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Review

Incentive salience & psychopathy: A bio-behavioral exploration

Daniel Nelson Jones[a,*], Adon Lee Neria[b]

[a] University of Nevada, Reno, United States of America
[b] University of Texas at El Paso, United States of America

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ABSTRACT

Not all individuals attribute incentive salience to conditional stimuli. For some, reward-cues are more motivating than are actual rewards. Individuals disproportionately attracted to reward-cues are referred to as *sign-trackers* whereas those attracted to actual rewards are referred to as *goal-trackers*. In nonhuman animals, sign-tracking is associated with addiction, impulsivity, behavioral persistence, and reinstatement of misbehavior, whereas goal-tracking is associated with intact inhibitory control, reward focus, and the ability to extinguish learned behaviors. In humans, psychopathy is a personality trait that exhibits many sign-tracking characteristics, leading to self- and other-destructive behaviors. Thus, incentive salience may be useful for defining patterns of antisocial behavior within psychopathy.

Research on behavioral reinforcement in animals has identified a novel distinction in an individual's propensity to transfer incentive salience to reward *cues* rather than to the reward itself (Robinson & Berridge, 1993). Incentive salience is the emotional and motivational properties aroused through a reinforcing stimulus (e.g., Rescorla, 1988). Organisms that transfer incentive salience from reward to reward-cues (i.e., are differentially motivated by cues to reward as opposed to the reward itself) are referred to as *sign-trackers*, whereas organisms that focus on the reward itself (as opposed to the reward-cue) are referred to as *goal-trackers* (Flagel, Watson, Robinson, & Akil, 2007). Sign-trackers have increased levels of impulsivity (Lovic, Saunders, Yager, & Robinson, 2011), reinforcement specificity (Yager & Robinson, 2010), attentional difficulties (Dion, Reichel, & Bevins, 2011), predispositions towards drug addiction (Flagel et al., 2010), predispositions for behavioral relapse (Flagel, Watson, Akil, & Robinson, 2008), drug-cue related cravings (Mahler & Wit, 2010), hoarding behavior (Desai, 2009), and socialization and developmental difficulties (Lomanowska et al., 2011). Goal-trackers, however, are not readily altered by drug-cue salience, are not impulsive, pay relevant attention to context, do not readily struggle with drug-cue cravings, are socialized in a typical fashion, and are not prone addiction or hoarding. Further, context matters tremendously for goal-tracking individuals. For example, Robinson, Yager, Cogan, and Saunders (2014) found that goal-tracking individuals do indeed have greater context (but not cue) induced reinstatement.

Sign-tracking rats, which have behavioral reactivity towards reward cues, have parallel neurological processes to that of humans with externalizing (Flagel et al., 2010) or Cluster B personality disorders such as Antisocial Personality Disorder or Narcissistic Personality Disorder (He, Cassaday, Howard, Khalifa, & Bonardi, 2011). Moreover, the behavioral differentiations of incentive salience observed between sign-tracking and goal-tracking individuals are strikingly similar to those observed among individuals high in psychopathy (who resemble sign-trackers; Flagel, Waselus, Clinton, Watson, & Akil, 2014). Individuals high in psychopathy over-emphasize immediate gratification and are much more likely to be responsive to stimulus in ways that mirror sign-trackers (Hosking et al., 2017).

To illustrate, behavior associated with psychopathy and behavior associated with sign-tracking are similar with respect to the following characteristics: impulsivity (Newman, 1987); proneness to addiction (Alterman, Cacciola, & Rutherford, 1993; Smith & Newman, 1990); attentional deficits (Bernstein, Newman, Wallace, & Luh, 2000); criminal recidivism (i.e., being re-arrested for similar crimes; Douglas, Vincent, & Edens, 2006; Harris, Rice, & Cormier, 1991), difficulty inhibiting hedonic desires (Brown & Forth, 1997; Camilleri, Quinsey, & Tapscott, 2009; Williams, Cooper, Howell, Yuille, & Paulhus, 2009); associations with poor socialization (Frick, Bodin, & Barry, 2000; Loney, Huntenburg, Counts-Allan, & Schmeelk, 2007); and—perhaps what is most compelling—similar neurobiological structures (Buckholtz et al., 2010; Hoenicka et al., 2007; Hosking et al., 2017; Zuckerman, 2002). For example, psychopathy has been linked to dopaminergic sensitivity associated with addiction (Hoenicka et al., 2007), and individuals high in psychopathy have, *in particular*, dopaminergic sensitivity specific to mesolimbic regions of the brain (Buckholtz et al.,

* Corresponding author at: University of Nevada, Managerial Sciences, 1664 N. Virginia Ave, Reno, NV, 89557, United States of America.
E-mail address: Djones2@unr.edu (D.N. Jones).

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2010). In addition, individuals high in psychopathy have impoverished orbitofrontal cortex (OFC) functioning (Blair et al., 2006), especially in decision making processes related to inhibitory control in seeking reward. In brief, the OFC is associated with appropriate or acceptable behavior in social settings (Alvarez & Emory, 2006). Further, research has shown that lesions to these regions lead to behaviors that are associated with psychopathy, such as impulsivity and antisocial behavior (Alvarez & Emory, 2006). Thus, an impoverished OFC among individuals high in psychopathy results in decision making patterns that resembling sign-tracking (Hosking et al., 2017).

Further, Hosking et al. (2017) found a positive correlation between psychopathy and value signaling such that as psychopathy increased, there was greater ventral striatal subjective value signaling. This finding demonstrated that there is a compromised neural circuit when it comes to decision making in individuals high in psychopathy. Thus, individuals high in psychopathy place too much emphasis on immediate benefits, with little consideration of future costs. Further, this value-related reward was not tempered by connectivity with the ventromedial prefrontal cortex (vmPFC) because that connection is compromised in individuals high in psychopathy (Hosking et al., 2017).

These patterns parallel observations of sign-tracking organisms, most especially with respect to the relevant role of dopamine in addiction (Flagel et al., 2007) and the strong reactions (i.e., greater dopamine transmission) Sign-tracking organisms have to dopamine in mesolimbic regions of the brain (Flagel et al., 2007). It is important to note that D1-like dopamine (responsible for direct excitation and inhibition of a neuron) is increased in sign-tracking individuals, whereas the inhibitory processes of a particular neuron (that associated with D2-like dopamine) is diminished in sign-tracking individuals (Flagel et al., 2007). In addition to dopaminergic differences, impulsive nonhuman animals fitting a sign-tracking profile also show OFC deficiencies (Chang et al., 2012). In this way, individuals high in psychopathy display many of the individual difference characteristics that are descriptive of sign-tracking organisms.

In the following theoretical argument we highlight five key areas of overlap between psychopathy and behavioral constructs, including: (a) attentional deficits, (b) neurological patterns, (c) impulsivity and novelty, (d) addiction and relapse, (e) reward focus vs. cues to reward.

It is critical to note at the start that we do not argue that all sign-tracking humans are high in psychopathy. To be sure, there are individuals for whom incentive salience attributed to reward-cues (e.g., problem gamblers, drug addicted) who are not at all high in psychopathy (e.g., they have remorse or empathy). Thus, not that all sign-trackers are high in psychopathy, however, all individuals who are high in psychopathy are sign-trackers.

This incentive salience model of human malevolence put forth in the present paper constitutes a merging of theoretical and empirical research from both nonhuman animal behavioral models and adult psychopathology/personality. In so doing, we argue that this theoretical perspective can: (a) articulate why individuals high in psychopathy have a predisposition towards antisocial behavior in the absence of any tangible rewards that would more obviously explain the behavior, (b) help inform models of antisocial behavior in nonhuman animals, (c) encourage increased dialogue between animal behaviorists and personality, forensic, and/or clinical psychologists with respect to dispositional traits, and (d) provide methods and tools for differentiating psychopathy from related constructs (e.g., Machiavellianism) in the absence of self-report. In sum, we argue that the sign-tracking/goal-tracking distinction is a useful tool that can guide future research and help refine the psychopathy.

1. Sign- & goal-tracking: brief overview

Ivan Pavlov's seminal research on classical conditioning had a profound impact on the field of psychology. He found that pairing a bell with a food-reward led dogs to salivate at the mere sound of the bell (Pavlov, 1927). However, subsequent work on this effect found that individuals attributed differential incentive salience to reward-*cues* (i.e., conditioned stimulus such as a bell) vs. the reward itself (i.e., unconditioned stimulus such as food). Early replications of Pavlov's studies mirror these early observations by showing that, when dogs were unrestrained, some would approach the bell whereas others would approach a food dish (Zener, 1937). This distinction was observed and reported, but little subsequent work was immediately conducted to investigate why. At present, there is now a large body of research investigating this phenomenon, demonstrating stable individual differences in the attribution of incentive salience to either reward-cues or the rewards themselves (Meyer et al., 2012; Saunders & Robinson, 2013). For example, multiple studies have shown that when a lever protrudes, indicating an impending food reward, some rats would approach the lever before approaching the food location, whereas others would only approach the food location (Robinson & Berridge, 1993). It is critical to note that these effects were not the result of behavioral reinforcement for approaching the lever, nor were they associated with the speed with which the rats learned the lever/food association. Indeed, pressing the lever had absolutely no effect on whether the food would be presented (see Fig. 1, which illustrates the general sign-tracking/goal-tracking model).

In sign-tracking individuals, the tendency to attribute incentive salience to reward-cues can be so powerful that such individuals may actually sacrifice the reward in order to approach the reward-cue. For example, in a study involving pigeons, Hearst and Jenkins (1974) paired a light stimulus with a food reward at opposite ends of a long skinner box. Their results showed a similar distinction among subjects: some would approach the food end of the box when the light came on, others would approach the light itself, at the opposite end. In fact, when the authors manipulated their experiment such that pigeons would not be able to both obtain the food-reward and approach the light, it was revealed that sign-tracking pigeons would still consistently approach the light—thus losing the food reward altogether.

2. Psychopathy: brief overview

Psychopathy is a trait associated with aggression, deception, manipulation, callousness, and antisocial tendencies (Hare, 1996). Even at the subclinical level (Lebreton, Binning, & Adorno, 2006), psychopathy predicts both instrumental and reactive aggression (Reidy, Zeichner, Miller, & Martinez, 2007), aggressive responses to direct provocation (Jones & Paulhus, 2010), and aggression in the absence of provocation (Reidy, Zeichner, & Martinez, 2008). In addition, psychopathy is associated with impulsivity (Newman, 1987), substance abuse (Hemphill, Hart, & Hare, 1994; Smith & Newman, 1990), recidivism (Skeem & Mulvey, 2001; Walters, 2003), and other self- and other-destructive behaviors (Cleckley, 1976).

Individuals high in psychopathy are also predisposed to antisocial behavior and engage in it frequently (Hare & Neumann, 2008). However, it should be noted that there is debate as to whether antisocial behavior is part of the definition of the construct of psychopathy, or whether it is merely a downstream correlate (e.g., Hare & Neumann, 2010; Skeem & Cooke, 2010). Whether considered a predictor or an outcome, it is nonetheless clear that individuals high in psychopathy do engage in reckless antisocial behaviors (Hare, 1996). Individuals high in psychopathy show little forethought or planning (Lilienfeld, Hess, & Rowland, 1996), exhibit poor executive control (Morgan & Lilienfeld, 2000), and will engage in self-destructive behavior regardless of deterrence (Newman & Kosson, 1986).

Moreover, such individuals are prone to dysfunctional forms of impulsivity (Jones & Paulhus, 2011). Although psychopathy is not correlated with frequency of deviant sexual fantasies, it is linked with acting upon them (Williams et al., 2009). Individuals high in psychopathy also engage in risky forms of cheating, which are more costly than they are beneficial (Williams, Nathanson, & Paulhus, 2010).