Review

The psychoticism–psychopathy continuum: A neuropsychological model of core deficits

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ABSTRACT

A neuropsychological model of a proposed psychoticism–psychopathy continuum is sketched, which postulates that the core deficits seen both in the personality trait of psychoticism and the clinical condition of psychopathy result from a dysfunction in a *behavioural inhibition system* (BIS; concerned with detecting and resolving goal-conflicts and associated with the emotion of anxiety) which leads to cognitive inflexibility, inattentiveness and response modulation deficit. Furthermore, differences in activity in a *fight-flight-freeze system* (FFFS; concerned with avoidance/escape and associated with the emotion of fear) are postulated to differentiate primary (low fearful) and secondary (adequately fearful) psychopaths, with the latter type also experiencing increased activity in a *behavioural approach system* (BAS; concerned with approach behaviour and associated with the emotion of hopeful anticipation) resulting in dysfunctional impulsiveness. Sub-clinical levels of psychoticism are postulated to result from a defective FFFS and BIS, coupled with an over-active BAS (specifically the fun-seeking, impulsivity facet) – this postulation raises the possibility that psychoticism may be a conflation of these separate influences and may differentiate into two types similar to those found in psychopathy. This model reconciles previously inconsistent findings relating the BIS to psychopathy and points to new avenues of research.

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1. The psychoticism–psychopathy continuum: a neuropsychological model of core deficits

The claim that the personality trait of psychoticism and the clinical condition of psychopathy are related constructs, and lie on the same continuum, is not new (e.g., Corr, 2000; Eysenck, 1992; Eysenck & Eysenck, 1976; Eysenck & Gudjonsson, 1989). This postulation has encouraged research aimed at identifying shared core deficits. This article outlines a neuropsychological model of these core deficits and discusses the additional morbid features that contribute to the full-blown clinical expression of psychopathy. This model derives from the revised reinforcement sensitivity theory (RST) of personality (Gray & McNaughton, 2000; McNaughton & Corr, 2004, 2008; for a summary see, Corr, 2008), based upon three systems: *behavioural inhibition system* (BIS), *behavioural approach system* (BAS), and the *fight-flight-freeze system* (FFFS). This material is presented in the light of the potential of revised RST to resolve a number of current debates in the psychopathy literature (e.g., Newman & Malterer, 2009; Poythress, Skeem, Lilienfeld, Douglas, & Edens, 2009; Poythress et al., 2008); however, it is acknowledged that considerable research is still needed to characterize this psychoticism–psychopathy continuum and that the model proposed is little more than a prolegomenon.

2. Personality trait of psychoticism

Eysenck's (1952) original postulation of a psychoticism dimension is well known, ranging from a highly socialized pole to one containing schizotypy, bipolar disorder, psychopathy and schizophrenia. However, as noted by Claridge (2009), Eysenck's psychoticism factor was originally seen as a broad dimension covering all of the personality aspects of psychotic illness, but his use of the construct in later years (e.g., Eysenck & Eysenck, 1991) came to reflect a much narrower perspective, focusing, largely, on antisocial behaviour, lack of conformity, aggressiveness, and impulsivity – although its ties with psychosis were not broken and remained important (for further discussion, see Rawlings & Dawe, 2007).

In one form or another, the majority of personality models contain a dimension comparable to the construct of psychoticism (P; Eysenck & Eysenck, 1976). For example, Tellegen's (1985) Constraint, the Five-Factor model of Agreeableness (–) and Conscientiousness (–) (McCrae & Costa, 1999), Zuckerman's Impulsivity-Unsocialised Sensation Seeking (Zuckerman, Kuhlman, Thornquist, & Kiers, 1991), and Rothbart and Bates' (2006) Effortful Control. In a manner similar to clinical psychosis, psychoticism is related to dysfunctions even among non-psychiatric individuals (e.g., Compton, Carter, Kryda, Goulding, & Kaslow, 2008) and is a risk factor for the development of antisocial behaviour, as related to adult personality traits, psychopathy, and violent behaviour over the life span (Klinteberg, Johansson, Gacono, & Alm, 2008; for a review,

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see Cale, 2006). Intriguingly, psychoticism is also associated with creativity. For example, Abraham, Windmann, Daum, and Güntürkün (2005) found that it was related to a greater degree of conceptual expansion and elevated levels of originality in creative imagery, but was unrelated to the practicality/usefulness of an idea.

Eysenck (1992) suggested that psychoticism may be associated with diminished inhibition of neural impulses resulting from excessive production of dopamine by the nervous system, thus linking such concepts as impaired latent inhibition (see below), schizotypy/schizophrenia and creativity (the latter representing dopamine-related loose associations, cognitive overinclusiveness and a less steep semantic horizon).

In support of this dopamine link, there are negative correlations between psychoticism and cerebral perfusion in the basal ganglia (putamen and caudate, both right side) and thalamus (right side) (O'Gorman et al., 2006) – cerebral perfusion is a fundamental physiological quantity reflecting the rate of delivery of oxygen and other nutrients to an organ or tissue. Psychoticism has also been associated with decreased metabolic rate in the basal ganglia and thalamus (Haier, Sokolski, Katz, & Buchsbaum, 1987). The psychoticism–dopamine relationship is consistent with the negative association between psychoticism and dopamine D^2 binding (Gray, Pickering, & Gray, 1994) and resting fMRI signal (Kumari, Ffytche, Williams, & Gray, 2004). In relation to dopamine, Corr and Kumari (2000) reported an interaction of psychoticism with (5 and 10 mg) *d*-amphetamine challenge on self-reported mood: in low psychoticism individuals, *d*-amphetamine increased energetic arousal and hedonic tone, and reduced tension arousal; whereas, in high psychoticism individuals, energetic arousal and hedonic tone were lowered, and tense arousal raised.

The association of psychoticism with cognitive and attentional anomalies (Eysenck & Eysenck, 1991) are important in pointing towards possible underlying core neuropsychological deficits. For example, high psychoticism is associated with impaired latent inhibition (LI; a retardation of unconditional stimulus–conditional stimulus (UCS–CS) learning following prior exposure of a CS, e.g., white noise, without reinforcing consequences; Lubow, 1989). LI effect is interpreted as reflecting inadequate processing of the pre-exposed CS due to impaired inhibitory processes (i.e., a failure to learn that the CS is of no consequence). Dopamine agonists worsen LI and dopamine antagonists either restore (in the case of schizophrenics) or enhance it (see Gray, Feldon, Rawlins, Hemsley, & Smith, 1991). These data, along with those reported above, are consistent with the hypothesis that high psychoticism individuals are in a hyper-dopaminergic state (or, at the very least, have a hyper-responsive dopamine system). It is noteworthy that LI is thought to operate at an automatic level of control, which, as we shall see below, may hold particular theoretical significance for understanding the causal basis of psychoticism. A number of studies point to specific attentional control problems in psychoticism.

Nęcka and Szymura (2001) and Szymura and Nęcka (2005) argued that the requirement of attentional flexibility in cognitively-demanding tasks is crucial to finding performance differences between low and high psychoticism individuals. Psychoticism may be associated with either strength or weakness of selective attention, depending upon task characteristics (see Rawlings, 1984, 1985; Thompson, 1985). Poor inhibition seems to give high psychoticism individuals an advantage, for example, in negative priming tasks, but exerts a high cost on interference tasks (e.g., dual-task processing) where attentional flexibility is crucial. Across three visual selective attention experiments, Szymura, Smigasiewicz, and Corr (2007) found that *low* psychoticism was associated with superior performance when the selection rule was predictable; however, when it was unpredictable, *high* psychoticism was related to superior performance, presumably because

these individuals were less sensitive to the regularities in stimuli presentation due to their impaired attentional processing (for further relevant data, see Szymura & Nęcka, 1998).

Performance differences between low/high psychoticism individuals may be explained with reference to two systems: (1) an automatic and diffuse (orienting sensitivity); and (2) effortful control (Rothbart, Ahadi, & Evans, 2000). Orienting sensitivity seems to be related to psychoticism (as well as creativity and openness). In consequence, high psychoticism individuals show performance superiority when effortful control is not necessary and orienting sensitivity is sufficient to perform the task. However, they show performance inferiority when attentional control needs to be engaged to improve cognitive effectiveness. In support of these conclusions, Corr (2003) reported that high psychoticism individuals were significantly impaired in dual-task processing, whether the dual-task was cognitively-demanding mental arithmetic or the relatively easy counting of nonsense syllables (as used in human LI experiments; see above). These data suggest that high psychoticism individuals have difficulty processing different sources of information, and that impairment by controlled processing significantly disrupts procedural (automatic) learning of stimuli regularities.

3. Clinical condition of psychopathy

The clinical characterization of psychopathy owes much to the seminal work of Cleckley (1941), who noted that the psychopath has a 'mask of sanity', comprising features of good adjustment (e.g., superficial charm and adequate intelligence) which coexist with features of poor adjustment (e.g., behavioural deviance) and underlying dysfunctions, including behavioural deficits (acting on impulsive whims), cognitive deficits (e.g., poor judgment), emotional and interpersonal deficits (e.g., shallow emotions, lack of empathy, remorse, shame and insincerity), motivational deficits (poorly motivated antisocial behaviour) and ego-distortion (egocentricity). Research has laid stress on the well-documented failure of the psychopath to learn and benefit from experience (especially, although not exclusively, from punishing experience).

In terms of prevalence and societal consequences, psychopaths comprise, approximately, 1% of the general population, but some 15–25% of the prison population (Hare, 1996). Psychopathic offenders, as compared with non-psychopathic offenders, are also much more likely (2–5 times) to re-offend (Hemphill, Hare, & Wong, 1998). However, not all (or most) psychopaths are identified and diagnosed, and many live what seem successful and productive lives (see Cleckley, 1941), although they often exert negative influences through their, otherwise, respectable activities (Babiak & Hare, 2007).

Following Karpman (1941, 1949), psychopathy is often differentiated into *primary* and *secondary* types. Primary psychopathy is related to an innate fearless temperament that impairs socialization; and *secondary* psychopathy, although similar in behaviour to the primary type, is related to neuroticism and susceptible to depression, anxiety and guilt (Karpman, 1948) – this latter type is sometimes assumed to be a result of early learning experiences (Porter, 1996). Secondary psychopaths are assumed to have an adequately developed conscience, and the capacity for empathy; however, they behave recklessly due to their hyperactive reward-related sensitivity. There is evidence that highly anxious and lowly anxious psychopaths can be meaningfully discriminated. (For a discussion of the differentiation of primary and secondary psychopathy, see Blackburn, 1979; Hare, 1970). Primary and secondary psychopathy are also referred to as 'instrumental' and 'reactive' (or, sometimes, 'affective') types (Blair, 2001) (for a discussion, see Kumari & Taylor, 2010).

The idea that the BIS is defective in psychopathy has attracted considerable attention (e.g., Fowles, 1980, 1988). This approach has relied upon the pre-2000 BIS theory (Gray, 1982), which postulated that the BIS is activated by conditioned stimuli for punishment and non-reward. This earlier theory was typically interpreted in terms of the BIS being the main system that mediated most forms of punishment (save the unconditioned variety) relevant to human emotion, motivation and learning.

In an extension of Fowles' (1980, 1988) work, Lykken (1995) used Gray's (1982) BIS and BAS constructs to account for the differences between primary and secondary psychopathy. He proposed that primary psychopathy was associated with an under-active BIS, but normal levels of BAS reactivity, leading to maladaptive behaviour via impaired processing of stimuli associated with potential threats or punishment. Lykken contended that the innate 'fearlessness' of primary psychopathy does not lead automatically or inevitably to highly antisocial behaviour, but provides the foundations for the development of such behaviour when combined with perverse appetite or an aggressive temperament (i.e., comorbid features). In contrast, he proposed that secondary psychopathy was associated with an over-active BAS, but normal levels of BIS reactivity, leading to impulsive and reckless behaviour. In consequence, secondary psychopaths experience relatively high levels of negative affect as a result of their increased exposure to adverse outcomes because of their inability to regulate adaptively reward-related, reactive-type, behaviour. It should be noted that the differentiation of fear and anxiety in these studies was not made clear (indeed, Lykken explicitly related primary psychopathy to low fear and then related this low fear to the BIS; see Fowles & Dindo, 2006, p. 13).

Experimental research confirms that psychopaths may be differentiated from non-psychopathic controls by a number of key features, especially their under-reactivity (e.g., as measured by electrodermal skin activity) to anticipated aversive stimuli (e.g., electric shock). Such data lend support to the hypothesis that the BIS of psychopaths is under-active and that they are generally low in fear/anxiety (Fowles, 1980). However, other data do not support this interpretation. Wallace and Newman (2008, p. 401) stated,

> "...in our research we have *not* embraced the idea that primary psychopathy is caused by a weak or hypo-reactive BIS...In particular, primary psychopaths do not manifest a general or global hyporeactivity to punishment cues. Rather, psychopaths' insensitivity to punishment cues is unambiguously situation-specific."

Thus, it seems not to be the case that psychopaths are always insensitive to punishment; situational factors are also highly relevant (Schmitt & Newman, 1999). For example, Newman and Kosson (1986) showed that the primary psychopath's deficit in response to punishment is contingent upon the presence of rewarding stimuli (punishment alone does not lead to a deficit). Wallace and Newman (2008) strengthen their case by showing that response inhibition deficits are observed in psychopaths even when non-emotional stimuli are used. For example, Newman, Schmitt, and Voss (1997) demonstrated that, consistent with the dual-task effects discussed above in relation to psychoticism, psychopaths are less affected than controls by the distractor stimuli, even though the distractors were not associated with punishment. The sum of these findings suggests that psychopaths are relatively unresponsive to contextual cues that are peripheral to their dominant response set (i.e., primary task), irrespective of whether the task entails emotional content.

To account for such findings, Wallace and Newman (2008) argue that psychopaths manifest disinhibition (i.e., a decreased ability to regulate behaviour to avoid adverse consequences) in situations in which the avoidance of an adverse outcome requires overriding a prepotent response or modifying an existing behavioural goal. For primary psychopaths, selective attention is not appropriately re-allocated, in an automatic manner, to the processing of stimuli that are unrelated to their attentional focus. As noted by Wallace and Newman (2008), psychopaths do not have a general deficit in attentional focus (they perform as well as controls when task-specific stimuli are within their attentional focus); rather, they have a specific deficit in *shifting* their focus when attention has been captured by dominant stimuli in their environment.

4. Revised reinforcement sensitivity theory (RST) of personality

As discussed in detail elsewhere (McNaughton & Corr, 2004, 2008; for summary, see Corr, 2008), Gray's (1982) theory was substantially revised by Gray and McNaughton (2000). Revised RST postulates three major neuropsychological systems underlying emotion, motivation and learning: FFFS, BIS and BAS (see above). The concept of the BIS, in particular, has undergone significant refinement. However, the majority of studies examining the relationship between, on the one hand, psychoticism and psychopathy, and, on the other hand, BIS and BAS, have relied upon the measures derived from the unrevised theory; and, to date, only Poythress et al. (2008) has extended revised RST to a prison sample of relevance to the topic of psychopathy.

Specifically, the BIS is no longer, as in the 1982 version, responsible for mediating reactions to conditioned aversive stimuli (this now belongs to the FFFS); instead, it is responsible for the detection and resolution of goal-conflict in very general terms (e.g., between BAS-approach and FFFS-avoidance). In typical animal learning situations, BIS outputs have evolved to permit an animal to enter a dangerous situation (i.e., leading to cautious 'risk assessment' behaviour) or to withhold entrance (i.e., passive avoidance). It serves to resolve the evolutionarily-important conflict resulting from risk-aversion (FFFS) and risk-proneness (BAS). It also functions to block both approach and avoidance behaviours when neither are adaptive. (For a review of animal models, neural systems, pharmacology and clinical implications of the differentiation of FFFS-fear and BIS-anxiety, see Blanchard, Blanchard, Griebel, & Nutt, 2008.)

The BIS is involved in the processes that finally generate the emotion of anxiety (via activation of the FFFS that provides the emotional fuel), and entails the inhibition of prepotent conflicting behaviours, the engagement of risk assessment processes, and the scanning of memory and the environment to help resolve concurrent goal-conflict, which is experienced subjectively as worry, apprehension and the feeling that actions may lead to a bad outcome. The revised BIS resolves goal-conflicts by increasing, through recursive loops, the negative valence of stimuli (held in cortical stores), via activation of the FFFS, until resolution occurs either in favour of approach or avoidance. Theta activity is the neural signature of this BIS rumination and can be identified in EEG coherence during emotionally-charged rumination (for a discussion and empirical confirmation, see Andersen, Moore, Venables, & Corr, 2009).

5. Psychoticism–psychopathy correlates with BIS/BAS scales

Studies have related scores on questionnaire scales of the FFFS, BIS and BAS to psychoticism/psychopathy, and a summary of them is given here. However, it should be noted that these scales were developed on the basis of unrevised RST where the differentiation of (FFFS) fear and (BIS) anxiety was not made explicit. As will become obvious, this fact is a major limitation of existing

correlational studies and a challenge for future research. With this major caveat in mind, these correlations will help to inform the neuropsychological model proposed below.

5.1. Psychoticism correlations with RST-relevant scales

In terms of correlations of putative FFFS (fear) and BIS (anxiety) questionnaire measures, data show some consistencies as well as variations (all $ps < 0.05$). For example, in one sample ($N = 141$; Perkins & Corr, 2006), the following was found: significant negative Psychoticism correlations with Fear Survey Schedule (FFS; Wolpe & Lang, 1977; $r = -.17$), Carver and White's (1994) BIS scale ($r = -.36$); and a significant positive correlation with Carver and White's BAS Fun Seeking scale ($r = .27$), but a significant negative correlation with their BAS Reward Responsiveness scale ($r = -.17$). In this sample, the correlation with Spielberger trait anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was nonsignificant ($r = -.12$).

In different samples, ($N = 101$, candidates going through Territorial Army officer selection; Perkins, Kemp, & Corr, 2007), and general public ($N = 99$; unpublished), the following correlations were found, respectively: no significant correlations between psychoticism and Fear Survey Schedule scores, a negative correlation with the BIS scale ($r = -.38$), but only in the first sample; but in both samples, a positive correlation with the BAS Fun Seeking scale ($rs = .21/.28$). Knyazev, Slobodskaya, and Wilson (2004), in a Russian sample, reported similar findings: negative correlations with the BIS scale ($r = -.27$) and positive correlations with the BAS Fun Seeking scale ($r = .25$).

Heym, Ferguson, and Lawrence (2008) hypothesized (observed correlations in parentheses) that psychoticism would be positively correlated with the BAS Fun Seeking scale ($r = .33$), and negatively with the BAS Reward Responsiveness scale (-0.13, ns), BIS-anxiety (-0.38) and FFFS-fear (-0.28). Moreover, follow-up mediational analyses revealed that the relationship between psychoticism and FFFS-fear was entirely due to reduced BIS-anxiety, suggesting that it is specifically a dysfunctional BIS in high psychoticism individuals that leads to the lack of fear/punishment sensitivity (Heym, 2009).

Perkins and Corr (2006) found that, using a questionnaire measure of human defensive behaviours to threat scenarios, psychoticism was related to defensive intensity with low scorers being more sensitive to threat in general and high scorers being more threat insensitive. This finding associates psychoticism with FFFS-fear in terms of revised RST, which also received support from the above data.

There are clearly consistencies in the above data, but also anomalies especially concerning the importance of (FFFS) fear and (BIS) anxiety. This pattern parallels a similar one in the psychopathy literature.

5.2. Psychopathy correlations with RST-relevant scales

Correlations with scales of psychopathy have yielded the following results: in general, psychopaths, compared with controls, have higher BAS scores and lower BIS scores (e.g., Book & Quinsey, 2004). For example, in prison inmates ($N = 517$ males), Newman, MacCoon, Vaughn, and Sadeh (2005) tested Lykken's hypothesis by classifying them as either psychopaths or nonpsychopaths using the Psychopathy Checklist-Revised (PCL-R; Hare, 2003; Hare & Neumann, 2009). Results showed that primary psychopaths had significantly lower BIS scores than non-psychopathic inmates (BAS scores were not significantly different); and, in addition, secondary psychopaths had significantly higher BAS scores (BIS scores were more inconsistent).

In interpreting these findings, it should be borne in mind that primary and secondary psychopathic groups were defined in terms of low fear/anxiety. As noted by Wallace and Newman (2008), measures of trait anxiety (or negative affectivity) have tended to be used to distinguish between primary and secondary psychopaths (e.g., Newman et al., 2005, study). This fact may give rise to the, possibly, incorrect conclusion that certain aspects of the BIS (e.g., negative emotionality) are not dysfunctional in secondary psychopathy. This should be a target for future research (see below).

The above pattern of correlations is consistent with the finding that BIS scores are significantly related to Factor 1 of the PCL-R (related to low anxiety and deficient emotion processing), whereas BAS scores were related to Factor 2 (related to generalized externalizing behaviours) (Wallace, Malterer, & Newman, 2009).

5.3. Problems with existing fear and anxiety measures

The most commonly used questionnaire measures of the BIS, namely, the Carver and White (1994) BIS/BAS scales, contain separate fear and anxiety components (Corr & McNaughton, 2008; Heym et al., 2008; Poythress et al., 2008). The implications of these findings are currently under debate (e.g., Newman & Malterer, 2009; Poythress et al., 2008, 2009). This debate reflects the broader problem of the roles played by FFFS-fear and BIS-anxiety in psychoticism/psychopathy which is bedeviled by the lack of consensus concerning the adequacy of existing questionnaire measures. For example, some 'fear' questionnaires, such as the Fear Survey Schedule (Wolpe & Lang, 1977), contain a mixture of fear (e.g., animal and tissue damage items) and anxiety (e.g., social conflict) items which are differentiated by structural equation modeling (Cooper, Perkins, & Corr, 2007).

This lack of clarity concerning the relationship between fear and anxiety extends to psychophysiological measures. For example, one of the major psychophysiological measures of 'fear' is the emotional modulated startle reflex, where the magnitude of the startle reflex is potentiated by ambient aversive stimuli (e.g., unpleasant slides; e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001). However, the anxiolytic drug diazepam has been shown to reduce potentiated startle in human beings (Patrick, Berthot, & Moore, 1996; Thornton, 1998), suggesting that this experimental paradigm is related to anxiety and not fear per se. 'Fear' potentiated startle is reduced in psychopaths (Patrick, Bradley, & Lang, 1993) which, taken together with the diazepam findings, suggest that BIS-related anxiety may be more important than FFFS-related fear. Indeed, the anxiolytic nature of 'fear' potentiated startle (encompassing both classical and novel, serotonergic, anxiolytic drugs) was one of the major reasons why the amygdala (which mediates this potentiation) was incorporated into Gray and McNaughton's (2000) BIS theory of anxiety. In relation to psychopathy, we must be left wondering as to the roles played by fear and anxiety; as shown, for example, by Levenston, Patrick, Bradley, and Lang (2000), who reported that psychopathic prisoners have a heightened aversion threshold as compared to non-psychopathic prisoners. Other research shows that different aspects of psychopathy (emotional detachment vs. antisocial) show differential patterns of modulated startle (Vanman, Mejia, Dawson, Schell, & Raine, 2003), further pointing to the importance of differentiating between FFFS-fear and BIS-anxiety in this psychophysiological paradigm (see also Justus & Finn, 2007; Sommer et al., 2006).

In support of the response modulation deficit of Newman (see above), there is evidence that psychopaths' deficit in potentiation of the startle reflex when viewing unpleasant slides is modulated by higher-order attentional control: psychopaths show normal potentiated startle under threat-focused conditions but impaired potentiation under alternative-focus conditions (Newman, Curtin, Bertsch, & Baskin-Sommers, 2010).

6. Neuropsychological model of the psychoticism–psychopathy continuum

It is not yet possible to construct a fully adequate model of the core deficits in the psychoticism–psychopathy continuum. It may, however, be possible to discern the outlines of one. The summary of overlaps between, on the one hand, psychoticism/psychopathy, and, on the other hand, FFFS/BIS/BAS constructs, points to a number of general characterizations that can be used to inform such a model.

First, psychoticism and primary psychopathy are both associated with, relatively, low BIS scores; and psychoticism and secondary psychopathy are associated with, relatively, high BAS Fun Seeking (impulsivity) scores. Secondly, there is evidence that psychoticism is associated with low FFFS-fear and low BAS Reward Responsiveness scores. However, these general characterizations do not preclude the association of low FFFS-fear with primary psychopathy, which has been obscured by the lack of clarity concerning the distinction between fear and anxiety in the original BIS theory, as well as in empirical studies: resolving this issue should be a principal target for research.

The possibility that the FFFS may be related to primary psychopathy comes from two sources: the first is the association of fearlessness and primary psychopathy (e.g., Cleckley's and Lykken's theory); and the second is the fact that the most widely-used measure of the BIS (Carver & White, 1994) breaks shown onto FFFS (fear) and BIS (anxiety) components, as predicted by revised RST (see Corr & McNaughton, 2008; Heym et al., 2008; Poythress et al., 2008; see also, Johnson, Turner, & Iwata, 2004). Recent structural equation modeling adds further support to the fear–anxiety differentiation hypothesis (Cooper et al., 2007), as do predictive validity studies (e.g., Perkins et al., 2007); however, the full implications of this for psychopathy research are not known.

From the general perspective of RST, and consistent with the correlations presented above, the dysfunctions seen in psychoticism and psychopathy could result from the operation of the FFFS, BAS and BIS, either in isolation or combination. However, the BIS is likely to be the central system (especially in primary psychopathy) because it is involved in the *regulation* of goal-conflict detection and resolution. For example, BIS dysfunction will cause a failure of the inhibition of inappropriate behaviour which can be just as important as excessive approach (BAS) tendencies; and it is heavily involved in attention allocation and response modulation. Specifically, whereas the BAS and FFFS deal with responses to simple appetitive and aversive situations, respectively – where reward (or punishment omission) needs only to be approached, and punishment (or reward omission) needs only to be avoided – the BIS regulates the operation of these two systems when conflict occurs. Such BAS-FFFS conflicts are common, especially in the context of psychopathic-related behaviour.

7. Bifurcation of core deficits into primary and secondary psychopathy

The model proposes that the core neuropsychological deficits bifurcate into primary and secondary types (Fig. 1). This differentiation is commonplace in psychopathy research but not so in psychoticism research; however, if the BIS and BAS (and FFFS) are independent systems, with their own genetic control, then a similar differentiation of psychoticism types should be expected on the basis of statistical probability, with a mixed type being the rarer variety (see below).

Psychoticism is associated with an under-active FFFS, BIS, and the BAS Reward Responsiveness component, but an over-active BAS Fun Seeking (impulsivity) component. Primary psychopathy is related principally to an under-active BIS and FFFS; and second-
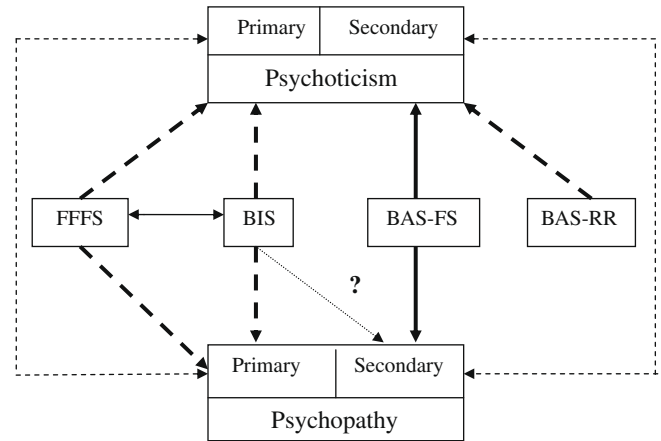

Fig. 1. Patterns of known (bold) and hypothetical (fine) correlations between FFFS, BAS and BIS processes for the personality trait of psychoticism (divided into primary and secondary types, following Heym (2009)) and the clinical condition of psychopathy (divided into primary and secondary types). Hypo-active links are shown by broken lines (negative correlations); hyper-active links by unbroken lines (positive correlations). The bidirectional arrows between the FFFS and BIS reflect the ambiguity over their nature and measurement (see text). Given the problem of the measurement of the BIS (including its sub-processes), the hypothetical association between it and secondary psychopathy points to the possibility of a core BIS deficit in both forms of psychopathy.

ary psychopathy is related principally to an over-active BAS Fun Seeking component, leading to rash impulsive behaviour. These conclusions are in conformity with the pattern of correlations discussed above.

It is noteworthy that, in primary psychopathy, despite their BIS dysfunction, their behaviour is not overly impulsive (Karpman, 1949; Levenson, 1993; Wells, 1988). This conclusion is consistent with Banks (2009) study of Dickman's (1990) functional and dysfunctional forms of impulsivity: functional impulsivity is related to psychometric proxies of primary psychopathy, whereas dysfunctional impulsivity is more related to secondary psychopathy. These observations suggest that there may well be an effective brake on normally-occurring BAS-related behaviour, and their core deficit in that BIS relates to a failure of attention switching and cognitive control. It may also be claimed that the predatory planning often seen in primary psychopaths implicates a functionally adequate BAS, at least in terms of its goal-planning aspects.

Revised RST provides a parsimonious framework for integrating the various effects found with both psychoticism and psychopathy. In particular, the association with low BIS scores is no longer inconsistent with the findings, reviewed above, which show that primary psychopaths are not always insensitive to cues of punishment (for a review, see Wallace & Newman, 2008). Rather, they show deficits in their ability to shift attention to prevailing environmental contingencies when their attention has been captured by salient stimuli. This attention-centric view is also consistent with the experimental evidence relating to the association between psychoticism and various forms of task performance (see above).

7.1. BIS processes/components

An impaired BIS means that, in the context of goal-conflicts, psychoticism and primary psychopathy will be associated with an impaired ability to switch attention and modulate responses and, in consequence, a failure to learn from exposure to aversive experiences (often psychopaths do not even appreciate their significance until it is too late). In revised RST, the BIS resolves

goal-conflicts by increasing, through recursive loops, the negative valence of stimuli, via activation of the FFFS, until resolution occurs either in favour of approach or avoidance. It is proposed that, for psychoticism and primary psychopathic individuals, the activity of the BIS is unable effectively to detect and, thus, resolve this goal-conflict. Revised BIS is not a simple system; rather, it comprises multiple sub-systems and processes, each of which can be dysfunctional. However, a significant dysfunction in one part of the BIS is highly likely to lead to overall BIS dysfunction. These possibilities are explored below.

The inhibition of prepotent behaviour and attentional control are different processes within the BIS, reflecting different levels of processing: inhibition of prepotent control is, largely, an automatic process, while attentional control requires more controlled processes (for a discussion of the distinction between controlled vs. controlled processes in RST, see Corr, 2008). A dysfunctional BIS would fail to provide adequate and appropriate cognitive control of executive and attentional resources, sufficient to focus on salient cognitive demands. It may also, depending on the specific sub-process involved, fail to resolve BAS-FFFS conflict (or any other kind of goal-conflict), leading to a variety of emotional and behavioural consequences. It is, therefore, proposed that psychoticism and primary psychopathy are caused by an inability of the BIS to process effectively goal-conflicts between either conflicting stimuli or conflicting responses, which lead to a general failure to resolve such conflicts and, thereby, regulate behaviour by the engagement of appropriate risk assessment processes, and the scanning of memory and the environment.

In the case of primary psychopathy, where predation planning is sometimes highly developed, this dysfunction would be restricted to a deficit in the switching of attention, rather than an inability to impose a brake on prepotent behaviour. Unlike primary psychopaths, who are not excessively impulsive, and assuming some form of BIS deficit, secondary psychopaths *may* have specific deficit in stopping prepotent behaviour, as shown by their rash impulsiveness which may, further, be strengthened by their BAS reactivity.

The above conclusions could be taken to indicate that psychoticism and psychopathy are associated with low BIS activity, but it is preferable to view the BIS as dysfunctional rather than under or overactive. For this reason, the failure to find lower BIS scores in secondary psychopaths may conceal the possibility that their BIS (or, at least, a significant part of it) is, indeed, defective. It is quite feasible that the cognitive and motivation components of the BIS are under-active, but in secondary psychopaths the processes leading to negative emotions are functioning relatively normally – indeed, given their reckless behaviour, they should experience considerable conflict and, therefore, greater BIS-related anxiety and FFFS-generated fear.

7.1.1. Neurobiology of the BIS

In terms of the neurology of revised RST (see McNaughton & Corr, 2008), the following systems may be associated with the psychological processes involved. First, the detection of simple goal-conflict is based in the hippocampus as the main locus; however, it can be detected at all levels of the BIS, ranging from the periaqueductal gray, medial hypothalamus, amygdala, septo-hippcampal system, and posterior cingulate to the prefrontal dorsal stream (McNaughton & Corr, 2008; see Fig. 2). Lower levels detect conflict between quick and dirty goal representations and produce simple fast responses (such as defensive quiescence); and higher ones, with slower more sophisticated goal representations (with the top end involving "planning"), produce more long-term complex responses (such as worry). Secondly, in terms of attentional processing, neurotransmitter systems, principally, acetycholine and norepinephrine, are likely to be heavily involved (Gray &

McNaughton, 2000). Thirdly, behavioural inhibition is likely to be controlled by the inferior frontal gyrus, or under very tight time constraints the presupplementary motor cortex (Aron, Fletcher, Bullmore, Sahakian, & Robbins, 2003; Aron et al., 2007; Floden & Stuss, 2006).

Fourthly, in terms of the inhibition of prepotent behaviour, inhibition involves output from the BIS to whatever motor areas provided the input that generated the conflict. The output will be to the lower levels of the motor system, leaving the activation of the goal representation itself intact but preventing its normal capture of the motor system. Given impairment of the BIS, common stimuli are less likely to be tagged as similar, and thus these stimuli act as novel inputs further disrupting the smooth operation of attentional processing by, for example, triggering orienting reflexes. Lastly, the activation of the BAS, FFFS and the BIS is likely to lead to high levels of arousal, especially emotional arousal via the amygdala, which serves to exacerbate existing symptoms.

7.1.2. Neuroimaging in psychopathy

It should be possible to gain insights into the neuropsychological deficits of psychopathy by using structural and functional neuroimaging. Whilst this literature is not sufficiently mature to derive firm conclusions, knowledge is rapidly accumulating. However, there are caveats to this literature (e.g., testing mainly criminal and violent offenders; comorbidity with psychosis; and the fact that differences observed could be state effects rather than trait-predictor effects; an excellent overview is provided by Kumari & Taylor, 2010).

The frontal and temporal lobes seem especially compromised in psychopathy. Muller et al. (2008) found significant gray matter reductions in frontal and temporal regions in psychopaths compared with controls, especially in the right superior temporal gyrus. These data support the hypothesis that a disturbed frontotemporal network is involved (these findings were the same for both factors of the Hare Psychopathy Checklist). Weber, Habel, Amunts, and Schneider (2008) conducted a review of structural abnormalities in psychopathy, reporting a reduction in prefrontal gray matter, gray matter loss in the right superior temporal gyrus, amygdala volume loss, a decrease in posterior hippocampal volume, an exaggerated structural hippocampal asymmetry, and an increase in callosal white matter. These findings suggest that psychopathy is associated with brain abnormalities in a prefrontal-temporo-limbic circuit (i.e., regions that are involved in emotional and learning processes). Yang and Raine (2009), in a meta-analysis of 43 structural and functional studies in psychopaths, found reduced prefrontal structure and function in antisocial individuals, restricted to the right orbitofrontal cortex, right anterior cingulate cortex, and left dorsolateral prefrontal cortex. Wahlund and Kristiansson (2009) reviewed 48 studies, reporting strong consensus on the connection between dysfunctional parts of the frontal and temporal lobes (but they suggest there should be greater focus on the limbic system). These data are consistent with a dysfunctional BIS in psychopathy, especially the loss of volume in the hippocampus, amygdala and frontal regions (significantly, the orbitofrontal cortex).

To date, there have been no functional neuroimaging studies designed to test specific hypotheses relating the FFF/BIS/BAS to psychopathy, although there have been several studies of more general relevance. For example, work that has addressed the developmental deficit in emotion processing long-held to be associated with psychopathy, especially the primary type (e.g., Herba et al., 2007).

The model proposed above should be sufficient to initiate a programme of functional neuroimaging research exploring the BIS in particular (including its separate response inhibition and attentional components) in relation to different types of psychopathy

(and, possibly, psychoticism; see below). Separating FFFS-fear and BIS-anxiety would be especially important here – this research could build upon recent work showing their pharmacological dissection in a human experimental paradigm (Perkins et al., 2009).

7.2. Development

It is assumed that the above core neuropsychological dysfunctions are present during childhood and shape the development of adult personality. In the case of psychoticism, BIS-related response modulation deficits, and specifically an inability in adaptive attention switching, would lead to poor socialization and the development of high levels of disagreeableness and a lack of conscientiousness (both these domains of the Big Five highly correlate with psychoticism). In the case of psychopathy, additional influences may be at work, including exposure to harsh/cruel treatment and the development of insensitivity to, and tolerance, of aggression and hostility, which coupled with strong BAS-related motives associated with reward (e.g., sexual gratification and interpersonal coercion/control) would produce, in a significant number of these individuals, the predatory psychopath. Although these developmental paths are speculative, adequate measurement of the FFFS, BIS and BAS would allow research in children to determine how such core neuropsychological deficits segue to psychopathy.

7.3. Experimental approaches

The above assertions and conclusions are speculative, based as they are on a less than complete empirical database. They are, however, consistent with revised RST constructs which has proved valuable in accounting for the performance deficits seen in psychopathy (see Wallace & Newman, 2008), and, arguably, psychoticism (see above). Speculation is one thing, empirical confirmation quite another. To test the validity of the psychoticism–psychopathy continuum proposed here, research could proceed in the following way. As discussed above, there are a number of experimental tasks that differentiate psychopaths from normal controls, and there are a number of tasks that differentiate low/high psychoticism individuals. It would, thus, be valuable to use psychopathy-sensitive (e.g., response modulation) tasks with low/high psychoticism individuals; and, conversely, psychoticism-sensitive (e.g., dual-task processing and latent inhibition) tasks with psychopaths. This strategy follows in the footsteps of Eysenck's (1950,1992) 'proportionality criterion', which is part of his ingenious criterion factor analysis: in this context, any test that discriminates *between* psychopathy and psychoticism should also discriminate between low and high scorers *within* each group. In other words, differences between people, both within and across samples, should be quantitative, not qualitative.

Further psychometric evaluation of the structural overlap of psychopathy and psychoticism would also be valuable, especially in the context of the separate FFFS/BAS/BIS sub-processes. This is currently not possible with existing questionnaire scales; but more refined ones are now under development. In addition to this psychometric differentiation, especially of FFFS-fear and BIS-anxiety, experimental measure of these two processes should also be attempted. Recent work has produced one possible experimental measure, based on one-way (related to FFFS-fear) and two-way (related to BIS-anxiety) avoidance in human beings (Perkins et al., 2009) – this task could be easily modified to allow functional neuroimaging and, by this route, the proportionality criterion of the psychoticism–psychopathy continuum could be tested. It should be relatively easy to devise neuroimaging tasks that measure FFFS (punishment-motivated avoidance/escape) and BAS (reward-motivated approach) sensitivity and activity; and once this

has been achieved then it would be possible to examine the sensitivity and activity of the BIS when they are placed in goal-conflict. In this regard, it would be important to devise tasks that allow independent measurement of distinct BIS control processes, relating to: (a) response inhibition; (b) attention allocation; and (c) the generation of emotion.

7.4. Coda: primary and secondary psychoticism

The split of psychopathy into primary and secondary sub-types, and its proposed continuity with psychoticism, suggests that the latter too may similarly split into primary (affective-interpersonal) and secondary (impulsive-antisocial) sub-types (see Fig. 1). This possibility was proposed and tested by Heym (2009), who conducted a Principal Components Analysis with varimax rotation on the 32-item EPQ-R psychoticism scale (Eysenck & Eysenck, 1991). The first two extracted factors resembled the psychopathy sub-types: Factor 1 contained 12 items reflecting impulsive-antisocial style (similar to the features of secondary psychopathy); and Factor 2 contained seven items reflecting interpersonal-affective style (similar to primary psychopathy). These two factors accounted for 18% of common variance, and 13 items did not load on either of factors, suggesting that psychoticism is measuring more than these qualities alone. The possible differentiation of psychoticism into two types deserves further attention; and this possibility is supported by the separate genetic control of the FFFS, BIS and BAS that jointly influence this apparently unitary phenotype.

8. Conclusions

It has been argued that psychoticism and psychopathy share a number of core neuropsychological deficits centred on the BIS, but involving also the FFFS and BAS, sufficient to warrant the proposal of a 'psychoticism–psychopathy continuum'. This RST-inspired theoretical perspective offers a more precise statement of possible relations than previous perspectives based on notions of arousal and activation (e.g., Robinson & Zahn, 1985). BIS theory has already placed an important role in understanding the neuropsychology of psychopathy (Fowles' and Lykken's theories), and revised BIS theory is affording further insights into its pathogenesis (e.g., Wallace & Newman, 2008).

Evidence has been adduced to support the claim of such a continuum, which points to a number of (albeit tentative) conclusions. Psychoticism is seen as an amalgam of FFFS, BIS and BAS processes and, in this sense, may be seen as a secondary derived factor of them. Given the separate genetic control of functionally independent FFFS, BIS and BAS systems (and also their respective sub-processes), the differentiation of psychopathy into different sub-types is to be expected, as should a statistically rarer mixed type containing features of both primary and secondary psychopathy. The same reasoning applies to psychoticism, which similarly may differentiate into primary and secondary types. There is now evidence to support this assertion, which is worthy of further scrutiny. Full-blown psychopathy can be distinguished from high psychoticism by the addition of morbid features (e.g., lack of self-directness, ego-centricity, grandiosity, schizotypical ideation, paranoia, predatory aggression).

The model proposed is only a sketch of what a fully adequate model might look like after a period of sustained programmatic research. This prolegomenon to a fully-developed theory may not, however, be without merit. It is constructed on a well-established model of emotion, motivation and learning, which has already played a prominent role in psychopathy research, and continues to do so.

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