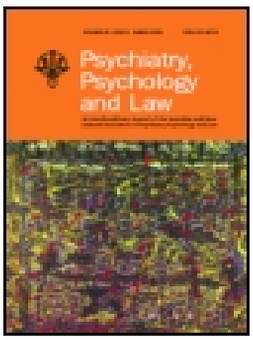

Psychiatry, Psychology and Law

ISSN: 1321-8719 (Print) 1934-1687 (Online) Journal homepage: http://www.tandfonline.com/loi/tppl20

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To cite this article: Melissa A. Hughes, Mairead C. Dolan & Julie C. Stout (2015): Decision-making in Psychopathy, Psychiatry, Psychology and Law, DOI: 10.1080/13218719.2015.1081228

To link to this article: http://dx.doi.org/10.1080/13218719.2015.1081228

Published online: 07 Sep 2015.

Psychiatry, Psychology and Law, 2015
http://dx.doi.org/10.1080/13218719.2015.1081228

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Decision-making in Psychopathy

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Psychopathy is a complex developmental personality disorder. Recent theories have linked psychopathy to impairment in the frontostriatal circuitry linking the amygdala and ventromedial prefrontal cortex (vmPFC). Similar neural regions have been implicated in decision-making. Given the importance of decision-making in the context of personal and societal problems, together with the convergence of brain regions important in both decision-making and psychopathy, the study of decision-making in psychopathy has the potential to illuminate important cognitive and neurobiological bases for psychopathy. In this review, we synthesise past research on psychopathy and decision-making, and then describe three decision-making tasks that we predict would be useful for understanding cognitive decisional processes in psychopathy.

Key words: cognitive decision processes; decision-making; decision-making tasks; neurocognitive; personality disorder; psychopathy.

Introduction

Psychopathy is a personality disorder characterised by emotional dysfunction and antisocial behaviours. Psychopathic offenders are known for committing crimes that are impulsive and poorly planned, resulting in a high likelihood of being caught. Furthermore they do not appear to be deterred by previous punishments (Hare, 1991).

For example, one highly psychopathic offender we observed, Bob (name has been changed), who was a known repeat offender, claimed he was 'held up' when volunteering to bank money for his workplace. Bob was able to describe to police the robber and weapon in great detail, so much so that the suspicious police obtained a warrant and found the exact same weapon at his residence.

Examples such as this suggest that psychopathy could be related to alterations in decision-making in contexts involving motivational and cognitive factors. Relatedly, an expanse in decision-making research and knowledge has led to an increased understanding of the behaviours, and the underlying motivational and cognitive factors, of clinical populations such as people with substance use disorders. Therefore, characterising decision-making in psychopathy could highlight motivational and cognitive factors contributing to these individuals' real-life decisions and behaviours.

The current review is therefore an overview and synthesis of decision-making research within the context of psychopathy. Our aim was to review the relevant literature on psychopathy and decision-making in order

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to identify the overarching findings, as well as the gaps in knowledge that may benefit from additional research.

Review Outline

Psychopathy is a chronic and persistent developmental personality disorder encompassing various affective, behavioural, and interpersonal manifestations (Blackburn, 2007; Neumann, Hare, & Newman, 2007; Ogloff, 2006). Behaviourally, psychopaths are impulsive, risk-taking and sensation-seeking, and they engage in antisocial behaviour. Affectively, they display shallow affect and callous unemotional traits. Interpersonally, they are grandiose, egocentric, and manipulative.

Psychopathy is a complex disorder associated with a number of separate characteristics and traits. The understanding and assessment of psychopathy are inextricably intertwined and continue to develop. Thus, how psychopathy is understood and measured naturally influences the outcome of any study of cognitive characteristics associated with this complex construct. As such, this review begins with a consideration of both the construct *and* measurement of psychopathy. In psychopathy, research into neurocognitive factors has suggested differences in aspects of cognition and motivation that are likely to affect decision-making. We summarise some of the key neurocognitive findings in psychopathy, and then explain the utility of investigations into decision-making characteristics associated with psychopathy. The next section of the review considers laboratory-based decision-making tasks that we considered potentially relevant for examining key aspects of the decision-making characteristics of psychopaths.

Overview and Measurement of Psychopathy

Reports of what is now described as psychopathic personality can be traced back to ancient times (Arboleda-Flórez, 2007), and across various cultures (Blackburn, 2007; Cooke, Michie, & Hart, 2006; Skeem, Edens, Camp, & Colwell, 2004). Based on personal clinical experience, Hervey Cleckley reported the first formal conceptualisation of psychopathy, describing it as a severe affective deficit masked by normal psychological adjustment. He also outlined 16 specific characteristics to identify psychopathy (Cleckley, 1988).

Some of Cleckley's criteria were non-specific, requiring fairly subjective clinical interpretation. For example, criterion number 13 states psychopathic individuals will show 'fantastic and uninviting behaviour with drink and sometimes without' (Cleckley, 1988, pp. 338−339), which could be interpreted differently by different clinicians. Diagnoses using Cleckley's criteria were therefore not necessarily comparable between clinicians or researchers, which is of course problematic for research attempting to understand the cause or impact of psychopathy. To develop a common and reliable assessment tool for psychopathy, Hare and colleagues conducted a series of psychometric analyses of Cleckley's criteria, as well as other traits and behaviours deemed relevant. A total of 22 traits were determined to have the best discrimination and psychometric properties for identifying psychopathy, and formed the basis of the Psychopathy Checklist (PCL; Hare, 1980). The original factor analysis of the PCL uncovered a two-factor model, with Factor 1 representing affective and interpersonal characteristics and Factor 2 reflecting antisocial and lifestyle characteristics. Further refinement resulted in more detailed scoring criteria and 20 traits in the revised version (PCL-R, see Figure 1; Hare, 1991). The factor analysis of the PCL-R traits derived a two-factor, four-facet hierarchical model. A total of 18 of the traits load onto one of the four facets (Affective, Interpersonal, Lifestyle, Antisocial), which in turn load onto Factor 1 (Affective/Interpersonal) or Factor 2 (Lifestyle/Antisocial).

Although considered by many researchers to be the 'gold standard' tool (Patrick, Venables, & Drislane, 2013), there are a few issues regarding measurement of psychopathy with the PCL-R. Some debate surrounds

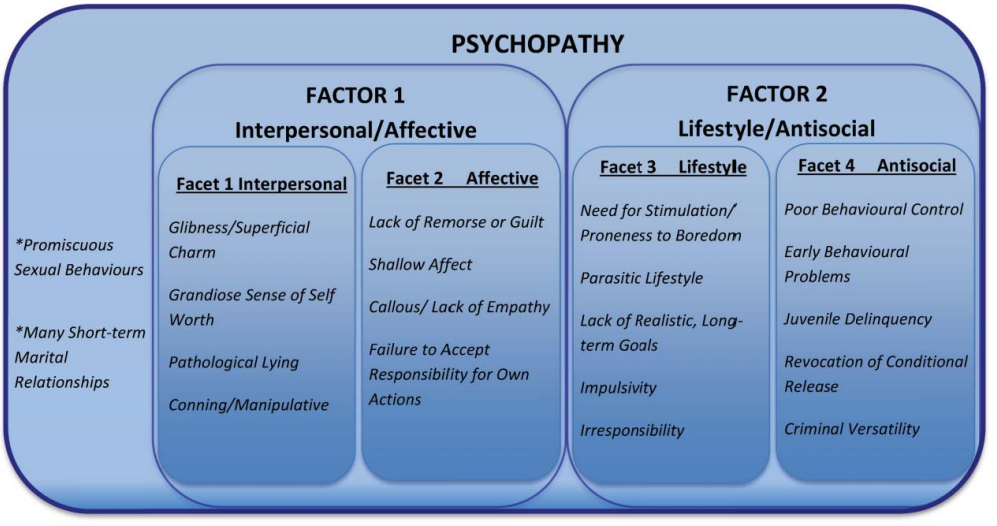

Figure 1. The Psychopathy Checklist – Revised (PCL-R; Hare, 1991) Operationalisation of the Psychopathy construct.
Note. *Traits comprising Total psychopathic score but not loading onto facets or traits. The PCL-R definition of psychopathy is of a hierarchical construct comprised of two factors, four facets, and 20 individual traits.

the exact elements comprising the psychopathy construct. Specifically, this debate relates to whether the inclusion of antisocial characteristics confounds criminal behaviour with inherent personality traits. Because of this there is debate as to whether psychopathic traits are best described with a three-factor model, excluding some antisocial characteristics, rather than the more commonly accepted two-factor four-facet model (Cooke, Michie, & Skeem, 2007; Hare & Neumann, 2008). Additionally, the PCL-R was developed for use in forensic populations yet it is known that psychopathy extends into the non-institutionalised general community (Hall & Benning, 2006; Neumann & Hare, 2008). The PCL-R therefore has limited utility in non-institutionalised individuals. For non-offender samples a screening version was developed (PCL:SV), although this requires considerable time and collateral information, often making it difficult to use in research with non-offenders.

Our current understanding and measurement of the clinical features of psychopathy may limit our ability to assess the neurocognitive functions contributing to these features. Despite this it is important to note that neurocognitive approaches to understanding psychopathy could have important implications for diagnosis. Relating psychopathy to neurocognitive functions could inform a refinement of the characterisation of psychopathy and its traits, and increase understanding of aetiological factors and which traits group together from a neurocognitive perspective.

Neurocognitive Descriptions of Psychopathy

Many theories have been developed to explain psychopathy. These theories include, but are not limited to, the frontal lobe dysfunction model (Neumann, Uzieblo, Crombez, & Hare, 2013; Price, Salekin, Klinger, & Barker, 2013), paralymbic dysfunction (Kiehl, 2006; Kiehl et al., 2001) attention-based accounts (Lorenz & Newman, 2002; Newman, Schmitt, & Voss, 1997), and emotion-based accounts (Olver, Lewis, & Wong, 2013). Each of these theories has

considerable merit, and it is possible that varied aetiologies may lead to similar behavioural and personality features. One prominent model that attempts to link affective and neurocognitive features of psychopathy is the Integrated Emotion Systems (IES) model (Blair, 2005a). The IES relates psychopathic features to dysfunction in a neural circuit that links the amygdala and ventral medial prefrontal cortex (vmPFC) to provide reciprocal modulation of emotion and cognition (Blair, 2005a). Dysfunction within this neural circuit may result in the reported impairments in punishment/reward reinforcement-based learning and decision-making (Mitchell, Colledge, Leonard, & Blair, 2002), and deficits in appropriate emotional responses to others' distress cues (Dolan & Fullam, 2006; Glass & Newman, 2006), which may ultimately lead to impaired social behaviours and moral development (Blair, 2005a).

Neurocognitive Findings

Psychopathy is not associated with a general intellectual impairment (Kiehl, 2006). Neurocognitive research has not found consistent relationships between psychopathy and broad neuropsychological functioning domains such as visuospatial skills, memory, selective attention, motor control, or executive function (Lapierre, Braun, & Hodgins, 1995; Mitchell et al., 2002).

Psychopathy has been related to more specific neurocognitive abnormalities in some areas of cognitive and affective processing, which logically might affect socialisation and appropriate decision-making. In brief, individuals with higher levels of psychopathy display a reduced or absent startle potentiation when processing negatively valanced stimuli, suggesting they are not as responsive as non-psychopaths to aversive sights or sounds (Levenston, Patrick, Bradley, & Lang, 2000; Vaidyanathan, Patrick, & Bernat, 2009). In line with this, highly psychopathic individuals show impairments with the processing of sad and fearful stimuli, such as the recognition of others' vocal or facial distress (Dadds et al., 2006; Dolan & Fullam, 2006; Marsh & Blair, 2008). Psychopathy has also been related to impaired punishment and reward learning, particularly on tasks involving aversive information (Flor, Birbaumer, Hermann, Ziegler, & Patrick, 2002; Mitchell et al., 2006), as well as emotional memory (Dolan & Fullam, 2005; Glass & Newman, 2009). Finally, high levels of psychopathy are associated with impairments in learning to change or stop behaviour when reinforcement contingencies change (Budhani & Blair, 2005; Mitchell et al., 2002).

A number of neuroscientific studies have related psychopathy to alterations in brain structure and function (for a comprehensive review, see Muller, 2010). Further, cognitive impairments have been linked to dysfunction or hypofunctioning of frontolimbic neural regions (Kiehl, 2006; Veit et al., 2002). In particular, alterations in amygdala and vmPFC functioning appear to be most relevant to cognitive and emotional impairments (Craig et al., 2009; Sommer et al., 2006). Disruptions in the integration of these neural circuits may therefore impact on the processing of aversive and appetitive information, learning from reward and punishment, and behaviour monitoring. Such disruptions are likely to impact on the ability of individuals to make appropriate lifestyle and social choices.

Putting these findings in the context of abilities needed for social and emotional behaviour, we know that individuals with psychopathic traits have dysfunction in learning the reinforcement value of behaviours, which are necessary for learning social and emotional consequences. We know that there is impairment in the recognition of distress cues, which are important for recognising and responding to social and emotional cues. We also know that there is dysfunction in forms of behavioural regulation specific to the situation. However, we have fairly limited information on the integration of affective information and behavioural regulation, which would be necessary for the regulation

of many real-world judgements and behaviours.

Further, because psychopathy is a multidimensional construct (see Figure 1 for the PCL-R conceptualisation), neurocognitive processes, including decision-making, may differentially relate to the various elements of psychopathy (i.e., the traits, facets and factors). Yet relatively little is known about the relationships between neurocognitive processes and the various elements of psychopathy. Theoretically, the IES model has linked amygdala dysfunction with psychopathic affective and interpersonal characteristics. This is primarily due to the amygdala's importance in representations of affective information (Blair, 2008). The model also links vmPFC dysfunction to lifestyle and antisocial characteristics. This is primarily due to the vmPFC's importance in representing reinforcement (reward or punishment) expectancies and error monitoring, which is important for modifying behaviour (Blair, 2008). Although intuitive, these assumptions require validation in cognitive neuroscience studies.

One area of neuroscientific investigation we could use to further understand the neurocognitive underpinnings of psychopathy is decision-making research. Our reasons for this line of investigation are twofold. Firstly, the IES suggests that psychopathy is associated with impaired decision-making due to impaired reciprocal emotion-cognition modulation. Available research also suggests that highly psychopathic individuals are impaired on processes relevant to decision-making such as passive avoidance and reversal learning (Blair, 2008; Finger et al., 2008). Secondly, over the past 40 or so years we have seen a huge expanse in the understanding of decision-making, which has been used to understand other psychopathologies. Thus, decision-making research in psychopathy may help to further elucidate neurocognitive underpinnings, as well as some of the difficulties associated with psychopathy in daily life.

Decision-making

Brain imaging studies of decision-making in humans have revealed activation in neural regions known to be associated with emotional regulation (Livet, 2010). We now understand that decisions involving multiple options or goal-directed behaviour require a complex interplay of affective information and behavioural regulation, and that this interplay is mediated by frontolimbic neuroanatomical structures (Dillard, Salekin, Barker, & Grimes, 2013; Furuyashiki & Gallagher, 2007; Rolls, 2008). For example, we know that emotions serve as reinforcers – people try to attain positive and avoid negative emotions, which modulate behaviours including decision-making. Imaging studies have also shown activation in frontolimbic neural regions such as the medial prefrontal cortex, anterior cingulate cortex, and amygdala on various decision-making tasks (Dillard et al., 2013). Complex decision-making therefore requires interaction in the amygdala-vmPFC circuit (Blair, 2008). The IES explains this interaction functionally as the amygdala sending reinforcement (reward or punishment) information associated with stimuli to the vmPFC, which then represents reinforcement expectancies associated with each of the options to allow for appropriate decision-making (Blair, 2008). If psychopathy is associated with dysfunctional emotion-cognition modulation then alterations in decision-making would be expected.

Assessment of psychopathic decision-making could also draw upon research conducted in other clinical populations. Neuroscientific assessment of the decision-making of clinical populations began in the 1990s when Bechara and colleagues found that lesions to the vmPFC (Bechara, Damasio, Damasio, & Anderson, 1994) or amygdala were associated with decisions that were not guided by the anticipation of future consequences (Bechara, Damasio, Damasio, & Lee, 1999). Subsequently other clinical groups were characterised on their decisional

styles. For example, individuals with Asperger's show erratic choices but are sensitive to loss (Lilienfeld, 2013), while substance-dependent individuals show hypersensitivity to reward (Bechara & Damasio, 2002). Therefore, characterising decision-making in psychopathy may also highlight motivational and cognitive factors contributing to real-life decisions and behaviours in this population.

Decision-making Methodologies

To characterise psychopathic decision-making we can make use of a range of methodologies, each allowing the assessment of different aspects of decision-making. Decision task methodologies can differ in the extent to which choices are descriptive, experiential, dynamic or static. Descriptiveness relates to how much information is told to participants about the conditions of a choice, often without the opportunity to learn from the results. Experiential refers to the degree to which participants can experience outcomes from their decisions, allowing them to learn from experience, and to experience outcomes that might affect future choices. Static choices are completely defined one-off decisions. Dynamic decisions are choices that can change over time, occurring in situations where participants make multiple decisions and receive feedback about each choice, providing the opportunity to learn from outcomes (Kerstholt & Raaijmakers, 1997).

Decision tasks can also differ in terms of face validity for real-world decisions. Some tasks look like games yet tap into processes and styles used in the real world. Other tasks are more contextualised and therefore have more face validity for real-world decisions, and can assess social aspects of decision-making. Mathematical modelling of decision-making is an additional methodology that can be used to form theoretical bridges between observable behaviours and underlying processes (Busemeyer, Jessup, Johnson, & Townsend, 2006). This is because similar observable choices are often made for different unobservable reasons, the result of a combination of several unseen neurocognitive processes. Comparing only observable decisions limits our ability to detect differences in evaluation processes used to arrive at the decisions. Thus, mathematical modelling of performance data enables detection of evaluation processes. Once exposed, the various processes can be separated and evaluated individually (Stout, Rock, Campbell, Busemeyer, & Finn, 2005).

Because decision-making is such a complex area, decisional behaviours and processes likely differ under different situations with different types and amounts of information. Thus to assess psychopathic decision-making, a range of tasks differing in terms of methodological features may be most informative. Using a combination of tasks may also assist in overcoming limitations in any one task. Next, we outline three types of laboratory-based tasks we believe are potentially relevant to understanding neurocognitive processes in psychopathy. One descriptive-based task enables the assessment of the moral components of decision-making, relevant to a disorder appearing to lack such considerations. Another task assesses the subjective experience and use of emotions, particularly relevant given neurocognitive theories suggesting psychopathy is associated with impaired emotion-based behavioural regulation. The final task outlined is experiential, and assesses decision under risk and ambiguity. Its associated mathematical model also allows further insight into cognitive processes underlying decisions.

Decision-making in Situationalised Contexts: The Moral Judgement Task

Moral reasoning relates to socially-based decisions. Included are such notions as harm, fairness, loyalty, and authority (Haidt, 2007). Due to deficits in appropriate emotional responses to the distress of others, psychopathy is thought to be primarily associated with

impairment in moral reasoning about actions that may harm others (Blair, 2007). Surprisingly, however, there has only been limited neurocognitive investigation into relationships between psychopathic traits and moral decision-making.

Some important moral-based research in psychopathy has used the moral/conventional distinction task, which requires static judgements about the permissibility of moral and conventional transgressions. On this task individuals with higher levels of psychopathy are commonly reported to show less distinction between conventional and moral transgressions, and their reports of why an action is wrong focus less on the victim's welfare (Blair, 1995, 1997; Dolan & Fullam, 2009; Fisher & Blair, 1998); however, it must be noted that this is not always found (Aharoni, Sinnott-Armstrong, & Kiehl, 2012). Other moral-based research has shown that higher levels of psychopathy relate to an impaired understanding of social contracts (Ermer & Kiehl, 2010), positive attitudes towards offending (Ray & Jones, 2011) and lower levels of moral concern for others (Glenn, Iyer, Graham, Koleva, & Haidt, 2009).

Such studies provide important information about general issues relating to social rules. They do not, however, provide information about moral judgements in a given scenario. Appropriate for this purpose is the Moral Judgement Task (MJT; Greene, Nystrom, Engell, Darley, & Cohen, 2004; see Figure 2). On the MJT individuals decide whether they would undertake proposed actions in hypothetical scenarios involving non-moral, personal moral, and impersonal moral content (Koenigs et al., 2007). Personal moral dilemmas involve three criteria, including violation to a specified person or group of persons, likely bodily harm, and agency of the transgressor. These scenarios thereby elicit social-emotional responses (Greene et al., 2004). Impersonal moral dilemmas lack one of these three criteria, resulting in less salience of the affective information and decisions driven by more non-affective cost-benefit cognitive processes (Blair, 2007; Moll, De Oliveira-Souza, & Zahn, 2008).

On the MJT, healthy individuals endorse the fewest actions in the personal moral scenarios (Ciaramelli, Muccioli, Ladavas, & Di Pellegrino, 2007; Koenigs et al., 2007), and show activation in the amygdala-vmPFC circuit (Berthoz, Armony, Blair, & Dolan, 2002; Greene et al., 2004; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Harenski & Hamann, 2006). Patients with vmPFC lesions make similar judgements to healthy individuals on impersonal moral scenarios, but endorse more actions on personal moral dilemmas (Koenigs et al., 2007). Higher levels of endorsement in personal moral scenarios can be referred to as a utilitarian decision-making style (Koenigs et al., 2007). Such a decision-making style may reflect a reduced ability to consider social affective aspects of a decision in comparison to cognitive rational considerations, which we may expect to see in psychopathy.

Surprisingly, limited studies have assessed the relationship between psychopathy and moral judgements. One study using a modified version of the self-report psychopathy scale (SRP-III; Paulhus, Neumann, & Hare, in press) found that higher levels of psychopathy in a college sample were related to more endorsement in personal moral scenarios (Bartels & Pizarro, 2011). Another community study using Levenson's Self-Report Psychopathy scale (LSRP; Levenson, Kiehl, & Fitzpatrick, 1995) found that higher psychopathy scores were associated with reduced amygdala activation (Glenn, Raine, & Schug, 2009), but did not report whether this reduced activation was related to the judgements. A recent community study using the short form of the SRP (SRP-4-SF; Paulhus, et al., in press) did not find relationships between moral judgements and the two primary psychopathy factors (Seara-Cardoso, Neumann, Roiser, McCrory, & Viding, 2012). Only two studies have looked at moral judgement in prisoners, both using the PCL-R; one found no differences in judgements

Non-Moral: You are bringing home plants from a store, if you bring them all home in one trip you would need to put some on the back seat and ruin the upholstery, would you make two trips to avoid ruining the upholstery? (Y/N)

(a)

Impersonal: A runaway trolley is headed for five people who will be killed if the trolley proceeds on its present course, the only way to save them is to hit a switch which will turn the trolley and kill one person instead of five, would you hit the switch? (Y/N)

(b)

Personal: You are on a bridge beside a large man. A trolley below is heading towards five men who will be killed if the trolley proceeds. The only way to save the men is to push the stranger onto the tracks, he will die but his large body will save the others, would you push him onto the tracks? (Y/N)

(c)

Figure 2. Abbreviated examples of dilemma scenarios in the (a) Non-Moral, (b) Impersonal Moral, and (c) Personal Moral conditions (Greene et al., 2004).

between psychopaths and non-psychopaths (Cima, Tonnaer, & Hauser, 2010), the other found that psychopaths endorse more actions in impersonal scenarios and low-anxiety psychopaths endorse more actions in personal scenarios (Koenigs, Kruepke, Zeier, & Newman, 2011).

Clearly, further research is required to overcome inconsistencies in previous findings and better understand psychopathic moral reasoning. In addition to the consideration of factors such as the measure used and the sample size and type (forensic vs non-forensic, variation in focus on anxiety/attention factors, differences in assignment to psychopathic and non-psychopathic groups), a possible partial contributor to the mixed findings could be differences in the particular constellation of traits in the sample assessed. Thus further research could also assess dimensional relationships between specific facets of psychopathy and moral judgements across a sample with a range of psychopathic traits and behaviours. Such research would lead to a more detailed understanding of how psychopathic traits, and their combinations (i.e., facets and factors) relate to decisions involving both rational and social affective considerations.

Affective Responses to Choices: The Regret Task

Psychopathy has been associated with dysfunction in the amygdala-vmPFC circuit, which is important for the integration of emotion and cognition (Blair, 2005a). Such dysfunction is therefore likely to reduce the ability of emotional experiences to regulate behaviours. One strong regulatory emotion is regret. Regret is experienced when one feels personal responsibility for an unwanted outcome, and the avoidance of regret may prevent behaviours that lead to poor outcomes for oneself or others. Thus, assessing the experience and impact of regret on decision-making may potentially provide a means for assessing whether alterations in regret experience may contribute to psychopathic behaviours.

One tool to investigate *regret* is the Regret Task (Camille et al., 2004; see Figure 3). The Regret Task is a simulated gambling task that attempts to induce regret

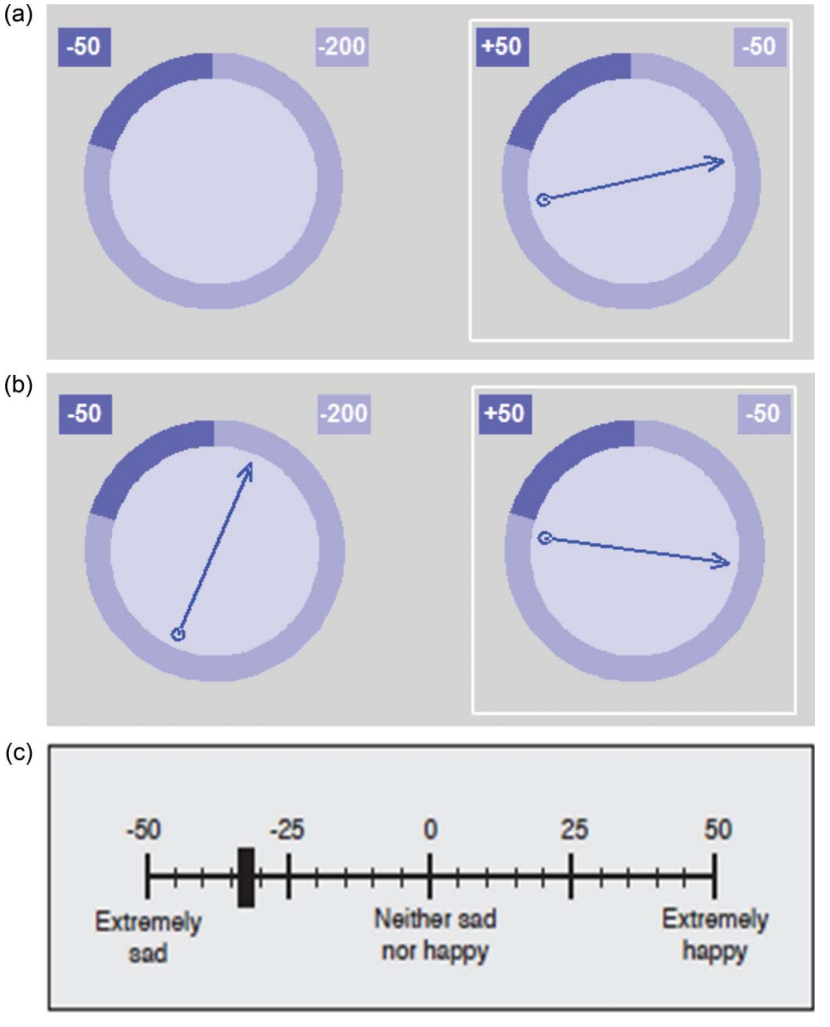

Figure 3. Screen shots of the gambling choice paradigm in the (a) Partial and (b) Complete feedback conditions (Camille et al., 2004).
Note. Two wheels represent the two gambling choices. The two sectors for each wheel indicate the outcome values by the colour coinciding with that of the colour-coded value of the number above, and the probability of receiving each outcome by the size of its sector. Feedback is given via an arrow pointing to the outcomes of the gambles. In the Partial condition (a), feedback is given only for the chosen wheel, while in the Complete condition (b), feedback is given for both the chosen and unchosen wheels. Following each trial, participants rate their affective state using the mood scale (c).

in participants by providing feedback about both the unfavourable *chosen* gamble, and a more advantageous result on a gamble they *did not choose*. On this task participants choose between two gambles, represented as two wheels, with explicitly stated reward values and outcome probabilities. Once a selection has been made participants receive feedback as to the result of their chosen gamble, as well as the result of the unchosen alternative. Participants then rate their affective state on a scale from 'extremely sad' to 'extremely happy'. Because regret depends on counterfactual reasoning between obtained outcomes and outcomes of rejected alternatives, affective ratings in trials with negative

payoffs are thought to index regret. As a comparison of emotional responses to outcomes, a partial condition, where feedback is only provided about the chosen gamble, is performed prior to the complete condition.

On this task, Camille et al. (2004) found that healthy individuals report experiencing regret if an unchosen gamble won more, regardless of whether or not their chosen gamble won money. In contrast, despite reporting being *disappointed* when their choices lost, patients with vmPFC lesions did not experience *regret*. That is, patients did not report more negative affect in the complete as compared to the partial feedback condition, nor were their ratings as negative as that of controls. Following a number of negative payoffs healthy individuals began to show *regret aversion*, choosing more gambles with lower expected value but higher reward probability. Conversely, vmPFC patients continued to choose based solely on expected values of the gambles (Camille et al., 2004). A further imaging study in healthy individuals found activation in the amygdala-vmPFC circuit in response to missing out on preferred outcomes, and immediately prior to subsequent decisions (Coricelli et al., 2005).

Because psychopathy is associated with reduced emotional experience (Blair, 2005b) we expect there would be relationships between psychopathic affective experience and use of emotional information in decision-making. On a modified version of the regret task, a small group of offenders experienced a reduced sense of regret compared to a sample of community participants, and there was some suggestion that different psychopathic factors and facets may differentially relate to experience and use of emotions (Hughes, Dolan, & Stout, 2013). Thus using the Regret Task in a larger sample characterised by level of psychopathy could potentially provide important insights into psychopathy-associated decisional styles or biases, in the context of experience and use of affective information.

Decision-making in Ambiguous Contexts: The Iowa Gambling Task (IGT)

Most real-life decisions occur in the context of some level of risk and/or ambiguity. Thus it is useful to examine psychopathic decision-making under such contexts using laboratory tasks that can assess biases that may contribute to real-world decisions. Appropriate to this end is the Iowa Gambling Task (IGT; Bechara et al., 1994; see Figure 4).

During the IGT, participants must make a series of selections from four decks of cards, with the only goal being to maximise payoffs.

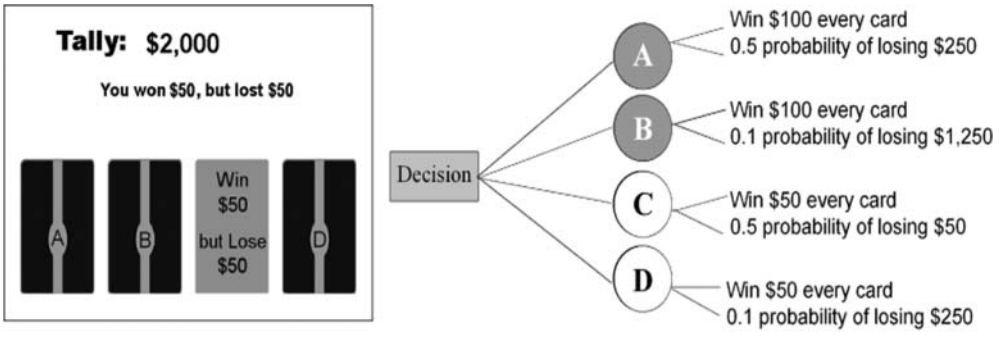

Figure 4. A screen shot and visual depiction of the IGT (Bechara et al., 1994), with an explanation of the available outcomes. Note. Decks A and B are disadvantageous, as although participants receive $100 each trial they have a higher loss probability. Decks C and D are advantageous, as although they win only $50 each trial they also have a lower loss probability. Note that participants win in each trial, but also frequently lose in the same trial, as in the example above, where the participant won and lost $50.

Two decks are disadvantageous, distributing high rewards with each selection but also intermittent large losses, resulting in overall loss magnitude. Two decks are advantageous, providing lower rewards with each selection but also intermittent small losses, resulting in an overall gain magnitude (Yechiam et al., 2008). This deck structure is not explicit, meaning that the best decks to maximise payoffs must be deduced through the accumulated card-by-card experience of outcomes (Bechara, 2004; Brand et al., 2005). This design results in a complex environment of rewards and punishments, consistent and intermittent outcomes, set in an ambiguous context. In this way the IGT replicates real-life decision-making elements, including learning, memory, motivation, and reward-seeking.

On the IGT healthy individuals usually begin choosing from disadvantageous decks; they then improve throughout the trials to select more from the advantageous decks (Bechara, Tranel, & Damasio, 2000; Mitchell et al., 2002; Northoff et al., 2006). Patients with lesions to the vmPFC (Bechara, 2004) or amygdala (Bechara et al., 1999) do not show learning over trials and continue to select from disadvantageous decks. Imaging of healthy individuals performing the IGT has shown activation in the amygdala-vmPFC circuit (Northoff et al., 2006; Rao, Korczykowski, Pluta, Hoang, & Detre, 2008; Xue et al., 2009).

Research into associations between psychopathy and IGT performance has received only limited attention, which has reported mixed results. Three studies reported that psychopathic individuals made less advantageous choices than non-psychopathic individuals (Blair, Colledge, & Mitchell, 2001; Boulanger, Habib, & Lanáon, 2008; Mitchell et al., 2002). Three other studies, however, did not find performance differences between psychopathic and non-psychopathic individuals (Blair & Cipolotti, 2000; Losel & Schmucker, 2004; Schmitt, Brinkley, & Newman, 1999). The inconsistencies across studies may be due to differences in the nature of the sample and setting (incarcerated vs non-incarcerated, children vs adults, subclinical vs psychopathic, variation in focus on anxiety/attention factors), differences in assignment to psychopathic and non-psychopathic groups, differences in task delivery (actual cards vs computerised) and task instructions and incentives. Further investigation is therefore necessary to clarify the relationship between psychopathy and IGT performances.

As psychopathy is a multifaceted construct with dimensions that are theoretically likely to relate differentially to decision-making, an additional reason for inconsistent findings could relate to the constellation of traits in each sample. Surprisingly only two published studies (Losel & Schmucker, 2004; Schmitt et al., 1999) examined psychopathy factor-IGT relationships, neither of which found significant associations between psychopathy and performances. Furthermore, no reported study to date has examined psychopathy facet or trait-level relationships with IGT performance. Such investigation is necessary to delineate whether and how different dimensions of the psychopathy construct relate to decision-making under risk and ambiguity.

As seemingly similar observable choices can be made for different unobservable neurocognitive reasons, to further extract and assess psychological mechanisms underlying IGT performance we could also make use of a mathematical modelling technique (Fridberg et al., 2010). Currently the best model to extract these processes is the Prospect Valence Learning (PVL) model (Ahn, Busemeyer, Wagenmakers, & Stout, 2008).

PVL Model

Application of mathematical modelling to IGT data has shown how decisions on the IGT can relate to different psychological processes (Busemeyer & Stout, 2002; Fridberg et al., 2010; Yechiam, Busemeyer, Stout, &

Bechara, 2005). For example, one process relates to the evaluation of gains and losses for the subjective utility of a particular deck; some individuals perceive the utility of a deck according to the amount of gain on a trial and are thus sensitive to rewards, while for others utility is based on frequency of gains. A related component is the impact that losses have on perceived utility; loss aversive individuals are likely to shy away from decks with large negative payoffs. A third process is the tendency to pay attention to more recent outcomes and discount past outcomes; individuals paying more attention to recent outcomes are more likely to make the mistake of choosing decks providing large losses earlier. Another process relates to the consistency of choices; a pattern of highly random choices is unlikely to result in the maximisation of payoffs. These psychological components have been articulated using the PVL mathematical model (Ahn et al., 2008; Fridberg et al., 2010), which produces four corresponding parameters: shape of the subjective utility, aversion to losses, weighting of recent versus past outcomes, and degree of consistency. The application of mathematical models to IGT performance has proven useful in a range of populations (Yechiam et al., 2005). For example, while cocaine abusers pay more attention to gains and recent outcomes, individuals with Parkinson's disease are highly sensitive to losses (Yechiam et al., 2005).

Techniques for understanding choice evaluation processes such as mathematical modelling have never been used in a psychopathic population. This must be addressed if we wish to fully understand what drives the choice behaviour of individuals with high levels of these traits. Understanding these choice evaluation processes could influence approaches to treatment and strategies. For example, if individuals with particular traits pay more attention to gains or are not affected by losses, then approaching treatment by pointing out what they will gain from participation is likely to be more effective than talking to them about what they have lost and hence why they should participate.

Synthesis

Human decision-making is highly complex, involving integration of cognitive and emotional factors, and various psychological elements such as motivation and learning. It is therefore unlikely that any one decision-making technique could completely capture decisional processes in psychopathy. Thus, a combination of tasks differing in methodological features may be most informative. A highly descriptive task like the MJT can provide information about psychopathic decision-making in the context of social affective information. The Regret Task can tell us about the subjective experience and use of negative emotional information for decisions. A highly experiential-based task such as the IGT can inform us about decisions in the context of risk and uncertainty. Mathematical models such as the PVL can then be applied to further assess the cognitive processes underlying these decisions. The accumulation of findings from these tasks could provide insights into psychopathy-associated neurocognitive processes and biases contributing to problematic real-life behaviours. This information may be used to build more comprehensive neurocognitive explanations of psychopathy, as well as more targeted treatment initiatives.

Because psychopathy is such a multifaceted construct, it is probable that different aspects of psychopathy will differentially relate to decisional processes. Investigations should therefore assess how specific facets and traits relate to performances on these tasks. Assessing whether traits differentially relate to decisions would allow insight as to whether there are specific traits that are more associated with particular decisional processes. If traits are found to relate differentially to decisional styles and biases, this information may allow for further specificity of treatment initiatives.

In conclusion, integrating what is known about psychopathy with what is known about decision-making highlights an important area of focus for psychopathy research. Specifically, focused attention on differentiating specific contexts and decision-making styles will prove essential to further understanding this complex disorder. Investigating decision-making in psychopathy with three promising tools could provide insight into neurocognitive mechanisms associated with psychopathy. This information may help to develop a more complete neurocognitive account of psychopathy, and possibly even lead to improved characterisation and measurement of psychopathic traits. In turn, and most importantly, a more detailed understanding of the neurocognitive underpinnings of psychopathy maybe used to develop targets for treatment.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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