Reinforcement sensitivity driven biobehavioural traits predict the intensity of dreams

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Summary. Sentinel function theory suggests that dreaming relates to the fight-or-flight response, protoconsciousness theory suggests that dreams prepare a person for behaviour upon waking, and threat simulation theory suggests that dreams prepare a person to deal with threat upon waking. Revised reinforcement sensitivity theory (rRST) includes three bio-behavioural systems. A behavioural approach system (BAS) is active when reward is anticipated, received, or pursued. A fight-flight-freeze system (FFFS) is active when avoidance of threat, and/or responses to threat, are required. A behavioural inhibition system (BIS) detects risk, and is implicated in the experience of anxiety. Participants (N = 279; mean age 36.5) completed an online survey that measured self-reported reinforcement sensitivity and four self-reported dream intensity constructs. Elevated BIS sensitivity was related to increases in self-reported dream quantity, dream vividness, diffusion, and altered dream episodes in zero-order and multiple regression analyses. There were no zero-order relationships between FFFS sensitivity and the four dream intensity constructs. Thus, FFFS and BIS sensitivity were differentiable within an analysis of dream intensity. BAS sensitivity was positively related to dream vividness, diffusion, and altered dream episodes in the zero-order analysis, and to diffusion, altered dream episodes (and less reliably to dream vividness) in the multiple regression analyses. There is considerable overlap between the neurobiology described in rRST and the neurobiology implicated in dream genesis. Our data suggests that rRST might be an interesting way to examine how personality is related to the intensity of dreams.

Keywords: Dreaming, personality, behavioural inhibition, behavioural approach, fight-flight-freeze

1. Introduction

Dreaming is a subjective conscious experience that occurs during sleep. Whereas rapid eye movement (REM) sleep may be the optimal or typical physiological state for realized dreams to occur, it is not an absolute requirement (Revonsuo, 2000). There are many theories of why we dream that have been reviewed extensively (Rimsh & Pietrowsky, 2020). However, here we discuss three somewhat overlapping perspectives: proto-consciousness theory (Hobson, 2009), sentinel function theory (Snyder, 1965), and threat simulation theory (Revonsuo, 2000), that suggest that dreams prepare a person for waking state behaviour. The experience of dreaming has been related to psychopathology and the full spectrum of sub-clinical and clinical anxiety disorders (Rimsh & Pietrowsky, 2020). Anxiety and psychopathology are related to the biobehavioural systems that manifest observable personality traits (Gray & McNaughton, 2000). The present study examines how biologically defined personality traits relate to the intensity of dreams.

Protoconsciousness theory suggests that REM sleep is a protoconscious state which prepares the brain to function in the waking state (Hobson, 2009), and as such dreaming can be compared to virtual reality (Rimsh & Pietrowsky, 2020). Levels of cortisol (the fight-or-flight hormone) begin to increase in the middle of night and peak by morning time. Cortisol equips an individual to cope with the demands of stressful situations in daily life. It stimulates adrenaline (epinephrine) and noradrenaline (norepinephrine) release which elevates blood pressure and heart rate so that the body can initiate a rapid behavioural response. These reactions occur over and above the variability in heart rate and increases in blood pressure that are related to REM sleep (Smiley, Wolter, & Nissan, 2019). Sentinel function theory suggests that dreaming in REM sleep serves a predictive and preparatory function which prepares an organism for immediate fight-or-flight responses upon waking when the environment is potentially harmful. However, if the environment is safe then pleasant dreams should occur (Snyder, 1966).

Similarly, threat simulation theory suggests that we dream because historically the nocturnal practicing of skills relating to threat-processing and threat-avoidance would have increased the likelihood of threat avoidance in real life, which, from an evolutionary perspective, would have increased reproductive success (Revonsuo, 2000). This account has been extended beyond the focus on threat processing, to include the dream rehearsal of social situations and interactions. Theoretically, this serves to aid the development of the cognitive and social skills that are needed in real life situations (Franklin & Zyphur, 2005).

A review of the relationship between anxiety and dreams has shown that elevated trait anxiety, and the presence of

an anxiety disorder, can predict an elevated negative tone and increased threat-related content in dreams, a higher frequency of such dreams, increased nightmares, and a higher rate of dream recall (Rimsh & Pietrowsky, 2020). The frequency of dream recall is increased when high levels of fear and state anxiety are experienced prior to sleep (Yu, 2007). Trait anxiety can also relate to some peculiar transformations of dreams and dream content. For example, elevated trait anxiety is related to the occurrence of animal imagery in dreams (DeCicco, 2007).

Lucid dreaming is where a person is aware that they are dreaming and, in some cases, have control over their actions in the dream. Lucid dream intensity, but not lucid dream frequency, has been shown to be negatively correlated with anxiety and depression (Aviram, Soffer & Dudek, 2018). However, the frequency of lucid dreaming has been shown to be negatively correlated with neuroticism, and to be unrelated to extraversion. Whereas in the same study neither neuroticism nor extraversion were related to dream recall frequency (Schredl et al., 2022). Other research using the dream intensity scale (DIS; Yu, 2012) shows that neither neuroticism nor extroversion relate to lucid dreaming. However, neuroticism was positively correlated with dream quantity, and with dream diffusion effects (for example, the merging of real-world characters into one dream character, misrepresentation of real-world characters in dreams, anthropomorphic characters in dreams, and Dejavu and dream reality confusion). By contrast, extraversion was weakly negatively correlated with dream quantity, and was weakly positively correlated with dream vividness (Yu, 2012).

The possible link between trait neuroticism and dream behaviour is interesting as high neuroticism compared to low neuroticism can be related to higher salivary cortisol levels recorded 30 minutes after waking (Portella et al., 2005). This suggests a possible link between neuroticism and the preparatory fight-or-flight response explanation of dreaming described by sentinel function theory (Snyder, 1966). The possible link between trait extraversion and dream behaviour is also interesting as extraversion is theorized to be linked to dopaminergic reward processing (Smillie et al., 2019), and theoretically the mesolimbic-mesocortical dopamine system is involved in dream genesis (Domhoff, 2001; Solms, 2000). Thus, neuroticism and extraversion might be related to dream activity for different reasons.

The traits of neuroticism and extraversion are considered to be general traits that are mediated by neuropsychological motivational systems that contribute to personality (Smillie, 2008). For example, a biobehavioural model of anxiety, motivation, and personality referred to as revised reinforcement sensitivity theory (rRST; Gray & McNaughton, 2000) describes three interrelated brain-behavioural systems: a behavioural approach system (BAS); a fight-flight-freeze system (FFFS); and a behavioural inhibition system (BIS). The three neuropsychological systems described in rRST are theorised to be responsible for manifesting social behaviours that are related to approach and avoidance motivation.

In rRST the BAS is activated by approach related stimuli such as conditioned and unconditioned signals of potential reward and/or non-punishment (Corr & McNaughton, 2012; Gray & McNaughton, 2000). Although the biological theory (Gray & McNaughton, 2000) does not subdivide the BAS, psychometric studies based on factor analysis suggest that self-reported BAS related behaviour could be subdivided into four categories (Vecchione & Corr, 2021). From this perspective the BAS output of *reward interest* would manifest as a motivation to pursue potential rewards; the BAS output of *goal-drive-persistence* would manifest as the active pursuit of goals when reward from such goals is not immediate; the BAS output of *reward reactivity* would manifest as excitement upon successful achievement; and the BAS output of *impulsivity* would manifest as a fast reaction to stimuli without engaging in any depth of thought about the pursuit of reward (Vecchione & Corr, 2021).

In contrast to the function of the BAS, the FFFS is activated when an immediate defence response is required due to the detection of threat-related, punishment-related, or frustration-related stimuli. FFFS activity can manifest as an active avoidance *flight* response, but sometimes a *freeze* response can occur. FFFS activity is associated with the felt experience of fear and/or panic (Gray & McNaughton, 2000; McNaughton & Corr, 2004). In rRST, the BIS detects risk, is activated by goal conflict, and manifests cautious approach related and/or passive avoidance behaviour. The BIS therefore restrains FFFS and BAS responses when required, and resolves goal conflict when the FFFS and BAS are coactivated. BIS activity is associated with the felt experience of anxiety, and vigilance towards any potential risk. Elevated levels of dispositional BIS sensitivity make a FFFS response more likely than a BAS response in many situations. In summary, in rRST fear and anxiety are separable constructs, and are mediated by the FFFS and BIS respectively (Gray & McNaughton, 2000; McNaughton & Corr, 2004). The combination of FFFS and BIS sensitivity contributes substantially to the biological basis of the general personality trait of neuroticism, and BAS sensitivity is the underlying biological basis of the personality trait of extraversion (Smillie, 2008).

The reinforcement sensitivity driven bio-behavioural traits can be assessed with self-report measures (e.g., Vecchione & Corr, 2021). We are unaware of any studies that adopt a rRST perspective on understanding how personality relates to dreaming. The present study investigates how BIS, FFFS, and BAS sensitivity relate to the effects of dream quantity, dream vividness, dream diffusion, and altered dream episodes as measured by the dream intensity scale (Yu, 2012). We assess reinforcement sensitivity with the RST-PQ-S (Vecchione & Corr, 2021). By using this measure, we can separate out the effects of fear (FFFS sensitivity) and anxiety (BIS sensitivity) that are confounded in general measures of neuroticism. Based upon the above literature on anxiety (Rimsh & Pietrowsky, 2020) we predict that BIS sensitivity will be positively correlated with dream quantity. Based on the neuroticism effects reported by (Yu, 2012) we also tentatively predict that BIS sensitivity will be positively correlated with dream diffusion. We will explore whether FFFS sensitivity also relates to these effects, or whether rRST differentiates the effects of fear (FFFS sensitivity) and anxiety (BIS sensitivity) on these dream effects. Moreover, based on the extraversion correlations reported by Yu (2012) BAS sensitivity might be weakly negatively correlated with dream quantity, and positively correlated with dream vividness. However, in the RST-PQ-S (Vecchione & Corr, 2021), BAS sensitivity is subdivided into subscales representing the four different BAS mediated behaviours discussed above: *reward interest*; *goal-drive-persistence*; *reward reactivity*; and *impulsivity*. Thus, we intended to explore whether any of the

individual BAS subscales share any individual relationships with the dream intensity constructs.

2. Method

2.1. Participants and sampling procedure

Ethical approval was granted by the Department of Psychology, Sociology, and Politics at Sheffield Hallam University. Participants were invited to take part in an online survey concerning personality and dreaming. The survey was distributed via social media, and some email invites. No financial incentive was offered. In line with the declaration of Helsinki, participants gave informed consent, and were informed of their right to withdraw. However, failure to answer one of the questions activated a pop-up message asking the participant if they wanted to answer the missed question. The question could either be completed, or the pop-up message could be dismissed by the participant (without answering the question), before they transitioned to the next page of questions. There were 445 respondents initially, but after removing participants who did not fully complete all of the questions there were 279 participants. The final sample (166 females; 112 males; 1 non-binary) had a mean age of 36.5 (SD = 14.3). 87 were students and 9 of those received course credit from the host institution in return for participation. At the time of participation, 84 participants were located in Europe, 164 were located in Asia, 15 were located in Africa, 9 were located in North America, 1 participant was located in South America, and 6 participants were located in Australia. Of these participants, 228 were originally from Asia, 36 were originally from Africa, 14 were originally from Europe, and 1 participant was originally from Australia.

2.2. Measures

2.2.1 Dreaming

The dream intensity scale (DIS; Yu, 2012) is a trait measure of dream intensity that includes four latent factors. We used the sum of scores derived from Likert scale responses to the questions from each of the four factors as four separate measures of dream behaviour. The 5-item dream quantity factor contained questions about dream awareness and recall, multiple dreams, and nightmare frequency/awakening. The mean score in the present study was 19.7 (SD = 8.9). Cronbach's alpha (α) was 0.80. The 5-item dream vividness factor contained questions about the experience of colours, sounds, emotions, odours, and tastes in dreams. The mean score in the present study was 8.6 (SD = 4.1), and α = 0.72. The 6-item diffusion factor contained questions about the merging of real-world characters into one dream character, misrepresentation of real-world characters in dreams, anthropomorphic characters, object symbolism in dreams, and deja-vu and dream reality confusion. The mean score in the present study was 8.5 (SD = 5.6), and α = 0.69. The 4-item altered dream episodes factor contained questions about lucid dreaming, self-scripted dreams, reconnecting with dreams, and reexperiencing wishful dreams. The mean score in the present study was 8.7 (SD = 7.1), and α = 0.72. Higher scores on each of the dream intensity measures indicated greater levels of the experience of each of the four dream intensity phenomena.

2.2.2 Personality

Personality was assessed with the Reinforcement Sensitivity Personality Questionnaire short version (RST-PQ-S; Vecchione & Corr, 2020), which is a shortened version of the RST-PQ (Corr & Cooper, 2016). The RST-PQ-S asks participants to rate how accurately a list of statements concerning day-to-day feelings and behaviours relate to them using a Likert scale. The 5-item BIS scale contains statements about feeling blue without reason, worry about letting people down, the ease of behavioural interruption, difficulties in getting thoughts out of one's own head, and waking up with thoughts running through one's head. The mean score in the present study was 13.4 (SD = 3.0), and α = 0.67. The 5-item FFFS scale contains statements about running away from threat, freezing when threat is present, and avoidance of contact with possible threat. The mean score in the present study was 12.8 (SD = 3.4), and α = 0.58. The 3-item BAS reward interest (BAS-RI) scale contains statements about trying new activities for enjoyment, and getting carried away with projects. The mean score in the present study was 7.8 (SD = 1.9), and α = 0.57. The 3-item BAS goal-drive-persistence (BAS-GDP) scale contains statements about motivation for success and achievement. The mean score in the present study was 9.4 (SD = 2.0), and α = 0.78. The 3-item BAS reward reactivity (BAS-RR) scale contains statements about feelings of positive affect when good news or praise is received, or the celebration of accomplishments. The mean score in the present study was 9.1 (SD = 2.0), and α = 0.62. The 3-item BAS impulsivity (BAS-I) scale contains statements about not being able to control impulses such as talking, risk taking, and spur of the moment acts. The mean score in the present study was 6.9 (SD = 2.1), and α = 0.59. The mean score for the total BAS scale including all 12 BAS subscale items was 33.1 (SD = 5.6), and α = 0.76. Higher scores on each of the rRST measures indicated greater levels of each of the self-reported reinforcement sensitivity constructs.

There were two rRST scales that produced an α reliability of less than 0.6. The FFFS scale contained 5 items and obtained a reliability level of α = 0.58. Thus, for the FFFS scale we ran an exploratory reliability analysis removing each of the items from the scale one at a time, thus leaving four items in each analysis. This yielded α statistics ranging from 0.45 - 0.59. As the greatest improvement in α was an increase in 0.01 (in effect an increase from 0.58 to 0.59) we opted to leave all 5 items in the total score of the FFFS scale. The BAS-RI scale produced an α reliability of 0.57. when we ran an exploratory reliability analysis removing each of the items from the scale one at a time, thus leaving two items in each analysis. In these analyses α ranged from 0.32 - 0.67. Thus, when we removed the item "*I get carried away by new projects*" α was increased from 0.57 to 0.67. Thus, we used this two item BAS-RI scale in our zero-order analyses.

3. Results

Statistical analyses were conducted using Jamovi version 1.6.23. Initially we used zero-order correlations to examine the relationship between the dream intensity variables and the rRST variables. Table 1 shows that BIS sensitivity was positively correlated with all four dream intensity constructs. By contrast, FFFS sensitivity was uncorrelated with the four dream intensity constructs. Neither BAS-RI nor BAS-GDP were significantly correlated with any of the four dream in-

Table 1. The zero-order correlations between the dream intensity constructs and the rRST constructs

Explanatory Variable	Dream quantity	Diffusion	Altered dream episodes	Dream vividness
Behavioral inhibition sensitivity	0.28***	0.28***	0.19**	0.19**
Fight-flight-freeze sensitivity	-0.02	-0.01	-0.06	-0.03
Behavioral approach sensitivity (reward interest)	-0.03	0.09	0.11	0.10
Behavioral approach sensitivity (goal drive persistence)	0.01	0.02	0.03	-0.03
Behavioral approach sensitivity (reward reactivity)	0.10	0.18**	0.09	0.14*
Behavioral approach sensitivity (impulsivity)	0.13*	0.18**	0.18**	0.15*
Behavioral approach sensitivity (total score)	0.11	0.20***	0.16**	0.15*

Note. * p < 0.05, ** p < 0.01, *** p ≤ 0.001.

tensity constructs. BAS-RR was positively correlated with diffusion and dream vividness, and BAS-I was positively correlated with all four dream intensity constructs. Total BAS scale scores were significantly positively correlated with diffusion, altered dream episodes, and dream vividness, and non-significantly positively correlated with dream quantity.

The second part of our analysis used multiple regression to reveal how prominently each of the rRST constructs relate to each of the dream intensity constructs, whilst examining how strongly the collective effect of reinforcement sensitivity predicts each of the four dream intensity constructs. Thus, dream quantity, dream vividness, diffusion, and altered dream episodes were entered as the dependent variable (DV) in four separate regression analyses that included rRST variables as predictor variables. Based upon the correlations in Table 1, both BAS-RR and BAS-I shared a correlation with two or more of the dream intensity variables, as did the total BAS score. As the above reliability analysis showed the total BAS scale to have a greater reliability than either the BAS-RR or BAS-I subscales we opted to include the total BAS scores in our multiple regression analysis, alongside BIS scores. As FFFS did not share any significant zero-order correlations with any of the dream intensity variables it was not included as a predictor in the multiple regression analyses. We also confirmed that none of the assumptions of regression were violated.

Table 2 shows that BIS sensitivity shared a significant positive relationship with dream quantity, whereas BAS sensitivity did not. Table 2 shows that overall, reinforcement sensitivity predicted approximately 7% of the variance in dream quantity. Table 3 shows that BIS sensitivity shared a significant positive relationship with dream vividness, whereas BAS sensitivity did not. However, the predictive effect of BAS on vividness could be interpreted as a statistical trend. Table 3 shows that overall, reinforcement sensitivity predicted approximately 4% of the variance in dream vividness. Table 4 shows that both BIS sensitivity and BAS sensitivity shared a significant positive relationship with diffusion.

Table 4 also shows that overall, reinforcement sensitivity predicted approximately 9% of the variance in diffusion. Table 5 shows that both BIS sensitivity and BAS sensitivity shared a significant positive relationship with altered dream episodes. Table 5 also shows that overall, reinforcement sensitivity predicted approximately 4% of the variance in altered dream episodes.

We ran some exploratory analyses which repeated the above series of regression analyses. This time we included the separate BAS-RR and BAS-I subscale scores, alongside BIS scores, as predictors of the dream intensity variables. When dream quantity was the DV, neither BAS-RR nor BAS-I were significant individual predictors (both ts < 0.30, both standardised beta estimates = 0.02, both ps > 0.700). Similarly, when dream vividness was the DV, neither BAS-RR nor BAS-I were significant individual predictors (both ts < 1.40, both standardised beta estimates ≤ 0.08, both ps > 0.190). When diffusion was the DV, neither BAS-RR nor BAS-I were significant individual predictors (both ts < 1.70, both standardised beta estimates ≤ 0.10, both ps ≥ 0.095). When altered dream episodes was the DV, BAS-RR was not a significant predictor (t= 0.13, standardised beta estimate = 0.01, p = 0.898), whereas BAS-I, as a predictor, approached the threshold of statistical significance (t= 1.87, standardised beta estimate = 0.12, p = 0.063).

4. Discussion

Personality, as operationalised as the variability in the combination of self-reported BIS and BAS sensitivity, accounted for 4% of the variability in altered dream episodes, 4% of the variability in dream vividness, 7% of the variability in dream quantity, and 9% of the variability in diffusion. However, the individual rRST constructs also shared some interesting differential relationships with these dream intensity constructs.

The zero-order correlations clearly showed that whereas BIS sensitivity was positively correlated with all four dream

Table 2. Regression of the rRST constructs onto dream quantity.

Model: Adj. R² = 0.07, F (2, 276) = 12.2, p < 0.001						*95% Confidence Interval of the standardized estimate*	
	Estimate	*SE*	*t*	*p*	*Stand. Estimate*	*Lower*	*Upper*
Behavioral inhibition sensitivity	0.80	0.17	4.60	<.001	0.27	0.16	0.39
Behavioral approach sensitivity (total score)	0.06	0.10	0.58	0.565	0.03	-0.08	0.15

Table 3. Regression of the rRST constructs onto dream vividness.

Model: Adj. R² = 0.04, F (2, 276) = 6.95, p < 0.001					95% Confidence Interval of the standardized estimate		
	Estimate	*SE*	*t*	*p*	*Stand. Estimate*	*Lower*	*Upper*
Behavioral inhibition sensitivity	0.22	0.08	2.72	0.007	0.17	0.05	0.28
Behavioral approach sensitivity (total score)	0.08	0.04	1.77	0.079	0.11	-0.01	0.23

intensity constructs, FFFS sensitivity was not. Thus, FFFS related fear and BIS related anxiety appear to be differentiable within an analysis of dream intensity. This is important as in rRST (Gray & McNaughton, 2000) fear and anxiety are separate constructs that relate to avoidance, and defensive approach behaviours respectively. We also note that the multiple regression analysis also showed that BIS sensitivity positively predicted all four dream intensity constructs.

As noted above, protoconsciousness theory suggests that REM sleep prepares the brain to function upon waking (Hobson, 2009), thus dreaming might be considered a form of virtual reality (Rimsh & Pietrowsky, 2020). This virtual reality would allow an organism to prepare for immediate fight-or-flight responses upon waking (Snyder, 1966), and/or rehearse social situations and interactions that are needed in real life situations (Franklin & Zyphur, 2005). Elevated BIS sensitivity related to elevated scores on all of the dream intensity constructs. In rRST the BIS is responsible for risk analysis, uncertainty, and defensive approach behaviour (Gray & McNaughton, 2000). Preparatory responses to possible social threats upon waking could be considered a form of risk management, and a preparation for defensive approach responses.

According to rRST BIS activation involves the prefrontal dorsal stream, posterior cingulate, amygdalae, medial hypothalamus, periaqueductal gray, and the septo-hippocampal system (McNaughton & Corr, 2004). There is some overlap between the proposed anatomical basis of the BIS and the proposed anatomical basis of dream genesis. For example, the amygdaloid complexes and hippocampal formation are implicated in the encoding and consolidation of emotional memories. During REM sleep, the co-activation of these regions may elevate the emotional intensity of some dreams (Braun et al., 1997; Desseilles et al., 2011; Maquet et al., 1996; Nofzinger et al., 1997). Moreover, the amygdalae and hippocampal formation are involved in dream genesis (Cipolli & De Gennaro, 2021). Furthermore, the emotional intensity of dreams can be positively correlated with hippocampal volume (De Gennaro et al., 2016), whereas dream vividness can be related to the thickness of the left medial prefrontal cortex (mPFC) and to the amygdalae (De Gennaro et al., 2016).

Thus far we have focused upon discussing the effect of BIS sensitivity upon dream intensity. However, total BAS scores were also significantly positively related to dream vividness, diffusion and altered dream episodes in the zero-order analysis, and in the multiple regression analysis (although the BAS effect on vividness appeared as a statistical trend in the regression analysis). Dreaming most often occurs during REM sleep (Revonsuo, 2000), and activity in reward-related brain regions such as the ventral tegmental area and nucleus accumbens is elevated during REM sleep (Perogamvros & Schwarz, 2012). Dopamine is involved in reward processing (Schultz, 2010), and possibly the genesis of longer dreams and/or more prolific dreams during REM sleep (Perogamvros & Schwarz, 2012). Moreover, the nucleus accumbens is part of the ventral striatum / basal ganglia which is part of the neurocircuitry that forms the BAS in rRST (McNaughton & Corr, 2004). As already discussed, dreaming is considered a form of virtual reality (Rimsh & Pietrowsky, 2020) that aids the rehearsal of social situations that occur in real life situations (Franklin & Zyphur, 2005). Thus, social situations that may lead to reward could be rehearsed (or reexperienced) during sleep in the same way as social situations that relate to threat are rehearsed during sleep. From an rRST perspective, this process might increase the efficiency of any BAS activated route towards any potential social or biological reward. This could offer some explanation of the association between the biobehavioural personality dimension of BAS and aspects of self-reported dream intensity.

As noted above, in the present study there was a zero-order correlation between total BAS scores and dream vividness scores, but not dream quantity scores. In partial contrast, extraversion has previously been shown to be weakly negatively correlated with dream quantity, and to be weakly positively correlated with dream vividness (Yu, 2012). This partial inconsistency occurs in spite of the viewpoint that BAS sensitivity provides the biological basis of the personality trait of extraversion (Smillie, 2008).

It is also notable that in the present study the BAS-I subscale positively predicted the four dream intensity factors in the zero-order analysis. These relationships were not very prominent in the exploratory multiple regression analyses that included the BAS-RR and BAS-I subscale scores as

Table 4. Regression of the rRST constructs onto diffusion.

Model: Adj. R² = 0.09, F (2, 276) = 14.15, p < 0.001					95% Confidence Interval of the standardized estimate		
	Estimate	*SE*	*t*	*p*	*Stand. Estimate*	*Lower*	*Upper*
Behavioral inhibition sensitivity	0.45	0.11	4.08	<.001	0.24	0.13	0.36
Behavioral approach sensitivity (total score)	0.13	0.06	2.25	0.025	0.13	0.02	0.25

Table 5. Regression of the rRST constructs onto altered dream episodes.

Model: Adj. R² = 0.04, F (2, 276) = 7.21, p < 0.001						95% Confidence Interval of the standardized estimate	
	Estimate	SE	t	p	Stand. Estimate	Lower	Upper
Behavioral inhibition sensitivity	0.36	0.14	2.58	0.011	0.16	0.04	0.28
Behavioral approach sensitivity (total score)	0.16	0.08	2.03	0.043	0.12	0.00	0.24

predictors. However, BAS-I predicted altered dream episodes at a trend level. Thus, future work might retest whether impulsivity relates to lucid dreaming, self-scripted dreams, reconnecting with dreams, and/or reexperiencing wishful dreams. Interestingly, impulsivity has been associated with dopaminergic neurotransmission, but it is a multifaceted construct, and its link with dopamine is complex, not fully understood, and may involve complex interactions with the serotonin system (Dalley & Roiser, 2012). The BAS-RR subscale also positively predicted the dream intensity variables of diffusion and vividness in the zero-order analysis, but these relationships were not prominent in the exploratory multiple regression analyses that included the BAS-RR and BAS-I subscale scores as predictors.

5.   Limitations

We close our discussion by considering some limitations. Firstly, we were interested in rRST (Gray & McNaughton, 2000) as a biologically appealing perspective on personality and approach and avoidance motivation. Thus, we chose to discuss the biologically appealing theories of dreaming that can be linked to the fight-or-flight response. That is to say, we have discussed theories suggesting that dreaming is related to the preparation for behaviour upon waking. An alternative perspective on dream function, not discussed above, explains dreams as a loose style of thinking that reflects the forming of connections between memories, or emotions and memories that are unlikely to be formed in a waking state via focused thinking on its own (Stickgold et al., 2001). In which case the association between the dream intensity constructs and rRST measures would require a different explanation. For example, we cannot rule out an explanation that elevated BIS sensitivity simply relates to an increased awareness upon waking that this memory consolidation process has been occurring, and that the content of dream recall reflects disjointed memories of real-life events.

Secondly elevated levels of insecure attachment can relate to increased dream recall, dream frequency, and emotional intensity in dreams, whereas REM sleep and/or dreaming might aid the promotion of attachment (McNamara & Andresen, 2001). Moreover, salivatory cortisol is elevated in attachment anxiety (Jaremka et al., 2013), and attachment anxiety is positively correlated with BIS sensitivity (Jiang & Tiliopoulos, 2014). Attachment anxiety was not measured in our participants. Thus, future studies on rRST and dream intensity might also examine if the effect of attachment anxiety shares any variance with self-reported dream intensity, that is not accounted for by BIS sensitivity.

Thirdly, we also discussed the neurobiology of rRST when discussing the relationship between reinforcement sensitivity and the dream intensity constructs. However, in the present study self-report measures were used to measure the sensitivity of reinforcement sensitivity-based personality constructs that are intended to reflect the reactivity of the theoretical biobehavioral systems described in rRST (Gray & McNaughton, 2000). Thus, as with most rRST studies, we did not directly compare the reactivity of the underlying brain behavioural systems that are theorised to manifest observable personality traits to the scores on the DV(S), which were in the present study the four dream intensity constructs.

Fourthly, in our zero-order analysis FFFS sensitivity was unrelated to dream intensity, but we cannot rule out the possibility that using the short form of the FFFS scale as it appears in the RST-PQ-S (Vecchione & Corr, 2020) would produce a slightly different effect than the longer FFFS scale as it appears in the original RST-PQ (Corr & Cooper, 2016). Vecchione and Corr (2020) suggest that the full-length RST-PQ might be more suitable if individuals are to be assessed in an applied setting, and the test score has a consequence for any particular individual. However, the FFFS scale from the RST-PQ-S has previously been shown to be very strongly correlated (r = 0.79) with the FFFS scale from the RST-PQ (Vecchione & Corr, 2020).

6.   Conclusion

We are unaware of any studies that have adopted a rRST perspective on understanding how personality relates to dreaming. Thus, we have provided novel data showing how reinforcement sensitivity predicts four dream intensity constructs. Elevated self-reported BIS sensitivity was related to increases in self-reported dream quantity, dream vividness, dream diffusion, and altered dream episodes in zero-order and multiple regression analyses. By contrast, there were no zero-order relationships between FFFS sensitivity and the four dream intensity constructs. FFFS related fear and BIS related anxiety were differentiable within an analysis of dream intensity. This is interesting as in rRST (Gray & McNaughton, 2000) fear is a defensive avoidance behaviour, and anxiety is a defensive approach behaviour. BAS sensitivity was positively related to dream vividness, diffusion, and altered dream episodes in the zero-order analysis, and to diffusion, altered dream episodes (and less reliably to dream vividness) in the multiple regression analyses. As noted above, there is some considerable overlap between the neurobiology described in rRST and the neurobiology thought to be involved in dream genesis. Our data suggests that rRST might be an interesting way to examine how personality is related to dream intensity.

Data Accessibility Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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