnormalities in social cognition are found in ‘ordinary’ antisocial groups and not just highly-selected psychopathic groups. They also suggest that the Scottish prison population might be suitable for the development of and use of treatments for antisocial behaviour that are based upon the neurobiological findings in antisocial groups.

Finally, this thesis has described three studies covering several subject areas. The first study was able to provide valuable evidence regarding the validity of a screening instrument for ASD in prisons. The second and third studies demonstrated differences between Scottish prisoners and controls during social cognition tasks. These results were in keeping with investigations in other antisocial populations, although the fMRI study was the first to demonstrate such a difference during complex social judgements. This thesis has demonstrated the unique challenges faced during research in prisons and with antisocial populations. It has also indicated why, despite these challenges, such research continues to be necessary.

APPENDICES

Appendix A ASD Screening Instrument

PRISONER NUMBER _____

DATE _____

Q		ASDI Area	Yes	Maybe	No
1	Appears 'odd' when compared to other prisoners of a similar age	1			
2	Described as a 'loner'	1			
3	Appears reluctant to mix with other prisoners (e.g. during association periods). Keeps self to self	1			
4	Stands too close to other people (invades personal space) and seems oblivious of this	1			
5	When compared to other prisoners lacks a sense of humour or humour is regarded as odd. Doesn't seem to 'get' jokes	1			
6	Unusual gaze – stares or avoids eye contact	5			
7	Talks a lot about a narrow range of topics (regardless of interest of listener)	2			
8	May be comfortable talking with one person but uncomfortable or inappropriate in groups	1			
9	Asks the same question(s) over and over again (regardless of answers). Repetitive	2			
10	Good memory/ ability for facts or figures or very knowledgeable about a particular topic	2			
11	Popular with other prisoners. A ringleader (has a number of followers)	1			
12	Does not appear to follow conversations or instructions or frequently misunderstands them (e.g. – picks up on isolated words or may take what is said literally)	4			
13	Stickler for the rules- becomes upset if rules are broken or promises are not kept (to an unusual degree)	3			
14	Resists changes in routine – or is upset by them (to an unusual degree)	3			
15	Frequently interrupts or 'talks over' people	5			
16	Voice too loud or has a peculiar pitch – or speaks in a monotonous voice	4			
17	Tries to be sociable but is only 'tolerated' or even rejected by others	1			
18	Not keen on games involving physical exercise. (e.g. may avoid ball games or is poorly coordinated and very bad at them e.g. pool, football.)	6			
19	Clumsy, bumps into things or finds it difficult to walk or run in a straight line. Has problems keeping up or in step with others	6			
20	Complains about noise or bright lights	n/a			

Scoring the ASD Screening Instrument

Area 1- questions 1-5, 8, 11, 17

Area 2-questions 7, 9 and 10

Area 3- questions 13, 14

Area 4- 12, 16

Area 5- 6, 15

Area 6- 18, 19

Area 7- 20

An area is scored as positive if one or more of the items within that area is scored as a “Yes”. A score on question 11 (leadership question) of ‘yes’ or ‘maybe’ led to a score of zero in that area (area 1). The ASD screening instrument is scored as positive if 5 or more of the 7 areas are positive.

Appendix B. Studies of Facial Emotion Recognition in Antisocial Groups

Subjects Grouped by Behaviour

Authors/date	Groups characterised and numbers	Test	Results	Comments
Kropp and Haynes (1987)	20 abusive mothers 20 non-abusive mothers	Slides of babies' faces- 7 emotions distress/pain, surprise, sadness, joy, interest, fear, and anger: forced choice	Abusive mothers: deficits in labelling emotion, particularly anger and fear	Age and education matched
Hudson et al., (1993) Study 1	75 male prisoners: Non-sexually violent 21 Sexual offences 21 Drug offences 9 Theft 24	Ekman Pictures of Facial Affect (Ekman and Friesen, 1976) 6 emotions, can choose more than one label	Violent most accurate across all emotions, fear and anger worst; Sex offenders poorest, and confuse surprise and fear	No control for IQ
Study 2	Male child molesters 20 Community controls 20	Line drawings of adults (Emotional Expression subtest of (1976) Test of Social Intelligence); created drawings of children 4 emotions, forced choice	Controls more accurate, no difference in either group in accuracy between adult and child	Matched for age not IQ Empathy measure

Walz and Benson (1996)	18 aggressive, 21 non-aggressive men with borderline mental retardation (RPBC used to discriminate groups)	Ekman Pictures of Facial Affect plus non-emotion control pictures Not given choices of named emotions	No difference between groups	No IQ or age difference between groups
Matheson and Jahoda (2005)	Mental retardation: 19 aggressive (11 men, 8 women); 15 non-aggressive (7 men 8 women)	Ekman Pictures of Facial Affect, not given choices of named emotions	No difference between groups	IQ matched
Woodbury-Smith et al. (2005)	21 offenders (any conviction) with ASD (18 men 3 women); 23 non-offenders with ASD (20 men 3 women); 23 community controls (17 men 6 women)	Ekman Faces Test (FEEST)- morphed images of 6 emotions, forced response	ASD offenders worse at fear recognition than non-ASD controls, Controls worse than non-offending ASD at anger	Data adjusted for IQ as group difference
Hall (2006)	84 undergraduates (68 women, 16 men) Aggression Scale of the Personality Assessment Inventory (PAI; Morey, 1991)	Diagnostic Analysis of Nonverbal Accuracy (DANVA) (Nowicki and Duke in Hall, 2006) - Facial Expression receptive subtest Happy sad anger fear	Higher aggression associated with over-identifying anger; no association with ability to identify emotion	Gender included as covariate in analysis

Hoaken et al. (2007)	Male Violent offenders/non-violent offenders/ controls 20:20:20	Ekman Pictures of Facial Affect 6 emotions plus neutral, forced choice task	Violent offenders < non-violent offenders=controls on total, sad and disgust	No control for IQ Also examined executive function: no association with affect recognition
Babcock et al. (2008)	69 intimate partner violent (IPV) and 32 nonviolent men IPV into 3 types by cluster analysis: Family only (FO)43 Borderline or dysphoric (BD)14 (MCMI-III;) Generally antisocial (GA)-12 (had higher psychopathy factor I on SRP-II)	Ekman and Friesen Test of recognition	No difference overall between IPV v controls, but NV worse on disgust and fear GA more errors than BD; BD fewer errors than FO; GV worse than BD at anger happiness, neutral, and surprise	IQ not measured
Hastings et al. (2008)	145 male prisoners PCL:SV (23% psychopathic)	Photographs of faces (Hess and Blairy 1995, cited in Hastings et al): happiness, fear, anger, surprise, sadness, and shame 60% and 100% intensities Rate picture for each emotion on Likert scale	Increasing psychopathy associated with worse recognition overall at 60% intensity but not 100%; no association with any individual emotion; 2 factors not independently associated with deficit	No control for IQ

Gery et al. (2009))	Male Sex offender prisoners /non-sex offender prisoners/ community controls 10:10:10	Ekman Pictures of Facial Affect 6 emotions plus neutral, forced choice task	Sex offenders worse at disgust fear and anger and surprise	No control for IQ age gender and educational level matched
Oliver et al. (2009)	Non-violent male child sex offenders 23; Non-offender controls 26	Adult faces, forced choice fear or surprise	No differences in recognition	IQ higher in control group
Dobbelar BA thesis (Dobbelaar, 2010)	29 male prisoners(violent) 26 male controls no criminal history	Matching facial expressions in 2 alternative forced choice task	Violent better at fear recognition than controls	Matched on education and age
Marshall and holtzworth-Munroe (2010)	48 men IPV past year Self report of psychopathy SRP used (9 antisocial behaviour items excluded) Correlation analysis	Male and female faces photographs; wives' faces photographs 6 emotions	IPV negatively correlated with sensitivity to female fear; no correlation between psychopathy and wives or actors' fear recognition; psychopathy negative correlation with wife happy recognition only	

<p>von Borries et al. (2012)</p>	<p>17 Male violent offenders from psychiatric institution PCL-R\geq26 15 healthy non-criminal controls (age and IQ matched, no PCL-R scores)</p>	<p>Ekman and Friesen set Anger happy and neutral</p>	<p>No difference in recognition ability</p>	<p>Also 'approach avoidance' task</p>
<p>Schönenberg et al. (2014)</p>	<p>44 imprisoned violent male offenders 43 sex age and educational level-matched controls</p>	<p>Animated morphs from neutral to 6 basic emotions (Raboud Faces Database) (Langner et al., 2010) cited in Schonenberg et al 2014</p>	<p>Fear and surprise recognition significantly impaired in violent offenders</p>	<p>Accuracy measured as percentage of emotion intensity required to correctly detect emotion Study excluded domestic violence and sex offenders Violent offenders significantly older Offenders scored more highly on BPAQ</p>

Subjects Grouped by Diagnosis

<p>Blair and Cipolotti (2000)</p>	<p>Male prisoners 5 ppathic (>30): 5 nonppathic (3-14) PCL-R</p>	<p>Test from Calder et al (in Blair and Cipolotti 2000) 6 adult facial emotions Forced response</p>	<p>Psychopaths no expression recognition deficit</p>	<p>IQ and age of groups similar</p>
<p>Habel et al. (2002)</p>	<p>17 males prison/forensic treatment facility; all APSD and 20 or more on PCL-R 17 male controls matched for age and gender , PCL-R scores of controls unknown</p>	<p>PENN facial discrimination test Neutral happy sad: bipolar intensity scale</p>	<p>Prison group worse than controls in total emotion recognition; no difference between groups with mood induction; Within prisoners, factor 1 of PCL-R associated with better recognition ability</p>	<p>No IQ measure or matching, age matched</p>
<p>Kosson et al. (2002)</p>	<p>34 high psychopathy (>30 PCL-R) 33 low (<20 PCL-R) All right handed Using left hand group 17ppaths, 18 non-ppaths Using right hand 17ppaths 15non-ppaths</p>	<p>Ekman Pictures of facial affect Happy sad fear anger disgust surprise, forced choice</p>	<p>Overall ppaths worse at disgust only, with both hands No difference between left and right hand responding in ppaths; Ppaths better than controls with right hand for anger</p>	<p>IQ, age, ethnic group controlled</p>

Blair et al. (2004)	Male prisoners 19 high psychopathy (>30) 19 low (<20) PCL-R	Ekman and Friesen pictures of facial affect, emotional expression multimorph task (Murray et al cited in Blair 2004), varying intensities	High<low on total and fear	No covariates tested Age matched
Montagne et al. (2005)	Male and female students BIS/BAS 16 strong BAS/weak BIS (ppathic): 16 low ppathic traits	Adult faces 6 emotions, Morphs Forced choice	Psychopathic group significantly worse fear	No correction for gender or IQ (similar proportions, all college students)
Eisenbarth et al. (2008)	13 psychopathic female offenders hospital patients (PCL-R >30) 15 non-psychopathic female offenders PCL-R <30 16 healthy female controls (psychopathy not measured)	Fear, angry, disgust, happy, neutral, sad, surprise (Karolinska Directed Emotional Faces set (KDEF))	Psychopathic group worse than non-psychopathic; forensic worse than controls at total scores even co-vary for education;	Education included as covariate
Hansen et al. (2008)	43 male prisoners PCL-R	Ekman and Friesen Pictures of facial affect: sad, fear, disgust, angry, surprise, happy, neutral	Antisocial and impulsive facets of PCL-R positively related to the recognition of disgust faces, negative relationship between Facet 1 (arrogant interpersonal style) and recognition of disgust	No IQ control

Pham and Philipot (2010)	<p>20 male prisoners psychopathic (PCL-R 25-32)</p> <p>23 male prisoners non psychopathic (PCL-R 4-20)</p> <p>25 male controls</p>	Philipot facial affect recognition test: happy anger sadness fear disgust	<p>Controls better across emotions than prisoners</p> <p>No difference between ppath and non ppath prisoners in total,</p> <p>fear and sadness criminal non-psychopaths worse than criminal ppaths, other emotions ppaths worse than non-criminals</p> <p>s</p>	<p>Controls differed in education</p> <p>No IQ measure or control</p>
Glass and Newman (2006)	<p>111 male prisoners:-</p> <p>50 high psychopathy; 61 low psychopathy</p> <p>PCL-R, also distinguished by high and low anxiety</p>	<p>Macbrain face stimulus set (cited in Glass and Newman)</p> <p>6 emotions</p> <p>Anger fear happy sad</p>	No difference across all emotions with or without attentional priming	No group differences in age/IQ
Dolan and Fullam (2006)	<p>49 male offenders dissocial PD, 49 community male controls</p> <p>Within offenders 22 psychopathic (PCL SV)</p>	Ekman and Friesen set, variable intensity	<p>Dissocial PD worse than controls on total scores</p> <p>High psychopaths worse than low psychopaths on sad faces</p>	<p>No group differences age or sex;</p> <p>IQ matched</p>

Mitchell et al. (2006)	5 controls; 5 psychopathic offenders (30-33); 5 non-psychopathic offenders (3-20)(PCL-R)	Psychopaths impaired fear and happiness, non-psychopathic offenders not impaired	Ekman and Friesen series	Forensic samples IQ matched, community group not IQ and age matched
Aylett et al. (2006)	University students 20 high psychopathy; 20 medium psychopathy 20 low psychopathy Self Report Psychopathy Scale III (SRPIII)	Facial emotion recognition task	'Psychopathic tendencies associated with poor recognition of negative emotions eg disgust'	Conference abstract only- no detail on methods
Book et al. (2007)	59 prisoners : (prisoners significantly higher on LSRP) 60 community controls	happy, sad, fearful, angry fear disgusted, neutral from The Japanese and Caucasian Facial Expressions of Emotion and Neutral Faces (Matsumoto & Ekman, 1988)	No difference in emotion recognition prisoners/controls	
Iria and Barbosa (2009)	Criminals : psychopaths 22; non-psychopaths 11 Non-criminals: psychopaths 16; non-psychopaths 13; PCL:SV	Go/no-go task for facial fear, NimStim (Tottenham et al., 2009), stimuli included fear happy neutral surprise	Criminals worse than non-criminals at fear; Both in criminal group and non-criminal group psychopaths worse than non-psychopaths	Matched on age and education level

Children

Zabel (1979)	40 emotionally disturbed 51 non-disturbed children. Male and female	Ekman and Friesen 6 emotions plus neutral, forced choice	Deficits in disturbed group fear and happiness	No association with age or IQ
Walker (1981)	Children 15 'unsocialised-aggressive personality disorder' (9 males 6 females) 15 'normal' (7 males 8 females) DSM-II	8 emotions shown, labelling task Joy, anger, surprise, disgust, shame, fear, sadness and interest.	No significant differences	No significant IQ, age educational level differences
McCown et al. (1986)	40 incarcerated male youths (13- 16) 40 non-delinquent high risk male youths	Ekman pictures of facial affect plus neutral, forced choice	Delinquent group significantly more errors in total and difference on surprise and disgust	Controls younger and lower IQ
Walker and Leister (1994)	191 adolescents emotional and behavioural disorders 273 controls Male and female	Ekman faces	Emotional and behavioural disorder group worse at recognising emotions overall Externalising as good as controls for disgust; internalising worse at sadness and disgust than externalising	Age matched

Blair and Coles (2000)	21 children (11-14) boys and girls 11 psychopathic traits (ASPD) 10 controls	Expression recognition hexagon stimuli (Calder et al., 1996) (ie 6 emotions from Ekman and Friesen)	ASPD total score inverse correlation with total recognition Sadness and fear deficit correlated with Factor 1 (CU traits), fear deficit correlated with Factor 2 (impulsivity/conduct)	
Franklin (2000) Dissertation abstract	Adolescent – sex not stated 24 outpatient sex offenders 30 inpatient sex offenders 29 inpatient serious non-sex offenders 22 non-offenders	Photographs of child faces 6 emotions, forced choice	No difference between any of the groups	No information on sex, control for confounders
Blair et al. (2001)	Boys 20 psychopathic tendencies (ASPD) 31 controls	Ekman Pictures of Facial Affect- 6 expressions, morphed (Murray et al) Forced choice	Sadness and fear deficit	IQ controlled
Stevens et al. (2001)	Male children 9:9 APSD	DANVA	Sadness and fear deficits	

Carr and Lutjemeier (2005)	29 male youth offenders resident probation facility, no control group but community norm data 11-12 year olds (n=4 n controls 286 13-14 (n=4, control group, n = 177) 15-17 (n=21 control 333)	Happy sad anger fear (The Diagnostic Analysis of Nonverbal Accuracy (Nowicki and Duke, 1994)	Offenders worse than community norm data for significant for 11-12 year olds, not 13-or 15-17 overall sad and fear impairment Positive association anger recognition in adult faces /delinquent act, inverse relation ability to recognise child's expression / violent acts, inverse relationship fear recognition / violent acts	
Dadds et al. (2006)	1. 33 boys 2. 65 boys Callous emotional traits and antisocial behaviour in community samples No control groups APSD	University of New South Wales Facial Emotion Task (Dadds <i>et al</i> , 2004), happiness, sadness, anger, disgust, fear or neutral expression on four adult faces, forced choice	Antisocial behaviour associated with interpreting neutral as anger; callous unemotional traits associated with poor fear recognition-deficit reduced when instructed to look at eyes	
Jones et al. (2007)	Adolescent male young offenders 15; 22 male college students	Ekman Pictures of Facial Affect-6	When adjust for IQ offenders worse at anger and disgust Also impaired in eye gaze direction	Age matched

Woodworth and Waschbusch (2008)	73 boys and girls with disruptive behaviour problems aged 7-12: (DBDRS, APSD) 17 Controls 32 Conduct problems (CP) only 26 CP+ CU	Photographs and cartoon faces anger fear disgust happy sad surprise	CU traits associated with less accuracy in labelling sad expressions but better at labelling fear, regardless of conduct problems; high conduct problem and low CU worse at fear	
Dadds and Leist (2009)	23 16-18 yr olds (17 male, 6 female) in residential rehabilitation programme for mental health and substance misuse problems (APSD, SDQ Maltreatment index)	Happy sad anger fear disgust neutral	Antisocial behaviour associated with poor anger, and neutral, and good fear recognition, CU traits associated with impaired fear recognition Maltreatment associated with better recognition sadness and fear	no IQ measure
Sato et al. (2009)	24 male adolescent prisoners 24 age/sex matched controls Severe behaviour problems using CBCL	6 emotions (Ekman and Friesen and Matsumoto and Ekman) forced choice	Delinquents less accurate at disgust identification and misrecognised disgust as anger	Control IQs higher, MANCOVA showed no effect of IQ

<p>Munoz (2009)9</p>	<p>Community sample boys 55 ICU (self report CU traits), self-report of delinquency questionnaire (antisocial behaviour)</p>	<p>Ekman facial expressions Happy sad fear anger surprise disgust 6 option forced choice, also emotional body postures</p>	<p>Callous unemotional traits associated with poor face recognition, with or without controlling for antisocial behaviour or violence, Both violence and CU traits associated with poor fear recognition</p>	<p>No IQ control Small sample</p>
<p>Fairchild et al. (2009)</p>	<p>Male adolescents 14-18;42 with early-onset CD and 39 adolescent onset CD; 40 controls ; Youth Psychopathic traits inventory (YPI)- higher in both CD groups than controls;</p>	<p>Emotion hexagon task (Calder et al 96) 6 emotions;</p>	<p>EO CD: anger disgust and happiness impaired comp with controls; AO-CD: fear recognition impaired in comp with controls; In CD total group high psychopathy scores (n31) significantly worse at fear sadness surprise than low PP scores (n46)</p>	<p>Age, sex IQ matched controls, PDD excluded, Axis I included, controls higher SES no ethnic differences</p>

<p>Fairchild et al. (2010)</p>	<p>25 female adolescents with CD or ODD; 30 controls (K-SADS-PL) YPI for psychopathic traits and callous-unemotional traits CD had higher levels of psychopathic and CU traits than controls</p>	<p>Emotion Hexagon Task (6 emotions)</p>	<p>CD impaired anger and disgust comp with controls; even when control for IQ CD high in PP traits impaired sadness compared with CD low PP traits, not accounted for by IQ CD impaired fear conditioning No differences CD affective startle modulation or by psychopathic traits</p>	<p>Age and sex matched-controls higher IQ, all IQ>75, PDD excluded</p>
<p>Pajer et al. (2010)</p>	<p>35 adolescent girls with conduct disorder (mean age 17.9), 30 controls C-DISC-IV</p>	<p>Ekman pictures of facial affect: Happy sad surprise disgust fear anger</p>	<p>No evidence of impairment on total or any individual emotion; Association between abuse history and fear recognition error; IQ associated with accuracy</p>	<p>IQ controlled for, Race, IQ and abuse/neglect history also examined</p>

Abbreviations used

DANVA Diagnostic Assessment of Non-verbal accuracy
DBDRS Disruptive Behaviour Disorder Rating Scale(Pelham et al., 1992)
PSD psychopathy screening device (PCL-R extension devised for children)
Antisocial Process Screening device (Hare and Frick, 2002)
PCL-R SV PCL-R Screening Version (Hart et al., 1995)
CCB Checklist of Challenging Behaviour (Harris et al., 1994)
BIS/BAS Behavioural inhibition scale/behavioural activation scale).(Carver and White, 1994)
RPBC Revised problem behaviour checklist (Quay and Peterson, 1983)
SRP-II Self-report of psychopathy II (Hare, 1990)
SRP-III Hare Self report of psychopathy III (Paulhus et al., 2009)
BPAQ Buss-Perry Aggression Questionnaire (Buss and Perry, 1992)
Self Report Psychopathy Levenson LSRP; (Levenson et al., 1995)
Millon Clinical Multiaxial Inventory;(Millon and Davis, 1997)
C-DISC IV Computerized Diagnostic Interview Schedule for Children, IV (NIMH, 1997)
YPI Youth Psychopathic traits inventory (Andershed H et al., 2002)
K-SADS-PL Schedule for Affective Disorders and Schizophrenia for school age children (Kaufman et al., 1997)
Inventory of Callous unemotional traits (Frick, 2004)
CBCL Child behaviour checklist Achenbach TM 1991 in (Sato et al., 2009)
APSD Antisocial process screening device (Hare and Frick, 2002)

Appendix C. fMRI Studies of Facial Emotion Recognition in Antisocial Groups

Study	Participants	Task	Contrast	Direction	Regions	Comments
Gordon et al. (2004)	20 male healthy community students High and low PPI score groups	anger fear sad happy Emotion condition: match emotion to face or identity condition	emotion condition all faces v baseline	High emotional-interpersonal scores <low	right inferior frontal cortex right amygdala right medial prefrontal cortex	
Deeley et al. (2006)	6 male criminal PP (>24 PCL-R) forensic patients 9 healthy male controls	Implicit facial processing Fear, happy, neutral 3 intensity levels Gender labelling task	Fear v baseline	PP<HC	cerebellum fusiform gyrus left postcentral gyrus	Fear v neutral: psychopaths activate different regions- decreased visual cortical response to fearful face instead of increased in controls
			Happy v baseline	PP<HC	Right fusiform gyrus left lingual gyrus left cerebellum left precentral gyrus	
			Fear v neutral	PP<HC	Right cerebellum Right fusiform gyrus (HC activate, PP deactivate fusiform gyrus, HC activate bilateral fusiform gyrus, PP do not))	
			Happy v neutral	HC >PP HC increased activation; PP decreased activation	right lingual and fusiform cortices	

Coccaro et al. (2007)	10 Intermittent Explosive Disorder (+ higher aggression levels)(5 male; 5 female) 10 healthy controls (5 male; 5 female)	angry, happy, sad, fear, surprise, disgust, neutral gender labelling task ROI and whole brain analyses	angry v baseline	IED > control IED < control	left amygdala OFC	All met DSM criteria for IED but not ASPD Age gender educational level matched No coupling amygdala-OFC in IED group, HC had negative correlation in activation of amygdala – OFC Amygdala activity to angry faces related to lifetime history of aggression
			happy v baseline	IED < control	OFC	
Pardini and Phillips (2010)	Community sample 20 chronically violent men; 22 non-violent men, (criminal record, parent, teacher, self-assessment) Also state trait inventory (anxiety); substance use questionnaire, SRP-III Urine drug screen	happy sad fearful neutral, 100% and 50% intensity, gender labelling task ROI	all faces v baseline	violent < control	dorsomedial prefrontal cortex anterior cingulate gyrus	Groups matched for IQ, violent men higher rates of ADHD and substance use-no effect when covaried No association with any abnormalities and psychopathy; no evidence psychopathic features associated with abnormal amygdala response
			neutral v happy	violent > control to happy faces	left amygdala;	
			neutral v mild fear	violent > control	dorsomedial prefrontal cortex (lost when covary for ADHD symptoms)	

Howner et al. (2011)	7 male ppathic offenders (PCL-R>30) 7 male offenders with ASD (all offenders recruited from inpatient forensic psychiatric assessment facility) 12 male controls (non-criminal)	fear and neutral gender judgement	Fear v neutral	Offenders (all)>HC	Bilateral amygdala Medial cingulate cortex Left hippocampus	IQ no significant difference between offender groups IQ not measured in HC No behavioural differences Functional co-activation analysis: PP correlation left amygdala and left anterior cingulate cortex
				PP>ASD	Left Insula Anterior cingulate cortex	
				ASD>PP	Right Insula Left lingual gyrus/fusiform gyrus Left cingulate cortex	
				High emotional-interpersonal ppathy>low	visual cortex right dorsolateral prefrontal cortex	
				High social deviance ppathy >low	Right amygdala	

Han et al. (2011)	Healthy non-criminal community rated on PPI –R cold-heartedness subscale: 16 (10 female, 6 male) high; 16 (9 female, 7 male) low: Age 17-35	Partial Face Encoding (PFE) – novel task of emotion recognition:5 emotions; Whole-face condition; ‘eyes-only’ condition; ‘eyes-removed’ condition Separate response screen for button press emotion choice (explicit task)	Least v most socially meaningful condition: Fear: eyes-removed v eyes-only	Low callous > high callous	medial frontal gyrus inferior parietal lobule superior frontal gyrus Right cingulate gyrus Left amygdala (which showed group x condition difference-high callous group reduced de-activation for least v most socially meaningful, low callous group amygdala activation reduced same comparison)	Behaviourally: All participants’ recognition lowest for eyes removed for fear and anger (eyes important); for happy or disgust better recognition for eyes removed than eyes only (face important).
			Happy: Eyes-only v eyes removed	Low callous> high callous	Left fusiform gyrus Left middle temporal gyrus Bilateral amygdala	
Hoff et al. (2009)	1 male psychopath (PCL-R 37) 12 controls (6 male, 6 female)	6 emotional facial drawings, 6 control scrambled faces Nback task	Emotional v neutral	PP>HC	cerebellum, left insula, left thalamus, left putamen, left cingulate right caudate body left medial frontal gyrus right substantia nigra,	Difference in performance on task (PP worse than controls)
				controls >PP	L antsup temporal gyrus L inf frontal gyrus R inf frontal gyrus L precentral gyrus L and R parietal lobe Middle temporal gyrus	

Co-morbid schizophrenia

Dolan and Fullam (2009)	<p>12 violent male patients with schizophrenia, high psychopathy traits (PCL:SV >median of group (12.5))</p> <p>12 violent male patients with schizophrenia with PP traits < median (<12.5 PCL:SV)</p>	anger disgust fear sad, neutral gender task	Fear v neutral	low PP >High PP	Right amygdala,	<p>No differences age, IQ, medication No behavioural differences Activation right medial superior frontal cortex positively correlated with total ppathy score for negative face expressions Fear: responses right amygdala negatively correlated with PCL:SV total score and PCL:SV affective facet scores Right medial superior frontal cortex activation positively correlated with PCL:SV lifestyle scores. Sad: activation in right orbitofrontal cortex negatively correlated with PCL: SV lifestyle and PCL: SV antisocial facet scores. Angry: right amygdala activations negatively correlated with PCL:SV affective facet scores ventrolateral prefrontal cortex activations negatively correlated with PCL: SV lifestyle facet scores. right anterior cingulate activation negatively correlated with PCL: SV antisocial facet scores. Disgust: right amygdala activation positively associated with PCL: SV total, lifestyle facet, and antisocial facet scores. left orbitofrontal cortex activation positively associated with PCL:SV antisocial facet</p>
			Disgust v neutral	High PP >low PP	Right amygdala	

PPathy= psychopathy PP=psychopath group

Evaluation of a Screening Instrument for Autism Spectrum Disorders in Prisoners

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Abstract

There have been concerns that individuals with autism spectrum disorders (ASDs) are over-represented but not recognised in prison populations. A screening tool for ASDs in prisons has therefore been developed.

Aims: We aimed to evaluate this tool in Scottish prisoners by comparing scores with standard measures of autistic traits (Autism Quotient (AQ)), neurodevelopmental history (Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI)), and social cognition (Ekman 60 Faces test).

Methods: Prison officers across all 12 publicly-run closed prisons in Scotland assessed convicted prisoners using the screening tool. This sample included male and female prisoners and both adult and young offenders. Prisoners with high scores, along with an equal number of age and sex-matched controls, were invited to take part in interviews. Prisoners' relatives were contacted to complete a neurodevelopmental assessment.

Results: 2458 prisoners were screened using the tool, and 4% scored above the cut-off. 126 prisoners were further assessed using standardised measures. 7 of those 126 assessed scored 32 or above (cut-off) on the AQ. 44 interviews were completed with prisoners' relatives, no prisoner reached the cut-off score on the ASDI. Scores on the screening tool correlated significantly with AQ and ASDI scores, and not with the Ekman 60 Faces Test or IQ. Sensitivity was 28.6% and specificity 75.6%; AUC was 59.6%.

Conclusions: Although this screening tool measures autistic traits in this population, sensitivity for scores of 32 or above on the AQ is poor. We consider that this limits its usefulness and do not recommend that the tool is routinely used to screen for ASDs in prisons.

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Introduction

Autism spectrum disorders (ASDs), which include autism, Asperger syndrome and Pervasive Developmental disorder - Not Otherwise Specified, encompass impairments in social interaction, abnormalities in communication, and restricted, repetitive and stereotyped patterns of behaviour [1]. Results of prevalence studies vary, but community prevalence in adults in England is estimated to be 9.8 per thousand [2].

There is no evidence that individuals with ASDs are more likely to offend than those without [3]. However, the relatively high levels of ASDs found in high-security psychiatric settings [4], [5], have led to concerns that individuals with ASDs are not being recognised in the criminal justice system. Without such recognition, it may be difficult to make sense of their offence and assess criminal responsibility in order to allow an appropriate defence. While in prison these individuals may be particularly vulnerable to bullying or exploitation [6]. They are at increased risk of psychiatric comorbidity, particularly ADHD and mood disorders [7,8]. In

addition, they may present management problems as a consequence of poor social and communication skills. Their early identification in prison would allow appropriate care to be provided, and risk of future offending to be more effectively assessed and managed.

The prevalence rate of ASDs in prisons is not known. A study asking staff in the Scottish Prison Service how many cases they were aware of yielded 19 people with an established diagnosis of learning disability and/or ASDs across 16 prisons [9]. This did not take into account undiagnosed cases or those where the diagnosis was not known to staff, and was not intended as a measure of prevalence.

In community samples, reported rates of ASDs vary. A rate of 15% was found for pervasive developmental disorder in a sample of young offenders referred for forensic psychiatric assessment in Stockholm [10]. A UK community study, although not a prevalence study, found lower rates of offending in individuals with a diagnosis of ASD than in a comparison group [11].

Diagnosis of ASDs usually requires a neurodevelopmental history and a clinical assessment. Although a number of clinical diagnostic instruments, such as the Autism Diagnostic Observation

Schedule (ADOS) [12], are available, such instruments are too lengthy to be employed across a large population in a prison setting. Screening tools for other mental disorders have been used in prisons [13]. However, there is no such tool available for ASDs.

Against this background, a screening instrument for use in prisons has been devised. We sought to evaluate the screening questionnaire by comparing it against two other assessments used commonly by mental health professionals to assess for ASDs and an objective measure of social cognition, known to be impaired in individuals with ASDs [14].

Methods

Screening of the prison population

All 12 publicly-operated closed prisons in Scotland were invited to take part in the study. Prison officers completed the screening tool on convicted prisoners whom they had known for at least a week, during a specified one-week period.

The screening tool (Table 1) was designed by a group of researchers in the field of autism [15] in association with the charity Research Autism (www.researchautism.net), and based upon the Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI) [16]. It was intended to be completed for each prisoner by a prison officer who knows that prisoner well.

Responses are based on behaviours that the officer will have observed as part of their professional role. No training is required to use the instrument and it takes on average 1.5 minutes to complete. A score of 5 or above was chosen as a positive score at the time of its design.

Interviews

Following the screening process, we aimed to interview and further assess all prisoners scoring above the proposed cut-off of 5 on the screening tool, and an equal number of age and sex-matched controls scoring below 5. However, as very few prisoners scored above 5, we invited all prisoners scoring above 0 to participate in interviews, along with age and sex-matched controls (scoring 0).

Interviews and assessments with prisoners were carried out by a team of psychiatrists trained in the measures used. Interviewers were blind to screening status. Participants in whom the initial clinical assessment suggested possible current mental disorder were fully clinically screened with a standardised instrument, the Clinical Interview Schedule [17]. All interviewed prisoners were asked to consent for a relative to be contacted in order to conduct a telephone interview.

Background information was obtained from all interviewed participants, including age, date of admission and estimated date

Table 1. ASD screening instrument.

Q	ASDI Area	Yes	Maybe	No
1	Appears 'odd' when compared to other prisoners of a similar age	1		
2	Described as a 'loner'	1		
3	Appears reluctant to mix with other prisoners (e.g. during association periods). Keeps self to self	1		
4	Stands too close to other people (invades personal space) and seems oblivious of this	1		
5	When compared to other prisoners lacks a sense of humour or humour is regarded as odd. Doesn't seem to 'get' jokes	1		
6	Unusual gaze – stares or avoids eye contact	5		
7	Talks a lot about a narrow range of topics (regardless of interest of listener)	2		
8	May be comfortable talking with one person but uncomfortable or inappropriate in groups	1		
9	Asks the same question(s) over and over again (regardless of answers). Repetitive	2		
10	Good memory/ ability for facts or figures or very knowledgeable about a particular topic	2		
11	Popular with other prisoners. A ringleader (has a number of followers)	1		
12	Does not appear to follow conversations or instructions or frequently misunderstands them (e.g. – picks up on isolated words or may take what is said literally)	4		
13	Stickler for the rules- becomes upset if rules are broken or promises are not kept (to an unusual degree)	3		
14	Resists changes in routine – or is upset by them (to an unusual degree)	3		
15	Frequently interrupts or 'talks over' people	5		
16	Voice too loud or has a peculiar pitch – or speaks in a monotonous voice	4		
17	Tries to be sociable but is only 'tolerated' or even rejected by others	1		
18	Not keen on games involving physical exercise. (e.g. may avoid ball games or is poorly coordinated and very bad at them e.g. pool, football.)	6		
19	Clumsy, bumps into things or finds it difficult to walk or run in a straight line. Has problems keeping up or in step with others	6		
20	Complains about noise or bright lights	n/a		

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of liberation from prison. Forensic, substance misuse, past medical and psychiatric, educational and employment histories were taken. Participants provided accounts of past offending. Current IQ was measured using the Quick Test [18], a brief, standardised measure of intelligence that can be used in non-readers; and reading age using the Schonell Graded Word Reading Test [19].

Three standardised measures were used with the interviewed group of prisoners- a measure of autistic traits (Adult Autism Spectrum Quotient [20]); an interview with a relative (Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview [16]); and a measure of facial emotion recognition (Ekman 60 Faces Test [21]).

Adult Autism Spectrum Quotient (AQ). The AQ is a self-report questionnaire that measures a range of mild autistic traits in a relatively brief and simple format. An initial study demonstrated excellent sensitivity and specificity in the identification of participants with ASDs [20]. In the general population, 80% of adults of normal intelligence meeting criteria for ASDs would be expected to score 32 or above in the test, in comparison with 2% of controls. The AQ was not devised specifically for antisocial groups, and some of the questions refer to aspects of life unfamiliar to many prisoners, such as visits to theatres and museums. However, good sensitivity and specificity in identifying individuals with ASDs has been demonstrated in a forensic psychiatric sample [22]. Due to low literacy levels in the current study population each question was read aloud to the participant.

Ekman 60 Faces Test. This neuropsychological test of basic facial emotion recognition consists of a battery of photographs of faces drawn from the Ekman and Friesen series [21]. Sixty photographs, comprising ten representing each of six basic emotions (happiness, surprise, disgust, fear, anger and sadness) are separately displayed upon a computer screen in a pseudo-random order. The participant is required to identify which of the six emotions each photograph represents. This test has been used successfully to characterise deficits in emotion recognition displayed by adults with ASDs [14].

Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI). This structured clinical interview was developed to include a range of aspects of behaviour typically affected by ASDs [23]. It is designed for use with a first-degree relative who has known the individual well since their childhood. Relatives of prisoners who had provided consent were contacted. The ASDI was carried out by telephone by the same researcher (LR), blind to screening status.

Ethics Statement

This study was approved by the Scottish Prison Service Ethics Committee and the Multicentre Research Ethics Committee (MREC). Written information about the study was displayed in areas agreed with individual prisons, and prisoners could choose to opt out of the screening process. Before participation in interviews, prisoners were given written information and written informed consent was obtained. MREC stipulated that only convicted prisoners could be included in the study. Patients' relatives were provided with written information, and either written (where possible) or verbal consent was obtained from them, documented, dated and signed by the researcher. Verbal consent was used both because of anticipated problems with literacy and the likelihood of the lifestyles of some individuals leading to difficulty in receiving and returning forms by mail. This was approved by MREC.

Statistical Methods

Data from prison officers, prisoners and relatives were analysed anonymously using SPSS 14.0 for Windows.

Results

Screening, interviews and assessments took place between February 2008 and September 2009.

Screening Tool

2458 convicted prisoners were screened using the tool. The convicted prisoner population at that time was 6156 [24], therefore approximately 40% of the convicted population in Scotland was screened. Prisons included local and long-stay prisons, one male Young Offenders' Institution (YOI) and one women's prison and YOI. 127 of the prisoners screened were women. 15 prisoners from Inverness were screened at the health centre; all other prisoners were screened by staff on the prison halls (main living areas).

Minimum score on the tool was 0, maximum was 7. Median score across all prisons was 0, (interquartile range 0–2) (Figure 1).

Median score from those prisoners attending Inverness prison health centre was 4 ($n = 15$, IQ range 2–4). When those from the health centre in Inverness were excluded from the total sample of prisoners screened, median score remained 0 (0–2) ($n = 2443$). Distribution of scores across prisons is shown in Table 2. 97 prisoners (4.0%) scored 5 or more, the cut-off chosen for the screening tool at its design.

On comparison of the distribution of scores between prisons, the Kruskal–Wallis one way analysis of variance test is significant beyond the .01 level: chi-square (11) = 197.97; $p < .01$, meaning that there are statistically significant differences between the prisons.

Reliability. Data on reliability were obtained from HMP Peterhead only. Data on inter-rater reliability data were not obtained. Regarding intra-rater reliability nine prisoners were re-scored after a week had elapsed by the officer who had first scored them. Median score for the 9 prisoners for the first screen was 0, (IQ range 0–2), and for the repeat screen was 2 (IQ range 1–4.5). There was no significant correlation over time between the ratings of the same prison officer for the same subject ($ICC < 0$), and intra-rater reliability was therefore poor.

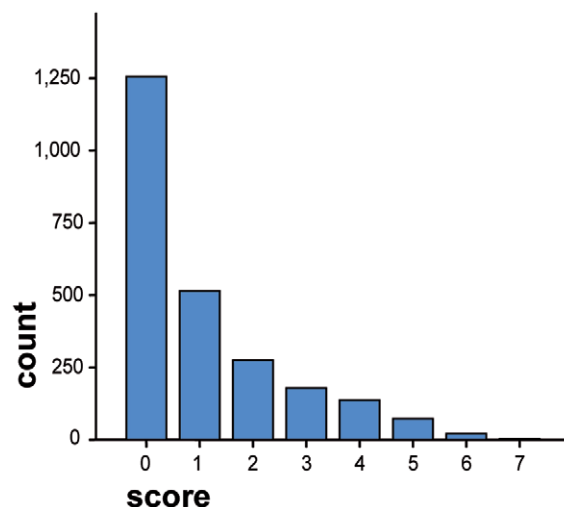


Figure 1. Distribution of scores on the screening tool on all prisoners screened ($n = 2458$).

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Table 2. Scores on screening tool by prison.

Prison (N)	Prisoner group	Median score (interquartile range)
Edinburgh (340)	Local, male, all sentence lengths	2 (1–4)
Barlinnie (574)	Male, all categories	1 (0–3)
Perth (143)	Male, short and long-term	0 (0–1)
Shotts (371)	Male, long-term	1(0–2)
Greenock (61)	Male, short-term and long-term	2 (0–4)
Dumfries (121)	Male, short-term and offence-related protection prisoners	1 (0–1)
Peterhead (280)	Male, long-term sex offenders	1 (0–1)
Polmont (226)	Male young offenders (16–21)	0 (0–1)
Cornton Vale (127)	Female, young offenders and adult, all categories	1 (0–2)
Aberdeen (113)	Local, male up to 4 years	0 (0–1)
Inverness (67)	Local, male, short-term	0 (0–1)
Glenochil (35)	Male, long-term	0 (0–2)
Total 2458		

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Interviews

103 participants scoring above zero on the screen were invited for interview along with an equal number of age and sex-matched participants scoring zero. 51 of the 103 (49.5%) participated, of whom 33 had scored 5 or above on the screen (the cut-off). 27 refused (26%), and 17 (16.5%) were unavailable (at court, liberated or transferred). For one individual who did not attend the reason was not known. 76 (73.7%) of those invited and scoring zero on the tool chose to participate. In total, 127 prisoners who had been scored with the screening tool attended for interview, and 126 took part in all of the further assessments. Seven of those interviewed were women.

Participant Characteristics

IQ/ reading age. Age, IQ and reading age are shown in Table 3. On the Quick Test one participant's score was too low to allow calculation of IQ. IQ was estimated at less than 70 in 6 participants.

Health/Substance Use. Mean estimated alcohol intake in the week before prison admission was 91.1 units per person (males 91.5; females 83.4) (range 0–595, sd 123.2). 102 (81%) participants had ever used illegal drugs, and 46 (36.5%) had used drugs while in prison. 42 (33%) had a history of IV drug abuse. 69 (54.8%) had a history of head injury leading to hospital admission or loss of consciousness. 74 (58.7%) were being prescribed medication, 22 of whom were prescribed methadone. 77 (61.1%) had ever seen a psychiatrist, 17 (13.5%) stated that they had been detained under the Mental Health Act. Six said that they had been given diagnoses of schizophrenia or psychosis, 13 depression, 6 substance misuse problems, 5 PTSD, 6 ADHD, and one possible

Table 3. Demographic characteristics of participants.

	N	Mean; (range, standard deviation)
Age (years)	126	35.2 (17.7–65.7; 11.3)
IQ	125	92.5 (45–130; 15.4)
Reading Age (years)	125	12.6 (6.8–15; sd 1.8)

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ASD. Two had been seen for anger management, and 43 gave a history of deliberate self harm.

Forensic Characteristics. See Table 4. 114 (90.5%) prisoners had previous convictions and 94 (74.6%) had served previous prison sentences.

Education/Employment. 36 (28.6%) of prisoners had received special educational support at school. 114 (90.5%) said that they can read and write. 85 (67.5%) had been excluded from school, and 47 (37.3%) had formal educational qualifications. 107 (84.8%) had ever been employed.

Mental Illness Screen. Seven prisoners were examined with a formal mental illness screen [17]. Three had no symptoms, two had symptoms of depression and anxiety, one had dissociative symptoms, and one had symptoms suggestive of an organic brain syndrome.

Autism Quotient. Mean AQ score was 20.1 (range 6–41, sd 7.3) (Figure 2). Seven of the 126 participants (5.65%) scored 32 or above, the cut-off at which further investigations for ASDs are recommended by the authors [20].

ASDI. An ASDI was carried out with 44 prisoners' relatives (3 female and 41 male prisoners). No participant reached the diagnostic cut-off score of 5 (median score was 0, interquartile range 0–1.75) (Figure 3).

Ekman 60 Faces Test. This test provides a score out of 10 for each of the 6 emotions (happiness, sadness, disgust, fear, anger, surprise) and a total score out of 60. 126 screened prisoners were

Table 4. Self-reported index offence.

Offence Type	N (%)
Violent	86 (68.3)
<i>of which sexual</i>	22 (17.5)
Drug-related	16 (12.7)
Theft	9 (7.1)
Breach of the Peace	5 (4.0)
Other	10 (8.0)
Total	126 (100)

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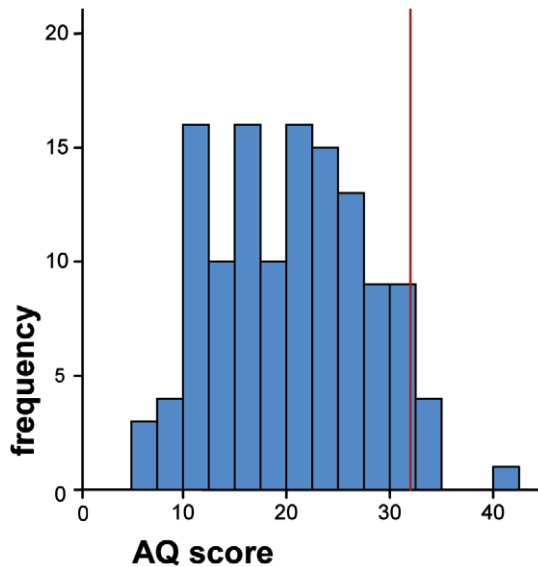


Figure 2. Distribution of AQ scores, showing cut-off of 32.
doi:10.1371/journal.pone.0036078.g002

examined, mean score was 41.1 (range 24–55, sd 7.3). Performance was not consistent across emotion type, with prisoners performing best at recognising happiness (mean score 9.8) and worst at fear (mean score 4.2). The prisoner group performed poorly at this task in comparison with normal IQ- and sex-matched controls [25].

Relationship between measures

AQ and ASDI scores ($\rho = 0.35$, $p = 0.018$), and AQ and IQ scores ($\rho = 0.25$, $p = 0.006$), showed significant correlations. IQ and Ekman score were also significantly correlated ($\rho = 0.35$, $p < 0.001$). There was no significant association between IQ and ASDI score. While AQ and Ekman scores showed a significant correlation ($\rho = 0.25$, $p = 0.005$), this becomes non-significant when IQ is used as a covariant.

Relationship between measures and screening tool scores

AQ and ASDI. Figure 4 shows the relationship between categories of screening tool status (above or below the cut-off of 5), AQ status (above or below 32) and ASDI status (above or below 5).

A statistically significant association was found between the numerical scores on the screening tool and AQ score ($\rho = 0.177$, $p = 0.047$). A statistically significant correlation was also found between the screening tool score and ASDI ($\rho = 0.37$, $p = 0.012$).

Relationship with Ekman 60 test scores. There was no statistically significant correlation between score on the screening tool and Ekman 60 score ($\rho = 0.21$, $p = 0.41$).

Relationship with IQ. The screening tool score did not correlate significantly with IQ ($\rho = 0.05$, $p = 0.579$). In addition, there was no significant association between the screening tool score and reading age or whether an ASDI was performed.

Characteristics of the screening tool

In the tool design, a score of 5 was designated as the cut-off (i.e. individuals scoring 5 or above were screened as positive).

Comparison against AQ results. In this analysis a score of 32 or above on the AQ represents a case. The rate of a score of 32 or above was 5.5% in this sample. We note, however that the AQ

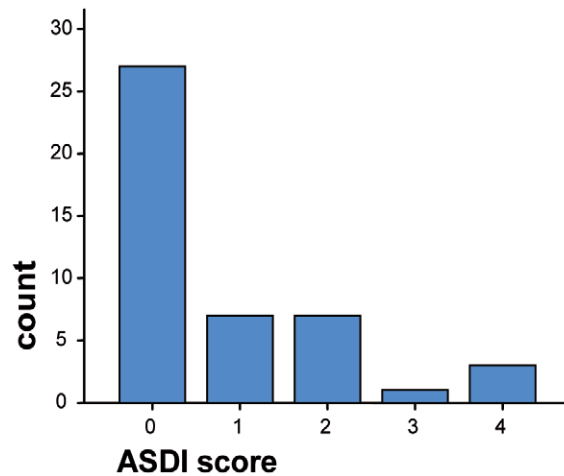


Figure 3. Score distribution on the ASDI.
doi:10.1371/journal.pone.0036078.g003

is not a diagnostic instrument and that all three participants scoring 32 or above on the AQ who were also assessed using the ASDI did not reach the diagnostic threshold on that measure.

Table 5 shows the contingency table for screening tool cut off against AQ cut-off ($\chi^2 = 0.063$, $p = 0.80$).

Sensitivity and specificity of the screening instrument. Sensitivity was 28.6% and specificity 75.6%. A ROC curve was plotted (Figure 5). Area under the curve is 59.6% (where a figure close to 100% suggests a good screening measure and a figure of 50% indicates that it is no better than chance); significance is 0.44, i.e. probability that the test performs better than at random is low. Regardless of cut-off score chosen, sensitivity in particular is low (Table 6.).

Discussion

This study examined a tool designed to be completed by prison officers with the aim of screening for ASDs in prisoners.

Generalisability

The tool was evaluated in a large sample of convicted prisoners that included both sexes and range of ages. Scores on the Quick Test can be compared with those obtained during a survey of the prison population of England and Wales [26]. In that sample 24% of male sentenced and 16% of female sentenced prisoners scored 41 or more (equivalent to an IQ of 100 or more), while in the current, Scottish sample 40% of males and 29% of females scored 41 or more. The sample in this study therefore appears to have a relatively larger proportion of individuals with an IQ score above 100, although it does not reach the expected population rate of 50%. With respect to low IQ, a study of both remand and sentenced prisoners in England and Wales [27] found that 4% scored 25 or less on the Quick Test (indicating an IQ of less than or equal to 65) and also had no educational qualifications. Similarly, in the current sample, 6 prisoners (4.7%) met both of these criteria. The high levels of substance misuse and head injury in this sample are in also keeping with other prison populations [28] [29].

Although there was considerable past psychiatric contact, we did not find evidence of high rates of current major mental illness. This contrasts with data from other sentenced prisoner populations. For example, rates of current psychotic illness have been estimated as 7% of male sentenced prisoners [26] [30], and 14% of

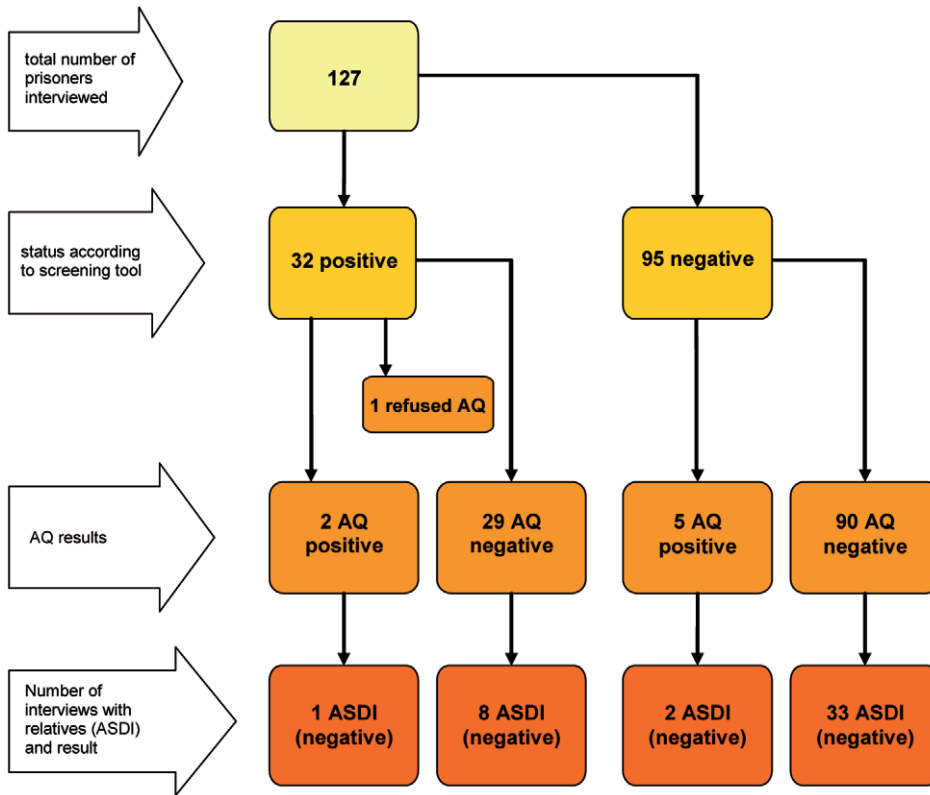


Figure 4. Summary of screening tool, AQ and ASDI results.
doi:10.1371/journal.pone.0036078.g004

female sentenced prisoners in England and Wales [26]. Results from this study are keeping with prevalence studies in remand populations which suggest that levels of major mental illness in prisons may be lower in Scotland, (2.3%), than in England and Wales (10%) [31] [26], most likely as a result of greater diversion from the prison system in Scotland [32].

Importance of the test

This screening test does appear to measure autistic traits. Its results correlate both with a self-report measure of autistic traits (AQ) and scores on a structured relative interview (ASDI). Importantly, this relationship remains when we control for IQ. The facial emotion recognition (Ekman 60 Faces Test) scores do not correlate with measures of autistic traits and appear to reflect an ‘antisocial’ pattern of deficits discussed further elsewhere [33].

Although specificity is good, sensitivity against AQ scores is poor and, although limited, the data suggest poor reliability. The poor intra-rater reliability may relate to individual characteristics of this tool or reflect more general difficulties in a design using prison officers. We conclude therefore that although this tool is simple

and practical, its use in a prison population is limited by its poor sensitivity and intra-rater reliability.

Prevalence

This study was not designed to estimate ASD prevalence. However, it is to our knowledge the largest ever study examining screening for ASDs in a prison setting. We did not find large numbers of individuals with high self-report scores of autistic traits. In addition, no developmental history taken was suggestive of an ASD. This may be because individuals with ASDs did not take part in assessments (selection bias) or that the particular tools used did not identify individuals with ASDs in this population. However, it may be because levels of ASDs in this prison population are in fact low. This might be due to diversion of such individuals early in the criminal justice process, or because prisoners with ASDs may not tolerate a prison environment resulting in transfer to hospital once admitted to prison (these explanations could explain the relatively high rates of ASDs identified in the special hospitals). It is also possible that individuals with ASDs are less likely to offend, and therefore would be under-represented throughout the criminal justice system [11].

Table 5. Contingency table: screening tool results and AQ cut off.

		AQ cut off reached (case)	AQ cut off not reached	Total
5 or above on screen	yes	2	29	31
	no	5	90	95
Total		7	119	126

doi:10.1371/journal.pone.0036078.t005

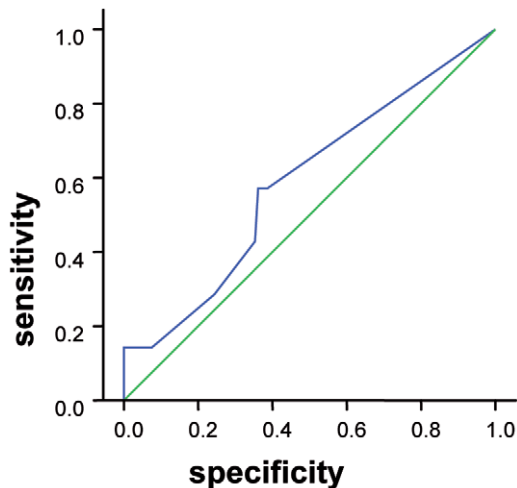


Figure 5. ROC curve demonstrating sensitivity and specificity.
doi:10.1371/journal.pone.0036078.g005

Limitations

There are several limitations to this study. We were unable to examine remand prisoners. Remand prisoners differ from convicted populations and in particular are more highly morbid with respect to mental disorders [26]. However, although there may therefore have been more cases of ASD, we do not consider that the performance of the tool would have been affected and this would not therefore alter our conclusions.

Although most prisoners took part in the screening, fewer of those screening positive than negative on the tool chose to take part in the study. As we know that the screen does provide some measure of autistic traits, this may mean that individuals with ASDs were less likely to take part in the interviews. Again, we do not consider that this would have altered the overall assessment of the tool.

It did not prove possible to obtain data on inter-rater reliability, and data on intra-rater reliability were limited. We were reliant upon the co-operation of prison officers to obtain these, and reasons for the difficulties may have included constraints on their time or an inadequate explanation on our part to officers for the reasons for repeat screenings. These data are important, however. Those we do have suggest poor reliability. This suggests that the screen would be of limited use regardless of its other characteristics. Although it is unlikely that this screen will be used, this is an important consideration in the design of other screening tools completed by prison officers.

We did not attempt to provide a DSM-IV diagnosis of an ASD, and did not carry out the gold-standard test of a clinical assessment. Diagnosis of this condition is complex and particularly difficult in a prison environment, with its rapid turnover and frequent and unannounced movement of prisoners. It appears likely, therefore, that using a full clinical assessment would have led to lower numbers of participants in the study.

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Table 6. Sensitivity and specificity of the screening tool.

Screen score	Sensitivity	Specificity
0	1.0	0.00
1	0.57	0.61
2	0.57	0.62
3	0.57	0.62
4	0.43	0.65
5	0.29	0.76
6	0.14	0.92
7	0.14	1.00

doi:10.1371/journal.pone.0036078.t006

Conclusions

To our knowledge, this is the largest study of a screening tool for ASDs in a prison carried out to date. Although specificity was good, the sensitivity of this tool was poor in this convicted Scottish prisoner population. We do not, therefore, recommend its use in screening for ASDs in prisons.

Although this was not a prevalence study, we did not find evidence to suggest that ASDs are common in this population. In addition, we did not find evidence suggesting elevated rates of current major mental illness in this population. However, we did find high levels of head injury and substance misuse. The extremely high self-reported levels of alcohol use in particular (average intake for men more than 4 times the recommended weekly limit, and for women almost six times) are a significant problem in this population. At present alcohol misuse is not routinely screened for in Scottish prisons and it is likely that many individuals with alcohol misuse disorders are not identified by prison staff [34].

We suggest that rather than routinely screen for ASDs in prison, staff should be encouraged to raise concerns about individuals struggling to cope in prison. We also recommend that mental health staff should be trained to recognise ASDs and that there should be access to specialist ASD services where clinically appropriate.

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Author Contributions

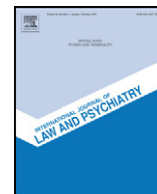
Conceived and designed the experiments: LR MDS LDGT ACS JH DGCO ECJ. Performed the experiments: LR MDS LDGT ACS JH DGCO ECJ. Analyzed the data: LR. Wrote the paper: LR. Gathered data: LR MDS ACS LDGT ECJ JH DGCO. Contributed to a draft of the manuscript: LR MDS ACS LDGT ECJ JH. Approved the final manuscript: LR MDS ACS LDGT ECJ JH DGCO.

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Facial emotion recognition in Scottish prisoners

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ABSTRACT

Background: Studies of antisocial populations have found that they show deficits in recognition of facial affect. Such deficits are also found in other populations with clinical conditions such as autism spectrum disorders, schizophrenia and obsessive compulsive disorder.

Aims: We aimed to investigate the hypothesis that facial affect recognition in the Scottish prison population would differ from matched controls. In addition, we aimed to investigate any relationship between facial affect recognition deficits and offence history.

Methods: A sample of serving convicted prisoners, drawn from a larger study, was assessed for ability to recognise facial affect. Other variables were also measured and a self-report offending history obtained.

Results: 127 prisoners were assessed in 11 prisons. Male prisoners were significantly worse than age, sex and IQ-matched controls at recognising negative facial emotions, specifically anger, fear, sadness and disgust. Within the sample of prisoners, deficits in fear recognition were associated with a history of previous prison sentences but not previous convictions. With respect to offending history, sex offenders were relatively better at recognising sadness and worse at recognising surprise than the other offenders. These relationships remain after controlling for IQ.

Conclusions: Scottish convicted prisoners show deficits in recognising negative facial emotions in a pattern consistent with other antisocial populations. We also demonstrated a relationship between particular patterns of deficit and types of offending history not previously described.

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1. Introduction

In common with the rest of the UK, the Scottish prison population is growing (National Statistics for Scotland, 2009) and reconviction rates are high (National Statistics for Scotland, 2010). Prisoners are an under-researched group, despite the need for an understanding of this population in order to improve outcomes and reduce re-offending.

To behave in an antisocial or violent manner is not a psychiatric condition. However, many antisocial or violent individuals meet criteria for antisocial personality disorder (ASPD), according to DSM-IV characterised by a 'pervasive pattern of disregard for and violation of the rights of others' (American Psychiatric Association, 1994). For example, ASPD was diagnosed in more than 80% of prisoners in a study in one Scottish prison (Bartlett, Thomson, and Johnstone, 2001). Psychopathy (as first described by Cleckley in 1941) is rarer

than ASPD and is estimated to affect 7.7% of male and of 1.9% of female prisoners in England and Wales (Coid et al., 2009).

There has lately been substantial interest in neurobiological differences between antisocial groups and controls. These include abnormalities in judging facial emotions, a type of social cognition (motivational and emotional aspects of the brain regulation of social behaviour) also impaired in various psychiatric conditions such as autism spectrum disorders (Philip et al., 2010) and schizophrenia (Marwick & Hall, 2008). Brain regions typically involved in this type of task include amygdala, prefrontal, and temporal cortex (Lee & Siegle, 2009).

A meta-analysis of 20 such studies in antisocial groups, defined both by behaviours (eg offenders) and by clinical diagnosis, demonstrated clear deficits in both types of group in general facial recognition ability and fearful expressions in particular (Marsh & Blair, 2008). Such distress cues form part of normal social interaction, and are thought to elicit empathy and inhibit aggression (Marsh, Klek, & Ambady, 2005). In addition, they may play a role in conditioning in children to avoid antisocial behaviour (Integrated Emotional Systems IES model) (Blair, 2005).

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Although deficits in facial emotional recognition have been shown in antisocial groups defined by behaviour as well by clinical diagnosis there is some evidence that social cognition deficits are related to psychopathy in particular. For example, with respect to fear recognition one study found that a group of both criminal and non-criminal psychopaths was worse at recognising fearful facial expressions than a group of non-psychopathic criminals (Iria & Barbosa, 2009).

Functional imaging permits demonstration of the neural basis of such social cognitions and this has been shown to be different in studies of subjects with antisocial behaviour. In psychopathic groups activation differences from controls have been shown in the occipitotemporal cortex (Deeley et al., 2006); the amygdala, prefrontal cortex, cingulum, parahippocampal gyrus and temporal cortex (Muller et al., 2003); and prefrontal and superior temporal gyrus (Muller et al., 2008). In 52 children and adolescents with conduct disorder (i.e. aggressive and antisocial behaviour) there were abnormalities in amygdala, prefrontal cortex, orbitofrontal cortex, insula and anterior superior temporal sulcus/gyrus responses (Passamonti et al., 2010).

1.1. Offence type

Less attention has been paid to any relationship between patterns of deficits in facial affect recognition and type of offending behaviour. The studies that have been performed are small and the results heterogeneous.

Hoaken et al. (2007) reported deficits in facial emotion processing and executive dysfunction in 20 violent in comparison with 20 non-violent male offenders and 20 controls. However, IQ was not controlled for in this study and it is therefore difficult to interpret. In contrast, a study of 75 male prisoners in New Zealand (Hudson et al., 1993) found that violent prisoners were more accurate than those with a history of sex offending, drug offending or theft at recognising facial emotions. A comparison of 10 imprisoned sex offenders with 10 non-sex offender prisoners and 10 community controls (Gery, Miljkovitch, Berthoz, & Soussignan, 2009) found that the sex offenders were worse at recognising anger, disgust, surprise and fear than the other groups, and this correlated with a measure of affective empathy. However, again IQ was not controlled for in this study.

1.2. Research question

Here, we investigated whether Scottish convicted prisoners would show an 'antisocial' pattern of deficits in their ability to recognise emotional expressions on faces in comparison with a community control group. In addition, we asked whether social cognition would relate to markers of antisociality and to offence history.

2. Methods

2.1. Participants

A group of serving convicted prisoners was recruited as part of a recent extensive investigation of the population of convicted prisoners in Scotland (full details being prepared for publication) which examined a screening tool aimed at identifying autistic characteristics in this population. 2458 convicted prisoners were examined with this tool and, of these, 128 who either were most likely to have relatively high levels of autistic traits or clearly did not have high levels, based on their score on the tool, were studied in more detail.

2.2. Interview

All prisoners were interviewed within the prison by a psychiatrist who had received specific training in the measures used. Those in whom the initial screen suggested possible current mental disorder

were clinically screened with a standardised instrument, the Clinical Interview Schedule (Goldberg, Cooper, Eastwood, Kedward, & Shepherd, 1970).

Basic demographic details were obtained. In addition psychiatric, medical, medication, educational, substance and employment histories were taken. Prisoners provided accounts of past offending. Current IQ was assessed using the Quick Test (Ammons & Ammons, 1962) and reading age using the Schonell Graded Word Reading Test (Schonell & Schonell, 1960). Level of autistic traits was measured using the Adult Autism Spectrum Quotient (AQ) (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). This self-report questionnaire measures a range of mild autistic traits in a relatively brief and simple format. An initial study demonstrated excellent sensitivity and specificity in the identification of participants with ASD. In the general population 80% of adults of normal intelligence meeting criteria for autism spectrum disorder would be expected to score 32 or above in the test, in comparison with 2% of controls.

The Ekman 60 Test (Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002) (an established method for measuring this aspect of social cognition) was employed to establish basic facial emotion processing ability. Photographs of the faces of 10 people were taken from the Ekman and Friesen series (1976). For each face, there were poses corresponding to each of 6 basic emotions (happiness, surprise, fear, sadness, disgust, and anger), giving a total of 60 photographs (10 for each emotion). These were shown on a computer monitor one at a time in pseudo-random order, for 5 s each. The task involved deciding which of the emotion names (happiness, surprise, fear, sadness, disgust, or anger) best described the facial expression shown. The names of the six emotions were at the bottom of the screen, and this was available throughout the test. Participants received no feedback on task performance.

2.3. Control group

Community healthy control participants were recruited in Germany and the UK. IQ in the control group was measured using the NART (Nelson, 1982) and an abbreviated German version of the WAIS (Wechsler, 1997).

2.4. Ethical approval

All study volunteers provided informed consent and the study was approved by the Scottish Prison Service Research Ethics Committee. The study was approved by the Multicentre Research Ethics Committee (MREC). All usual procedures required by the Ethics Committees to ensure participants could provide fully informed consent were followed.

2.5. Data analysis

Statistical analysis was carried out in SPSS version 14.0 for Windows (SPSS Inc., USA). Mean differences between the prisoner and control groups on Ekman facial recognition were investigated using *t* tests. Repeated-measures analyses of variance (ANOVAs) were used for each task of emotion recognition with emotion as the within-subject variable and group as the between-subject factor. Following this the effect of group was investigated for each emotion separately using univariate ANOVA.

3. Results

3.1. Demographic information

128 convicted prisoners were recruited from 11 prisons across Scotland. These included one Young Offenders' Institution for men and one prison for women that included young offenders. Seven

were women and 121 men. Mean age was 35.1 (sd 11.3). Interviews were carried out in the period between February 2008 and June 2009.

127 prisoners took part in the IQ test. One, for whom English was a second language, was unable to complete the task. Mean IQ of the 126 remaining was 92.5 (sd 15.3). Mean reading age was 12.6 (sd 2.1).

3.2. Sample characteristics

3.2.1. Drug and alcohol use

125 prisoners provided information on their alcohol intake in the weeks before coming into prison. Mean number of units consumed per week was 90.7 (sd 122.8, range 0–595). 103 of 128 prisoners (80.5%) said they had previously used illegal drugs. 43 (34%) had ever injected drugs.

3.2.2. Health

74 of 128 (58%) were prescribed medication. 70 of 128 (55%) gave a history of a head injury resulting in loss of consciousness or hospital admission. 78 (61%) had ever seen a psychiatrist. 43 of 122 who answered (36% of whole sample) gave a history of deliberate self harm, and 64 of 128 (50%) a history of serious physical illness.

3.2.3. Offences

103 prisoners (83%) had previous convictions (Table 1).

3.2.4. Education/employment

43 (34%) had difficulty reading and 41 (32.5%) difficulty writing at school. 36 (14.6%) received special educational support at school. 109 (85.2%) said that they had ever been employed.

3.2.5. Autistic traits

1 prisoner did not complete the AQ. Mean AQ score was 20 (range of 6–41 (sd 7.30)). Seven (5.5%) reached the screening cut-off score of 32 or above. An ASDI was carried out with 44 (65%) of the prisoners' families, none of which reached the diagnostic cut off of 5.

3.2.6. Mental illness

A full examination was performed on 7 prisoners (4 men, 3 women), in whom an initial screen suggested possible current mental disorder. Three (2 men, 1 woman) were found to have no current symptoms; 2 (both women) had symptoms of depression and anxiety, 1 man had dissociative symptoms, and 1 man had features suggestive of an organic brain syndrome.

3.3. Social cognition

The Ekman 60 test, described above, assesses recognition of prototypic facial expressions and provides a score out of 10 for each of the 6 emotions (happiness, sadness, disgust, fear, anger, surprise) and a total score out of 60.

127 prisoners undertook the test (Table 2).

Table 1

Offence types.

Index offence	Total (percentage)
All violent	87 (67.9%)
...nonsexual crime of violence	65(50.7%)
...sexual offences	22 (17.2%)
Drug related	17 (13.3%)
Crimes of dishonesty including theft	9 (7.0%)
Breach of the peace	5 (4.0%)
Other crimes	9 (7.0%)
Not disclosed	1 (0.8%)

Table 2

Prison sample scores (n = 127).

Emotion	Mean score (sd)
Total	41.1 (7.3)
Happiness	9.8 (0.7)
Surprise	8.3 (1.8)
Anger	6.3 (2.2)
Sadness	6.7 (2.1)
Disgust	5.7 (2.8)
Fear	4.2 (2.6)

3.4. Comparison with community controls

Results from males and females were analysed separately as there are known to be gender differences in facial emotion recognition ability. The small size (7) of the female group meant that comparisons with a control group could not be made with sufficient statistical power. They are included in the tables for completeness (Table 3 and 4).

The scores from male prisoners and controls were analysed using repeat measures ANOVA. There was a significant between subject effect ($p < 0.001$), indicating an overall significant difference between the groups. Within subjects there was also a significant interaction (with emotion ($p < 0.001$)) and emotion by group ($P < 0.001$). These data were therefore analysed using GLM univariate ANOVA. There were significant differences in total score, $F = 101.247 = p < 0.001$, anger $F = 51.451 = p < 0.001$; fear $F = 89.114 = p < 0.001$; sadness $F = 41.838 = p < 0.001$; and disgust $F = 36.38 = p < 0.001$.

3.4.1. Age and IQ-controlled males

Age and IQ were controlled in order to make a more meaningful comparison between the groups. In the prisoner group, males with IQ under 70 or no measure of IQ were excluded. 116 prisoners remained in this group (mean IQ 93.5 (sd 14.12), mean age 35.6 (sd 11.4)). Male controls were matched by IQ and age by hand so that they did not differ statistically from the prisoners. In this 'low IQ' male control group N was 19, mean IQ 93.5 (sd 7.8) and mean age 37.2 (sd 10.3). Repeated measures ANOVA showed a trend towards significance in difference between subjects ($p = 0.06$), significant effect of emotion ($p < 0.001$) and significant group by emotion interaction ($p = 0.01$). Comparison of data using univariate GLM/ANOVA is shown in Table 5. Differences in Ekman total score, anger, fear and sadness remained significant at $p < 0.001$, while difference in disgust was significant at $p < 0.05$ (Fig. 1). There were no significant differences in recognition of happiness or surprise between the groups.

3.4.2. Control for autistic traits

Due to the nature of the recruitment of the prisoner group, it is important to establish that deficits in this group are not a result of higher levels of autistic traits.

Where all male prisoners scoring 32 or more on the AQ in the QI and age-matched group were removed ($n = 110$, mean AQ 19.3, sd 6.6) and compared with the age and IQ matched control group there were still significant deficits in prisoners on fear, sadness and anger recognition ($p < 0.001$) and disgust ($p < 0.05$).

Table 3

Age and IQ of prisoners.

	Male prisoners (N = 120)	Male controls (N = 56)	Female prisoners (N = 7)	Female controls (N = 74)
Mean age (SD)	35.3 (4.9)	36.5 (13.7)	32.0 (9.7)	36.4 (13.9)
Mean IQ (SD)	92.4 (15.2) (Quick test)	101.3 (13.7) (NART/WAIS)	91.6 (17.7) (Quick test)	101.6 (8.9) (NART/WAIS)

Table 4
Scores on facial emotion recognition in prisoners and controls.

Emotion	Mean score (sd) male prisoners (N = 120)	Mean score (sd) male controls (N = 56)	Mean score (sd) female prisoners (N = 7)	Mean score (sd) female controls (N = 74)
Total Ekman score	40.8 (7.4)	51.5 (4.29)	45.00 (4.40)	52.30 (5.34)
Happiness	9.8 (0.7)	9.9 (0.4)	10.0 (0.00)	9.9 (0.3)
Surprise	8.2 (1.8)	8.6 (1.32)	9.3 (0.76)	9.0 (1.2)
Anger	6.3 (2.3)	8.5 (1.3)	6.6 (2.15)	8.5 (1.7)
Sadness	6.7 (2.1)	8.7 (1.4)	6.4 (2.30)	8.6 (1.9)
Disgust	5.6 (2.7)	8.0 (1.9)	7.7 (2.75)	8.7 (1.7)
Fear	4.2 (2.6)	7.8 (1.6)	5.0 (1.29)	7.6 (2.3)

In a further analysis, the IQ and age-matched male prisoner sample included only those prisoners who had been included as controls in the original study sample (scoring 0 on a screen for ASD and thought likely to have low levels of autistic traits) (mean AQ 19.5). Of this group, those scoring 32 or above on the AQ (diagnostic cut off) were also excluded. When this prisoner group (n = 67, mean AQ 18.72 sd 6.4) was compared with the age, sex and IQ matched controls described above, deficits in prisoners in recognising anger, fear, and sadness remained statistically significant at p < 0.001, and disgust at p < 0.05.

3.5. Within prisoners analysis

Tests of effects within the prisoner sample were performed using a univariate analysis of variance with IQ as covariant.

Forensic history might be expected to be associated with a more 'antisocial' pattern of face recognition. On repeat measures ANOVA covarying for IQ there was no overall significant difference between the group with a history of previous prison sentences and those without (p = 0.055). However, there was a significant emotion by group interaction (p = 0.016), and individual analysis of emotion found that this factor was significantly associated with a more severe deficit in fear recognition ((F 10.9), p = 0.001, mean difference - 1.167).

3.5.1. Violent offences

Repeated measures ANOVA found no significant difference in emotion recognition between or within subjects with a violent

Table 5
Scores on each emotion out of possible 10 (Total out of 60) for male prisoners and age and IQ matched controls.

Emotion	Male prisoners (IQ 70 or above) N = 116	Low IQ male control group N = 19	ANOVA/GLM group/emotion
Total	41.1 (sd 7.3)	50.8 (sd 3.9)	F = 32.02 p < 0.001**
Anger	6.3 (sd 2.2)	8.6 (sd 1.2)	F = 20.12 p < 0.001**
Disgust	5.7 (sd 2.7)	7.3 (sd 2.55)	F = 5.86 p = 0.017*
Fear	4.2 (sd 2.61)	7.7 (sd 1.2)	F = 31.90 p < 0.001**
Happy	9.8 (sd 0.76)	9.8 (sd 0.51)	F = 0.001 p = 0.98
Sad	6.8 (sd 2.1)	9.0 (sd 1.3)	F = 19.33 p < 0.001**
Surprise	8.3 (sd 1.67)	8.5 (sd 1.2)	F = 0.132 p = 0.72

** p < 0.001
* p < 0.05

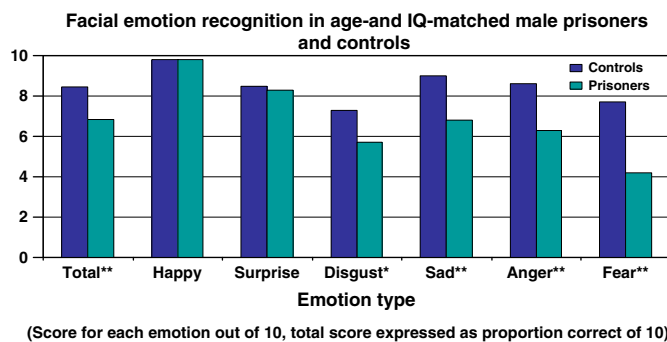


Fig. 1. Scores on Ekman 60 test of facial recognition.

conviction or those with a violent index offence in comparison with offenders without.

3.5.2. Sexual offences

Prisoners whose index offence was sexual (n = 22) showed no overall significant difference between groups. However interaction of emotion by group was significant (p = 0.013). This group performed better at recognising sadness (F 4.06, p = 0.046, mean difference 1.06) and worse at recognising surprise (F 7.97, p = 0.006, mean difference 1.03) than the rest of the prisoner group.

3.5.3. Background factors

3.5.3.1. Health. A relative deficit in total score was found in those who said that they had ever been detained under the mental health act (F = 4.76, p = 0.031) and in those with a history of serious head injury (F = 4.34, p = 0.039). Prisoners had ever seen a psychiatrist (F = 5.7, p = 0.018) and those being prescribed medication were worse at recognising fear (F = 5.79 p = 0.18) than other prisoners.

3.5.3.2. Substance use. A history of illegal drug use was significantly associated with a relative deficit in surprise recognition (F = 26.18, p = 0.021). There were no significant associations found between facial emotion recognition and level of alcohol intake immediately before admission to prison.

4. Discussion

Here we have demonstrated deficits in recognition of facial emotion in a large sample of convicted prisoners in Scotland who were selected based upon high and very low scores on an a screening tool for autistic traits. Male prisoners were significantly less able to recognise negative emotions of sadness, anger, fear (all p = < 0.001) and disgust (p < 0.05), in comparison with age, sex and IQ-matched controls. This is consistent with other studies on antisocial populations (Marsh & Blair, 2008) and does not appear to relate to autistic traits, IQ or major mental illness.

In addition, within the group of convicted prisoners a relative deficit in fear recognition was associated with a history of previous prison sentences. A history of sex offences was associated with relative deficit in recognition of surprise and a relative superior ability to recognise sadness.

With respect to background factors, there were abnormalities associated with history of head injury, detention under the mental health act, having ever seen a psychiatrist, being prescribed medication and illegal drug use. There was no relationship within the group on facial emotion recognition ability and alcohol intake.

The deficits in recognising negative emotions here are in keeping with other studies on antisocial populations. The cause is not known, although there is evidence from brain imaging studies of a

neural basis. It is plausible that these abnormalities are of relevance to offending, either influencing social interactions directly or as a result of their effect on early development. It is not possible for this study to conclude this however, as we do not know when such deficits first presented, and such deficits may be a result of experiencing a prison environment. However, we do know that other neurobiological abnormalities in antisocial groups are present at a young and pre-offending age (Gao, Raine, Venables, Dawson, & Mednick, 2010).

The association between relatively poorer fear recognition within prisoners and previous prison sentences again does not demonstrate a causal relationship. Those with previous sentences have had both more exposure to prison in addition to having presumably committed more and more serious offences, perhaps indicating more antisocial traits. It is of interest however, that deficits in fear recognition in particular have been associated with antisociality and that accurate recognition of fearful faces has been demonstrated experimentally to predict prosocial behaviour (Marsh, Kozak, & Ambady, 2007).

The particular pattern of facial emotion recognition shown by sex offenders in comparison with other prisoners is of interest as we are not aware that such an analysis has previously been reported. It is, of course, scarcely surprising that individuals who commit sex offences may view other people in a different way to those who commit other crimes, but the pattern of difference is not easily understood on a 'commonsense' basis. They show a relative deficit in an emotion, surprise, that has not been consistently associated with antisocial populations, and a relative superiority in recognising sadness. This differs, therefore, from a 'typical' antisocial pattern.

Given that deficits in social cognition are associated with a number of psychiatric conditions, the deficits in prisoners with history of contact with psychiatric services, head injury or prescribed medication is not surprising. Finally, the observed associations between drug use and particular deficits are of interest but not easy to interpret, as drug use may either be a cause of particular impairment or a result of a particular social cognition 'type'.

4.1. Limitations

The sample of prisoners was not random. As described above, they were recruited as part of a study in Scotland investigating autistic traits in prisoners. This resulted in autistic traits in the sample being higher than would be expected in the Scottish prison population. However, the difference in the level of autistic traits between subjects and controls is unlikely to account for the Ekman task differences reported, because these differences were found to be robust to the exclusion of subjects with high scores on the AQ.

Although we obtained measures of IQ for both subjects and controls, we acknowledge that different measures were used to assess IQ within these groups, and that therefore these IQ scores cannot be assumed to be equivalent. However this is unlikely to affect our main findings because IQ was measured in order merely to control for its effects rather than as a main independent variable of interest. In addition, some of the controls were from Germany rather than the UK.

Offending histories were based on self report by prisoners. We are therefore reliant on the offenders to give a truthful account of their offending history. However, as data were anonymised we consider that pressure on the prisoners to provide a false account was minimised.

Finally, we did not select prisoners and controls on the basis of their rates of substance abuse or head injury. Inevitably, therefore, such factors are likely to be over-represented within the offender group. However, as mentioned previously, we controlled for the effects of IQ and it is therefore unlikely that any associated cognitive decline could account for our findings.

Conflict of Interest

None.

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