THE DEVELOPMENT OF A REINFORCEMENT SENSITIVITY THEORY STATE SCALE

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Abstract

This thesis outlines the development and preliminary validation of a suite of self-report measures that assess state activation of the (revised) Reinforcement Sensitivity Theory (rRST) motivational systems and related anger/aggression. Scale content was informed by Corr & Cooper's (2016) trait-level rRST scale, the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ) as well as an extensive literature review. Exploratory and confirmatory factor analyses indicated a robust one-factor structure for the fight-flight-freeze system (FFFS); a higher-order structure for the Behavioural Activation System (BAS; comprised of a higher order BAS factor; and lower order Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity factors); a two-factor structure for the revised Behavioural Inhibition System (rBIS; Anxious Uncertainty and Behavioural Disengagement); and a three factor structure for the anger and aggression scales (Predatory Aggression, Anger/Frustration and Defensive Aggression). Convergent validity was demonstrated for the rBIS, BAS and FFFS scales by establishing the expected pattern of inter-correlations and relations with a trait-level measure of rRST. The rRST state scales are the first psychometrically validated measures of state rRST system activation and are also efficient to use and theoretically coherent.

Keywords: Revised Reinforcement Sensitivity Theory, Behavioural Inhibition System, Behavioural Activation System, Fight Flight Freeze System, Predatory Aggression, Defensive Aggression, Anger, Frustration, Scale Development, Factor Analysis, Measurement.

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Dedication

For Inés, Matisse and Johnathan.

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The Development of a Reinforcement Sensitivity Theory State Scale

Reinforcement Sensitivity Theory (RST) is an influential, biologically based theory of motivation first articulated by Gray (1970). RST is both a theory of state motivation and a personality theory based on individual differences in sensitivity to reward and punishment. The theory of state motivation describes the stimulus inputs (appetitive, aversive) and behavioural outputs (approach, avoid) of three motivational-emotional systems. The personality theory describes the tendency to approach and avoid appetitive and aversive stimuli based on motivational system sensitivity. Substantial interest in RST has led to the development of numerous trait-scales (Corr, 2016; Torrubia et al., 2008), however, despite the popularity of the theory in psychological research, and a substantial interest in understanding in-the-moment experiences of RST-motivational systems, no self-report state-based measure of RST motivational system activation currently exists. The purpose of this thesis was to develop and validate a series of brief, self-report state scales that measure RST motivational system activation.

Revised Reinforcement Sensitivity Theory

In 2000, Gray and McNaughton presented a substantial revision to RST based on evidence from Gray's lab that indicated that anxiety and fear were functionally, neurobiologically and psychopharmacologically distinct (Corr, 2013; Gray & McNaughton 2000). Prior to the revised Reinforcement Sensitivity Theory (rRST), the original Reinforcement Sensitivity Theory (oRST) proposed only two motivational systems: the Behavioural Activation System (BAS) which motivated approach behaviour and the Behavioural Inhibition System (BIS), which motivated avoidance behaviour. In rRST, Gray & McNaughton (2000) propose three motivational systems, the Behavioural Activation System (BAS; unchanged from oRST), the Fight Flight Freeze System (FFFS), which motivates avoidance of aversive stimuli and gives rise to the feeling of fear; and the Behavioural Inhibition System, which resolves motivational conflict (often an approach-avoidance conflict) and gives rise to the feeling of

anxiety. Specifically, in rRST, the BIS inhibits prepotent behaviours when goal conflict is detected and facilitates information-seeking activities so that goal conflict can be resolved.

It is important to note that although the term Behavioural Inhibition System (BIS) is used throughout the literature on RST, oBIS and rBIS are not conceptually equivalent. This is important to note because much of the personality research in RST uses questionnaires developed from oRST (e.g. the BIS/BAS scales (Carver & White, 1994) and the Sensitivity to Reward, Sensitivity to Punishment Questionnaires (Torrubia et al., 2001) which does not neatly translate to the updated theory. Throughout this paper, we will refer to oRST, rRST to distinguish between older and newer versions of RST; and oBIS and rBIS to distinguish between corresponding definitions of the BIS.

Behavioural Activation System

Life is full of good and desirable things: cupcakes, job promotions, attractive people. If you have ever wanted, pursued, obtained or enjoyed something good or desirable, you have your Behavioural Activation System to thank. The Behavioral Activation System (BAS) is sensitive to appetitive (e.g., good, desirable) stimuli and serves to move an organism along the temporo-spatial gradient towards a reinforcer (Corr, 2008) by orienting the organism's motivational and learning resources to environmental reinforcement contingencies (Pickering & Gray, 2001). BAS is sensitive to both appetitive stimuli and omission of punishment (McNaughton & Gray, 2000). People with more sensitive Behavioural Activation Systems learn about reinforcement contingencies better than those with less sensitive BASs (Pickering & Smilie, 2008). Heightened BAS sensitivity has been implicated in a number of disordered behaviors or syndromes including addictions (Cardoso et al., 2022; Flagel, 2009), mania in bipolar disorder (Jones et al., 2007) and externalizing behaviours (Cardoso et al., 2022) including revenge (Threadgill & Galbe, 2020); whereas low BAS sensitivity has been implicated in depressive

disorders (McFarland & Klein, 2009) and maladaptive behaviours such as procrastination (Bennett & Bacon, 2019).

Originally, BAS was conceived to be a unitary system located within nigrostriatal and mesolimbic dopamine systems (Pickering & Gray, 1991). Since then, researchers have identified sub-systems that support reinforcement learning and approach behaviour (e.g., Berridge, 1996), and theorists have suggested that BAS is a multifaceted system (Carver & White, 1994; Corr, 2008; Corr & Cooper, 2016; Krupic & Corr, 2017). From an evolutionary perspective, Corr argues, the relative complexity of BAS compared to other systems is the result of Dawkins and Krebs' (1979, as cited in Corr, 2008) 'Life Dinner Principle'. When a predator fails to kill its prey, it has lost its dinner; whereas when a prey has failed to escape a predator, it has lost its life. This results in more evolutionary pressure on avoidance systems (the fight, flight, freeze system), meaning that there may be considerably more variation in goal-directed BAS behaviour by comparison. In addition, there are a variety of appetitive goals, which necessitates a wider cognitive, affective, behavioural repertoire. Further, different behaviours will be needed at different stages of goal pursuit.

Corr & Cooper (2016) found support for four distinct BAS factors in their Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ), which are proposed to become active at different points as the organism moves along the temporospatial gradient towards the reinforcer. At early stages, *Reward Interest* facilitates novelty seeking and identification of a reinforcer. *Goal-Drive Persistence* consists of planning and executing behaviour to obtain the reinforcer. *Impulsivity* consists of fast action to obtain the reinforcer when it is within reach. Finally, *Reward Reactivity* consists of positive affect upon obtainment of the reward. Carver and White (1994) found that their BAS items formed three factors, which are conceptually equivalent to Corr & Cooper (2016) Goal-Drive Persistence, Reward Reactivity and Impulsivity. This provides further psychometric support for the idea that BAS is multifaceted.

Neurobiological research also suggests that behavioural approach is underpinned by multiple, interacting biological systems. Krupic and Corr (2017) have reviewed and suggested a potential association between some of these biological systems and the subfactors of the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ), a trait measure of RST system sensitivity (Corr & Cooper, 2016). Specifically, they suggest that Reward Interest is related to dopamine, Goal-Drive Persistence is related to serotonin, Impulsivity is related to testosterone and Reward Reactivity is related to endogenous opiates. The roles of dopamine and endogenous opioids has been well established in research. Work by Berridge and colleagues (Berridge, 1996; Berridge, 2007; Berridge, 2009; Berridge & Kringelbach, 2013; Berridge & Robinson, 1998; Berridge & Robinson, 2003; Berridge & Robinson, 2016) have provided robust support for a neurobiological distinction between *wanting* (also referred to as 'incentive salience'; underpinned by dopamine) and *liking* (the subjective pleasure experienced upon reward obtainment; underpinned by endogenous opioids)[1]. Serotonin in the Dorsal Raphe Nucleus has been found to be related to enhanced patience for future rewards and increased coping in the face of challenge (see Courtiol et al., 2021 for a review), suggesting that it is related to effort (i.e., the Goal-Drive Persistence scale) as Krupic and Corr (2017) suggest. Finally, testosterone has been related to less deliberative decision making in the face of reward (Poon et al., 2019), suggesting a relationship to motivationally-based impulsivity.

Although some theorists (Carver & White, 1994; Corr & Cooper, 2016; Corr, 2008; Krupic & Corr, 2017) argue that BAS is a multifaceted system; others do not agree. The majority of trait-level scales measure BAS as a unitary construct (Corr, 2016). Further, although Corr's (2008) multifaceted BAS theory describes how BAS sub-facets are activated at various points along the temporospatial gradient

[1] This neurobiological distinction, discovered in 1989 by Berridge, was foreshadowed by Pickering & Gray (1987) who remarked that there seem to be a parallel dissociation between *not wanting* and the *subjective experience of pain* – a distinction that (to my knowledge) has yet to be explored or explicated in the RST literature.

with respect to a reinforcer, it has yet to be tested at a state level. The primary purpose of the current program of research is to establish a state scale of rBIS, BAS and FFFS activation, however, one of the contributions of this thesis will be to test this theory by assessing the feasibility of a multifaceted BAS state scale.

Impulsivity. Another area of considerable disagreement within RST literature is how impulsivity is related to the motivational systems. Our scale development relies on Corr and Cooper's (2016) definition of BAS-Impulsivity defined as action without forethought. However, given the considerable disagreement about how impulsivity is related to BAS, a short discussion of major theories is included below.

Gray (1987a) originally proposed that impulsivity was a BAS personality trait, but he did not provide a precise definition of what he meant by impulsivity specifically (Pickering & Smillie, 2008). As has been repeatedly discussed in psychology literature over the past 30 years, 'impulsivity' is not well-defined in psychology, and is used to describe a wide number of related phenomena (Evenden, 1999; Mackillop et al., 2016; Whiteside & Lynham, 2001). A recent review identified 25 measures of impulsivity – most of which were conceptually distinct (i.e., different operationalizations: motor impulsivity, attentional impulsivity, poor self-regulation, etc.); with varying numbers of factors underpinning each measure (Hook et al., 2021). This lack of consensus on the definition of impulsivity has left considerable uncertainty as to what Gray was suggesting. Over the years, theorists have proposed several different relationships between types of impulsive behaviour and BAS, that fall into three main categories: a) that impulsivity is the behavioural output of the BAS; b) that impulsivity is related to, but not a direct behavioural output of the BAS; and c) that impulsivity is a sub-facet of the BAS. The idea that impulsivity is a sub-facet of BAS is consistent with Corr and Cooper's (2016) multifaceted BAS hypothesis, and is the definition adopted in the present thesis.

Theorists who assert that impulsivity is the behavioural output of the BAS do not see BAS as a multifaceted system. This idea was first articulated by Gray, when he suggested that impulsivity and anxiety were the major personality dimensions (Gray, 1970), and later proposed impulsive sensation seeking (Pickering & Gray, 1999); and then impulsive antisocial sensation seeking (Pickering & Gray, 2001) as the traits derived from BAS sensitivity. Since that time, other theorists have attempted to delineate the nature of the impulsivity that might characterize the behavioural output of the BAS.

Several theorists have suggested that impulsivity might arise from both BAS sensitivity and oBIS insensitivity (Carver & White, 1994; Dawe & Loxton, 2004; Dawe et al., 2004; Smillie & Jackson, 2006). Dawe and Loxton (2004) and Dawe et al., (2004) propose that *reward drive* is the result of a highly sensitive BAS that results in vigorous approach activity. At the state level, when signals of punishment are detected, it takes longer for approach behaviour to become inhibited because BAS is highly activated, resulting in behaviour that can be labelled 'impulsive'. Whereas *rash impulsivity* is the result of an insensitive oBIS (Gullo & Dawe, 2008). At the state level, when an aversive stimulus is detected during goal-pursuit, people who are rashly impulsive may fail to notice or simply fail to care that there are negative consequences associated with their ongoing goal pursuit. As a result, they are unable to inhibit their approach behaviour.

Smillie and Jackson (2006) developed a similar proposal, relating an extant two-dimensional model of impulsivity, Dickman's (1990) functional vs dysfunctional impulsivity, to BAS sensitivity and oBIS insensitivity. *Functional impulsivity* is defined as fast action without deliberation in contexts where it is beneficial to do so – such as when goal pursuit is uncomplicated by the presence of an aversive stimulus. Functional impulsivity allows an individual to take advantage of a small window of opportunity to achieve something. According to Smillie and colleagues (Pickering & Smillie, 2008; Smillie & Jackson, 2006), functional impulsivity is related to BAS sensitivity. *Dysfunctional impulsivity,* conversely, is action without deliberation when it is not beneficial to do so. In line with Dawe and colleagues, Smillie and

colleagues (Pickering & Smillie, 2008; Smillie & Jackson, 2006) have suggested that dysfunctional impulsivity, by definition, arises out of a failure of motivational systems to inhibit prepotent behaviours in the presence of an aversive stimuli. Researchers have suggested functional impulsivity may be the best way to characterize BAS-impulsivity, while Dysfunctional impulsivity may be more related to a failure of BIS activation. Both proposals suggest that distinct forms of impulsivity are a) a behavioural output of the BAS (Reward Drive or Functional Impulsivity), or b) results from a failure of the oBIS (Rash Impulsivity or Dysfunctional Impulsivity).

Other theorists have proposed that impulsivity is not directly related to BAS sensitivity. In a factor analytic study using self-report measures of impulsivity and reward sensitivity, Quilty and Oakman (2004) found that a two-factor model with impulsivity and trait-BAS as latent variables fit their data better than a one-factor model. Related theories, derived from Gray's early work and developed in parallel to RST (Krupic & Corr, 2022) have suggested that novelty-seeking (Cloninger, 1987), sensation seeking (Zuckerman, 1991) and the 'agency' subcomponent of extraversion (which 'reflects social dominance and the enjoyment of leadership roles, assertiveness, exhibitionism, and a subjective sense of potency in accomplishing goals' Depue & Collins, 1999) as the emergent personality trait that derives from sensitivity to positive reinforcement, underpinned by nigrostriatal and mesolimbic dopamine systems. Both extraversion and impulsive antisocial sensation seeking have been associated with markers of dopaminergic neurotransmission (see Depue & Collins, 1999, Pickering & Gray, 2001 for reviews). Other lines of research have highlighted positive affectivity (Depue & Iacano, 1989; Watson, 2009) and energetic arousal (Thayer, 1989) as BAS-related traits. This divergent body of research tying different behaviours and traits to BAS sensitivity informed more current thinking about BAS being a multifaceted system.

Theorists who assert that impulsivity represents a sub-facet of BAS have conceptualized BAS as a multifaceted system that gives rise to a variety of distinct behaviours. The idea that BAS could be

multifaceted arose, in part out of an effort to account for the divergent theories of what trait best characterizes sensitivity to reward articulated in similar biologically-based approach-avoidance theories, giving rise to Carver and White's (1994) BIS/BAS scales which has three distinct BAS factors, one of which measures impulsive behaviour (Corr, 2016). In Corr's (2008) theory of multifaceted BAS, impulsivity represents the behavioural output of the BAS observed when is the final stage of obtaining a reinforcer.

In sum, there are three views of how impulsivity is related to BAS within the RST literature. First, there are those who think that impulsivity occurs when BAS is highly activated; or oBIS fails to inhibit approach behaviour appropriately (e.g., Dawe & Loxton, 2004; Dawe, et al., 2008). Second, there are those who view impulsivity as a related, but distinct construct (e.g., Depue & Collins, 1999, Quilty & Oakman, 2004). Finally, there are those who believe impulsivity is a sub-facet of BAS – a process that occurs when the organism is within close proximity to a reinforcer (Corr & Cooper, 2016; Corr, 2008). As previously mentioned, we will be using Corr's multifaceted BAS theory, and corresponding conceptualization of BAS-Impulsivity as operational definitions of BAS activation during item development.

The theory and research reviewed above gives rise to the first criteria in the creation of a state BAS scale with good content and construct validity:

1. Reward Interest, Goal Drive Persistence, Reward Reactivity and Impulsivity items should form four distinct factors, which contribute to an overall BAS factor.

Fight-Flight-Freeze System

When you come across a bear in the great outdoors, the US National Parks Service (National Park Service, n.d.) recommends different defensive strategies depending on the nature of your encounter. If you're at a large distance and the bear hasn't noticed you, quietly leave the area. If the

bear is charging at you, lie face down with your hands clasped behind your neck and elbows covering your face. And if the bear appears to be hunting you? “Fight back as if your life depends on it, because it does.”

This practical advice codifies the defensive strategies that constitute the behavioural output of the Fight Flight Freeze system (FFFS) common to all vertebrates, including humans (Blanchard & Blanchard, 2005). The FFFS is sensitive to aversive stimuli (e.g., as bears might be to humans) and omission of reward; and serves to move an organism away from dangerous or threatening situations (Gray, 1982, 1987b; Gray & McNaughton, 2000; McNaughton & Corr, 2008). The FFFS mediates the emotions of fear and panic and the behavioral response of active avoidance. Defensive behaviour is deployed in a hierarchical manner: avoidance takes the form of fleeing when the situation allows (e.g., leaving the area with the bear); or defensive fight and freezing when fleeing is not possible (Gray & McNaughton, 2000). While some trait-level scales have developed three-factor FFFS scales, with fight, flight and freeze as factors (J-5: Jackson, 2009; rRST-Q: Reuter et al., 2015; RSQ: Smederevac et al., 2014), the current scale has been developed to create a single factor (consistent with RST-PQ: Corr & Cooper, 2016) based on the reasoning that fight, flight and freeze do not constitute specific states, but rather behavioural outputs that are contingent on situational demands (e.g., a bear who hasn’t noticed you vs. a bear that is hunting you), underpinned by a common emotional-motivational system characterized by the experience of fear and the goal of avoidance.

Due to practical and ethical limitations, our understanding of the FFFS is deeply rooted in the study of animal behaviour and neurobiology, and not experimentation or observation of humans. However, a small number of studies suggest that the FFFS functions in a similar way in humans. Blanchard et al. (2001) created a series of threat scenarios that differed in the intensity of the threat and whether or not escape was possible. They asked participants to indicate how they would respond in the given threat scenario among 10 options: six pertaining to animal behaviour (fight, flight, freeze, hide, call

for help, risk assessment) and four pertaining to distinctly human behaviour reflecting strategies that represent verbal abilities (threaten to scream; threaten to attack; beg, plead or negotiate) or tool use (look for a weapon). They found that humans typically indicate that they would respond in ways that are consistent with behaviours observed in animals. This study has since been replicated in different cultural contexts with similar results (see Blanchard et al., 2010 and Blanchard, 2017 for reviews; Harrison et al., 2015; Mesquita et al., 2011; Perkins et al., 2006; Shuhama et al., 2007).

At the trait-level, higher FFFS sensitivity means that one is more sensitive to signals of danger and threat (or perceives situations as more threatening); and will more likely engage in defensive behavior and active avoidance in the presence of an aversive stimulus. The FFFS system is underpinned by neurobiological systems within the amygdala, cingulate cortex and ventral prefrontal cortex (McNaughton & Corr, 2008). Heightened FFFS sensitivity is involved in syndromes such as phobias and panic disorder (Corr, 2008); whereas low FFFS sensitivity is associated with increased risk-taking behavior (Broerman et al., 2014).

Two important concepts related to the FFFS are ‘defensive distance’ and ‘defensive direction’ (McNaughton & Corr, 2008). Defensive distance refers to the distance to/intensity of threat that will activate the FFFS. Defensive distance has a strong effect on which defensive strategy will be chosen (fleeing at greater distances; fighting at near 0 distance). Those with more sensitive FFFS will perceive greater threat with a certain intensity of aversive stimuli than others. These individuals will require less intensity (distance, magnitude) of aversive stimulus to experience fear and engage in defensive behaviours (fight, flight, freeze).

Defensive direction refers to movement of the organism towards (approach) or away from (avoid) an aversive stimulus and is an important distinction between rBIS and FFFS mediated behaviour (McNaughton & Corr, 2008). Both the rBIS and FFFS operate under the presence of threat but are

activated under different circumstances. When a threat is uncompromised by conflict, the organism experiences fear and engages in active avoidance strategies. However, when a threat must be approached (e.g., there is a conflict that prevents active avoidance), the rBIS is active.

The operationalization of the FFFS state scale will be based on the following: a) defensive direction away from aversive stimuli; b) emotion of fear; c) behavioural outputs of freezing, fleeing and active avoidance. Although defensive fighting is conceptually related to the FFFS, research consistently shows an association between aggression and the Behavioural Activation System, which has led researchers to develop trait-level scales that have a separate 'fight' scale (e.g., RST-PQ, Corr & Cooper, 2016; Jackson-5, Jackson 2009). The same strategy is employed here. In sum, the theory and evidence reviewed above gives rise to a specific theory-driven properties of a psychometrically sound FFFS state scale:

2. The FFFS (pertaining to fear, active avoidance, flight and freeze, but not defensive fight) should form one factor.

Revised Behavioural Inhibition System (rBIS)

To this point, I have outlined the neurobiological systems that respond to appetitive and aversive stimuli by facilitating approach or avoidance behaviour. The BAS and FFFS operate in situations where things are clearly (or mostly) good and desirable or bad and undesirable. But often, the situation isn't so obvious, and sometimes actions can have both desirable and undesirable outcomes. For example, a cupcake is tasty, but eating it might conflict with your goal to eat more healthfully. When motivational conflicts like this arise, it is the (revised) Behavioural Inhibition System's (rBIS) job to resolve them.

The rBIS is sensitive to goal conflict, typically between approach (mediated by BAS) and avoidance (mediated by FFFS) motivations (Corr, 2008; McNaughton & Corr, 2008). The rBIS is part of the defensive system, along with FFFS, but is activated when threat must be approached rather than

avoided (McNaughton & Corr, 2008). rBIS activation can result in two distinct states which occur differentially based on whether aversive stimuli are seen as avoidable or not (Gray & McNaughton, 2000). The first is characterized by anxiety, uncertainty, vigilance, and rumination when aversive stimuli are perceived as potentially avoidable. This first state, herein referred to as *anxious uncertainty*, occurs in animal research paradigms when a rodent is approaching food (BAS-mediated approach) and then detects the scent of a cat (FFFS-mediated avoidance). Simultaneous activation of both systems feeds into the rBIS so that the approach-avoidance conflict can be resolved. While BIS is activated, pre-potent (approach) behaviour is inhibited, information seeking (internal (memory) and external environment is scanned) and is accompanied by the feeling of anxiety.

The second state is characterized by behavioral disengagement, resignation and dysphoria when aversive stimuli are seen as unavoidable, or after prolonged stress (related to the concept of *learned helplessness*, Seligman, 1975 as cited in Gray, 1982). This second state, herein referred to as *behavioural disengagement*, is also characterized by the conflict that arises out of having to approach an aversive stimulus. The approach-avoidance conflict that characterizes anxious uncertainty and behavioural disengagement are distinct in that in the case of anxious uncertainty, the aversive stimulus is perceived as avoidable.

Another situation where the rBIS might result in behavioural disengagement rather than anxious uncertainty is a FFFS-FFFS conflict. To this point, I have focused on approach-avoidance conflicts, which are the most commonly discussed inputs to rBIS activation (Corr, 2008). However, the rBIS can be activated by any form of motivational conflict, including approach-approach (e.g. deciding between two desirable but mutually-exclusive alternatives) and avoidance-avoidance (e.g. rock and a hard place or damned if you do damned if you don't situations, Corr, 2008). Therefore, another situation that might result in an aversive situation needing to be approached would be an avoidance-avoidance conflict.

When your only option is to accept something bad or something else that is equally bad, it results in rBIS-mediated behavioural disengagement.

At the trait-level, higher rBIS sensitivity means that one is more sensitive to signals of goal conflict and will more frequently experience the state of anxious uncertainty or behavioural disengagement when goal conflict is detected. rBIS activity is underpinned by the septohippocampal system (Gray, 1982; Gray & McNaughton, 2000). Heightened rBIS sensitivity is related to anxiety disorders and OCD (Corr, 2008); whereas low rBIS sensitivity is associated with personality disorders such as psychopathy (Broerman et al., 2014).

The theory and evidence reviewed above gives rise to the specific theory-driven property of a psychometrically sound rBIS state scale:

3. The rBIS items should form one or two factors based on item content reflecting a) anxiety and b) behavioural disengagement.

Interaction Between rBIS, BAS and FFFS

According to RST, when perception of the magnitude of aversive and appetitive stimuli are not equal; or when they are not in conflict, approach and avoidance systems have inhibitory effects on each other (Gray & Smith, 1969). Practically speaking, this means when BAS is activated by the presence of reward it dampens activation of the FFFS system (and vice versa for the presence of threat dampening BAS activation). When perception of reward and punishment are relatively equal (goal conflict), it results in the activation of the rBIS, which inhibits prepotent behaviour and facilitates information gathering behaviour that will resolve the conflict (vigilance, scanning of internal memory). The rBIS biases information towards the FFFS and remains active until the BAS-mediated approach or FFFS-mediated avoidance wins out.

The theory and evidence reviewed above gives rise to specific theory-driven properties of a psychometrically sound rRST state scale:

4. BAS factors should be negatively associated with rBIS and FFFS factors.
5. FFFS and rBIS items should form distinct factors.
6. rBIS and FFFS factors should be positively associated.

Systems can work in opposition to each other (inhibiting activity in other systems, or with goal conflict), but they can also work together. There are several situations in life where one behaviour can serve to simultaneously avoid bad things and obtain good things. It has been hypothesized that relative activations and complex interactions between systems can give rise to the full spectrum of human emotional-motivational states (Corr, 2008; Corr, 2013; Gray, 1994). Currently, RST accounts for anxiety, fear, panic, depression, hope, excitement and pleasure; and has sought to explain relief and frustration (Carver, 2004; Carver & Harmon-Jones, 2009; Corr, 2002; Corr, 2013; McNaughton & Corr, 2008); however, due to the potential involvement of multiple motivational systems of these states; as well as dynamic system-context interactions, determining exactly how various states fit into RST has been a point of much debate among theorists, particularly anger. Below I review theory and evidence that informed the creation of the rRST anger/aggression state scales.

Anger and Aggression

Anger and aggression are conceptually related to RST systems in a complex way. Within wider psychology research, anger is defined as a negatively-valanced, activated emotional state elicited by a perceived threat to oneself or one's possessions; or to goal pursuit (Averill, 2012); or when goal pursuit is impeded (Corr, 2008). Aggression can be defined as physical or verbal acts performed with the intent to harm or threaten to harm others (Berkowitz, 1993). Aggression is highly related to anger in that anger often precedes aggression; and aggression is often the result of anger, but this is not always

the case. Specifically, aggression can be provoked by perceived threat (reactive aggression), in which case it is likely accompanied by feelings of anger (Weinshenker & Siegel, 2002). However, aggression can also be an instrument of goal pursuit, or even a reinforcing experience in and of itself (Chester, 2017) which in some cases will be accompanied by positively valanced emotion associated with obtaining a reinforcer (e.g. BAS-related emotions such as excitement, anticipation) (Corr, 2008; Standford et al., 2003; Weinshenker & Siegel, 2002).

Early on in the development of RST, aggression was studied exclusively in relation to threat. However, a program of research conducted by Harmon-Jones and colleagues (Carver, 2004; Harmon-Jones & Allen, 1998; Harmon-Jones, 2003; Harmon-Jones et al., 2003; Harmon-Jones & Siegelman, 2001; see Carver & Harmon-Jones, 2009 for a review) suggests that anger can be associated with approach-orientation. Harmon-Jones began to study anger as a way to experimentally investigate whether left-right anterior cortical asymmetry was a marker of approach and avoidance or positive and negative affect. In a series of experimental studies, Harmon-Jones and colleagues measured right and left anterior cortical asymmetry in participants who were made to feel angry. They found that anger was consistently associated with left-cortical asymmetry, which supported the idea that anger is an approach-related emotion, and that left-cortical asymmetry is a marker of approach rather than positive affect.

The association between anger and approach motivation has also been found in self-report research. Harmon-Jones investigated anger and aggression using the Buss-Perry Aggression Inventory and the Carver and White's (1994) BIS/BAS scales. Reasoning that affective valance and motivational direction would be conflated in self-report studies as well (most positive emotions are approach related, most negative emotions are avoidance related; and this is reflected in the BIS/BAS scales), he entered PANAS scores as a covariate into his regression analyses. With affective valance as a covariate, BAS and anger (but not oBIS and anger) were significantly associated. In another series of experimental and

observational studies, Carver (2004) related trait oBIS and BAS sensitivity (measured by the BIS/BAS scales, Carver & White, 1994) to emotional states (measured by emotion words on Likert type scale) and found that frustration and anger was consistently related to BAS sensitivity.

Corr (2013; 2016) has identified three different types of anger/aggression that may derive from RST system activation in distinct ways: a) Predatory (psychopathic) aggression; b) frustration/frustrative aggression; c) defensive aggression. It is important to note that the conceptualizations of anger and aggression derived this distinction – and used in the development of the present rRST anger/aggression state scales are more specific than the conceptualizations of anger and aggression reviewed above. Specifically, finer distinctions are made between anger/frustration and fear/rage. These emotional-motivational states further characterize the nature (purpose) of the aggression that may result from them. Frustration occurs in situations of non-reward (omission, delay, partial reinforcement); whereas rage is closely associated with fear and accompanies defensive aggression. Scales used in the studies cited above may conceptually subsume these finer distinctions.

Frustrative nonreward. The associations found by Harmon-Jones, and Carver at the trait level may be well explained by Reinforcement Sensitivity Theory. Corr (2002) has suggested that frustrative nonreward should be related to both appetitive and aversive system sensitivity. Corr's (2002) paper was based on oRST, meaning that he only detailed the interaction of two systems, and I will extend on his reasoning here. Because omission of reward is detected within reward systems by a decrease in phasic firing of dopaminergic cells in the ventral tegmental area (Pickering & Smillie, 2008), before being projected to the aversion systems (oBIS, or FFFS) (Gray, 1982, 1987b) habitual BAS activation would be a prerequisite for anger derived from reward omission (frustrative nonreward). Sensitivity of aversive systems (oBIS, FFFS) is required to register the omission or delay of an anticipated reward as aversive. Corr therefore hypothesized that the relationship between BAS-sensitivity and the frequency and intensity of anger/frustration would be moderated by FFFS-sensitivity (originally oBIS sensitivity). In

other words, if Corr's (2002) hypothesis is correct, anger and frustration would be experienced most frequently by those whose oBIS and BAS sensitivities are roughly equal. This hypothesis has received some support. Tibubos et al. (2014) found that oBIS x BAS sensitivity interaction, whereby those high in oBIS and BAS (measured with the BIS/BAS scales, Caver & White, 1994); and those low in oBIS and BAS sensitivity experienced more anger (measured by self-report, physiology and behaviorally) in their experiment. Additionally, a short scale developed to measure the tendency to become disengaged after a situation of frustrative nonreward was found to share significant small positive associations with both Carver and Whites (1994) BAS-Reward Responsiveness scale and BIS scale (Wright et al., 2009).

To extend Corr's (2002) account of frustration within RST to accommodate the updated 3-system theory, frustrative nonreward should input into rRST's conceptualization of rBIS when the aversive nature of the nonreward situation is roughly equal to the appetitive motivational strength of the reinforcer. Insofar as non-reward (whether a delay, omission or decrease in value of reward) is aversive, but obtainment of reward is still perceived as possible and desirable, the result is an approach-avoidance conflict. Through this lens, frustration is another motivational-emotional state under the purview of the rBIS, potentiated by a BAS (goal pursuit)-FFFS (delay/omission/obstacle) conflict, which may be resolved by either BAS (increased goal-drive persistence), FFFS (withdrawal/avoidance) or lead to rBIS-mediated behavioural disengagement (giving up). This thinking is in line with earlier theorizing, suggesting that at low levels, frustration should lead to increased effort at goal-pursuit, and at high levels lead to various forms of disengagement from goals (e.g. leaving or giving up, Carver & Schierer, 2012). In support of this idea, Harmon-Jones and colleagues (Harmon-Jones et al., 2003) found that student research participants that were made to feel angry (told about a large and unexpected increase in tuition) and led to feel that action was possible (they could sign a petition) registered increased markers of approach motivation (left cortical asymmetry); which was not observed in a group of participants who were not presented with an opportunity for action. In another study, Zinner et al.

(2008) evoked anger in a situation where anger expression was unlikely to be seen as acceptable and found that participants exhibited higher levels right frontal asymmetry – a cognitive marker of oBIS. Right frontal cortical asymmetry has historically been viewed as a marker of avoidance (i.e., FFFS activation in rRST), but a growing body of research suggests that it could be a maker of rBIS rather than FFFS (see Lacey & Gable, 2022). This research suggests that anger can be associated with approach, avoidance or behavioural disengagement, depending on situational constraints, and provides some indirect support for Carver and Schierer's hypothesis. Others have noted that BAS-mediated aggression and oBIS-mediated depression are two common responses to frustration in psychopathological populations (Baars et al., 2011).

Although Frustrative nonreward is a particularly complex case of how anger and aggression relate to RST motivational systems, there are two types of aggressive behaviour that are conceptually associated with only one system.

Predatory aggression. Predatory aggression is a concept that comes from animal literature and can be defined as a predator hunting for a meal. Given that this type of aggression is related to obtaining a reinforcer, it should not be underpinned by anger or fear, but by emotions that accompany goal pursuit (e.g., anticipatory pleasure; Weinshnker & Siegel, 2002). Although this type of aggression is typically defined as cross-species hunting in animal research (Blanchard et al., 2010), predatory aggression has been related to instrumental psychopathic aggression seen in humans (e.g., Corr, 2013; 2016).

Within the context of psychopathy, 'predatory' or instrumental aggression is hypothesized to be more common because Type 1 Psychopaths have less sensitive FFFS and/or rBIS systems (oBIS) (Lykken, 1995, Fowles, 1980, 1988; but see Wallace & Newman 2008, for an alternate account). Aggression is an inherently risky class of behaviour. For example, aggression might lead to harm befalling the aggressor,

or later retaliation (Molho et al., 2017). In most societies, physical aggression has legal or other institutional consequences. Socialization also leads to self-censure when aggression has a negative evaluation. In sum, aggression is risky and associated with a wide array of negative consequences. Therefore, in most contexts, the prospect of acting aggressively should elicit some degree of fear (FFFS-mediated) and lead to an approach-avoidance conflict (rBIS-mediated). Activation of the rBIS should be associated with inhibition of aggressive impulses (Corr & Perkins, 2009). Conversely, in those who have insensitive FFFS or rBIS systems instrumentally aggressive impulses are more likely to be acted upon.

Research has found that primary psychopaths have less sensitive oBIS systems (Heym & Lawrence, 2010) and fail to learn from punishing experience (Corr, 2010). Other research has found that decreased oBIS sensitivity partly explains the relationship between Type 1 psychopathy and externalizing behaviour (Johnson et al., 2014). Research using measures of rRST (with a fear-anxiety distinction) has found that primary psychopathy is negatively related to rBIS sensitivity, positively related to BAS sensitivity, and unrelated to FFFS sensitivity (Salgari et al., 2022). Previous research using diverse measures of fear and anxiety have found primary psychopathy to be associated with decreased anxiety but normal levels of fear (see Hoffman et al., for a review)

Research shows that anxiolytics (anxiety-reducing substances) can increase aggression in animals and humans. Alcohol has been shown to decrease anxiety and increased both offensive and defensive aggression (Blanchard et al., 1993) and frustrative aggression (Bond & Silveira, 1993). Alprazolam and diazepam (anxiolytics) use can lead to increased aggression, specifically in response to provocation, or when an individual has dispositional attributes associated with aggressive impulses (Bond & Silveira, 1993; Ben-Porath & Taylor, 2002). Research has also found that violent offenders are more likely to be alprazolam-dependent than non-violent offenders (Albrecht et al., 2017). Taken together, this research supports the idea that decreased anxiety is associated with decreases suppression of typically inhibited behaviour, such as aggression.

Defensive aggression. Defensive aggression pertains to the Fight response of the Fight Flight Freeze system. Aggression in this context is underpinned by fear and/or rage (Gray, 1994; Corr & Perkins, 2009) and is performed with the intention to protect and ultimately distance the self from perceived threats. Theoretically, defensive fight is engaged in as a last resort, when flight and freezing are not possible (McNaughton & Gray, 2000), although inter-species differences exist based on an animal's evolutionary history (e.g. fast, long-legged mammals who can detect threats at longer distances are more likely to flee, Blanchard & Blanchard, 2005). It involves defense of the subject's own bodily integrity (Blanchard et al., 2003). This type of fear-based aggression is not commonly reported by humans (or at least not by a group of undergraduate university students living in Hawaii in the 1980s) and is behaviorally different from other forms of aggressive acts, in that it involves screaming, biting and clawing at one's opponent (Blanchard & Blanchard, 2003).

Extant scales of defensive aggression have been found to correlate with trait BAS rather than trait FFFS (Corr, 2016), leading to arguments that the fear-aggression phenotype in humans does not exist (Blanchard, 2017). An examination of trait measures reveals that the proactive nature of the aggression suggested by some of the items may be driving the association. McNaughton and Corr (2012) propose that in early stages of the aversive contingencies, avoidance is mediated by the FFFS. Once aversive stimulus contingencies have been learned, and one can be more proactive about one's safety, active avoidance can become a BAS-mediated goal, rather than an FFFS-mediated reaction. In other words, the goal is proactive and appetitive (seeking safety) rather than reactive and aversive (avoiding danger). In order to observe a relationship between defensive fighting and fear, items should emphasize a desire to distance oneself from an aversive stimulus, rather than proactively approach to prevent a foreseeable undesirable outcome.

The theory and evidence reviewed above produce several requirements for a conceptually sound anger and aggression scale:

7. Predatory Aggression, Anger/Frustration and Defensive Aggression should form distinct factors (scales).
8. The Predatory Aggression scale should be positively associated with BAS.
9. The Defensive Aggression scale should be positively associated with FFFS
10. The Anger/Frustration scale should be positively associated with BAS (but not reward reactivity) and rBIS.

Reinforcement Sensitivity Theory in Context

The idea that humans endeavor to seek pleasure and avoid pain has been present in philosophical discourse for centuries (Corr & Krupic, 2022; Ryan & Deci, 2000). RST examines these two motivations primarily through a behavioural lens, in the context of biologically based learning theories that emphasize classical and instrumental conditioning, and positive and negative reinforcement (Corr & Krupic, 2022). RST was articulated in response to Hans Eysenck's (1967) biological model of introversion-extraversion and neuroticism; which sought to uncover causal influences of personality through multivariate statistical analyses (factor analysis). Gray (1970) proposed that individual differences in sensitivity to reward and sensitivity to punishment was a more parsimonious way to account for internalizing/externalizing disorders than Eysenck's Introversion-Extraversion and Stability-Neuroticism factors; and endeavored over the next several decades to provide a viable "bottom-up" scientific account of personality based on these concepts (sensitivity to reward and punishment) – an effort that has not been equaled since (Corr & Krupic, 2022).

Gray's work has given rise to or inspired several other approach-avoidance theories (see Corr & Krupric, 2022 for a review; and Smillie, 2008 for an explanation of their commonalities). As a result, there are several distinct but highly related conceptualizations of reward sensitivity such as approach temperament (Elliot & Thrash, 2010), Sensation Seeking (Zuckerman, 1991), Novelty Seeking and

Reward Dependence (Cloninger, 1987), Agentic Extraversion (Depue & Collins, 1999); and corresponding conceptualizations of punishment sensitivity, such as avoidance temperament (Elliot & Trash, 2010) and Harm avoidance (Cloninger, 1987).

There is a group of approach/avoidance theories that come from social psychology that also parallel RST that view approach-avoidance motivation through a more cognitive lens. Although these theories were not directly inspired by Gray's work, and are not rooted in neurobiology and animal experiments, their underlying theory converges with and adds to RST. Higgin's (1987) Regulatory Focus Theory; Elliot's (Elliot & McGreggor, 2001) Achievement Goal theory; Khul's (1981, 1992) State vs. Action orientation and Krugalniski et al.'s (2018) Locomotion vs. assessment are all theories that include conceptualizations of approach and avoidance that emphasize cognition or self-regulation. Included in these theories are concepts such as end-states or goals and an objective sense of the self (Regulatory focus theory, achievement goal theory; Monni et al., 2020); or a form of cognitive style that emphasizes action vs. deliberation (State vs. Action Orientation, Locomotion vs. Assessment), that share parallels with BAS and rBIS sensitivity.

Within the family of neurobiologically-based approach-avoidance theories, Reinforcement Sensitivity Theory remains the most reflective of its neurobiological and animal origins. Within the wider context of approach/avoidance theories, RST provides a well-supported bottom-up theory of personality and state motivation that ties behaviour to neurobiological causal mechanisms. Extensive investigation and robust support in neurobiological research lend the theory utility and credibility, and the popularity of RST continues to grow (Corr & McNaughton, 2019). RST is appealing as a multidisciplinary, parsimonious explanation of a wide variety of human experience. However, the theory has two notable limitations.

Emotion

RST is a well-supported theory of motivation and emotional states; but not all emotions are currently accounted for within the theory (Corr, 2008). RST gives a full and nuanced account of fear and anxiety; and identifies positive emotions associated with approach (the Behavioural Activation System) such as hopefulness, pleasure, desire and determination. Anger is another emotion that has received attention within the RST literature, but various theorists have attributed the emotion to the FFFS (e.g., McNaughton & Gray, 2000) the BAS (e.g. Carver & Harmon-Jones, 2009) and oBIS (Corr, 2002). Gray proposed that the three motivational systems give rise to emotions with different patterns of activation; akin to how the cones of the retina give rise to the full spectrum of visible colour (Gray, 1994); and theorists have put forth several proposals for how a variety of emotions are related to approach and avoidance; and in what contexts they arise (Carver, 2006, Harmon-Jones, 2019); however more work is needed to substantiate these proposals. In sum, RST is a well-supported theory of three motivational systems and accounts well for fear, anxiety and positive emotions such as pleasure and desire. Further work is needed to determine if and how the rBIS, BAS and FFFS can account for the full range of human emotional experience.

Cognition

RST is a theory born of biological and behavioural research and has never included a strong emphasis on the role of cognition. Recent extensions of RST, particularly concerning BAS processes (e.g sub-goal scaffolding, Corr, 2008), have extended RST further into the cognitive realm, but cognition continues to be peripheral to the theory. The fact that humans have more advanced cognitive capacities than the animal subjects that informed RST has been a source of criticism (e.g., Matthews, 2008). In recent years, theorists have attempted to compare and incorporate various cognitive or self-regulatory theories with RST (e.g. Collins et al., 2017; Krupic & Corr, 2020; Monni et al., 2020), suggesting that the work of expanding RST into the cognitive realm is already underway.

The Current Study

The sections above have reviewed RST as well as established the theories' considerable strengths, while noting its current limitations. RST is a personality theory based on a state theory. Furthering our understanding of how biological systems that give rise to reinforcement sensitivity respond dynamically to situations in humans necessitates a psychometrically validated state scale of RST system activation. Several psychometric scales have been constructed to measure oBIS, rBIS, BAS and FFFS sensitivity (see Corr, 2016 and Torrubia et al., 2008 for reviews). Currently no validated self-report state measure of motivational system activation exists.

Extant measures of state RST system activation are methodologically or theoretically flawed. For example, one way of measuring state activation of RST motivational systems has been to measure anterior cortical asymmetry using electroencephalogram (EEG), where right anterior cortical asymmetry is a marker of withdrawal/avoidance (oBIS); and left anterior cortical asymmetry is a marker of approach (BAS; Coan & Allan, 2004). However, as there is no differentiation between avoidance (FFFS) and conflict (rBIS) in this type of measure (Lacey & Gable, 2021), it is consistent with oRST – a version of RST that is currently 22 years out of date. Other researchers have relied on modification of trait measures to measure state RST system activation, which have not been validated at the state level (e.g., Carver, 2004; Eftekhari et al., 2017).

The purpose of the current research was to create a suite of practical, cost-effective, comprehensive and theoretically updated rRST-state scales sensitive to in-the moment activation of RST motivational systems. Specifically, I sought to develop scales to measure a) rBIS activation; b) BAS activation; c) FFFS activation; and d) BAS, rBIS and FFFS-mediated anger and aggression. Based on current theory and evidence, it was determined that the scales would need to meet the following

criteria to obtain acceptable validity. Criteria 1-10 were specified above. Four new criteria (11-14) are added here.

1. Reward Interest, Goal Drive Persistence, Reward Reactivity and Impulsivity items should form four distinct factors (sub-scales), which contribute to an overall scale that measures state BAS activation. Due to ambiguity surrounding the a) relationship of impulsivity to BAS, and b) the multifaceted nature of BAS, one and three-factors (no impulsivity) were also considered.
2. The FFFS (pertaining to fear, active avoidance, flight and freeze, but not defensive fight) should form one factor.
3. The rBIS items should form one or two factors based on item content reflecting a) anxiety and b) behavioural disengagement.
4. BAS factors should be negatively associated with rBIS and FFFS factors.
5. FFFS and rBIS items should form distinct factors.
6. rBIS and FFFS should be positively associated.
7. Predatory Aggression, Anger/Frustration and Defensive Aggression should form distinct factors.
8. The Predatory Aggression factor should be positively associated with BAS and unassociated with rBIS and FFFS.
9. The Defensive Aggression factor should be positively associated with FFFS and unassociated with BAS.
10. The Anger/Frustration factor should be positively associated with BAS (but not reward reactivity) and rBIS.
11. State rBIS should be positively associated with Trait rBIS.
12. State FFFS should be positively associated with Trait FFFS.
13. State BAS should be positively associated with trait BAS.
14. State Defensive Aggression should be positively associated with trait Defensive Aggression.

Method

Item Pool

A large pool of candidate items was developed. Items were derived from a) Extant trait-level RST questionnaires (e.g., RST-PQ, Corr & Cooper, 2016), b) a thorough literature review, and c) with the consideration of Sherer's (2005) component theory of emotion.

Items for the BAS state scale were developed specifically to reflect Corr and Cooper's (2016) four BAS factors: Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity. In keeping with Corr and Cooper's (2016) model of multidimensional BAS, impulsivity in my study was defined as fast action with little forethought when a reinforcer is within reach. Items for the FFFS state scale were developed to specifically reflect the thematic facets of behavioural response identified by Corr and Cooper (2016): flight, active avoidance and freeze. Items for the rBIS state scale were developed specifically to reflect the thematic facets of motor planning interruption, cautious risk assessment, obsessive thoughts and behavioural disengagement. Finally, items for the Anger/Aggression state scale were developed to reflect three facets identified in RST literature that may pertain to anger within the context of specific goal-directed behaviour: a) defensive aggression; b) predatory aggression; and c) anger/frustration.

Where possible, items were generated to reflect the different components outlined in Sherer's (2005) component theory of emotion: a) cognitive component (appraisal); b) neurophysiological component (bodily symptoms); c) motor expression component (facial and vocal expression); d) motivational component (action tendencies) and e) subjective feeling component (emotional experience). Qualitative literature aimed to describe bodily sensations associated with feeling states was reviewed and incorporated into item development as well (Eatough et al., 2008; Nummenmaa et al., 2014).

Items were reviewed by lab members for readability, redundancy, and clarity; and evaluated with the Question Appraisal System (Willis & Lesser, 1999). Items were administered, evaluated using item statistics and factor analyses, and revised iteratively until provisional scales were created. Factor structure and model fit were assessed using CFA. The present thesis describes a series of factor analyses run on three different samples. of item analysis, modification and generation of new items are included in the Results section.

Participants

All participants were recruited from Prolific, a web-based survey service. Participants came from the UK and North America. Participants were compensated for their participation at a rate of £7.50/hour, based on median time to complete the study. Previous research has suggested that sample sizes larger than 400 may be necessary when there are issues with the models being fit; or when the number of items measuring a single latent construct is low (e.g. 2); and that larger sample sizes will lead to more accurate results (Fabrigar & Wegener, 2011). In order to minimize the chance that model estimates would be inaccurate, we sought large sample sizes (*N* = 700 to 800) for each study.

Sample 1

Data collection on the first sample of participants (*N* = 802) occurred on July 20th, 2021. This sample was heavily biased towards young female participants due to a sampling error on the part of Prolific. Participants in this sample completed a survey consisting of a) 46 BAS items, and b) 44 rBIS items. They also completed the RST-PQ, demographic questions and attention check (see measures described below). Participants were compensated £1.75 upon survey completion. On average (mean), participants took 9.42 minutes to complete the survey.

Sample 2

Data collection on the second sample of participants (*N* = 701) occurred on the December 8th, 2021. Based on statistical and theoretical analyses, some items that were administered to Sample 1 were removed or modified and some new items were added. Participants in this sample completed a survey consisting of a) 51 BAS items; b) 40 rBIS items; c) 35 Anger/Aggression items; d) 19 FFFS items. They also completed the Conscientious Responders Scale (Marjanovic et al., 2014), demographic questions and attention check (see measures described below). Participants were compensated £1.50 upon survey completion. On average (mean), participants took 11.58 minutes to complete the survey.

Sample 3

Data collection on the third sample of participants (*N* = 714) occurred on April 28th, 2022. Based on statistical and theoretical analyses, some items that were administered to Sample 2 were removed or modified and some new items were added. Participants in this sample completed a survey consisting of a) 42 BAS items; b) 52 Anger/Aggression items; c) 19 FFFS items. They also completed the Conscientious Responders Scale (Marjanovic et al., 2014), the Reinforcement Sensitivity Theory of Personality – Short Form (Vecchione & Corr, 2021), demographic questions and attention check (see measures described below). Participants were compensated £1.50 upon survey completion. On average (mean), participants took 12.94 minutes to complete the survey.

Measures

Demographics

Participants answered three demographic questions (Appendix A), about their age, gender identity and ethnicity. Demographic information was obtained to ensure that data was representative, and that data cleaning did not disproportionately remove a specific demographic.

Reinforcement Sensitivity Theory of Personality Questionnaire – Short Form (RST-PQ-SF)

The Reinforcement Sensitivity Theory of Personality Questionnaire – Short Form (Vecchione & Corr, 2021; Appendix B) is a 22-item version of Corr and Cooper's (2016) RST-PQ. Answers are indicated on a 4-point scale (1 = *very false for me*; 4 = *very true for me*).

Defensive Fight Scale

The Defensive Fight Scale (Corr & Cooper, 2016; Appendix C) is an 8-item scale designed to measure the tendency to engage in FFFS-mediated aggression. Answers are indicated on a 4-point Likert-type scale (1 = *very false for me;* 4 = *very true for me*).

Conscientious Responders Scale

The Conscientious Responders Scale (Marjanovic et al., 2014; Appendix D) consists of five items that are interspersed randomly among other scales to detect non-conscientious responders. Items ask participants to answer questions in a particular way (e.g., "To answer this question, please choose option number four"). In my study, the five questions from the conscientious responders scale were divided up as follows: one question each was added to the rBIS, FFFS and Anger/Aggression State scale items; and two were added to the BAS scale items. The position of the question within each scale was randomized between participants.

Attention Check

At the end of the study, participants were asked whether they were able to follow study instructions (Appendix E). Participants were able to check a box that stated, "I was not able to follow instructions today". They were informed that even if they indicate they were unable to follow instructions, that they would still receive compensation for their participation in the study.

rRST-state Scales

The suite of scales being developed in the present study are the rRST state scales, measuring in-the-moment self-report activation of a) the Behavioural Inhibition System; b) the Behavioural Activation System; c) the Fight Flight Freeze System. Additionally, different forms of d) state anger and aggression are included on a separate scale. The rRST-state Scales are Likert-type scales with 7 response categories (1 = *Completely disagree*; 2 = *Disagree*; 3 = *Somewhat disagree*; 4 = *Neither agree nor disagree*; 5 = *Somewhat agree*; 6 = *Agree*; 7 = *Completely agree*). The aim of the overarching scale development study was to create brief scales with 3-5 items representing each factor. See Appendices F through M for the item pools administered to samples 1, 2, and 3.

Procedure

All aspects of the study were conducted online. Participants accessed the surveys on Qualtrics through a link on Prolific. In chronological order, participants completed a) Informed Consent; b) demographic questions, c) RST state scales (scales were presented in random order and items within each scale were presented in random order); d) trait scale (study 1 and 3 only); e) attention check. On studies 2 and 3, items from the Conscientious Responders Scale were included among questions on scales.

Analytical Procedure

In line with the study's aim to create a suite of brief scales, my goal during the Exploratory Factor Analysis phase was to identify a small number of items (approx. 3-5) for each theorized factor, that together, fully represent each construct's content domain and demonstrate good psychometric properties (i.e., fit indices, reliability, factor loadings). In order to achieve this goal, I started by eliminating problematic items: items with high values of skew, (> 3) and kurtosis (> 7) that might bias the results of a factor analysis (Kline, 2008); items that did not have linear associations with other scale items and redundant items (items with bivariate correlations above .80).

During the EFA phase of analysis, I sought to gain insight into how items were grouping together and what latent variables may be contributing to item variance in different models. I estimated a series of EFAs for each scale that varied based on a) number of factors; b) number of items; c) combination of subset items. The information gained during the EFA phase of analysis allowed me to a) identify candidate scale items; b) identify sources of variance that were not central to the constructs of interest; c) identify problems with items (e.g., ambiguity) that may be contributing to the observed variance. Based on this information, I modified problematic items, added new items and created provisional scales consisting of 3-5 items for each factor.

In the next phase of analysis, I tested competing models of each provisional scale to determine if items formed the hypothesized factor structures (criteria 1, 2, 3, 5, & 7). Theory, utility and model fit informed the choice of model for each scale. In the final phase of analysis, I obtained correlations between scales to determine if scale scores correlated with state and trait scales in the hypothesized ways (criteria 4, 6, 8, 9, 10, 11, 12, 13, & 14).

To determine how many factors to estimate in each EFA, I considered the following: RMR, difference in RMSEA, parallel analyses, scree plots, residual correlations, and theory. RMR values represent the average error variance between items, and values of < .6 were considered acceptable. An improvement of > .15 in RMSEA values as a model increases in number of factors is considered a significant improvement (Finch, 2020). Parallel analyses and scree plots were also examined (Horn, 1965). Finally, residual correlations were examined to assess local fit (Tomarken & Waller, 2003). All EFAs were estimated using ULS and Quartimin rotation.

I evaluated CFA model fit used the following fit indices: CLI, TLI, RMSEA and SRMR. CLI and TLI are incremental model fit indices. Higher values of CFI and TLI are indicate how much better the estimated model explains variance in the data than a null model, wherein the only non-zero parameters

are the variances of observed variables (i.e., variance of item responses). RMSEA values are used to assess how much variance in the data is not explained by the estimated model. As such, RMSEA value is a direct assessment of model fit, whereas CLI and TLI are assessments of improvement over a null model. SRMR is an average of inter-item error covariances. According to Browne Cudeck (1993) and MacCallum et al., (1996) an RMSEA < .05 is 'close fit', while values between .05 and .08 is indicative of 'acceptable fit'. An SMRM value of < .08 is considered good fit (Hu & Bentler, 1999). Values of CLI and TLI greater than .90 are adequate fit; larger than .95 is considered good fit (Brown & Cudeck, 1992; MacCallum et al., 1997; McDonald & Ho, 2002). Finally, in line with Tomarken and Waller's (2003) recommendations, I examined indices of local fit (item factor loadings and uniqueness) to determine whether any items or factors do not fit the data well.

Results

A series of Exploratory Factor Analyses and Confirmatory Factor Analyses were performed to develop four rRST motivational state scales: the Behavioural Activation System State Scale (BAS-state) the Behavioural Inhibition System State Scale (rBIS-state), the Fight-Flight-Freeze State Scale (FFFS-state) and the Anger State Scale (ANG-state). Analyses were performed on three samples from the UK and North America. Samples consisted of a) 802 adults (Mean age = 24.96, 695 Female[2]) b) 701 adults (Mean age = 35.87, 345 Female); c) 714 adults (Mean age = 41.37, 353 Female) (see Table 1, 2 and 3 for participant demographic information). All data were obtained through Prolific, a is a self-service data collection tool with a global participant pool. Surveys were hosted on Qualtrics. All data analyses were performed in R 4.0.2 (R Core Team, 2020) using misty (Yanagida, 2021), car (Fox et al., 2019), psych

[2] Due to an influx of young female participants on Prolific, our sample was heavily skewed towards young female participants.

(Revelle, 2020), corrgram (Wright, 2021), ppcor (Kim, 2015), multilevel, (Bliese, 2016), GPArotation (Bernaards & Jennrich, 2005), ltm (Rizopoulos, 2006) and semTools (Jorgensen et al., 2021).

Data Cleaning

Participant data was removed based on several criteria: a) Participants indicated that they had not been able to pay attention during the survey (Sample 1: n = 12; Sample 2: n = 11; Sample 3: n = 12); b) Participants took too short (less than 1.5 seconds per question) or too long (longer than an hour total) to complete the surveys (Sample 1: n = 5, Sample 2: n = 0; Sample 3: n = 6). Due to differences in survey collection validation procedures on Qualtrics, sample 1 also removed participant data due to c) failure to give consent (n = 3); and d) Missing data (BAS scale: n = 64; rBIS scale: n = 24; subsequent samples used forced entry and therefore did not have missing data). Surveys administered to samples 2 and 3 included catch questions (Non-Conscientious Responders Scale, Marjanovic et al., 2014); and therefore removed participants who e) failed catch questions (Sample 2: n = 55 (total; n= 48 additional [some people indicated they didn't pay attention and failed catch questions]); Sample 3: n = 45). Demographic statistics (age, ethnicity, gender) were compared before and after data removal to ensure data cleaning did not disproportionately remove data from any one group. Data cleaning did not substantially change the proportion of data obtained from any particular demographic in any sample (see Table 1, 2 and 3 for demographic statistics of sample before and after data cleaning). After data cleaning, the size of the sample 1 was 762 for the BAS scale; and 758 for the rBIS scale; Sample 2: 636; Sample 3: 660.

BAS State Scale

Feasibility of four-factor BAS scale

I conducted a series of EFAs on BAS items (Appendix F) to determine if Corr and Cooper's (2016) four factor BAS model would be a feasible factor structure to pursue during scale development. Skew (range = -1.23 to 0.41) and kurtosis (range = 1.05 to 2.46) were within acceptable levels. A scatterplot

matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. Items 35—46, developed to measure BAS-Impulsivity generally had weaker, positive relationships with other BAS items. Items 40, 45 and 46 were particularly problematic as they also did not appear to correlate highly with other items from the BAS-Impulsivity facet.

I estimated a series of models using the BAS items using ULS and Quartimin rotation. Oblique rotation was used as we expected potential BAS sub-factors would be correlated; given that they would be specific facets of approach motivation. Indices suggested one-factor and four-factor models would fit the data well (RMR = 0.6 for a one factor model; difference in RMSEA from one to two factors = 0.08; scree plot and residual correlations indicated four factors would fit the data best). I proceeded with the four-factor model because it was theoretically preferable and fit the data well. Overall, items loaded onto their conceptual latent variables, although items designed to measure Reward Interest and Impulsivity had substantial cross-loadings or loaded primarily onto other conceptual latent variables. I performed exploratory factor analyses on the Reward Interest and Impulsivity items. EFAs revealed that Reward Interest consisted of two factors – positive affectivity (optimism) and seeking; and that the impulsivity items I had developed were loading onto three distinct factors: a) seizing rewards; b) acting without thinking; and c) lack of doubt.

I identified four items each from the goal-drive persistence and reward reactivity factors that a) together, covered the content domain of the conceptual latent variable; b) loaded highly onto the intended factor (range = 0.53 to 0.91); and c) did not share substantial cross-loadings with other factors (range = |0.09| to |0.28|). Given that Reward Interest conceptually covers both seeking (looking for rewards) and identification (recognizing rewards); but items that were intended to measure identification had substantial cross-loadings on reward reactivity, I decided to reword some of the identification items for the next iteration of factor analyses.

The impulsivity items were characterized by two problems: (1) They were not highly correlated with each other and (2) they were moderately correlated with most other BAS items, regardless of the other item's conceptual factor. I determined that there were several issues with the first iteration of impulsivity items. First, some items were reflective of impulsivity, but not specific to motivationally derived impulsivity that emphasizes reward obtainment (e.g., "I feel uninhibited," "I feel unrestrained," "I'm not wasting much time on thinking before I act," "I'm acting on the spur of the moment"). Second, some items emphasized reward obtainment, but did not exclusively describe impulsivity (e.g., "I can't contain my eagerness," "I am acting decisively," "I am grabbing the good things in life as they come my way"). Drawing on Gullo and Dawe's (2004) two factor distinction between Reward Drive and Rash Impulsivity, I added some new items for the next iteration of factor analysis that emphasized impulsivity that is specifically tied to BAS activation.

Factor Analysis on Provisional BAS scale

This analysis was run on Sample 2 (See Table 2 for demographic descriptive statistics; see provisional scale in Appendix N). A total of 51 BAS items were administered (Appendix G; 11 Reward Interest, 10 Goal-Drive Persistence, 13 Reward Reactivity and 16 Impulsivity). This study was pre-registered on the Open Science Framework website (Appendix T). Descriptive statistics of subset of 16 items indicated that there was small to moderate skew (range = -0.75 to 0.31) and kurtosis (range = -0.99 to 0.11) in item scores. A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. A Pearson product-moment correlation matrix and a correlogram indicated that the majority of items have positive bivariate correlations that are small to medium in size. However, two impulsivity items (47 and 48) had moderate positive correlations with each other (r = 0.50), but weak positive or negative correlations with other items on the scale, including the two other impulsivity items (49 and 50). One Reward

Interest item (8) also appeared to be slightly problematic – correlating more highly with GDP and RR items (range: r = 0.48 to 0.66) than with other RI items (range: r = 0.33 to 0.51).

I compared three a-priori models of state BAS: a one-factor model, a four-factor model and a bifactor model. The one-factor (Robust RMSEA = 0.128, 90% CI = 0.121, 0.136; Robust CFI = 0.814; Robust TLI = 0.786, SRMR = 0.085) and four-factor (Robust RMSEA = 0.100, 90% CI = 0.093, 0.108; Robust CFI = 0.893, Robust TLI = 0.869, SRMR = 0.077) models demonstrated poor model fit, whereas the bi-factor model had adequate model fit (Robust RMSEA = 0.067, 90% CI = 0.059; 0.076, Robust CFI = 0.957; Robust TLI = 0.941, SRMR = 0.052). All models were characterized by poor local model fit on the impulsivity factor (e.g., Standardized error variances of impulsivity items for the four-factor model were 0.324, 0.623, 0.849 and 0.943, indicating that 94.3% of the variance of one of the items is not due to the latent variable). The modification indices confirmed what was suggested by the Pearson product-moment correlation matrix, correlogram and standardized error variances – that several impulsivity items did not load onto their intended sub-factor. Specifying item 49 as an indicator of GDP would bring the largest improvement to model fit (MI = 83.14); however, it would also improve the model to specify item 49 as an indicator of Reward Reactivity (MI = 14.06). Specifying item 50 as an indicator of Reward Reactivity was also associated with substantial model fit improvement (MI = 17.58). Modification indices also indicated that a third impulsivity item (item 48) would substantially improve the model if it were an indicator of Reward Interest (MI = 11.89) or Reward Reactivity (MI = 10.34). Taken together, the Pearson product-moment correlation matrix and modification indices suggest that there were substantial issues with the impulsivity items. Specifically, the impulsivity items did not form a distinct factor as intended; and instead seemed to be better conceptualized as indictors of other BAS sub-factors.

Modification indices also confirmed issues with items from the Reward Interest sub-factor. Specifically, items intended to measure the Reward Interest facet would substantially improve model fit if they were predicting the Reward Reactivity or Impulsivity facets. Items 8 and 9 were associated with

substantial improvement in model fit if they were predicting Reward Reactivity (MI = 26.87 and MI = 15.43). Additionally, items 9 and 11 were associated with substantial improvement in model fit if they were predicting Impulsivity (MI = 24.18 and MI = 24.03).

I performed additional factor analyses on the remaining items to determine if there were any items in the item pool that met psychometric and theoretical criteria for inclusion in the BAS scale. There were no other better combination of items. I therefore decided to create some new Reward Interest and Impulsivity Items in another iteration of factor analysis.

I reasoned that the Reward Interest items may be loading onto Reward Reactivity items because the fact that rewards were potential rather than apparent was not salient. I modified the items to make this conceptual distinction more salient. I also reasoned that Impulsivity items inspired by Dawe and Loxton's (2004) conceptualization of *Reward Drive* were not psychometrically or theoretically coherent with Corr an Cooper's (2016) definition of Impulsivity. I created new items that reflected the following item content, in line with Corr an Cooper's (2016, supplemental material) description: a) fast action to obtain reinforcer; b) reinforcer within close temporospatial proximity; c) a window of opportunity.

CFA of Final BAS Scale

This analysis was run on Sample 3 (See Table 3 for demographic information). A total of 42 BAS items were administered (Appendix H; 8 Reward Interest, 8 Goal-Drive Persistence, 10 Reward Reactivity and 16 Impulsivity). Four items from each factor (16 items in total) were selected for a final BAS scale (Appendix P). This study was pre-registered on the Open Science Framework website (Appendix U).

Descriptive Statistics. Descriptive statistics of subset of 16 items indicated that there was small to moderate skew (range = -0.80 to 0.60) and kurtosis (range = -1.00 to 0.29) in item scores. A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. A Pearson product-moment correlation matrix

and a correlogram indicated that the majority of items have positive bivariate correlations that are small to medium in size. A correlogram revealed that impulsivity items did not appear to form a strong specific factor, and also appeared to be more weakly correlated with other BAS items.

Models tested. It was decided a-priori to test three models: a one-factor model, a four-factor model, and a bi-factor model (described below). However, a higher-order model was also examined post-hoc to assess the feasibility of interpreting BAS subscales and BAS total score.

1. A One factor model with all items measuring BAS Activation was tested. If this model were the best fit for the data, the scale would be best described as a measure of BAS Activation, and the hypothesized sub-domains would not be meaningful. This factor structure is most common to BAS scales. Although there is evidence to suggest that the BAS is underpinned by multiple neuroendocrinal systems AND approach is theoretically characterized by different behaviour, affect, cognitions and physiological sensations as one moves along the temporo-spatial gradient towards a reinforcer, there are commonalities to the experience generated by the subsystems and throughout goal pursuit (e.g., positive affect, focus on reward).
2. A four-factor model with four items each measuring a) Reward Interest, b) Goal-Drive Persistence, c) Reward Reactivity, and d) Impulsivity was tested. If this model were the best fit for the data, the scale would be best described as a suite of four scales, with no meaningful general factor. This factor structure mirrors Corr's RST-PQ and recent review of neurobiological and endocrinal systems that underpin goal-directed behaviour.
3. A bifactor model with specific factors from the four-factor model and one general BAS factor was tested. This model recognizes that the endocrinal systems that underpin four proposed factors have complex interactions and work with each other. As such, the activation of the four endocrinal systems contribute to a unified BAS experience, but items tapping specific systems are more likely to co-occur with each other, leading to variance over and above what is likely to

be accounted for by a single factor by itself. Using this model would lead to an interpretable single 'BAS activation' score – with specific factors not interpretable.

4. A higher-order model with four items each measuring a) Reward Interest, b) Goal-Drive Persistence, c) Reward Reactivity, and d) Impulsivity; each contributing to a higher-order 'BAS Activation' Factor was tested. This factor structure would suggest that both subscale scores and total scale scores would be interpretable.

Testing the Models. Latent variables for each model were scaled by fixing variance to 1 (where applicable). All models were estimated using the robust Maximum Likelihood method in lavaan (Rosseel, 2012). The bifactor model had the best model fit indices (Table 4). However, it was decided that the higher-order or four-factor model would be preferable to allow for interpretable sub-scale scores and were also associated with acceptable fit. The higher-order model had almost identical model fit indices to the four-factor model (Table 4), so I decided to proceed with the higher-order model, as it allows for reliability to be assessed for sub-scales and full-scale scores.

The Higher-order model had adequate model fit, however, standardized error variances indicated an issue with local model fit: two impulsivity items had high uniqueness values (0.72 and 0.62), indicating that 72% and 62% of the variance of these items was not accounted for by the *impulsivity* latent variable. I removed the item with the highest uniqueness value (item 46 "I'm closing in quickly on something I want"). The model fit for the higher-order scale without this item was adequate to good (Robust RMSEA = 0.073, [90% CI = 0.058 – 0.081]; Robust TLI = 0.94; Robust CFI = 0.95; SRMR = 0.049). Standardized factor loadings for subscales are all quite high (range = 0.53 to 0.90; see Table 5 for Higher order-factor model parameter estimates). Factor loadings on the impulsivity factor were the lowest (range = 0.53 to 0.79). Standardized factor loadings for the higher-order factor were all high (range =

0.85 to 0.90). Reliability for four sub-scales are: reward interest: $\omega = 0.86$, goal-drive persistence: $\omega = 0.88$, reward reactivity: $\omega = 0.92$ and impulsivity: $\omega = 0.69$. The total scale had good reliability $\omega_{ho} = 0.88$.

FFFS State Scale

Based on common factor structures of FFFS at the trait level, I conducted a factor analysis on all 19 FFFS items to determine if a one or three-factor (Flight, freeze, active avoidance) model would be most appropriate for scale development. If possible, the second purpose of this EFA was to create a 4 – 8 item FFFS scale using items from the pool. Behavioural expressions of fear may be mutually exclusive on a state scale, leading to three distinct factors (flight, freeze, active avoidance). This analysis used Sample 2 data (Table 2 for demographic information of sample).

Skew (range = -0.14 to 2.10) and kurtosis (range = 1.05 to 5.05) for item scores were within acceptable levels. A scatterplot matrix showed that most items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. However, items 18, 19, and 10 were nonlinearly related. Items 18 and 19 shared non-linear relationships with each other and with item 10. Items 18 and 19 were removed because items that do not share linear relationships with other items are not appropriate for factor analysis.

Both a three-factor and a one-factor model appeared to be feasible. A scree plot, and RMR values (0.06) indicated a one-factor model would be preferrable; while parallel analysis (100 iterations), difference in RMSEA (from one to two = 0.031; from two to three = 0.023) and residual correlations (number larger than 0.10 in a three-factor model = 0) indicated a three-factor model would be preferrable. However, the items did not load onto their conceptual variables in the three-factor model. I reasoned that a one-factor model was theoretically superior to the one-factor model, and preferrable on the basis of model interpretability.

I created a provisional scale with the intention of creating a one-factor FFFS state scale. I chose items that represent each behavioural response, as well as cognitive appraisal, affective and physiological components of fear (Appendix R). The majority of indicators suggested a one-factor model would be the best fit for the data (scree plot, parallel analysis (100 iterations), RMR for one-factor model = 0.027, no residual correlations > .10). The one-factor model, estimated with ULS and Quartimin rotation had good model fit (RMSEA = 0.065, RMSR = 0.03) and good factor loadings (range: 0.72 to 0.87;).

Factor Analysis on Final FFFS scale

This analysis was run on Sample 3 (See Table 3 for demographic information; see item pool in Appendix M). A total of 19 FFFS items were administered. This study was pre-registered on the Open Science Framework website (Appendix U).

Descriptive Statistics. Descriptive statistics of subset of 6 items indicated that there was moderate skew (range = 0.54 to 1.43) and kurtosis (range = -1.11 to 0.95) in item scores. A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. A Pearson product-moment correlation matrix and a correlogram indicated that the majority of items have positive bivariate correlations that are small to medium in size. A correlogram revealed that impulsivity items did not appear to form a strong specific factor, and also appeared to be more weakly correlated with other BAS items.

Testing the Model. The latent variable was scaled by fixing variance to 1, and model fit was estimated using the robust Maximum Likelihood method in lavaan (Rosseel, 2012). The robust fit indices indicated that the one-factor model fit the data well. Robust RMSEA = 0.64 [90% CI = 0.033, 0.097], Robust CFI = 0.99, Robust TLI = 0.98, SRMR = 0.022. According to Browne and Cudeck (1993) and MacCallum et al. (1996), this value of RMSEA is associated with adequate to close fit. Standardized

factor loadings were all high (range = 0.730 to 0.870; Table 8). Standardized error variances indicate that most items have low uniqueness values (range = 0.24 to 0.47) indicating that most of the variance of the items are accounted for by the latent variable. In general, items that represented different behavioural responses to fear (flee, freeze, active avoidance) were associated with more uniqueness than general fear items, which would be anticipated given that behavioural responses may be exclusive of each other in some situations. Reliability for the scale was high: ω_u = 0.90.

rBIS State Scale

I conducted an EFA on rBIS items (Appendix I) to determine whether a one-factor or two-factor model would be a feasible factor structure to pursue during scale development. Both EFAs were estimated using ULS and Quartimin rotation. Skew (range = -0.76 to 1.26) and kurtosis (range = -1.42 to 0.85) for item scores were within acceptable levels. A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data.

Because there were an unequal number of anxious uncertainty and behavioural disengagement items, (27 and 14 respectively), I ran the EFA on a subset of items (Appendix P) that a) together fully represented the content domains of interest; b) correlated highly with each other; and c) reflected content from only one of the two possible factors. All indicators suggested that a two-factor model would be preferrable to a one-factor model (Scree plot and parallel analysis (100 iteration) both suggested a two-factor model would best fit the data; RMR for one factor = 0.019, difference in RMSEA from one to two factors = 0.079, residual correlations larger than .10 for one factor = 0).

The two-factor model demonstrated good model fit indices (RMSEA = 0.041, 90% CI = 0.025, 0.058; RMSR = 0.02) with items for the most part loading onto their conceptual factors (range = 0.46 to

0.81), without substantial crossloadings (range = |.01| to |0.34|). Item 37, "I want to get away from it all", did not perform as well. It had a small primarily onto the *Anxious Uncertainty* factor (0.46), and a substantial cross loading (0.34) on the *Behavioural Disengagement* factor. It was replaced with "I am retreating from life" for the subsequent CFA.

Factor Analysis on Final rBIS Scale

This analysis was run on Sample 2 (see demographics in Table 2; see item pool in Appendix J; see final scale in Appendix Q). The purpose of this study was to a) confirm the factor structure of the rBIS scale; and b) test three models to determine the best fit. This study was pre-registered on the Open Science Framework website (Appendix T).

Models tested. Three models were hypothesized and tested using confirmatory factor analysis. They are briefly described below.

1. A One factor model with all items measuring rBIS Activation. If this model were the best fit for the data, the scale would be best described as a measure of rBIS Activation, and the hypothesized sub-domains would not be meaningful. This factor structure is most common to rBIS trait scales.
2. A two-factor model with five items measuring *Anxious Uncertainty* and four items measuring *Behavioural Disengagement*. If this model were the best fit for the data, the scale would be best described as a suite of two scales, with no meaningful general factor. This would be unique in the RST literature; but coherent with the idea that learned helplessness and anxiety are different constructs.
3. A bifactor model with specific factors from the two-factor model and one general rBIS factor. This model recognizes the distinctness of *Anxious Uncertainty* and *Behavioural Disengagement*

but also recognizes that both states are thought to be reflective of rBIS activation and therefore aspects of the states may co-occur to a certain extent.

Testing the Models. Latent variables for each model were scaled by fixing variance to 1 (where applicable). All models were estimated using the robust Maximum Likelihood method in lavaan (Rosseel, 2012). The robust fit indices of the three models (Table 6) indicate that the two-factor and bi-factor models both fit the data well. The two-factor had better fit indices for Robust RMSEA, Robust CFI and Robust TLI. Given that it is best practice to estimate the simplest model if two models have similar fit, I decided that the two-factor model was preferable. The two-factor model had good model fit (Robust RMSEA = 0.04, [90% CI = 0.02 – 0.05]; Robust TLI = 0.99; Robust CFI = 0.99; SRMR = 0.02). According to Browne and Cudeck (1993) and MacCallum et al. (1996), this value of RMSEA is associated with "close fit". Standardized factor loadings for subscales are all quite high (range = 0.581 to 0.893; see Table 7 for two-factor Model parameter estimates). Standardized error variances indicate that most items have low uniqueness values (range = 0.20 to 0.66) indicating that most of the variance of the items are accounted for by the latent variables of *anxious uncertainty* and *behavioural disengagement.* However, item 33, "I am keeping an eye out for signs of trouble" had a standardized error variance of 0.66, indicating that 66% of the variance of the item was not accounted for by the *anxious uncertainty* latent variable. The anxious uncertainty and behavioural disengagement factors are highly correlated (r = 0.86). Reliability for both scales were high: anxious uncertainty: ωu = 0.89, and behavioural disengagement: ωu = 0.89.

Factor Structure of FFFS and rBIS

In order to determine whether the state FFFS and state rBIS scales met the criteria that FFFS and rBIS items should form separate factors, I compared the fit of a three factor (anxious uncertainty, behavioural disengagement, FFFS) and a one factor model on FFFS and rBIS items. The one-factor model had poor fit (Robust RMSEA = 0.130, 90% CI = 0.122, 0.139, Robust CFI = 0.855, Robust TLI = 0.831),

whereas the three-factor model had adequate to good fit (Robust RMSEA = 0.067, 90% CI = 0.059, 0.076, Robust CFI = 0.963, Robust TLI = 0.955). These results are consistent with Gray and McNaughton's (2000) rRST and meet the requirements of separate FFFS and rBIS factors articulated in the introduction of this paper (criterion 5).

Anger/Aggression State Scale

The purpose of this initial exploratory factor analysis was to understand how items in the item pool (Appendix K) were grouping together and to determine if our hypothesized three-factor model (Predatory aggression, defensive aggression, anger/frustration) would be feasible. It also seemed highly possible that items developed to reflect these distinct facets would share variance based on a) aggression (predatory aggression, defensive aggression) and b) negative affect (fear and rage in defensive aggression, and anger/frustration), resulting in one-factor or two-factor (fear/anger, aggression) models having the best fit. If possible, the second purpose of this EFA was to identify 3-5 items for each hypothesized sub-factor. Extant trait scales include the Fight facet of FFFS, but no scale has endeavored to include BAS-mediated forms of anger and aggression. This analysis used Sample 2 data (Table 2 for demographic information).

Skew (range = -0.29 to 2.17) and kurtosis (range = -0.14 to 4.51) in item scores were within acceptable levels. Item 22, "My face is flushed with anger" had a restricted range (1-6 out of 7 response categories) and was removed from further analysis. A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data. Because predatory aggression is conceptually experienced alongside positive BAS emotions (excitement, anticipation), it was anticipated that predatory aggression items would share small or negative correlations with frustrative aggression and defensive aggression items. However, we found that only items 4, "I feel powerful," and 6, "I feel confident" shared negative correlations with other

items. Re-examining the wording of some of the predatory aggression items revealed that the aspect of positive emotion was not apparent in many of them (e.g., item 1, “Right now, it seems to me that being dominant will get me what I want”), and that re-wording some of these predatory aggression items may be necessary in future iterations.

Most indices suggested a three-factor model would be the best fit for the data (RMR for three-factor = 0.032, difference in RMSEA from two- to three- factors = 0.027, residual correlations for 3-factor = 2). Scree plot and parallel analysis (100 iterations) suggested one-factor and a six-factor model respectively. Because the three-factor model was theoretically preferrable, and most indices suggested that it fit the data well, I proceeded with the three-factor model.

I estimated a three-factor model using ULS and Quartimin rotation. Predatory aggression items loaded primarily onto their intended factor (range = 0.60 to 0.82), with low cross-loadings (range = |0.01| to |0.12|). Anger/frustration items also loaded primarily onto their intended factor (range = .41 to 0.48), however, several had substantial cross-loadings (range = |0.02| to |0.35|). The third factor had loadings primarily from the defensive aggression items (e.g. Item 13, “I am angry that my point of view is not being considered”, 0.80). However, defensive aggression items loaded across the three factors, and sometimes had primary loadings on the predatory aggression and anger/frustration factors. I reasoned that this was likely happening because defensive aggression has some conceptual overlap with both predatory aggression and anger/frustration. Both predatory aggression and defensive aggression items reflect a willingness or an urge to behave aggressively. Both anger/frustration and defensive aggression items reflect emotions along the anger continuum (e.g., irritation, annoyance, anger). The results of this factor analysis suggest that some items were not conceptually distinct and that many defensive aggression items and some anger/frustration items would need to be reworded or removed.

Correlations

In order to determine which items were related to their intended motivational state (BAS, rBIS or FFFS), I examined the association between anger/aggression items with my rBIS, provisional BAS and provisional FFFS scale total scores. I also created a provisional scale to reflect state anger using two items that were theoretically ambiguous (did not clearly reflect item content from anger/frustration or defensive aggression: item 21, "My body is tense with anger", item 22, "My face is flushed with anger"). I discovered that the majority of predatory aggression items were not positively associated with the BAS-total score, a conceptual requirement of this scale (Criterion 8; with the exception of items 4, "I feel powerful," $r = 0.50$; and 6, "I feel confident," $r = 0.60$). Items 7, 8 and 9 ("I feel the urge to yell at others so that they'll give me the things I deserve," "I feel the urge to be threatening to get what is rightfully mine," "I feel the urge to be intimidating") were particularly highly associated with anger ($r = 0.67$; $r = 0.60$; $r = 0.58$, respectively). Predatory aggression is conceptually associated with BAS-related positive emotions (excitement or anticipation over getting a reward) and unassociated with anger. The positive correlation between anger and predatory aggression items therefore indicted that item content was not discriminating between different forms of aggression well. Additionally, items 4, 5, and 6 ("I feel powerful," "I feel dominant," "I feel confident") were not specific enough to predatory aggression on their own -- and might be more consistent with general BAS activation.

The items intended to measure anger/frustration generally had small, negative associations with BAS (range: -0.33 to 0.06); small to medium positive associations with FFFS (range: 0.30 to 0.51); and small to medium associations with rBIS (range: 0.25 to 0.59). Anger/frustration is conceptually an rBIS state potentiated by a BAS x FFFS conflict. I chose items that correlated more highly with rBIS than FFFS to retain for future scale development and decided to create new items that emphasized the possibility or desirability to continue pursuing goals, rather than give up. I reasoned that this may result in a more robust association with the rBIS scale, a less robust association with FFFS and possibly an association with BAS.

The items intended to measure defensive aggression had small, generally negative associations with BAS (range: -0.19 to 0.06); small to medium positive associations with FFFS (range: 0.26 to 0.45); and small to medium positive associations with rBIS (range: 0.25 to 0.44). Most had medium positive associations with anger, as intended but several did not (range: 0.26 to 0.55). I decided to retain items that were sufficiently correlated with anger and FFFS and discard those that were not.

Conclusion

Considering EFA parameters and associations with related constructs, I determined that there were several issues with the item pool that had to be resolved before a provisional scale could be constructed. With regards to the predatory aggression items, I determined that several of the items were not exclusively reflective of BAS-mediated aggression (dominance as a reward; aggression as a means to goal attainment). Additionally, several items were not exclusively reflective of anger and aggression but might be more generally BAS-related items (4,5,6).

With regards to anger/frustration, I determined that additional items should be added to reflect frustration where goal-pursuit is active rather than frustration characterized by withdrawal.

Finally, for the defensive aggression items, some items had more of a proactive and/or assertive tone (e.g., “I feel the need to stand up against future mistreatment,” which was also reflected in the pattern of correlations, factor loadings in the various analyses) not in line with rRST theories’ version of defensive aggression – a reactive, fear-based aggression. I removed any items that did not appear to accurately reflect defensive aggression.

Based on learning from the Anger/Aggression EFA, I removed several problematic items from the item pool and developed a number of new items. This new iteration of items was created to be more conceptually coherent and distinct from each other. I developed a new pool of predatory aggression items that each reflected: a) the presence of an appetitive stimuli (e.g. “something I want”,

this was intended to distinguish from defensive aggression); b) lack of rBIS activation (e.g. anxiety, hesitancy) related to the prospect of behaving aggressively (this was intended to distinguish from anger/frustration). I developed a new pool of defensive aggression items that each reflected: a) the presence of an aversive stimuli (e.g. threat); b) a defensive direction away from the aversive stimuli (e.g. a desire or intention to increase distance between self and threat); c) a readiness or willingness to behave aggressively. I also added some new anger/frustration items that reflected a) ongoing goal pursuit; b) nonreward (e.g., delay, partial reinforcement, omission); c) anger or frustration.

CFA on Final Anger/Aggression Items

This analysis was run on Sample 3 (See Table 3 for demographic information; see item pool in Appendix L). Based on learning from the second exploratory factor analysis, items were modified, and new items were generated to better capture constructs of interest. A total of 51 Anger/Aggression items were administered (15 predatory aggression, 13 anger/frustration, 17 defensive aggression and 6 general anger items). Four items from each factor (12 items in total) were selected for final Anger/Aggression scales (Appendix S). This study was pre-registered on the Open Science Framework website (Appendix U).

Descriptive Statistics. Skew (range = 0.21 to 3.04) and kurtosis (range = -1.40 to 10.76) in item scores was within acceptable range for most items with the exception of item 7, “Right now, I don’t care at all about potential repercussions of bullying others to get what I want;” which demonstrated sufficiently high levels of skewness and kurtosis to bias model estimates. An item with conceptual equivalence, but better with acceptable levels of skew and kurtosis was substituted (item 8, “Right now, I’m not worried about possible punishment for coercing others to get what I want”). Another item (item 23, “My rage is driving me to behave aggressively”) had skewness and kurtosis values approaching suggested cut-offs of Skew = 3 and Kurtosis = 7 (Kline, 2008), and was also substituted (item 24, “Fear

has me ready to repel any threats"). A scatterplot matrix showed that items were approximately linearly related and that Pearson product-moment correlations would be appropriate for the data.

Models tested. Three models were hypothesized and tested using confirmatory factor analysis. They are briefly described below.

1. 1-factor: The conceptual categories likely have significant overlap due to blending of the conceptual constructs they intend to measure: a) predatory aggression; b) affect relating to non-obtainment of reward (anger, frustration, irritation, annoyance); c) defensive aggression
2. 3-factor: This model would represent the three hypothesized factors: Predatory aggression, underpinned by the BAS; Anger/Frustration, also underpinned by the BAS; and defensive aggression, underpinned by the FFFS.
3. Bi-factor: This model would represent a Anger/Aggression general factor, and specific factors: predatory aggression, anger/frustration, and defensive aggression

Testing the Models. Latent variables for each model were scaled by fixing variance to 1 (where applicable). All models were estimated using the robust Maximum Likelihood method in lavaan (Rosseel, 2012). The robust fit indices of the three models (Table 9) indicated that the one-factor model did not fit the data well. The bifactor model had the best model fit indices (Robust RMSEA = 0.039, 90% CI = 0.024, 0.052; Robust CFI = 0.986; Robust TLI = 0.977; SRMR = 0.029). However, due to the shared variance between the defensive aggression and anger/frustration scale due to negative affect; and the shared variance between the predatory aggression and defensive aggression scales due to aggression, the bifactor model had parameters that would lead to difficulty in interpreting scale scores. Specifically, predatory aggression items and anger/frustration items loaded approximately equally onto the general factor and their specific factors; and defensive aggression items loaded more highly onto the general factor. Although these model parameters make sense given the shared variance between scales based

on negative affect and aggression, it would lead to issues with scale score interpretability. Because the three-factor model also showed good fit, Robust RMSEA = 0.51 [0.039, 0.063], Robust CFI = 0.969, Robust TLI = 0.961, SRMR = 0.044, and would be consistent with three individual scales, I decided to proceed with the three-factor model. Standardized factor loadings (Table 10) were fairly strong for all items (range = 0.639 to 0.770). In general, items had moderately high uniqueness values (range = 0.419 to 0.592), indicating that roughly half of the variance seen in items was the result of something other than the latent constructs in the three-factor model. Reliability for anger/aggression scales were good (predatory aggression: $\omega = 0.80$; defensive aggression: $\omega = 0.76$; anger/frustration: $\omega = 0.83$).

Validation with RST State and Trait Measures

Pearson product-moment correlations were obtained for scale total scores. Table 11 shows the intercorrelations between RST state scale scores; Table 12 shows the intercorrelations between the RST State Scale factors and the trait measures of RST motivational system sensitivity measured using the Reinforcement Sensitivity Theory of Personality Questionnaire – Short Form (RST-PQ-SF) and Defensive Fight scales. The RST State Motivational System Scales (state rBIS, state BAS, state FFFS) demonstrated the expected intercorrelations with each other and the RST trait scales (trait rBIS, trait BAS, trait FFFS). Specifically, state BAS was negatively associated with state rBIS (Anxious Uncertainty: $r = -0.46$; Behavioural Disengagement: $r = -0.63$) and state FFFS ($r = -0.37$). State rBIS and State FFFS were positively associated (Anxious Uncertainty: $r = 0.72$; Behavioural Disengagement: $r = 0.70$). State BAS was positively associated with trait BAS ($r = 0.62$); state rBIS was positively associated with trait rBIS ($r = 0.54$); and state FFFS was positively associated with trait FFFS ($r = 0.22$).

The state anger/aggression scales provided a more complex picture. Some associations were in line with predictions. As anticipated, state Defensive Aggression was positively associated with state FFFS ($r = 0.56$) and unassociated with state BAS ($r = 0.01$). But it was also positively associated with trait

BAS (r = 0.11) and unassociated with trait FFFS (r = 0.06). State Predatory Aggression and state Anger/Frustration were not positively associated with state BAS (PA, r = 0.08; A/F, r = -0.15) as anticipated; although state Predatory Aggression shares a positive association with state BAS-Impulsivity (r = 0.23) although state Defensive aggression was also positively associated with state BAS impulsivity (r = 0.21). Additionally, state Predatory Aggression shared a positive association with state FFFS (r = 0.27), state rBIS-Anxious Uncertainty (r = 0.17) and state rBIS-Behavioural Disengagement (r = 0.16). State Anger/Frustration was positively associated with state rBIS-Anxious Uncertainty (r = 54) and state rBIS-Behavioural Disengagement (r = 49) as anticipated.

Post-Hoc Correlations

Because we did not find the expected association between state Anger/Frustration and state BAS, I decided to test a theory articulated by Carver and Scheirer (2012) post-hoc: that Anger/ Frustration at low levels should result in increased goal-drive persistence; and at high levels should be associated with FFFS (avoidance/withdrawal) or rBIS-Behavioural disengagement. I looked at the Pearson-product moment correlations for participants who had scores in the lowest quartile on the anger/frustration scale (< 8). For these participants, there was a small, significant association with state Goal-Drive Persistence (r = 0.13) and all other BAS facets (range = 0.14 to 0.15); and no association with state Behavioural Disengagement (r = 0.02), state FFFS (r = 0.03) or state Anxious Uncertainty (r = 0.01). Contrary to Corr and Scheirer's (2012) theory, for highly frustrated people (upper quartile: scores on Anger/Frustration > 18, n = 143) there was a significant positive association between Anger/Frustration and Goal-Drive Persistence (r = 0.19). However, all other associations were as predicted: state Behavioural Disengagement (r = 0.12), Anxious Uncertainty (r = 0.12) and FFFS (r = 0.12). This suggests that at higher levels of Anger/Frustration, one might engage in rumination or risk assessment (rBIS-Anxious Uncertainty), stop trying to achieve your goal (rBIS-Behavioural Disengagement) or engage in

avoidance (FFFS); or, conversely, exert more effort to achieve a goal (BAS-Goal-drive persistence). This pattern of association shows partial support for Carver and Schierer's (2012) theory.

Discussion

Reinforcement Sensitivity Theory is a popular biologically-based theory of state motivation and a personality theory based on individual differences in sensitivity to reward and punishment. Since it's incarnation and through several revisions (Corr & Cooper, 2016; ; Corr, 2008; Gray, 1970; Gray & McNaughton, 2000), research based on RST has proliferated and grown, informing the development of prominent personality constructs such as sensation seeking (Zuckerman, 2007); research on psychopathology such as anxiety and depression (Zinbarg & Yoon, 2008) and psychopathy (Wallace & Newman, 2008); addictions (eg., alcohol misuse, Keough & O'Conner, 2014; Keough & O'conner, 2015; problem gambling, Keough et al., 2017); as well as diverse psychological constructs including procrastination (Bennett & Bacon, 2019), attachment (Jiang & Tiliopoulos, 2014; Shahzadi & Walker, 2020), eating behaviour (see Weydmann et al., 2022 for a review), organizational behaviour (Corr et al., 2016), emotional intelligence (Bacon & Corr, 2017), divergent thinking (Walker & Jackson, 2014), and more.

Several self-report scales have been constructed to measure RST system sensitivity (see Corr, 2016 and Torrubia et al., 2008 for reviews); although many of them do not reflect Gray and McNaughton's (2000) considerable revision to the theory which establishes two distinct threat-related motivational systems – one for anxiety (the Behavioural Inhibition System, rBIS) and one for fear (the Fight Flight Freeze System, FFFS); or mounting evidence that the appetitive/approach system (the Behavioural Activation System, BAS) is neurobiologically and behaviourally multifaceted (Carver & White, 1994; Corr & Cooper; Corr, 2008; 2016; Corr, 2016; Krupic & Corr, 2017).

Research using trait-level scales have added considerably to our understanding of how oRST (oBIS, BAS) and rRST (rBIS, BAS and FFFS) system sensitivities are related to other traits (e.g. Machiavellianism, Psychopathy, Narcissism; Neria et al., 2016), and even other states (e.g. anger; Corr, 2004). Trait-level scales have allowed for research to test and extend upon Gray and colleague's RST of Personality theory. However, integral to RST Personality theory is the theory of RST state motivation – specifically how emotional-motivational systems function dynamically in response to a variety of appetitive and aversive stimuli. In order to move forward with RST as both a theory of state motivation, and a personality theory – and especially to increase our understanding of RST motivational systems in human populations, valid and reliable measures of state RST system activation based on current versions of RST are required.

Extant state measures of RST system activation do not have established validity and reliability, or are outdated. One common way of measuring RST system activation is to use EEG markers EEG markers which conflate avoidance (FFFS) and conflict (rBIS; Harmon-Jones & Allen, 1998; Lacey & Gable, 2021; eg., Nash et al., 2012) or modification of outdated trait-level scales (e.g., Eftekhari et al., 2017). Currently no validated self-report state measure of motivational system activation exists.

In order to address the need for a valid, reliable and theoretically up-to-date measure of rRST system activation, I conducted a series of studies to develop and establish preliminary validation of a suite of six state scales measuring in the moment activation of revised Reinforcement Sensitivity Theory (rRST) motivational systems. These scales represent the first psychometrically validated state level measure of RST systems. The rRST state scales were also developed based on the most up-to-date understanding of rRST, including multidimensional BAS, separate fear (FFFS) and anxiety (rBIS) systems.

In a series of factor analyses, I established the internal validity of a state Behavioural Activation Scale, state Behavioural Inhibition Scale, state Flight, Freeze (Fear) Scale, state Defensive Aggression

Scale, state Predatory Aggression Scale and a state Anger/Frustration Scale. I also established construct validity by examining correlations between trait level measures of BAS, rBIS, FFFS and Defensive Fight. Future work is planned to establish construct validity among related constructs measured by a variety of related state and trait scales.

rRST State System Scales (rBIS, BAS and FFFS State Scales)

The rRST System State Scales (the rBIS, BAS and FFFS state scales) met all nine of the theory-based requirements outlined in the introduction of this paper. Exploratory Factor Analyses revealed robust two-factor structure for the State rBIS scale (criterion 3), one-factor structure for the FFFS state scale (criterion 2), and a four-factor structure for the BAS scale (criterion 1). These factor structures were supported using a CFA in a subsequent sample[3]. Motivational system state scales (rBIS, BAS, FFFS) demonstrated the expected pattern of associations with each other (criteria 4 and 6) and with related trait level constructs (criteria 11, 12, 13).

I established strong structural validity for the rRST defensive state scales (rBIS and FFFS). Specifically, rBIS items formed two factors, one relating anxious uncertainty; and the other relating to behavioural disengagement. This factor structure provides support for Gray and McNaughton's (2000) proposal that rBIS activation can result in distinct states based on whether aversive stimuli are avoidable or not. Of the existing rRST scales, only one other – the RST-PQ (Corr & Cooper, 2016) have included items that reflects behavioural disengagement in their trait rBIS scale. However behavioural disengagement is not a distinct factor on the RST-PQ, making the factor structure of the rBIS state scale reported in this thesis novel, but consistent with rRST. Because anxious uncertainty and behavioural disengagement, and their corresponding syndromes – anxiety disorders and depression, both arise out

[3] BAS-impulsivity items were replaced between the EFA and CFA, so the CFA is not a direct replication /confirmation of the earlier factor structure.

of the functioning of the septohippocampal system, a one-factor structure for a trait rBIS scale is theoretically coherent as both tendencies reflect rBIS sensitivity. However, at a state level, anxious uncertainty and behavioural disengagement are for the most part mutually exclusive. Anxious uncertainty is a high-arousal state occurring in situations where aversive stimuli are perceived as avoidable; whereas behavioural disengagement is a low-arousal state occurring in situations where aversive stimuli are perceived as unavoidable. Put simply, when in a state of anxious uncertainty, there's hope that bad things will be avoided and you're actively trying to figure out how to get out of your situation unscathed. When in a state of behavioural disengagement, you've given up. Therefore, a tendency towards states of anxious uncertainty and behavioural disengagement are related at the trait level, but in-the-moment, they are distinct. As such, a two-factor state scale and a one-factor trait scale to be theoretically coherent with each other.

The FFFS scale formed one factor (excluding defensive fight), which demonstrated adequate model fit (criterion 2). Of the trait measures of rRST, one scale has a one-factor structure for FFFS (with a separate fight scale, RST-PQ: Corr & Cooper, 2016) and three have a three-factor structure (fight, flight, freeze; J-5: Jackson, 2009; rRST-Q: Reuter et al., 2015; RSQ: Smederevac et al., 2014). It has become convention in RST scale development to separate the fight factor from other FFFS content due to the tendency of fight and BAS to correlate at the trait level, and the theoretical ambiguity surrounding how aggression is related to rRST systems (Corr, 2016). The decision to pursue a one-factor structure rather than a three-factor structure for the FFFS scale was based on the fact that these behavioural outputs are all derived from the same motivational-emotional system that gives rise to fear.

Consistent with the substantial revision to RST in 2000 (Gray & McNaughton, 2000), FFFS and rBIS items formed distinct factors (criterion 5). The distinction between the phenomenological, behavioural and adaptive function of fear and anxiety represents an important theoretical contribution to our understanding of defensive behaviour that is still often overlooked in research, twenty-two years

later. Fear and anxiety serve different purposes. Fear is experienced in the presence of threat that must be escaped. It facilitates avoidance behaviour: running away, freezing in place or fighting. Anxiety is experienced in threatening situations were there is some ambiguity about the level or presence of threat. Anxiety, vigilance and information-seeking help us to resolve this uncertainty. This neurobiological and behaviour distinction sheds light on why we are prone to these unpleasant states, the adaptive purpose they serve, as well as bringing us closer to understanding how malfunctioning defensive systems give rise to psychopathology such as phobias and anxiety disorders.

I also established structural validity of the state BAS scales. The BAS items formed four sub-factors reflecting Reward Interest, Goal-Drive persistence, Reward Reactivity and Impulsivity (criterion 1), which contribute to a single higher-order factor, reflecting overall BAS activation. We tested four-factor, one-factor, bi-factor and higher-order models during scale development. I found that a four-factor and higher-order models (consisting of four subscales contributing to a full-scale BAS activation total-score) had adequate fit. This is the first factor analytic study to establish support for Corr's (2008) multifaceted state-BAS theory, and the factor structure mirrors the theorized neurobiological organization of the system. This theory proposes that there are four highly coordinated biological systems that underpin approach behaviour that serve to move an organism up the temporospatial gradient towards a reinforcer. Briefly, these processes entail a) reward Interest: seeking and identifying rewards; b) goal-drive persistence: planning, effort to obtain rewards; c) impulsivity: fast action to obtain a reward when it is within grasp; d) reward reactivity: enjoyment of reward once the reward is obtained. Corr and Cooper (2016) have developed a trait-level scale with these factors; but this is the first state-level scale to do so. Further work is needed to substantiate proposed biological systems that underpin this approach behaviour (e.g., Krupic & Corr, 2017).

Although overall model fit for the BAS scale was adequate, the BAS impulsivity facet is not as strong. Given that the nature of the relationship between BAS sensitivity and Impulsivity remains

somewhat unclear, use of this impulsivity sub-scale should be taken with care. More research is needed to evaluate competing theories about BAS activation and impulsivity. As outlined in the introduction of this paper, different theorists have proposed different relationships between impulsivity and RST: a) that is the behavioural output of a highly activated BAS; b) that impulsivity is related to; but not a direct behavioural output of the BAS; and c) consistent with the operationalization in this thesis, that impulsivity is a behavioural output of the BAS at small temporospatial distances to a reinforcer and represents one of four factors that make up BAS behavioural output. Because we did not find strong support for the idea that impulsivity is a sub-factor of BAS, an interesting line of future work might be to test the possibility that impulsivity is a behavioural output of the BAS when BAS is highly activated. Statistical procedures from IRT that estimate item difficulty could provide some clarity on this. If impulsivity is a behavioural output of BAS when BAS is highly active, as researchers suggest (Dawe & Loxton, 2004; Gullo & Dawe, 2008), we would expect that impulsivity would be associated with higher item difficulty. In other words, we would expect people to indicate more impulsivity when they had indicated a high level of agreement with other BAS subfactors (Reward Interest, Goal-Drive Persistence, Reward Reactivity).

Understanding how impulsivity is related to reward sensitivity is also important in understanding how aggression and RST are related. In the current study, we found that BAS-Impulsivity was the main driver of BAS-aggression association. The relationship between impulsivity and aggression has been found in other research (e.g., Carlson et al., 2013; Perez Fuentes et al., 2016). Furthermore, theoretical accounts of aggressive behaviour exhibited by Type 1 and Type 2 psychopaths mirrors Gullo and Loxton's (2004) Rash Impulsivity and Reward Drive distinction. Specifically, Fowles has argued that Type 1 psychopaths have deficient oBIS systems and Type 2 psychopaths have overexcitable BAS systems. In other words, Fowles is arguing that Type 1 psychopaths exhibit rash impulsivity while Type 2 psychopath's impulsive behaviour is characterized by reward drive. Given that both impulsivity and

anger/aggression are sources of controversy within rRST, and the two constructs are related to each other, bringing more clarity to the relationship of impulsivity to various RST systems would be a useful starting point for future research.

The rRST state scales also were associated with each other; and with trait rRST scales in a theoretically coherent way. The RST State Motivational System Scales (state rBIS, state BAS, state FFFS) demonstrated the expected intercorrelations with each other and the RST trait scales (trait rBIS, trait BAS, trait FFFS), although the state and trait FFFS measures shared a smaller positive association with each other compared to other state-trait measure combinations. This was likely due to the way trait FFFS is operationalized. Previous scale developers have noted a distinction between a) the frequency with which someone experiences fear and FFFS activation; and b) the sensitivity of the FFFS. The main idea here is that people with sensitive FFF systems may not actually experience more frequent or intense FFFS activation because they will take care to avoid situations in which they are likely to experience fear (Gray, 1987a). It has become practice to operationalize FFFS sensitivity with hypothetical situations, (e.g., from the RST-PQ-SF: “I would run quickly if fire alarms in a shopping mall started ringing”) rather than assessing the frequency with which someone experiences FFFS activation. Trait measures of BAS and rBIS are based on frequency of experienced states (e.g., from the RST-PQ: “I often worry about letting down other people”, or “I regularly try new activities just to see if I enjoy them”). When trait measures reflect a tendency (increased frequency and/or intensity) to experience a state, you would anticipate a high degree of association between state and trait measures. However, because the FFFS trait scale takes into account the tendency of people with highly sensitive FFFS to engage in avoidance behaviour, thereby decreasing their tendency to experience fear, this association may be attenuated – as seen in this thesis.

Taken together, rBIS, BAS and FFFS state scales have demonstrated good structural validity, reliability and preliminary external validity. Additionally, this thesis has provided some initial

psychometric support for Corr and Coopers (2016) multifaceted BAS theory at the state level, and Gray and McNaughton's (2000) two-factor BIS theory at the state level. Future research is needed to establish external validity with established scales, structural invariance, and sensitivity to changes over time.

Anger/Aggression scales

The Anger/Aggression scales met some of the criteria (criteria 7, 9 and 14) outlined at the beginning of this paper. First, they demonstrated a robust 3-factor structure using a CFA (criterion 7). The Defensive Aggression scale demonstrated the expected pattern of associations with the FFFS and BAS state scales (criterion 9); and with trait defensive fight (criterion 14).

Defensive Aggression State scale

The Defensive Aggression scale demonstrated good psychometric properties and met the criteria for associations with rRST motivational system scales. Specifically, the Defensive Aggression scale was uncorrelated with the BAS State scale and had a positive association with FFFS. This is consistent with theory, as defensive aggression is conceptually mediated by the FFFS, accompanied by feelings of range and/or fear and serves the purpose to distance the self from aversive stimuli. Measuring defensive aggression has posed a long-standing problem for RST scale developers. Defensive fight and BAS scales are often positively associated at the trait level: Fight and BAS scales are positively associated for the RST-PQ (range with subscale: r = 0.19 to 0.39, Corr & Cooper) the rRST-Q (r = 0.37, Reuter et al., and the RSQ (r = 0.43, Smedervac et al., 2014). Furthermore, the body of research produced by Harmon-Jones and colleagues research (Carver, 2004; Harmon-Jones & Allen, 1998; Harmon-Jones, 2003; Harmon-Jones et al., 2003; Harmon-Jones & Siegelman, 2001; see Carver & Harmon-Jones, 2009 for a review) that has suggested that anger and aggression are related to the BAS rather than the oBIS. Because of these two consistent findings being at odds with animal research, there has been considerable debate surrounding how defensive aggression are related to RST. In this thesis, I

made clear conceptual distinctions between fear-based aggression, anger/frustration and predatory aggression. This differs from current trait-level scales of defensive aggression which often contain items that reflect anger, frustration or even proactive aggression (e.g. standing up for yourself), which may be conceptually more related to BAS-goals than FFFS-mediated fighting to save oneself (McNaughton & Corr, 2012). I found that excluding content related to proactive aggression or frustrative anger led to associations with state FFFS and BAS that are more in line with rRST and animal paradigms.

Anger/Frustration State scale

The Anger/Frustration state scale was negatively associated with state BAS, contrary to what was originally theorized (criterion 10). However, in post-hoc analyses, I found some support for Carver and Shierer's (2012) theory that frustration should be associated with (BAS-mediated) Goal-Drive Persistence at lower levels and (rBIS mediated) Behavioural Disengagement at higher levels. Specifically, I found that participants who scored in the lower quartile for Anger/Frustration, the Anger/Frustration scale had a small positive association with BAS. Participants who scored in the upper quartile on the Anger/Frustration scale had small positive associations with both rBIS scales and the FFFS scale. However, there was also a small positive association with the BAS-Goal Drive persistence scale for these participants. This finding, although inconsistent with Carver and Shierer's (2012) hypothesis, highlights the likely contribution of individual differences in self-regulatory or cognitive constructs not included in RST such as self-efficacy (Bandura, 1977) – or confidence in one's own ability to succeed in a plan of action, in frustrating situations. Judgements of one's own self-efficacy may lead to individual differences in responses to frustrating events.

In addition, associations between BAS and Anger/Frustration scores may be attenuated due to affective valance. Associations between trait measures of anger and BAS sensitivity have previously been found only when valance has been controlled for. It is likely that valance is driving the negative

association between Anger/Frustration and BAS in the current study. Anger and frustration are negatively valanced, activated emotions; while most BAS items mention positively valanced, activated emotions (e.g., "I feel great because of good things in my life"). Previous work relating Anger to RST systems has discussed the conflation of valance and approach/avoidance in self-report measures (Carver & Harmon-Jones, 2009; Harmon-Jones, 2003). Harmon-Jones (2003) found significant associations between trait measures of anger and trait measures of BAS, only when valance was a co-variate.

Given the good content validity of the Anger/Frustration scale, the theoretical complexity of anger and frustration (a BIS state potentiated by a BAS x FFFS conflict), and the well-established confounding influence of affect, the lack of association between BAS and Anger/Aggression (criterion 10) does not represent a substantial issue of validity. Future correlational studies that control for emotional valence could be conducted to determine whether the Anger/Frustration scale correlates with BAS as originally theorized.

Predatory Aggression state scale

The Predatory Aggression scale had two problematic associations. The first was the lack of positive association with state BAS. The conceptualization of Predatory Aggression in this thesis entails using aggressive behaviour to obtain a reinforcer. It is essentially a BAS-mediated behaviour and should be accompanied by typical state BAS activation expressed in the state BAS scale (e.g., Reward Interest, Goal-Drive Persistence, Reward Reactivity, Impulsivity). In the current study, the Predatory Aggression scale was only found to be positively associated with BAS-Impulsivity, and not the other BAS facets.

There are a few possible explanations for the lack of association between predatory aggression and BAS in this study. First, it's possible that the presence of reward is not salient in the predatory aggression items. The predatory aggression items are lengthy and contain a number of ideas: a) aggression; b) lack of anxious uncertainty; c) reward obtainment; d) state (vs. trait) distinction (e.g.,

"Right now, the prospect of hurting others to get what I want doesn't make me feel anxious at all"). This item content in line with our operationalization that Predatory Aggression: an instrumental-aggressive impulse that has not been inhibited by the rBIS, even though aggression is associated with a several negative consequences (e.g., social, legal, intrapersonal) and should therefore create an approach-avoidance goal-conflict. It is therefore possible that the purpose of the aggression (reward obtainment) is not salient when accompanied by other more exciting concepts (e.g., "hurting others," "feel anxious").

The second possible explanation for why there was no association observed between state BAS and state Predatory Aggression is that there is a low base rate of people willing to engage in aggressive behaviour for goal pursuit. In the current sample, Predatory Aggression items were highly negatively skewed. Corr (2010) and others have stated that Predatory Aggression is most often observed in Type 1 Psychopaths. Psychopaths comprise 1% of general population (Hare, 1996, as cited in Corr, 2010). Future research may require validation in populations that are more prone to this type of BAS-mediated instrumental aggression.

The third possible explanation for why there was no association observed between state BAS and state Predatory Aggression might also explain the second problematic association that was observed with the Predatory Aggression scale: a small positive association with the FFFS (r = .27). Both problematic associations (lack of association with BAS, positive association with FFFS) might be explained by context effects. In the current study, items representing all three facets of Anger/Aggression (Predatory Aggression, Anger/Frustration and Defensive Aggression) were presented together in random order. It is therefore possible that the negative valance (anger, fear) of the other scales was incorporated into participants' understanding and responses to the Predatory Aggression items. Future work could include predatory aggression items alongside BAS items to lend better context to the items.

In conclusion, the State Defensive Aggression and State Anger/Frustration scales have demonstrated excellent structural validity and internal validity. Validating the scales against the rRST State scales is complicated by several potential measurement issues (affect, context effects, base rates). Nevertheless, the pattern of associations for the Defensive Aggression State scale and the Anger/Frustration State scale are largely consistent with theory. Specifically, Anger/Frustration is associated with BAS activation when levels of Anger/Frustration are low; and associated with Behavioural Disengagement and FFFS when Anger/Frustration is high. However, it appears that high Anger/Frustration can also accompany increased effort (goal drive persistence), inconsistent with Carver and Schierer's (2012) hypothesis.

Finally, the Predatory Aggression State scale shows good structural validity but does not meet all of the required criteria outlined in the introduction of this paper. Specifically, it is not positively associated with state BAS; and it shares small positive associations with state FFFS and the two state rBIS scales. Three possibilities have been reviewed: a) that the items are not written clearly and reward is not salient; b) that there is a low base rate associated with this type of aggression; c) context effects based on the study's methodology may have affected how participants interpreted the predatory aggression items. These possibilities suggest three future directions for the development of the Predatory Aggression scale.

First, the State Predatory Aggression scale could be administered to a population that is more likely to endorse the items. The predatory aggression items should also be validated against trait measures of instrumental aggression, given that there is some question with regards to their content validity. Second, the predatory aggression items could appear alongside BAS items. This would utilize context effects to the benefit of the predatory aggression items. Finally, additional items could be generated for future iterations of scale development.

On a final note, in addition to the three potential measurement issues outlined above, there is a theoretical explanation for the association between predatory aggression and state fear. Previous researchers note that instances of aggression pertaining to the acquisition or protection of resources are dynamic. Even if a fight starts out as entirely resource-motivated and BAS-driven for both participants, it will quickly change to a defensive motivation for one of the participants (Blanchard & Blanchard, 2005). Furthermore, resource acquisition might be characterized by both BAS and FFFS mediated emotions and motivations. Panksepp and Zellner (2005) suggests that the common bimodal phenotypic distinction between predatory (or instrumental or offensive) aggression and defensive (or affective, or reactive) aggression may be better conceptualized as a continuum based on whether resource acquisition is only desired or necessary (i.e., failure to acquire resources is a threat). For example, an animal's initial attempt to get food might be primarily motivated by BAS. However, if the animal is unsuccessful for long enough, a failure to procure a meal will become more and more threatening, and more and more part of the motivational picture.

Conclusion

In this thesis, I described the development and preliminary validation of a suite of brief revised Reinforcement Sensitivity Theory state scales. These scales represent the first psychometrically validated purpose-built self-report measure of rRST system activation. The state Behavioural Activation System, state revised Behavioural Inhibition System and state Fight Flight Freeze System scales have all demonstrated robust structural, convergent and divergent validity. These scales offer a theoretically up-to-date, brief, cost-effective, psychometrically valid and reliable way to measure in-the-moment revised Reinforcement Sensitivity Theory emotional-motivational system activation. The BAS scale has meaningful unitary and sub-factor interpretation, which provides a useful tool to examine specific questions about how the BAS functions at different tempero-spatial gradients to the reinforcer; as well as provides a way to contextualize BAS activation with respect to previous research done with unitary

and multidimensional trait measures of BAS. Future work is needed to establish convergent and divergent validity with a wider variety of related and unrelated constructs, as well as invariance between different populations.

The present work has also contributed to understanding of rRST motivational systems and related anger and aggression at the state level. Specifically, CFAs were used to test competing models of rBIS, BAS and anger/aggression constructs (Predatory Aggression, Defensive Aggression, Frustrative nonreward) at the state level. We found that the rBIS had a robust two-factor structure reflecting Anxious Uncertainty and Behavioural Disengagement – two distinct states derived from the BIS that had been previously theorized. This study also provided support for Corr's multidimensional BAS hypothesis and represents the first test of this theory at the state level. Preliminary development of the Anger/Aggression scales has advanced understanding of how anger and aggression are related to rRST system activation at the state level; and has added clarity to some of the methodological challenges of assessing conceptually BAS- rBIS- and FFFS- mediated anger and aggression at state level. Specifically, this thesis has demonstrated that it is possible to distinguish between Predatory aggression, defensive aggression and frustrative nonreward at the state level, as evidenced by the robust three-factor structure of the current scale. Future work will be needed to disentangle the cause of the intercorrelations among anger/aggression scales and rRST emotional-motivational state scales to determine whether theoretically inconsistent intercorrelations are the result of measurement effects, or represent associations that can be used to expand upon our understanding of how anger and aggression are related to rRST.

References

Albrecht, B. et al. (2017). Benzodiazepine Use of Community-Based Violent Offenders: a Preliminary Investigation. *Journal of Substance Use, 22*(3), 295–303. https://doi-org.ezproxy.library.yorku.ca/10.1080/14659891.2016.1195893

Averill, J. R. (2012). *Anger and aggression: An essay on emotion.* Springer Science & Business Media.

Baars, M. Y., Müller, M. J., Gallhofer, B., & Netter, P. (2011). Depressive and aggressive responses to frustration: Development of a questionnaire and its validation in a sample of male alcoholics. *Depression Research and Treatment, 2011,* Article ID 352048. https://doi.org/10.1155/2011/352048

Bacon, A. M., Corr, P.J. (2019). Motivating emotional intelligence: A reinforcement sensitivity theory (RST) perspective. *Motiv Emot 41*, 254–264. https://doi.org/10.1007/s11031-017-9602-1

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review, 84*(2). https://doi.org/10.1037/0033-295X.84.2.191

Bennett, C., & Bacon, A. M. (2019). At long last-A Reinforcement Sensitivity Theory explanation of procrastination. *Journal of Individual Differences, 40*(4), 234–241. https://doi.org/10.1027/1614-0001/a000296

Ben-Porath, D. D., & Taylor, S. P. (2002). The effects of diazepam (valium) and aggressive disposition on human aggression: an experimental investigation. *Addictive behaviors*, *27*(2), 167-177. https://doi.org/10.1016/S0306-4603(00)00175-1

Berkowitz, L. (1993). *Aggression: Its causes, consequences and control.* New York: McGraw-Hill

Bernaards, C., A. and Jennrich, R., I. (2005) Gradient Projection Algorithms and Software for Arbitrary Rotation Criteria in Factor Analysis, *Educational and Psychological Measurement: 65,* 676-696. http://www.stat.ucla.edu/research/gpa

Berridge, K. C. (1996). Food reward: Brain substrates of wanting and liking. *Neuroscience & Biobehavioral Reviews, 20*(1), 1-25. https://doi.org/10.1016/0149-7634(95)00033-B

Berridge, K. C. (2007). The debate over dopamine's role in reward: The case for incentive salience. *Psychopharmacology, 191*(3), 391-431. https://doi.org/10.1007/s00213-006-0578-x

Berridge, K. C. (2009). Wanting and liking: Observations from the neuroscience and psychology laboratory. *Inquiry, 52*(4), 1-18. https://doi.org/10.1080/00201740903087359

Berridge, K. C., & Kringelbach, M. L. (2013). Neuroscience of affect: Brain mechanisms of pleasure and displeasure. *Current Opinion in Neurobiology, 23*(3), 294-303. https://doi.org/10.1016/j.conb.2013.01.017

Berridge, K. C., & Robinson, T. E. (1998). What is the role of dopamine in reward: Hedonic impact, reward learning, or incentive salience? *Brain Research Reviews, 28*(3), 309-369. https://doi.org/10.1016/S0165-0173(98)00019-8

Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neurosciences, 26*(9), 507-513. https://doi.org/10.1016/S0166-2236(03)00233-9

Berridge, K. C., & Robinson, T. E. (2016). Liking, wanting, and the incentive-sensitization theory of addiction. *American Psychologist, 71*(8), 670-679. https://doi.org/10.1037/amp0000059

Blanchard, D. C. (2017). Translating dynamic defense patterns from rodents to people. *Neuroscience & Biobehavioral Reviews*, *76*, 22-28. https://doi.org/10.1016/j.neubiorev.2016.11.001

Blanchard, D. C., & Blanchard, R. J. (2003). What can animal aggression research tell us about human aggression? *Hormones and Behavior, 44*(3), 171–177. https://doi.org/10.1016/S0018-506X(03)00133-8

Blachard, D. C., & Blanchard, R. J. (2005). Stress and Aggression. In R. J. Nelson (Ed.), *Biology of Aggression* (pp. 275 – 291). Oxford University Press.

Blanchard, C. D., Hynd, A. L., Minke, K. A., Minemoto, T., & Blanchard, R. J. (2001). Human defensive behaviors to threat scenarios show parallels to fear- and anxiety-related defense patterns of non-human mammals. *Neuroscience & Biobehavioral Reviews, 25*(7-8), 761 – 770. https://doi.org/10.1016/S0149-7634(01)00056-2

Blanchard, D. C., Defensor, E. B., & Blanchard, R. J. (2010). Fear, anxiety, and defensive behaviors in animals. *Encyclopedia of Behavioral Neuroscience*, 532–537. https://doi.org/10.1016/B978-0-08-045396-5.00090-7

Blanchard, D. C., Veniegas, R., Elloran, I., & Blanchard, R. J. (1993). Alcohol and anxiety: Effects of offensive and defensive aggression. *Journal of Studies on Alcohol, 54*(11), 9–19. https://doi.org/10.15288/jsas.1993.s11.9

Bliese, P. (2016). multilevel: Multilevel Functions. *R package version 2.6.* https://CRAN.R-project.org/package=multilevel

Bond, A. J., & Silveira, J. C. (1993). The combination of alprazolam and alcohol on behavioral aggression. *Journal of Studies on Alcohol, Supplement*, (11), 30-39. https://doi.org/10.15288/jsas.1993.s11.30

Broerman, R. L., Ross, S. R., & Corr, P. J. (2014). Throwing more light on the dark side of psychopathy: An extension of previous findings for the revised Reinforcement Sensitivity Theory. *Personality and Individual Differences, 68,* 165–169. https://doi.org/10.1016/j.paid.2014.04.024

Browne, M. W., & Cudeck, R. (1992). Alternative ways of assessing model fit. *Sociological methods & research*, *21*(2), 230-258.

Cardoso Melo, R. D., Groen, R. N., & Hartman, C. A. (2022). Reward sensitivity at age 13 predicts the future course of psychopathology symptoms. *Frontiers in Psychiatry, 13*, 1–12. https://doi.org/10.3389/fpsyt.2022.818047

Carlson, S. R., Pritchard, A. A., & Dominelli, R. M. (2013). Externalizing behavior, the UPPS-P Impulsive Behavior scale and Reward and Punishment Sensitivity. *Personality and Individual Differences, 54*(2), 202–207. https://doi.org/10.1016/j.paid.2012.08.039

Carver, C. S. (2004). Negative Affects Deriving from the Behavioral Approach System. *Emotion, 4*(1), 3–22. https://doi.org/10.1037/1528-3542.4.1.3

Carver, C. S. (2006). Approach, avoidance, and the self-regulation of affect and action. *Motivation and Emotion, 30*(2), 105–110. https://doi.org/10.1007/s11031-006-9044-7

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135*(2), 183–204. https://doi.org/10.1037/a0013965

Carver, C. S., & Scheier, M. F. (2012). Expectancies and disengagement. *On the Self-Regulation of Behavior,* 171–189. https://doi.org/10.1017/cbo9781139174794.011

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67*(2), 319–333. https://doi.org /10.1037/0022-3514.67.2.319

Chester, D. S. (2017). The Role of Positive Affect in Aggression. *Current Directions in Psychological Science, 26*(4), 366–370. https://doi.org/10.1177/0963721417700457

Cloninger, C. R. (1987). A systematic method for clinical description and classification of personality variants, *Archives of General Psychiatry, 44*(6), 573–588. https://doi.org/10.1001/archpsyc.1987.01800180093014

Coan, J. A., & Allen, J. J. B. (2004). Frontal EEG asymmetry as a moderator and mediator of emotion. *Biological Psychology, 67*(1-2), 7–49. https://doi.org/10.1016/j.biopsycho.2004.03.002

Collins, M. D., Jackson, C. J., Walker, B. R., O'Connor, P. J., & Gardiner, E. (2017). Integrating the context-appropriate balanced attention model and reinforcement sensitivity theory: Towards a domain-general personality process model. *Psychological Bulletin, 143*(1), 91–106. https://doi.org/10.1037/bul0000082

Corr, P. J. (2002). J.A. Gray's reinforcement sensitivity theory and frustrative nonreward: A theoretical note on expectancies in reactions to rewarding stimuli. *Personality and Individual Differences, 32*(7), 1247–1253. https://doi.org/10.1016/S0191-8869(01)00115-5

Corr, P. J. (2008). Reinforcement sensitivity theory (RST): Introduction. In P. J. Corr (Ed) *The Reinforcement Sensitivity Theory of Personality* (pp 1 – 43). Cambridge University Press. https://doi.org/10.1017/CBO9780511819384.002

Corr, P. J. (2010). The psychoticism-psychopathy continuum: A neuropsychological model of core deficits. *Personality and Individual Differences, 48*(6), 695–703. https://doi.org/10.1016/j.paid.2009.12.023

Corr, P. J. (2013). Approach and avoidance behaviour: Multiple systems and their interactions. *Emotion Review, 5*(3), 285–290. https://doi.org/10.1177/1754073913477507

Corr, P. J. (2016). Reinforcement Sensitivity Theory of Personality Questionnaires: Structural survey with recommendations. *Personality and Individual Differences, 89*, 60–64. https://doi.org/10.1016/j.paid.2015.09.045

Corr, P. J., & Cooper, A. J. (2016). The reinforcement sensitivity theory of personality questionnaire (RST-PQ): Development and validation. *Psychological Assessment, 28*(11), 1427–1440. https://doi.org/10.1037/pas0000273

Corr, P. J., & Krupic, D. (2022). Approach – Avoidance Theories of Personality. In P. J. Corr & G. Matthews (Eds.), *The Cambridge handbook of personality psychology* (pp. 259–272). Cambridge University Press. https://doi.org/10.1017/9781108264822.025

Corr, P. J., & McNaughton, N. (2008). Reinforcement sensitivity theory and personality. In P. J. Corr (Ed) The Reinforcement Sensitivity Theory of Personality (pp 155 - 187). https://doi.org/10.1017/CBO9780511819384.006

Corr, P. J., & McNaughton, N. (2012). Neuroscience and approach/avoidance personality traits: A two stage (valuation-motivation) approach. *Neuroscience and Biobehavioral Reviews, 36*(10), 2339–2354. https://doi.org/10.1016/j.neubiorev.2012.09.013

Corr, P. J., & McNaughton, N. (2019). Sensitivity to Punishment and Reward: Revisiting Gray (1970), In P. J. Corr (Ed.), *Personality and individual differences: Revisiting the classic studies* (pp. 115-136). Sage.

Corr, P.J., McNaughton, N., Wilson, M.R., Hutchison, A., Burch, G. & Poropat, A. (2016), Neuroscience of Motivation and Organizational Behavior: Putting the Reinforcement Sensitivity Theory (RST) to Work. In S.I. Kim, J. Reeve & M. Bong (Eds.), *Recent Developments in Neuroscience Research on Human Motivation* (Vol. 19, pp. 65-92). Emerald Group Publishing Limited.

Corr, P., & Perkins, A. (2009). Differentiating defensive and predatory aggression: Neuropsychological systems and personality in sex differences. *Behavioral and Brain Sciences, 32*(3-4), 274-275. doi:10.1017/S0140525X09990434

Courtiol, E., Menezes, E. C., & Teixeira, C. M. (2021). Serotonergic regulation of the dopaminergic system: Implications for reward-related functions. *Neuroscience and Biobehavioral Reviews, 128*, 282–293. https://doi.org/10.1016/j.neubiorev.2021.06.022

Dawe, S., & Loxton, N. J. (2004). The role of impulsivity in the development of substance use and eating disorders. *Neuroscience and Biobehavioral Reviews, 28*(3), 343–351. https://doi.org/10.1016/j.neubiorev.2004.03.007

Dawe, S., Gullo, M. J., & Loxton, N. J. (2004). Reward drive and rash impulsiveness as dimensions of impulsivity: Implications for substance misuse. *Addictive Behaviors, 29*(7), 1389–1405. https://doi.org/10.1016/j.addbeh.2004.06.004

Dawkins, R., & Krebs, J. R. (1979). Arms races between and within species. *Proceedings of the Royal Society of London. Series B. Biological Sciences*, *205*(1161), 489-511.

Depue, R. and Iacono, W. (1989), Neurobehavioral aspects of affective disorders, *Annual Review of Psychology,* 40, 457–492. https://doi.org/10.1146/annurev.ps.40.020189.002325

Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences, 22*(3), 491–517. https://doi.org/10.1017/S0140525X99002046

Dickman, S. J. (1990). Functional and dysfunctional impulsivity: personality and cognitive correlates. *Journal of Personality and Social Psychology, 58*(1), 95–102. https://doi.org/10.1037/0022-3514.58.1.95

Eatough, V., Smith, J. A., & Shaw, R. (2008). Women, anger, and aggression: An interpretive phenomenological analysis. *Journal of Interpersonal Violence, 23*(12), 1767–1799. https://doi.og/10.1177/0886260508314932

Elliot, A. J., & McGregor, H. A. (2001). A 2 × 2 achievement goal framework. *Journal of Personality & Social Psychology, 80*(3), 501–519. https://doi.og/10.1037//0022-3514.80.3.501

Elliot, A. J., & Thrash, T. M. (2010). Approach and avoidance temperament as basic dimensions of personality. *Journal of Personality, 78*(3), 865–906. https://doi.org/10.1111/j.1467-6494.2010.00636.x

Evenden, J. L. (1999). Varieties of impulsivity. *Psychopharmacology, 146*(4), 348–361. https://doi.org/10.1007/PL00005481

Eysenck, H. J. (1967). The biological basis of personality. Spring- field, IL: Thomas.

Fabrigar, L. R., & Wegener, D. T. (2011). *Exploratory factor analysis*. Oxford University Press.

Farrell, N., & Walker, B. R. (2019). Reinforcement sensitivity theory and problem gambling in a general population sample. *Journal of Gambling Studies*, *35*(4), 1163-1175.

Flagel, S. B., Akil, H., & Robinson, T. E. (2009). Individual differences in the attribution of incentive salience to reward-related cues: Implications for addiction. *Neuropharmacology, 56*(1), 139–148. https://doi.org/10.1016/j.neuropharm.2008.06.027

Flora, D. B., & Flake, J. K. (2017). The purpose and practice of exploratory and confirmatory factor analysis in psychological research: Decisions for scale development and validation. *Canadian Journal of Behavioural Science, 49*(2), 78–88. https://doi.org/10.1037/cbs0000069

Flora, D. B., LaBrish, C., & Chalmers, R. P. (2012). Old and new ideas for data screening and assumption testing for exploratory and confirmatory factor analysis. *Frontiers in Psychology, 3*, 1–21. https://doi.org/10.3389/fpsyg.2012.00055

Fowles, D. C. (1980). The three arousal model: Implications of Gray's two-factor learning theory for heart rate, electrodermal activity, and psychopathy. *Psychophysiology, 17*(2), 87–104. https://doi.org/10.1111/j.1469-8986.1980.tb00117.x

Fowles, D. C. (1988). Psychophysiology and psychopathy: A motivational approach. *Psychophysiology, 25*(4), 373–391. https://doi.org/10.1111/j.1469-8986.1988.tb01873.x

Fox, J. & Weisberg, S. (2019). *An {R} Companion to Applied Regression* (3rd ed). Sage. https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Gaher, R. M., Hahn, A. M., Shishido, H., Simons, J. S., & Gaster, S. (2015). Associations between sensitivity to punishment, sensitivity to reward, and gambling. *Addictive behaviors*, *42*, 180-184. https://doi.org/10.1016/j.addbeh.2014.11.014

Gray, J. A. (1970). The psychophysiological basis of introversion-extraversion. *Behaviour Research and Therapy, 8*(3), 249–266. https://doi.org/10.1016/0005-7967(70)90069-0

Gray, J. A. (1982). *The neuropsychology of anxiety: An investigation into the functions of the septo-hippocampal system* (1st ed.). Oxford University Press.

Gray, J. A. (1987a). Perspectives on anxiety and impulsivity: A commentary. *Journal of Research in Personality, 21*(4), 493–509. https://doi.org/10.1016/0092-6566(87)90036-5

Gray, J. A. (1987b). *The Psychology of Fear and Stress.* Cambridge University Press.

Gray, J. A. (1994). Three fundamental emotion systems. In P. Ekman and R.J. Davidson (Eds), *The Nature of Emotion: Fundamental Questions*. Oxford University Press.

Gray, J.A. & McNaughton, N. (2000). *The neuropsychology of anxiety an enquiry into the functions of the septo-hippocampal system* (1st ed.). Oxford University Press.

Gray, J.A., & McNaughton, N. (2003). *The neuropsychology of anxiety: An enquiry into the function of the septo-hippocampal system* (2nd ed.). Oxford University Press.

Gray, J. A. and Smith, P. T. (1969). An arousal decision model for partial reinforcement and discrimination learning. In R.M. Gilbert and N.S. Sutherland (Eds), *Animal Discrimination Learning* (pp. 243–272). Academic Press.

Gullo, M. J., & Dawe, S. (2008). Impulsivity and adolescent substance use: Rashly dismissed as "all-bad"? *Neuroscience and Biobehavioral Reviews, 32*(8), 1507–1518. https://doi.org/10.1016/j.neubiorev.2008.06.003

Harmon-Jones, E. & Allen, J. J. B. (1998). Anger and prefrontal brain activity: EEG asymmetry consistent with approach motivation despite negative affective valance. *Journal of Personality and Social Psychology, 74*(5), 159-163. https://doi.org/10.1037/0022-3514.74.5.1310

Harmon-Jones, E. (2003). Anger and the behavioral approach system. *Personality and Individual Differences, 35*(5), 995–1005. https://doi.org/10.1016/S0191-8869(02)00313-6

Harmon-Jones, E. (2019). On motivational influences, moving beyond valence, and integrating dimensional and discreet views of emotion. *Cognition and Emotion, 33*(1), 101-108, https://doi.org/10.1080/02699931.2018.1514293

Harmon-Jones, E. & Sigelman, J. D. (2001). State anger and prefrontal brain activity: Evidence that insult-related relative left-prefrontal activation is associated with experienced anger and aggression. *Journal of Personality and Social Psychology, 90*(80), 797-803.

Harmon-Jones, E., Sigelman, J. D., Bohlig, A., & Harmon-Jones, C. (2003). Anger, coping, and frontal cortical activity: The effect of coping potential on anger-induced left frontal activity. *Cognition and Emotion, 17*(1), 1–24. https://doi.org/10.1080/02699930302278

Harrison, L. A., Curie A., & Ralph A. (2015). Exploring the structure of human defensive responses from judgments of threat scenarios. *PloS one, 10*(8), e0133682. https://doi.org/10.1371/journal.pone.0133682

Heym, N., & Lawrence, C. (2010). The role of Gray's revised RST in the P-psychopathy continuum: The relationships of Psychoticism with a lack of fear and anxiety, and increased impulsivity. *Personality and Individual Differences, 49*(8), 874–879. https://doi.org/10.1016/j.paid.2010.07.021

Hofmann, M. J., Schneider, S., & Mokros, A. (2021). Fearless but anxious? A systematic review on the utility of fear and anxiety levels to classify subtypes of psychopathy. *Behavioral Sciences and the Law*, *39*(5), 512–540. https://doi.org/10.1002/bsl.2544

Hook, R. W., Grant, J. E., Ioannidis, K., Tiego, J., Yücel, M., Wilkinson, P., & Chamberlain, S. R. (2021). Trans-diagnostic measurement of impulsivity and compulsivity: A review of self-report tools. *Neuroscience and Biobehavioral Reviews, 120*, 455–469. https://doi.org/10.1016/j.neubiorev.2020.10.007

Horn, J.L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika, 30,* 179-85. https://doi.org/10.1007/BF02289447

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Hughes, K. A., Moore, R. A., Morris, P. H., & Corr, P. J. (2012). Throwing light on the dark side of personality: Reinforcement sensitivity theory and primary/secondary psychopathy in a student population. *Personality and Individual Differences, 52*(4), 532–536. https://doi.org/10.1016/j.paid.2011.11.010

Jackson, C. J. (2009). Jackson-5 scales of revised Reinforcement Sensitivity Theory (r-RST) and their application to dysfunctional real world outcomes. *Journal of Research in Personality, 43*(4), 556–569. https://doi.org/10.1016/j.jrp.2009.02.007

Jiang, Y., & Tiliopoulos, N. (2014). Individual differences in adult attachment and reinforcement sensitivity. *Personality and Individual Differences*, *68*, 205-210. https://doi.org/10.1016/j.paid.2014.04.022

Johnson, A. K., Sellbom, M., & Phillips, T. R. (2014). Elucidating the associations between psychopathy, Gray's Reinforcement Sensitivity Theory constructs, and externalizing behavior. *Personality and Individual Differences, 71,* 1–8. https://doi.org/10.1016/j.paid.2014.06.026

Jones, S., Shams, M., & Liversidge, T. (2007). Approach goals, behavioural activation and risk of hypomania. *Personality and Individual Differences, 43*(6), 1366–1375. https://doi.org/10.1016/j.paid.2007.04.005

Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2021). *semTools: Useful tools for structural equation modeling* (Version 0.5-5). https://CRAN.R-project.org/package=semTools

Keough, M. T., & O'Connor, R. M. (2014). Clarifying the measurement and the role of the behavioral inhibition system in alcohol misuse. *Alcoholism: clinical and experimental research*, *38*(5), 1470-1479. https://doi.org/10.1111/acer.12387

Keough, M. T., & O'connor, R. M. (2015). Interactive effects of the BIS and the BAS on trajectories of alcohol misuse after university graduation. *Substance abuse: research and treatment, 9*, SART-S31434. https://doi.org/10.4137/SART.S31434

Keough, M. T., Wardell, J. D., Hendershot, C. S., Bagby, R. M., & Quilty, L. C. (2017). Fun seeking and reward responsiveness moderate the effect of the behavioural inhibition system on coping-motivated problem gambling. *Journal of Gambling Studies, 33*(3), 769-782. https://doi.org/10.1007/s10899-016-9646-2

Kim, S. (2015). *ppcor: Partial and Semi-Partial (Part) Correlation.* (Version 1.1) https://CRAN.R-project.org/package=ppcor

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications.

Kruglanski, A. W., Thompson, E. P., Higgins, E. T., Atash, M. N., Pierro, A., Shah, J. Y., & Spiegel, S. (2018). To “do the right thing” or to “just do it”: Locomotion and assessment as distinct self-regulatory imperatives. In A. W. Kruglanski (Ed.) *The Motivated Mind: The Selected Works of Arie Kruglanski,* (pp. 299–343). https://doi.org/10.4324/9781315175867

Krupić, D., & Corr, P. J. (2017). Moving forward with the BAS: Towards a neurobiology of multidimensional model of approach motivation. *Psihologijske Teme, 26*(1), 25–45. https://doi.org/10.31820/pt.26.1.2

Krupić, D., & Corr, P. J. (2020). How reinforcement sensitivity theory relates to self-determination theory. *Personality and Individual Differences, 155*, 18–22. https://doi.org/10.1016/j.paid.2019.109705

Kuhl, J. (1981). Motivational and functional helplessness: The moderating effect of state versus action orientation*. Journal of Personality and Social Psychology, 40*(1), 155–170. https://doi.org/10.1037/0022-3514.40.1.155

Kuhl, J. (1992). A theory of self-regulation: Action versus state orientation, self-discrimination, and some applications. *Applied Psychology, 41*(2), 97–129. https://doi.org/10.1111/j.1464-0597.1992.tb00688.x

Lacey, M. F., & Gable, P. A. (2022). Frontal Asymmetry as a Neural Correlate of Motivational Conflict. *Symmetry*, *14*(3), 507-516. https://doi.org/10.3390/sym14030507

Lykken, D. T. (1995). *The antisocial personalities.* Lawrence Erlbaum Associates.

MacCallum, R.C., Browne, M.W., & Sugawara, H.M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1,* 130-149. http://doi.org/10.1037/1082-989X.1.2.130

MacKillop, J., Weafer, J., C. Gray, J., Oshri, A., Palmer, A., & de Wit, H. (2016). The latent structure of impulsivity: impulsive choice, impulsive action, and impulsive personality traits. *Psychopharmacology, 233*(18), 3361–3370. https://doi.org/10.1007/s00213-016-4372-0

McDonald, R. P., & Ho, M. H. R. (2002). Principles and practice in reporting structural equation analyses. *Psychological methods*, *7*(1), 64. https://doi.org/10.1037/1082-989X.7.1.64

Marjanovic, Z., Struthers, C. W., Cribbie, R., & Greenglass, E. R. (2014). The conscientious responders scale: A new tool for discriminating between conscientious and random responders. *SAGE Open, 4*(3). https://doi.org/10.1177/2158244014545964

Matthews, G. (2008). Reinforcement Sensitivity Theory: A critique from cognitive science. In P. J. Corr (Ed.), *The Reinforcement Sensitivity Theory of Personality* (pp. 482–507). https://doi.org/10.1017/CBO9780511819384.018

McFarland, B. R., & Klein, D. N. (2009). Emotional reactivity in depression: Diminished responsiveness to anticipated reward but not to anticipated punishment or to nonreward or avoidance. *Depression and Anxiety, 26*(2), 117–122. https://doi.org/10.1002/da.20513

McNaughton, N., & Corr, P. J. (2008). The neuropsychology of fear and anxiety: A foundation for Reinforcement Sensitivity Theory. In P. J. Corr (Ed.), *The Reinforcement Sensitivity Theory of Personality* (pp. 44-94). https://doi.org/10.1017/CBO9780511819384.003

Mesquita, S., V., C. et al. (2011). The response of social anxiety disorder patients to threat scenarios differs from that of healthy controls. *Brazilian Journal of Medical and Biological Research 44*(12), 1261–1268. https://doi.org/10.1590/S0100-879X2011007500137

Molho, C., Tybur, J. M., Güler, E., Balliet, D., & Hofmann, W. (2017). Disgust and anger relate to different aggressive responses to moral violations. *Psychological Science*, *28*(5), 609–619. https://doi.org/10.1177/0956797617692000

Monni, A., Olivier, E., Morin, A. J. S., Olivetti Belardinelli, M., Mulvihill, K., & Scalas, L. F. (2020). Approach and avoidance in Gray's, Higgins', and Elliot's perspectives: A theoretical comparison and integration of approach-avoidance in motivated behavior. *Personality and Individual Differences, 166*, 110163. https://doi.org/10.1016/j.paid.2020.110163

National Parks Service (n.d.) *Bear Encounter.* National Parks Service. https://www.nps.gov/yell/learn/nature/bearreact.htm

Nummenmaa, L., Glerean, E., Hari, R., & Hietanen, J. K. (2014). Bodily maps of emotions. *Proceedings of the National Academy of Sciences of the United States of America, 111*(2), 646–651. https://doi.org/10.1073/pnas.1321664111

Panksepp, J., & Zellner, M. (2004). Towards a neurobiologically based unified theory of aggression. *Revue Internationale de Psychologie Sociale*, *17*(2), 37–61.

Pérez Fuentes, M. D. C., Molero Jurado, M. del M., Carrión Martínez, J. J., Mercader Rubio, I., & Gázquez, J. J. (2016). Sensation-seeking and impulsivity as predictors of reactive and proactive aggression in adolescents. *Frontiers in Psychology, 7*, 1–8. https://doi.org/10.3389/fpsyg.2016.01447

Perkins, A. M., & Corr, P. J. (2006). Reactions to threat and personality: Psychometric differentiation of intensity and direction dimensions of human defensive behaviour. *Behavioural Brain Research 169*(1) 21–28. https://doi.org/10.1016/j.bbr.2005.11.027

Pickering, A. D. & Gray, J. A. (1999), The neuroscience of personality. In L. Pervin and O. John (Eds.), *Handbook of Personality* (2nd ed. Pp. 277-299). Guilford Press.

Pickering, A. D., & Gray, J. A. (2001). Dopamine, appetitive reinforcement, and the neuropsychology of human learning : An individual differences approach. In A. Eliasz & A. Angleitner (Eds.), *Advances in Research on Temperament* (pp. 113–149). Pabst Science.

Pickering, A. D., & Smillie, L. D. (2008). The behavioural activation system: Challenges and opportunities. In P. J. Corr (Ed.), *The Reinforcement Sensitivity Theory of Personality* (pp. 120-154). https://doi.org/10.1017/CBO9780511819384.005

Poon, J. A., Niehaus, C. E., Thompson, J. C., & Chaplin, T. M. (2019). Adolescents' pubertal development: Links between testosterone, estradiol, and neural reward processing. *Hormones and Behavior, 114*, 104504. https://doi.org/10.1016/j.yhbeh.2019.02.015

Quilty, L. C., & Oakman, J. M. (2004). The assessment of behavioural activation - The relationship between impulsivity and behavioural activation. *Personality and Individual Differences, 37*(2), 429–442. https://doi.org/10.1016/j.paid.2003.09.014

R Core Team (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/.

Revelle, W. (2020) *psych: Procedures for Personality and Psychological Research* (Version 2.0.12.) Northwestern University. https://CRAN.R-project.org/package=psych

Rizopoulos, D. (2006). ltm: An R package for Latent Variable Modelling and Item Response Theory Analyses*, Journal of Statistical Software, 17*(5), 1-25. http://www.jstatsoft.org/v17/i05/

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software, 48*(2), 1-36. http://www.jstatsoft.org/v48/i02/.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Salgari, G. C., Kramer, M. P., Spencer, C. C., Dvorak, R., Bohil, C., O'Donnell, J. P., & Bedwell, J. S. (2022). Psychometric psychopathy: Relationships with indices of reinforcement sensitivity theory factors. *Personality and Individual Differences*, *195*, 111669. https://doi.org/10.1016/j.paid.2022.111669

Scherer, K. R. (2005). What are emotions? And how can they be measured? Trends and developments: Research on emotions, 44(4), 695-729. http://doi.org/10.1177/0539018405058216

Shahzadi, K., & Walker, B. R. (2020). Reinforcement sensitivity theory and adult attachment: A replication study. *Curr Psychol 41,* 1440–1446. https://doi.org/10.1007/s12144-020-00685-5

Shuhama, R., Del-Ben, C. M., Loureiro, S. R., & Graeff, F. G. (2007). Animal defense strategies and anxiety disorders. *Anais da Academia Brasileira de Ciências*, *79*(1), 97-109. https://doi.org/10.1590/S0001-37652007000100012

Smillie, L. D., & Jackson, C. J. (2006). Functional impulsivity and reinforcement sensitivity theory. *Journal of Personality, 74*(1), 47–84. https://doi.org/10.1111/j.1467-6494.2005.00369.x

Smillie, L.D. (2008). What is Reinforcement Sensitivity? Neuroscience Paradigms for Approach-avoidance process theories of personality. *European Journal of Personality, 22*(5), 359-384. https://doi.org/10.1002/per.674

Stanford, M. S., Houston, R. J., Mathias, C. W., Villemarette-Pittman, N. R., Helfritz, L. E., & Conklin, S. M. (2003). Characterizing aggressive behavior. *Assessment, 10*(2), 183–190. https://doi.org/10.1177/1073191103010002009

Thayer, R. E. (1989). *The Biopsychology of Mood and Arousal.* Oxford University Press.

Threadgill, A. H., & Gable, P. A. (2020). Revenge is sweet: Investigation of the effects of Approach-Motivated anger on the RewP in the motivated anger delay (MAD) paradigm. *Human Brain Mapping, 41*(17), 5032–5056. https://doi.org/10.1002/hbm.25177

Tibubos, A. N., Pott, E. K., Schnell, K., & Rohrmann, S. (2014). All anger is not created equal: A multi-method approach to understanding the link of anger responses with approach and avoidance motivation. *Personality and Individual Differences, 70,* 160–164. https://doi.org/10.1016/j.paid.2014.06.045

Tomarken, A. J., & Waller, N. G. (2003). Potential problems with “well fitting” models. *Journal of Abnormal Psychology, 112,* 578–598. http:// dx.doi.org/10.1037/0021-843X.112.4.578

Torrubia, R., Ávila, C., & Caseras, X. (2008). Reinforcement sensitivity scales. In P. J. Corr (Ed.), *The Reinforcement Sensitivity Theory of Personality* (pp. 188-227). https://doi.org/10.1017/CBO9780511819384.007

Torrubia, R., Avila, C., Molto, J., & Caseras, X. (2001). The sensitivity to punishment and sensitivity reward questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences, 31*(6), 837–862. https://doi.org/10.1016/S0191-8869(00)00183-5

Vecchione, M., & Corr, P. J. (2021). Development and validation of a short version of the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ-S). *Journal of Personality Assessment, 103*(4), 535-546. https://doi.org/10.1080/00223891.2020.1801702

Wallace, J. F., & Newman, J. P. (2008). RST and psychopathy: Associations between psychopathy and the behavioral activation and inhibition systems. In P. J. Corr (Ed.), *The Reinforcement Sensitivity Theory of Personality* (pp. 398–414). https://doi.org/10.1017/CBO9780511819384.014

Watson, D. (2009). Locating anger in the hierarchical structure of affect: Comment on Carver and Harmon-Jones (2009). *Psychological Bulletin, 135*(2), 205–208. https://doi.org/10.1037/a0014413

Weinshenker, N. J., & Siegel, A. (2002). Bimodal classification of aggression: Affective defense and predatory attack. *Aggression and Violent Behavior, 7*(3), 237–250. https://doi.org/10.1016/S1359-1789(01)00042-8

Weydmann, G., Souzedo, F. B., Tavares, P., Corrêa, L., Heidrich, H., Holland, H., & Bizarro, L. (2022). Parsing the link between reinforcement sensitivity theory and eating behavior: A systematic

review. *Neuroscience & Biobehavioral Reviews, 134*, 104525. https://doi.org/10.1016/j.neubiorev.2022.104525

Whiteside, S. P. & Lynham, D. R. (2001). The Five Factor Model and impulsivity: using a structural model of personality to understand impulsivity. *Personality and Individual Differences, 30*(3), 669–689. https://doi.org/10.1016/S0191-8869(00)00064-7

Willis, Gordon & Lessler, Judith. (1999). Question Appraisal System QAS-99. *National Cancer Institute*.

Wright, K. A., Lam, D. H., & Brown, R. G. (2009). Reduced approach motivation following nonreward: Extension of the BIS/BAS scales. *Personality and Individual Differences, 47*(7), 753–757. https://doi.org/10.1016/j.paid.2009.06.015

Wright, K. (2021). *corrgram: Plot a Correlogram* (version 1.14). https://CRAN.R-project.org/package=corrgram

Yanagida, T. (2021). *misty: Miscellaneous Functions* (version 0.4.3). https://CRAN.R-project.org/package=misty

Zuckerman, M. (1991). *Psychobiology of Personality*. Cambridge University Press.

Table 1

Sample 1 Demographic Information for each scale before and after Data Cleaning

	Original Sample	BAS Cleaned	BIS Cleaned
	N = 802	N = 762	N = 758
Age	M = 24.96, SD = 7.70	M = 24.74, SD = 7.47	M = 24.88, SD = 7.48
Gender			
Female	695 (86.66%)	665 (87.27%)	662 (87.34%)
Male	95 (11.85%)	78 (11.15%)	84 (11.08%)
Gender var	11 (1.37%)	9 (1.31%)	10 (1.31%)
Non-binary	2 (0.25%)	2 (0.26%)	2 (0.26%)
Ethnicity			
White	630 (78.55%)	597 (78.35%)	593 (78.23%)
Black	30 (3.74%)	28 (3.67%)	29 (3.83%)
Latin American	40 (4.99%)	39 (5.12%)	39 (5.15%)
S. Asian	19 (2.37%)	18 (2.36%)	17 (2.24%)
E. Asian	11 (1.75%)	11 (1.44%)	10 (1.32%)
SE Asian	10 (1.25%)	8 (1.05%)	9 (1.19%)
Arab	6 (0.75%)	6 (0.79%)	6 (0.79%)
Aboriginal	0	0	0 (0.00%)
Other	8 (1.00%)	8 (1.05%)	8 (1.06%)

Note. Cleaned sample compositions did not differ substantially from the original sample.

Table 2

Sample 2 Demographic Information

	Original Sample	Cleaned	Change
	N = 701	N = 639	- 62
Age	M = 35.87, SD = 16.56	M = 35.96, SD = 16.87	
Gender			
Female	345 (49.22%)	316 (49.45%)	+ 0.23%
Male	348 (49.64%)	316 (49.45%)	- 0.19%
Gender var	8 (1.14%)	7 (1.10%)	- 0.04%
Not Listed	0	0	
Non-binary	1 (0.14%)	1 (0.16%)	+ 0.02%
Ethnicity			
White	570 (81.31%)	527 (82.47%)	+ 1.16%
Black	25 (3.57%)	20 (3.13%)	- 0.44%
Latin American	16 (2.28%)	14 (2.19%)	- 0.09%
S. Asian	40 (5.71%)	33 (5.16%)	- 0.55%
E. Asian	33 (4.71%)	28 (4.38%)	- 0.33%
SE Asian	16 (2.28%)	16 (2.50%)	+ 0.22%
Arab	7 (1.00%)	7 (1.10%)	+ 0.10%
Aboriginal	1 (0.14%)	1 (0.16%)	+ 0.02%
Other	8 (1.14%)	6 (0.94%)	- 0.20%
Prefer No ans.	7 (1.00%)	6 (0.94%)	- 0.06%

Note. Cleaned sample compositions did not differ substantially from the original sample.

Table 3

Sample 3 Demographic Information

Variable	Original		Cleaned		Change	
	N = 714		N = 660		N = -54	
Age	41.37 (SD = 14.53)		41.60 (SD = 14.45)		+ 0.23	
	N	%	N	%	N	%
Gender						
Female	353	49.44%	328	49.70%	-25	0.26%
Male	357	50.00%	327	49.55%	-30	-0.45%
Gender var	5	0.70%	5	0.76%		0.06%
Not Listed	1	0.14%	1	0.15%		0.01%
Non-binary	2	0.28%	1	0.15%	-1	-0.13%
Ethnicity						
White	602	84.31%	561	85.00%	-41	0.69%
Black	26	3.64%	24	3.64%	-2	-0.01%
Latin American	6	0.84%	6	0.91%		0.07%
S. Asian	33	4.62%	29	4.39%	-4	-0.23%
E. Asian	20	2.80%	20	3.03%		0.23%
SE Asian	11	1.54%	11	1.67%		0.13%
Arab	7	0.98%	5	0.76%	-2	-0.22%
Aboriginal	1	0.14%	1	0.15%		0.01%
Other	9	1.26%	9	1.36%		0.10%
Prefer No ans.	5	0.70%	4	0.61%	-1	-0.09%

Note. Cleaned sample compositions did not differ substantially from the original sample.

Table 4

Fit statistics for One factor, Four Factor and Bifactor Model of BAS scale.

Behavioural Activation Scale					
	CFA with MLR				
Fit stats	One Factor Model	Four Factor Model	Bi-factor Model	Higher Order	Higher Order of final scale
Robust RMSEA	0.135	0.074	0.50	0.074	0.073
90% CI	[0.128, 0.143]	[0.066, 0.081]	[0.041, 0.059]	[0.066, 0.082]	[0.064, 0.081]
Robust CFI	0.807	0.946	0.978	0.945	0.953
Robust TLI	0.778	0.934	0.970	0.934	0.943
SRMR	0.075	0.051	0.036	0.052	0.049
AIC	33958.927	33053.771	32854.645	33063.428	30587.653
BIC	34102.679	33224.476	33070.273	33225.149	30740.389

Note. Fit statistics for the final BAS scale are listed to the far right of the table. The final scale consisted of 3 rather than 4 impulsivity items, as item 42, “I’m moving fast so that I can grab what I want” had poor local fit.

Table 5

Standardized Factor loadings for BAS Higher-Order Model

Items	Standardized Factor Loadings				
	RI	GDP	RR	IMP	BAS
I feel that there are lots of potential opportunities for me to explore.	0.835				
I feel the urge to explore new possibilities.	0.820				
It is easy for me to think of potentially interesting things I can try.	0.753				
I feel the urge to try something new.	0.700				
I feel determined.		0.859			
I am persisting to reach my goals.		0.812			
I feel certain that my hard work will pay off.		0.776			
I am committed to my plans.		0.748			
I feel pleased.			0.900		
I am enjoying myself.			0.899		
I feel great because of good things in my life.			0.867		
I can’t stop smiling.			0.752		
I see a chance to get what I want and I’m springing into action.				0.785	
I am taking advantage of an opportunity get what I want.				0.618	
I’m seizing the moment to get something I’ve been wanting.				0.529	
Reward Interest					0.898

Goal-Drive Persistence	0.861
Reward Reactivity	0.853
Impulsivity	0.862

Table 6

Fit statistics for one, two and bi-factor model for BIS state scale.

Behavioural Inhibition Scale			
	CFA with MLR		
Fit stats	One factor Model	Two Factor Model	Bi-factor Model
Robust RMSEA	0.124	0.038	0.042
90% CI	[0.097, 0.120]	[0.018, 0.048]	[0.024, 0.062]
Robust CFI	0.931	0.994	0.994
Robust TLI	0.908	0.991	0.989
SRMR	0.046	0.019	0.014
AIC	19525.811	19282.574	19283.361
BIC	19606.313	19367.549	19404.114

Table 7

Standardized Factor loadings for Two Factor Model

Items	Standardized Factor Loadings	
	ANX	BD
I feel unsure.	0.886	
I feel hesitant.	0.851	
I am worried.	0.824	
I am ruminating.	0.722	
I am keeping an eye out for signs of trouble.	0.581	
I feel hopeless.		0.893
I am retreating from life.		0.808
I give up.		0.802
I feel that trying to improve my situation is futile.		0.762
BD	0.856	

Note. ANX = Anxiety; BD = Behavioural Disengagement

Table 8

Standardized Factor loadings for One Factor Model

Items	Standardized Factor Loadings
I feel afraid.	0.870
I feel vulnerable because unpleasant things are about to happen.	0.803
My fear has immobilized me.	0.763
I feel jumpy.	0.749
I have the urge to get away from something unpleasant.	0.730
I'm too scared to face my problems.	0.726

Table 9

Fit statistics for One factor, Three Factor and Bifactor Model of Anger/Aggression scale.

Anger/Aggression Scale			
	CFA with MLR		
Fit stats	One Factor Model	Three Factor Model	Bi-factor Model
Robust RMSEA	0.139	0.51	0.39
90% CI	[0.129,0.150]	[0.039, 0.063]	[0.024, 0.052]
Robust CFI	0.760	0.969	0.99
Robust TLI	0.707	0.961	0.98
SRMR	0.095	0.044	0.029
AIC	26103.151	25497.754	25454.566
BIC	26210.965	25619.044	25616.286

Note. Item 7 was substituted with item 6 due to a high level of skew and kurtosis. Item 6 and 7 were created to be alternates of each other; item 24 was substituted for item 23.

Table 10

Standardized Factor loadings for Anger/Aggression Three Factor Model

Items	Standardized Factor Loadings		
	PA	DA	A/F
Right now, I feel indifferent about pain I might cause to others in order to get what I want.	0.766		
In this moment, I wouldn't hesitate to be aggressive to get what I want.	0.733		
Right now, the prospect of hurting others to get what I want doesn't make me feel anxious at all.	0.692		
Right now, I'm not worried about possible punishment for coercing others to get what I want.	0.655		
Fear has me ready to repel any threats.		0.707	
I am lashing out to distance myself from potential danger.		0.666	
The only way out of the danger I currently face is to fight back.		0.645	
I am ready to attack others to defend myself.		0.639	
I'm annoyed that I have to work so hard to get what I want.			0.770
I'm angry because I want more than I've been given.			0.762
I'm frustrated by the things that are impeding my progress.			0.725
I'm irritated because it seems like I might not be able to have what I want.			0.686

PA	0.760	0.434
DA		0.677

Note. Two items were substituted : specifically, items 7 and 23 had very high skewness and kurtosis values, and conceptually similar items with better skew and kurtosis were substituted.

Note 2. PA = Predatory Aggression; DA = Defensive Aggression; A/F = Anger/Frustration

Table 11

	BAS Total	BAS - RI	BAS - GDP	BAS - RR	BAS - IMP	BIS - ANX	BIS - BD	FFFS	PA	DA	A/F
BAS Total	1.00										
BAS – RI	0.87***	1.00									
BAS – GDP	0.86***	0.67***	1.00								
BAS – RR	0.88***	0.66***	0.68***	1.00							
BAS – IMP	0.75***	0.60***	0.50***	0.58***	1.00						
BIS – ANX	-0.46***	-0.29***	-0.37***	-0.56***	-0.27***	1.00					
BIS – BD	-0.63***	-0.47***	-0.58***	-0.68***	-0.35***	0.76***	1.00				
FFFS	-0.37***	-0.24***	-0.33***	-0.47***	-0.15*	0.72***	0.70***	1.00			
PA	0.06	0.08	0.02	-0.03	0.20***	0.17***	0.16***	0.27***	1.00		
DA	-0.01	0.05	-0.03	-0.14***	0.14***	0.41***	0.35***	0.56***	0.60***	1.00	
A/F	-0.19***	-0.06	-0.09*	-0.37***	-0.06	0.54***	0.47***	0.50***	0.36***	0.54***	1.00

Note. Observed Pearson-product-moment correlations between scores in selected scales. * p < .05, ** p < .01, *** p < .001

Note 2. BAS = Behavioural Activation System, RI = Reward Interest, GDP = Goal Driver Persistence, RR = Reward Reactivity, IMP = Impulsivity, BIS = Behavioural Inhibition System, FFFS = Fight Flight Freeze System, DA = Predatory Aggression F/A = Frustration/Aggression, DA = Defensive Aggression, RST-PQ-SF = Reinforcement Sensitivity Theory- Short Form.

Table 12

Associations between State Scales and Trait Measures.

	Trait Scales			
State Scales	RST-PQ-SF-BAS	RST-PQ-SF-BIS	RST-PQ-SF-FFFS	Defensive Fight
BAS-Total	0.62***	-0.25***	-0.06	0.11**
BAS-RI	0.57***	-0.15***	-0.04	0.15***
BAS-GDP	0.55***	-0.19***	-0.04	0.07
BAS-RR	0.48***	-0.34***	-0.05	0.03
BAS-IMP	0.51***	-0.13***	-0.08	0.12*
BIS-ANX	-0.28***	0.54***	0.19***	0.00
BIS-BD	-0.34***	0.45***	0.15***	0.09
FFFS	-0.15***	0.52***	0.22***	0.04
PA	0.13***	0.08*	0.00	0.23***
AF	0.05	0.39***	0.10*	0.18***
DA	0.11**	0.27***	0.06	0.31***

Note. Observed Pearson-product-moment correlations between scores in selected scales.

* $p < .05$

** $p < .01$

*** $p < .001$

Note 2. BAS = Behavioural Activation System, RI = Reward Interest, GDP = Goal-Drive Persistence, RR = Reward Reactivity, BIS = Behavioural Inhibition System, FFFS = Fight Flight Freeze System, PA = Predatory Aggression, A/F = Anger/Frustration, DA = Defensive Aggression, RST-PQ-SF = Reinforcement Sensitivity Theory- Short Form.

Appendix A

Demographic Questions

1. What is your age? ___
    a. Prefer Not to Answer
2. To which gender identity do you most identify?
    a. Female
    b. Male
    c. Gender Variant/Non-Conforming
    d. Not Listed _____
    e. Prefer Not to Answer
3. Please Report your Ethnicity (check all that apply):
    a. White (Caucasian)
    b. Black (Caribbean, African, Haitian)
    c. Latin American
    d. South-Asian (Indian, Pakistani, Sri Lankan, Tamil, Bangladeshi, Nepalese)
    e. East-Asian (Chines, Japanese, Taiwanese, Mongolian, Korean)
    f. South-East Asian (Cambodian, Malaysian, Indonesian, Vietnamese, Singaporean)
    g. Arab/West-Asian (Armenian, Egyptian, Iranian, Lebanese, Moroccan)
    h. Aboriginal (First Nations, Inuit, Métis, American Indian)
    i. Other: _____
    j. Prefer Not to Answer

Appendix B

Revised Reinforcement Sensitivity Theory of Personality Questionnaire (rRST-PQ-S)

Instructions. Below are a list of statements about everyday feelings and behaviours. Please rate how accurately each statement describes you in general. Do not spend too much time thinking about the questions and please answer honestly.

Responses:

1 – Not at all

2 – Slightly

3 – Moderately

4 -- Highly

1. I would run quickly if fire alarms in a shopping mall started ringing.
2. I would instantly freeze if I opened the door to find a stranger in the house.
3. I would leave the park if I saw a group of dogs running around barking at people.
4. I would freeze if I was on a turbulent aircraft.
5. I would not hold a snake or a spider.
6. I sometimes feel “blue” for no good reason.
7. I often worry about letting down other people.
8. My behaviour is easily interrupted.
9. It’s difficult to get some things out of my mind.
10. I often wake up with many thoughts running through my mind.
11. I regularly try new activities just to see if I enjoy them.
12. I get carried away by new projects.
13. I am always finding new and interesting things to do.
14. I am motivated to be successful in my personal life.
15. I am very persistent in achieving my goals.
16. I will actively put plans in place to accomplish goals in my life.
17. Good news makes me feel overjoyed.
18. I get a special thrill when I am praised for something I’ve done well.
19. I always celebrate when I accomplish something important.
20. I sometimes cannot stop myself talking when I know I should keep my mouth closed.
21. I often do risky things without thinking of the consequences.
22. I find myself doing things on the spur of the moment.

Appendix C

Defensive Fight Scale

Instructions. Below are a list of statements about everyday feelings and behaviours. Please rate how accurately each statement describes you in general. Do not spend too much time thinking about the questions and please answer honestly.

Responses:

1 – Not at all

2 – Slightly

3 – Moderately

4 – Highly

1. I usually react immediately if I am criticized at work.
2. I have found myself fighting back when provoked.
3. I think retaliation is often the best form of defense.
4. I think you have to stand up to bullies in the workplace.
5. I would defend myself if I was falsely accused of something.
6. If I feel threatened I will fight back.
7. I would not tolerate bullying behaviour towards me.
8. I can be an aggressive person when I need to be.

Appendix D

Conscientious Responders Scale (CRS)

Note: the following questions are interspersed in the middle of the questions of scales on the study.

1. To answer this question, please choose option number four, “neither agree nor disagree.”
2. Choose the first option— “completely disagree”—in answering this question.
3. To respond to this question, please choose option number five, “somewhat agree.”
4. Please answer this question by choosing option number two, “disagree.”
5. In response to this question, please choose option number three, “somewhat disagree.”

Appendix E

Attention Check

Thank you very much for your participation in our research study!

To ensure that we can use our data for future research, we are asking that you please check the box below if you found that you could not follow our study's instructions (e.g., you randomly answered questions about how you were feeling; or you didn't understand the instructions). Please note that you will receive compensation for this study even if you check the box indicating that you were not able to follow instructions today, so please answer honestly.

□ **I was not able to follow instructions today**.

Appendix F

State Behavioural Activation System Scale – Sample 1 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. The world is providing me with rewarding possibilities.
2. I believe good things will happen to me.
3. I feel optimistic.
4. I feel hopeful.
5. I am looking for opportunities to enjoy myself.
6. I am interested in trying new things.
7. I feel motivated to explore new places.
8. I am receptive to good things that come my way.
9. I am motivated to engage with the world.
10. I know my hard work will pay off.
11. I will be rewarded if I keep trying.
12. I feel determined.
13. I feel enthusiastic.
14. I feel eager.
15. I feel driven.
16. I am persisting to reach my goals.
17. No matter what comes my way I will keep trying to reach my goals.
18. I am striving for success.
19. I am committed to my plans.
20. I am energized.
21. I am experiencing the joy of anticipating good things in my life.
22. Good things are in sight.
23. I am enjoying the opportunities life offers.
24. Life is giving me a chance to feel good.
25. I feel joyful.
26. I feel pleased.
27. I feel excited.
28. I am enjoying what I am doing.
29. I feel like jumping for joy.
30. I am taking as much pleasure from life as I can.
31. I can't stop smiling.
32. My body feels alive.
33. My body feels light.
34. I feel great because of good things in my life.
35. It is best for me to grab the opportunities available now.
36. If I act quickly, I can achieve what I want.
37. I feel uninhibited.
38. I can't contain my eagerness.
39. I am acting decisively.
40. I'm not wasting much time on thinking before I act.
41. I feel unrestrained.
42. I am grabbing the good things in life as they come my way.
43. I am seizing what I want.
44. I am taking a risk to get what I want.
45. I am acting on the spur of the moment.
46. My body is itching to move.

Appendix G

State Behavioural Activation System Scale – Sample 2 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. I feel optimistic.
2. I am receptive to good things that come my way.
3. I am motivated to engage with the world.
4. I feel that the world is providing me with rewarding possibilities.
5. I believe good things will happen to me.
6. I am looking for opportunities to enjoy myself.
7. I feel motivated to explore new places.
8. I feel that there are a lot of opportunities for me.
9. It is easy for me to think of interesting things I can do.
10. I feel the urge to explore new possibilities.
11. I feel the urge to try something new.
12. I feel certain that my hard work will pay off.
13. I feel enthusiastic.
14. I feel eager.
15. I feel driven.
16. I am persisting to reach my goals.
17. I am energized.
18. I am committed to my plans.
19. I will be rewarded if I keep trying.
20. I feel determined.
21. I am striving for success.
22. I am experiencing the joy of anticipating good things in my life.
23. Good things are in sight.
24. I am enjoying the opportunities life offers.
25. Life is giving me a chance to feel good.
26. I feel joyful.
27. I feel excited.
28. I am taking as much pleasure from life as I can.
29. I can't stop smiling.
30. I feel great because of good things in my life.
31. I feel pleased.
32. I am enjoying what I'm doing.
33. I am enjoying myself.
34. I feel like celebrating.
35. I feel unrestrained.
36. I am seizing what I want.
37. It is best for me to grab the opportunities available now.
38. If I act quickly, I can achieve what I want.
39. I feel uninhibited.
40. I can't contain my eagerness.
41. I am acting decisively.
42. I'm not wasting much time on thinking before I act.
43. I am grabbing good things as they come my way.
44. I am seizing what I want.
45. I am taking a risk to get what I want.
46. I am acting on the spur of the moment.
47. Right now, all I can think about is something I want.
48. Right now, it's hard to focus on anything other than what I am craving.
49. My desire for what I want is driving me to action.
50. I'm not letting doubt stop me from experiencing pleasure.
51. I'm taking as much pleasure from life as I can.

Appendix H

State Behavioural Activation System Scale – Sample 3 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. I am motivated to engage with the world.
2. I am looking for opportunities to enjoy myself.
3. I feel motivated to explore new places.
4. I feel that there are a lot of potential opportunities for me to explore.
5. It is easy for me to think of potentially interesting things I can try.
6. I feel the urge to explore new possibilities.
7. I feel the urge to try something new.
8. I feel certain that my hard work will pay off.
9. I feel eager.
10. I feel driven.
11. I am persisting to reach my goals.
12. I am energized.
13. I am committed to my plans.
14. I will be rewarded if I keep trying.
15. I feel determined.
16. I am striving for success.
17. I am enjoying the opportunities life offers.
18. Life is giving me a chance to feel good.
19. I feel joyful.
20. I feel excited.
21. I am taking as much pleasure from life as I can.
22. I can't stop smiling.
23. I feel great because of good things in my life.
24. I feel pleased.
25. I am enjoying myself.
26. I feel like celebrating.
27. I see a chance to get what I want and I'm springing into action.
28. I'm not letting doubt waste a chance to seize what I want.
29. I'm seizing the moment to get something I've been wanting.
30. I'm acting decisively to obtain something I've been waiting for.
31. I am taking advantage of an opportunity get what I want.
32. I'm closing in quickly on something I want.
33. I'm moving fast so that I can grab what I want.
34. I feel unrestrained.
35. I am seizing what I want.
36. If I act quickly, I can achieve what I want.
37. I feel uninhibited.
38. I'm not wasting much time on thinking before I act.
39. I am grabbing good things as they come my way.
40. I am acting on the spur of the moment.
41. Right now, all I can think about is something I want.
42. Right now, it's hard to focus on anything other than what I am craving.

Appendix I

State Behavioural Inhibition Scale – Sample 1 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. I need to be careful.
2. I am not at ease.
3. I don't feel at peace.
4. I feel like problems are just around the corner.
5. I am focused on problems.
6. I am ruminating.
7. I am not sure what to do next.
8. I can't stop thinking about something bad.
9. I can't get some thoughts out of my mind.
10. I feel apprehensive.
11. I feel unsure.
12. I feel uncertain.
13. I feel conflicted.
14. I feel nervous.
15. I feel hesitant.
16. I am worried.
17. I am concerned.
18. I am doubting myself.
19. I am keeping an eye out for signs of trouble.
20. I am being careful because I am not sure what is about to happen.
21. I am paralyzed by doubt.
22. I can't decide what to do.
23. I am having a lot of false starts.
24. I am pausing to reassess.
25. I feel jittery.
26. I feel unsettled.
27. My body is tense.
28. I feel restless.
29. I feel antsy.
30. I can't avoid the bad things in my life.
31. Trying to improve my situation is futile.
32. I feel hopeless.
33. I feel sad.
34. I feel down.
35. I feel pessimistic.
36. I give up.
37. I want to get away from it all.
38. I want to be on my own.
39. My body is moving slowly.
40. My body aches.
41. My body is listless.
42. I lack energy.
43. I feel drained.
44. I feel emotionless.

Appendix J

State Behavioural Inhibition Scale – Sample 2 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. I am not at ease.
2. I feel like problems are just around the corner.
3. I feel apprehensive.
4. I am worried.
5. I am concerned.
6. I feel unsettled.
7. My body is tense.
8. I feel restless.
9. I feel unsure.
10. I feel conflicted.
11. I feel hesitant.
12. I am doubting myself.
13. I am paralyzed by doubt.
14. I can't decide what to do.
15. I am having a lot of false starts.
16. I am ruminating.
17. I can't stop thinking about something bad.
18. I feel the need to be careful.
19. I feel down.
20. My body is listless.
21. I can't avoid the bad things in my life.
22. I feel hopeless.
23. I feel pessimistic.
24. I want to get away from it all.
25. I am retreating from life.
26. I give up.
27. I feel that it's too overwhelming to be around other people right now.
28. I feel that the world is too overwhelming for me right now.
29. I am focused on problems.
30. I am not sure what to do next.
31. I can't get some thoughts out of my mind.
32. I feel nervous.
33. I am keeping an eye out for signs of trouble.
34. I am pausing to reassess.
35. I feel jittery.
36. I feel that trying to improve my situation is futile.
37. My body aches.
38. I feel helpless.
39. I lack energy.
40. My body is moving slowly.

Appendix K

State Anger Scale – Sample 2 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. Right now, it seems to me that being dominant will get me what I want.
2. Right now, it seems to be that the best way to get what I want is to show my strength.
3. Right now, I feel that I could easily intimidate others into giving me things.
4. I feel powerful.
5. I feel dominant.
6. I feel confident.
7. I feel the urge to yell at others so that they'll give me the things I deserve.
8. I feel the urge to be threatening to get what is rightfully mine.
9. I feel the urge to be intimidating.
10. I feel the urge to use others to reach my goals.
11. My body language is displaying my dominance.
12. I need to be assertive to prevent an undesirable outcome.
13. I am angry that my point of view is not being considered.
14. I feel mad that I am being disrespected.
15. I'm angry because I feel as if I am being pushed into a situation that I dislike.
16. I feel the urge to defend myself from threats.
17. I feel the need to stand up against future mistreatment.
18. I feel compelled to push back against others trying to infringe on my freedom.
19. I feel compelled to enforce my boundaries with others.
20. My body language is displaying my readiness to fight back.
21. My body is tense with anger.
22. My face is flushed with anger.
23. I feel restless, like I want to lash out at something.
24. I feel like things are standing in the way of me getting what I want.
25. People had better get out of my way.
26. I feel the urge to overpower the things or people that are between me and my goals.
27. I feel the urge to yell at people who are holding me back from the things I want.
28. I feel the urge to intimidate someone who is slowing me down.
29. I feel like smashing things.
30. I feel like hitting something.
31. I feel like yelling.
32. I feel annoyed that my progress keeps getting interrupted.
33. I am irritated that my hard work hasn't paid off.
34. Thinking about my goals makes me feel frustrated.
35. I am angry that my goals are being blocked.

Appendix L

State Anger Scale – Sample 3 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. Right now, the prospect of hurting others to get what I want doesn't make me feel anxious at all.
2. In this moment, I wouldn't hesitate to be aggressive to get what I want.
3. Right now, I wouldn't hold back from humiliating others to get what I want.
4. In this moment, the thought of threatening others to get what I want doesn't make me feel at all uneasy.
5. In this moment, potential consequences for forcibly taking what I want doesn't concern me at all.
6. Right now, I'm not worried about possible punishment for coercing others to get what I want.
7. Right now, I don't care at all about potential repercussions of bullying others to get what I want.
8. Right now, I feel indifferent about pain I might cause to others in order to get what I want.
9. In this moment, it wouldn't bother me at all to harm others to get what I want.
10. Right now, I have no qualms about manipulating others to get what I want.
11. I feel powerful.
12. I feel dominant.
13. I feel confident.
14. I feel the desire to use others to reach my goals.
15. My body language is displaying my dominance.
16. I am actively pushing away things that are scaring me.
17. My body language is displaying my readiness to fight back.
18. I am backed into a corner and fighting for my life.
19. The only way out of the danger I currently face is to fight back.
20. I am actively defending myself.
21. I'm protecting myself with a show of force.
22. I am ready to attack others to defend myself.
23. My rage is driving me to behave aggressively.
24. Fear has me ready to repel any threats.
25. I am lashing out to distance myself from potential danger.
26. I am angry that my point of view is not being considered.
27. I feel mad that I am being disrespected.
28. I'm angry because I feel as if I am being pushed into a situation that I dislike.
29. I feel like things are standing in the way of me getting what I want.
30. I'm annoyed that I have to work so hard to get what I want.
31. I'm feeling impatient to get the things I have been working towards.
32. I'm annoyed because I want something now, but I have to keep waiting.
33. I'm frustrated by the things that are impeding my progress.
34. I can't accept that I won't get what I want.
35. I'm irritated because it seems like I might not be able to have what I want.
36. Despite my frustration, I'm working towards my goal.

37. My excitement is turning into frustration.
38. I'm irritated that circumstances have prevented me from achieving as much as I wanted.
39. I'm angry because I want more than I've been given.
40. I feel the urge to overpower the things or people that are between me and my goals.
41. I feel the urge to yell at people who are holding me back from the things I want.
42. I feel the urge to intimidate someone who is slowing me down.
43. I feel annoyed that my progress keeps getting interrupted.
44. I am irritated that my hard work hasn't paid off.
45. Thinking about my goals makes me feel frustrated.
46. I am angry that my goals are being blocked.
47. My body is tense with anger.
48. My face is flushed with anger.
49. I feel restless, like I want to lash out at something.
50. I feel like smashing things.
51. I feel like hitting something.
52. I feel like yelling.

Appendix M

Fight, Flight, Freeze State Scale – Sample 2 & 3 Item Pool

Instructions: Below are a number of statements. Please think about how you feel right now, even if it's different from how you usually feel. Indicate your answer by choosing an option below.

1 – Completely disagree; 2 – Disagree; 3 – Somewhat disagree; 4 – Neither agree nor disagree; 5 – Somewhat agree; 6 – Agree; 7 – Completely agree

1. I feel vulnerable because unpleasant things are about to happen.
2. I feel that bad things are around the corner.
3. I feel threatened by bad things in my life.
4. I feel the need to protect myself.
5. I can feel my heart beating.
6. I feel unsteady.
7. I feel jumpy.
8. I have the urge to get away from something unpleasant.
9. Right now, I feel that distancing myself from the bad things in my life is my best option.
10. My fear has immobilized me.
11. My mind is flooded with fear.
12. Fear has made my mind foggy.
13. I am putting a lot of effort into avoiding contact with things I dislike.
14. I feel compelled to come up with strategies to avoid being around things I find unpleasant.
15. I'm too scared to face my problems.
16. I feel scared.
17. I feel afraid.
18. My voice is shaking
19. My hands are trembling.

Appendix N

BAS Provisional Scale

Reward Interest Items

1. I feel that there are a lot of opportunities for me.
2. It is easy for me to think of interesting things I can do.
3. I feel the urge to explore new possibilities.
4. I feel the urge to try something new.

Goal-Drive Persistence Items

1. I feel certain my hard work will pay off.
2. I feel determined.
3. I am persisting to reach my goals.
4. I feel committed to my plans.

Reward Reactivity Items

1. I feel pleased.
2. I am enjoying myself.
3. I can't stop smiling.
4. I feel great because of good things in my life.

Impulsivity Items

1. Right now, all I can think about is something I want.
2. Right now, it's hard to focus on anything other than what I am craving.
3. My desire for what I want is driving me to action.
4. I'm not letting doubt stop me from experiencing pleasure.

Appendix O

BAS Final Scale

Reward Interest Items

1. I feel that there are a lot of potential opportunities for me to explore.
2. It is easy for me to think of potentially interesting things I can try.
3. I feel the urge to explore new possibilities.
4. I feel the urge to try something new.

Goal-Drive Persistence Items

1. I feel certain my hard work will pay off.
2. I feel determined.
3. I am persisting to reach my goals.
4. I feel committed to my plans.

Reward Reactivity Items

1. I feel pleased.
2. I am enjoying myself.
3. I can't stop smiling.
4. I feel great because of good things in my life.

Impulsivity Items

1. I see a chance to get what I want and I'm springing into action.
2. I'm seizing the moment to get something I've been wanting.
3. I am taking advantage of an opportunity to get what I want.
4. I'm closing in quickly on something I want.[4]

[4] This item was removed due to poor factor loading.

Appendix P

BIS Provisional Scale

Anxious Uncertainty

1. I am worried.
2. I feel unsure.
3. I am ruminating.
4. I am keeping an eye out for signs of trouble.

Behavioural Disengagement

1. Trying to improve my situation is futile.
2. I feel hopeless.
3. I give up.
4. I want to get away from it all.

Appendix Q

BIS Final Scale

Anxious Uncertainty

5. I am worried.
6. I feel unsure.
7. I am ruminating.
8. I am keeping an eye out for signs of trouble.

Behavioural Disengagement

5. Trying to improve my situation is futile.
6. I feel hopeless.
7. I give up.
8. I am retreating from life.

Appendix R

FFFS Provisional/Final Scale

1. I feel vulnerable because unpleasant things are about to happen.
2. I feel jumpy.
3. I have the urge to get away from something unpleasant.
4. My fear has immobilized me.
5. I'm too scared to face my problems.
6. I feel afraid.

Appendix S

Anger/Aggression Final Scales

Predatory Aggression

1. Right now, the prospect of hurting others to get what I want doesn't make me feel anxious at all.
2. In this moment, I wouldn't hesitate to be aggressive to get what I want.
3. Right now, I'm not worried about possible punishment for coercing others to get what I want.
4. Right now, I feel indifferent about pain I might cause to others in order to get what I want.

Defensive Aggression

1. The only way out of the danger I currently face is to fight back.
2. I am ready to attack others to defend myself.
3. Fear has me ready to repel any threats.
4. I am lashing out to distance myself from potential danger.

Anger/Frustration

1. I'm annoyed that I have to work so hard to get what I want.
2. I'm irritated because it seems like I might not be able to have what I want.
3. I'm frustrated by the things that are impeding my progress.
4. I'm angry because I want more than I've been given.

Appendix T

Study 2 Preregistration on Open Science Framework

People involved:

1) **Have any data been collected for this study already?**
   No, data have not been collected for this study yet.
2) **What's the main question being asked or hypothesis being tested in this study?**
   The main purpose of this study is to explore and/or validate the factor structure of a suite of scales designed to measure in-the-moment (state) activation of three motivational systems described in Reinforcement Sensitivity Theory (RST; Gray & McNaughton, 2000; Corr, 2008); as well as a scale for anger and aggression as conceptualized by RST. A brief description of each motivational system follows: The first is the Behavioural Activation System (BAS) which mediates approach to appetitive stimuli. Emotions associated with the BAS include hope and anticipatory pleasure. The second system is the Fight Flight Freeze System (FFFS) which mediates avoidance of aversive stimuli and is associated with fear (Corr, 2008) and/or rage (Gray, 2004). The third system is the Behavioural Inhibition System (BIS) which serves as a conflict detection and resolution system, mediates cautious approach and/or vigilance/rumination in response to conflicting (e.g., appetitive/aversive) signals and is associated with states of anxiety and depression. Anger and aggression are conceptually related to BAS when aggression is predatory in nature or anger and aggression results from frustrated goal-pursuit; but FFFS-related when anger and aggression are defensive in nature (Corr, 2016).
3) **Describe the key dependent variable(s) specifying how they will be measured.**
   As a scale development study, there are no key dependent variables.
4) **How many and which conditions will participants be assigned to?**
   All participants will fill out the same questionnaires.
5) **Specify exactly which analyses you will conduct to examine the main questions**
   The FFFS and the Anger/Aggression scale will be explored using Exploratory Factor Analyses. Item analysis will be used to select items for further scale development. For FFFS, one and two factor models will be considered. For the Anger/Aggression scale, one and three (BAS-predatory, BAS-frustration, FFFS-defensive) factor models will be considered.
   I will be testing specific models of the BIS and BAS scales (outlined below) and using Robust RMSEA, Robust TLI, Robust CFI and SRMR to determine which model has the best fit.
   1. BIS Models
      a. 1-factor
      b. Two-factor: Anxiety and Depression.
      c. Bifactor with specific factors for Anxiety and Depression.
      d. If none of the models we explore have good fit indices, we will take the following steps:
         i. Look at age and gender as covariates.
         ii. Look at modification indices and make changes to the best model to see if it can be improved sufficiently.
         iii. Explore the data with another series of EFAs.
   2. BAS Models

a. 1-factor: This factor structure is most common to BAS scales. Although there is evidence to suggest that the BAS is underpinned by multiple neuroendocrinal systems AND approach is theoretically characterized by different behaviour, affect, cognitions and physiological sensations as one moves along the temporo-spatial gradient towards a reinforcer, there are commonalities to the experience generated by the subsystems and throughout goal pursuit (e.g., positive affect, focus on reward).
b. 4-factors: Reward Interest, Goal-Drive Persistence, Reward Reactivity, Impulsivity. This factor structure mirrors Corr's RST-PQ and recent review of neurobiological and endocrinal systems that underpin goal-directed behaviour.
c. Bifactor with specific factors from 4-factor model – recognizes that the endocrinal systems that underpin four proposed factors have complex interactions and work with each other. As such, the activation of the four endocrinal systems contribute to a unified BAS experience, but items tapping specific systems are more likely to co-occur with each other, leading to variance over and above what is likely to be accounted for by a single factor by itself.
d. If none of the models we explore have good fit indices, we will take the following steps:
    i. Look at age and gender as covariates.
    ii. Look at modification indices and make changes to the best model to see if it can be improved sufficiently.
    iii. Explore the data with another series of EFAs.

6) **Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

The exclusion criteria for the main analyses will be: (1) incomplete responding, (2) random responders as determined by the Conscientious Responders Scale (Marjanovic, Struthers, Cribbie & Greenglass, 2012), (3) participants who check the box that says "I was not able to follow instructions today" on our attention check, and (4) outliers, defined as people who took under 1 second per question or over one hour to complete the survey.

7) **How many observations will be collected or what will determine sample size?**
No need to justify decision, but be precise about <u>exactly</u> how the number will be determined.

Between 700-800 participants (adults (18+) living in the UK and in North America) will be recruited through Prolific. Large sample sizes of 500+ are desirable for factor analytic studies.

8) Anything else you would like to pre-register?
(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)

We will include the item pool for all measures and path diagrams for the CFA models we are testing.

Appendix U

Study 3 Preregistration on Open Science Framework

People involved:

1) **Have any data been collected for this study already?**
   No, data have not been collected for this study yet.
2) **What's the main question being asked or hypothesis being tested in this study?**
   The main purpose of this study is to validate the factor structure of a suite of scales designed to measure in-the-moment (state) activation of three motivational systems described in Reinforcement Sensitivity Theory (RST; Gray & McNaughton, 2000; Corr, 2008); as well as a scale for anger and aggression as conceptualized by RST. A brief description of each motivational system follows: The first is the Behavioural Activation System (BAS) which mediates approach to appetitive stimuli. Emotions associated with the BAS include hope and anticipatory pleasure. The second system is the Fight Flight Freeze System (FFFS) which mediates avoidance of aversive stimuli and is associated with fear (Corr, 2008) and/or rage (Gray, 2004). The third system is the Behavioural Inhibition System (BIS) which serves as a conflict detection and resolution system, mediates cautious approach and/or vigilance/rumination in response to conflicting (e.g., appetitive/aversive) signals and is associated with states of anxiety and depression. Anger and aggression are conceptually related to BAS when aggression is predatory (disinhibited, instrumental) in nature or anger and aggression results from frustrated goal-pursuit; but FFFS-related when anger and aggression are defensive in nature (Corr, 2016).
3) **Describe the key dependent variable(s) specifying how they will be measured.**
   As a scale development study, there are no key dependent variables.
4) **How many and which conditions will participants be assigned to?**
   All participants will fill out the same questionnaires.
5) **Specify exactly which analyses you will conduct to examine the main questions**
   This is the third part in a series of EFAs/CFAs. Previous factor analytic studies have examined all four scales using EFAs. The BIS scale has been created and demonstrated good model fit as a two-factor model (using CFA). Based on EFAs from previous studies, provisional FFFS, BAS and Anger/Aggression scales have been created and will be tested with CFAs in the current study. I will be testing specific models of the FFFS, BAS and Anger/Aggression scales (outlined below) and using Robust RMSEA, Robust TLI, Robust CFI, SRMR, AIC and BIC to determine which model has the best fit. A chi square difference test will be used to determine whether model fit is statistically better than competing models for formally nested models.

2. Factor Analyses
    a. BAS Models (BAS State Scale)
        i. 1-factor: This factor structure is most common to BAS scales. Although there is evidence to suggest that the BAS is underpinned by multiple neuroendocrinal systems AND approach is theoretically characterized by different behaviour, affect, cognitions and physiological sensations as one moves along the temporo-spatial gradient towards a reinforcer, there are commonalities to the experience generated by the subsystems and throughout goal pursuit (e.g., positive affect, focus on reward) which may result in the 1 factor model having the best fit.

ii. 4-factors: Reward Interest, Goal-Drive Persistence, Reward Reactivity, Impulsivity. This factor structure mirrors Corr's RST-PQ and recent review of neurobiological and endocrinal systems that underpin goal-directed behaviour as well as their trait scale RST-PQ (Corr & Cooper, 2016).
iii. Bifactor with specific factors from 4-factor model – recognizes that the endocrinal systems that underpin four proposed factors have complex interactions and work with each other. As such, the activation of the four endocrinal systems contribute to a unified BAS experience, but items tapping specific systems are more likely to co-occur with each other, leading to variance over and above what is likely to be accounted for by the General BAS factor.
iv. If I am able to determine an appropriate model of the models listed above:
    1. Look at model difference as a function of age (median split) and gender (male, female).
    2. Correlations among state and trait scales (see below).
v. If none of the models we explore have good fit indices, we will take the following steps:
    1. Look at age and gender as covariates.
    2. Look at modification indices and make changes to the best model to see if it can be improved sufficiently.
    3. Explore the data with another series of EFAs.

b. FFFS Models (FFFS State Scale)
    i. 1-factor: This factor structure is most common to FFFS scales. A one-factor model would make sense given the underlying purpose of the FFFS: to facilitate avoidance of threatening stimuli, underpinned by feelings of fear. Previous EFA on our provisional FFFS scale have indicated that a one-factor model fits the data well.
    ii. If the one-factor model demonstrates good fit:
        1. Look at model difference as a function of age (median split) and gender (male, female).
        2. Correlations among state and trait scales (see below).
    iii. If none of the models we explore have good fit indices, we will take the following steps:
        a. Look at age and gender as covariates.
        b. Look at modification indices and make changes to the best model to see if it can be improved sufficiently.
        c. Explore the data with another series of EFAs.

c. Anger/Aggression Models (State Anger/Aggression Scale)
    i. 1-factor: The conceptual categories likely have significant overlap due to blending of the conceptual constructs they intend to measure: a) disinhibited instrumental aggression; b) affect relating to non-obtainment of reward (anger, frustration, irritation, annoyance); c) defensive aggression
    ii. 3-factor: This model would represent the three hypothesized factors: *Disinhibited instrumental aggression*, underpinned by the BAS;

Anger/Frustration, also underpinned by the BAS; and *defensive aggression,* underpinned by the FFFS.

iii. Bi-factor: This model would represent a *Anger/Aggression* general factor*,* and specific factors: *disinhibited instrumental aggression, anger/frustration and defensive aggression.* This is the preferred model based on theory. While conceptual distinctions between frustrative non-reward, defensive aggression and disinhibited instrumental aggression can be made at the theoretical level, motivation underpinning a single aggressive act might serve multiple purposes. For example, using aggression to obtain something might serve the purpose of getting something that you want, and the absence of which is perceived as threatening. In this way, aggression might be viewed as both disinhibited instrumental and defensive aggression. Additionally, disinhibited instrumental aggression and anger/frustration are not mutually exclusive scales – it is theoretically coherent that one might score high or low on both, or high on one and low on the other. In sum, while specific factors are theoretically distinct, there may be a high degree of co-occurrence (or blending) which makes a bi-factor model likely the best fit.

iv. If I am able to determine an appropriate model of the models listed above:
    1. Look at model difference as a function of age (median split) and gender (male, female).
    2. Correlations among state and trait scales (see below).

v. If none of the models we explore have good fit indices, we will take the following steps:
    a. Look at age and gender as covariates.
    b. Look at modification indices and make changes to the best model to see if it can be improved sufficiently.
    c. Explore the data with another series of EFAs.

3. Correlations between scales
    a. If the scales show good psychometric properties (good fit statistics, described above), I will perform the following analyses to assess validity:
        i. All state scales with each other (with relevant subscales). The following is predicted:
            1. BAS will be negatively associated with BIS and FFFS
            2. BIS and FFFS will be positively associated.
            3. Disinhibited Instrumental Aggression will be positively associated with BAS when scores on Anger/Frustration and Defensive Aggression are low.
            4. Defensive Aggression will be positively associated with FFFS.
            5. Anger/Frustration is conceptually related to BAS, but may be more highly associated with BIS due to the emotional valance of the items.
        ii. State scales with trait scales. See document 'Conceptual Association between State and Trait Measures'.

6) **Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

The exclusion criteria for the main analyses will be: (1) incomplete responding, (2) random responders as determined by the Conscientious Responders Scale (Marjanovic, Struthers, Cribbie & Greenglass, 2012), (3) participants who check the box that says "I was not able to follow instructions today" on our attention check, and (4) outliers, defined as people who took under 1 second per question or over one hour to complete the survey.

7) **How many observations will be collected or what will determine sample size?**
No need to justify decision, but be precise about <u>exactly</u> how the number will be determined.
Between 700-800 participants (adults (18+) living in the UK and in North America) will be recruited through Prolific. Large sample sizes of 500+ are desirable for factor analytic studies.

8) Anything else you would like to pre-register?
(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
We will include the item pool for all measures and path diagrams for the CFA models we are testing.