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Re-examining the relationship between mindfulness facets, attentional control, and dispositional reinforcement sensitivity

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This study re-examines the relationships between the five mindfulness facets of observing, describing, acting-with-awareness, non-judging, and non-reactivity, and the affective personality measures inspired by the revised Reinforcement Sensitivity Theory (rRST). The rRST measures assess behavioural inhibition sensitivity, fight-flight-freeze sensitivity, and the behavioural approach sensitivity components of reward interest, goal-drive-persistence, reward reactivity, and impulsivity. Research has suggested that relationships exist between specific mindfulness facets and specific rRST constructs. However, some non-significant relationships were reported, possibly due to the small sample used. Also included in the analyses is (self-reported) attentional control, a variable that has not been accounted for in rRST and mindfulness research, but is inter-correlated with mindfulness and anxiety. In a sample of 641 participants, behavioral inhibition sensitivity shared a negative relationship with the describing, acting with awareness, non-judging, and non-reactivity components of mindfulness, and the impulsivity component of behavioural approach sensitivity shared a negative relationship with the acting with awareness facet of mindfulness. This is consistent with previous research. Attentional control shared a positive relationship with the describing, acting with awareness. and non-judging facets of mindfulness. In conclusion, specific reinforcement sensitivity personality constructs and attentional control relate to specific mindfulness components. Trait mindfulness and/or the efficacy of mindfulness interventions could be affected by variations in reinforcement sensitivity and attentional control ability.

Keywords: mindfulness, reinforcement sensitivity, BIS, BAS, FFFS, attentional control

Mindfulness is a psychological construct that can be defined as a state of intensified attention to, and awareness of, what is occurring in the present moment (Brown & Ryan, 2003). Dispositional mindfulness can be assessed by using self-report measures. Self-reported mindfulness can be described by five facets: (1) *observing* refers to how frequently a person attends to sensations, emotions, and environmental stimuli; (2) *describing* refers to a person's ability to verbally describe their internalised experiences; (3) *acting with awareness* refers to the level of awareness a person has when attending to any experiences they have; (4) *non-judging* refers to how non-evaluative a person is of their internal experiences; and (5) *non-reactivity* refers to the tendency for a person to take no action when experiencing thoughts and feelings (Baer et al., 2006). The present study examines whether these mindfulness facets share specific relationships with the three affective personality constructs: behavioural inhibition sensitivity (BIS), behavioural approach sensitivity (BAS), and fight-flight-freeze sensitivity (FFFS), as described in revised Reinforcement Sensitivity Theory (rRST; Gray & McNaughton, 2000). The present study also examines whether scores for these mindfulness facets share specific relationships with the ability to control attention.

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In rRST (Gray & McNaughton, 2000), individual differences in approach and avoidance motivation are manifested by three neuropsychological systems: (1) a behavioural approach system (BAS) which underlies approach motivation and reward focused behaviours; (2) a fight-flight-freeze system (FFFS) which underlies avoidance motivation and escape behaviours; and (3) a behavioural inhibition system (BIS) which underlies the anxiety and resulting internalised conflict resolution that occurs when the BAS and the FFFS are co-activated. Elevated levels of BIS and FFFS sensitivity contribute to trait neuroticism, whereas elevated levels of BAS sensitivity contribute to trait extroversion (Smillie, 2008). The sensitivity of the brain-behavioural systems described in rRST are often measured using self-report personality measures. Although the neuropsychological theory of rRST (Gray & McNaughton, 2000) did not separate the BAS into subcomponents, factor analytical studies on self-report data suggest that BAS outputs could be described by four types of behaviour (Corr & Cooper, 2016, Vecchione & Corr, 2021): *reward interest* (BAS-RI) refers to how open a person is to new rewarding opportunities; *goal-drive-persistence* (BAS-GDP) refers to how motivated a person is to achieve long-term goals (if reward is not imminent); *reward reactivity* (BAS-RR) refers to the amount of pleasure experienced following reward; and *impulsivity* (BAS-I) which refers to the amount of rapid action deployed to secure potential rewards (Corr & Cooper, 2016).

Research on the relationship between reinforcement sensitivity and mindfulness is in its infancy. However, FFFS sensitivity has been shown to be negatively correlated with

the *describing*, *acting with awareness*, *non-judging*, and *non-reactivity* mindfulness facets, whereas BIS sensitivity was negatively correlated with the *acting with awareness* and *non-judging* mindfulness facets (Harnett, Reid, Loxton, & Lee, 2016). Harnett et al. (2016) also found that BAS sensitivity was positively correlated with the *observing*, *describing*, *non-judging*, and *non-reactivity* mindfulness facets. Moreover, BIS sensitivity has also been shown to be negatively correlated with the *describing*, *acting with awareness*, *non-judging*, and *non-reactivity* mindfulness facets (Hamill, Pickett, Amsbaugh, & Aho, 2015; Reese, Zielinski, & Veilleux, 2015).

Although Harnett et al. (2016) used a contemporary measure of rRST referred to as the Jackson 5 (Jackson, 2009), the BIS scale in that measure is considered to be low in construct validity (Corr, 2016). Moreover, Hamill et al. (2015), and Reese et al. (2015), used a BIS measure (Carver & White, 1994) based on an older version of RST (Gray, 1982), that included a slightly different (and now outdated) description of the BIS. Thus, for an accurate examination of any self-reported BIS and mindfulness relationships, there is still a need for more evidence derived from contemporary measures of rRST, that include a currently valid BIS scale.

One study that indeed used a contemporary rRST measure was the one by Dolatyar and Walker (2020), who applied the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ; Corr & Cooper, 2016), and also the Five Factor Mindfulness Questionnaire (Baer et al., 2008). Dolatyar and Walker (2020) demonstrated that some of the rRST constructs may share some relationships with aspects of mindfulness, as indexed by scores for specific mindfulness facets. In their analysis, BAS-GDP positively predicted *describing* and *non-reacting* and showed a trend towards positively predicting *non-judging*. BAS-RI negatively predicted *non-judging* and showed a trend towards positively predicting *observing*. BAS-I negatively predicted *acting with awareness*. BAS-RR showed a trend towards a positive relationship with *observing*. Thus, there is some evidence that specific subcomponents of BAS sensitivity share relationships with specific subcomponents of mindfulness.

Dolatyar and Walker (2020) also showed that BIS sensitivity negatively predicted *describing*, *acting with awareness*, *non-judging*, and *non-reacting*, but it did not predict *observing*. By contrast, no significant specific relationships were found between FFFS sensitivity and mindfulness facets. However, FFFS sensitivity did show a trend towards positively predicting *non-reacting* (Dolatyar & Walker, 2020). These results offer some insight into how reinforcement sensitivity relates to mindfulness. Dolatyar and Walker noted, however, that their study was limited by a small sample size (N = 115). A lack of statistical power may explain why some of the relationships between the rRST constructs and the mindfulness facets were only evident at a non-significant trend level.

There is another important variable to consider here, as mindfulness shares a positive correlation with self-reported attentional control (AC; Walsh et al., 2009). AC is the explicit ability to direct attention and flexibly control thought processes (Derryberry & Reed, 2002). Self-report measures of mindfulness and self-report measures of AC are both negatively correlated with self-reported levels of trait anxiety (Walsh et al., 2009). Moreover, there is a substantial amount of genetic covariance concerning levels of AC and trait anxiety (Gagne et al., 2017). Importantly, in rRST elevated BIS reactivity is related to elevated trait anxiety (Gray & McNaughton, 2000). Elevated trait anxiety is often found to be related to increases in cognitive interference which can be experienced as distraction (Eysenck, Derakshan, Santos, & Calvo, 2007). Trait anxiety also shares a negative zero-order correlation with the *describing*, *acting with awareness*, *non-judging*, and *non-reactivity* mindfulness facets, whereas AC (as indexed by both attentional shifting and attentional focusing components) shares a positive zero-order correlation with all of the five mindfulness facets (MacDonald & Olsen, 2020). Considering these intercorrelations, it is important to include a measure of AC in any analysis of the relationship between the mindfulness facets and the three reinforcement sensitivity constructs.

The inverse relationship between trait anxiety and the efficiency of AC may explain why some individuals experiencing anxiety can be particularly affected by the processing of internalised threat-related stimuli such as worried thoughts, and/or external *potentially* threat-related stimuli such as other people in social situations (Eysenck et al., 2007). Elevated levels of self-reported *non-judging*, *non-reactivity*, and *acting with awareness* predict low levels of anxiety, and elevated levels of self-reported *non-judging* predict low levels of depression (Medvedev et al., 2021). It is therefore important to understand the relationship between reinforcement sensitivity and the experience of what is measured by the mindfulness facets, as well as the relationship between AC and the experience of what is measured by the mindfulness facets. This analysis is important as high depression is related to low reward sensitivity (as reflected in low self-reported BAS sensitivity), and high anxiety and/or high depression are related to elevated punishment sensitivity (as reflected in high self-reported BIS sensitivity; Katz, Matanky, Aviram, & Yovel, 2020).

Research on mindfulness interventions suggests that from the pre-intervention stage to the post-intervention stage, mindfulness, as indexed by scores for the facets of *observing* and *non-reactivity*, may mediate the efficacy of interventions for depression. Moreover, mindfulness, as indexed by scores for the facet of *observing* may mediate the efficacy of interventions for anxiety. By contrast, from post-intervention stage to the follow-up stage, mindfulness, as indexed by scores for the sub-facets of *non-judging* and *acting with awareness*, may mediate the efficacy of interventions for depression and anxiety (Haenen et al., 2016). If any reliable relationships exist between specific reinforcement sensitivity constructs and specific mindfulness facets, then these relationships may be important to be considered when developing interventions for affective disorders. Moreover, mindfulness meditation is thought to improve the performance of attentional systems by modifying neural architecture and/or activity (Malinowski, 2013). Thus, it would be useful to understand how reliably self-reported AC relates to each dispositional mindfulness facet.

Table 1: Mean scores, 95% confidence intervals (95% CI), and Cronbach's alpha reliability statistics (α), for each of the scales from the RST-PQ, ACS, and FFMQ-15.

	Mean score	95% CI	α
RST-PQ-S (reinforcement sensitivity)			
BIS	14.2	14.1 - 14.4	0.70
BAS-RI	7.3	7.1 - 7.5	0.72
BAS-I	7.0	6.8 - 7.2	0.55
BAS-RR	9.2	9.1 - 9.4	0.60
BAS-GDP	9.1	8.9 - 9.3	0.80
FFFS	11.9	11.6 - 12.2	0.56
ACS (attentional control)			
Attentional Control	51.1	50.5 - 51.8	0.85
FFMQ-15 (mindfulness)			
Observing	9.8	9.6 - 10.0	0.53
Describing	9.3	9.1 - 9.6	0.78
Acting with awareness	8.7	8.6 - 8.9	0.58
Non-judging	9.2	8.9 - 9.4	0.82
Non-reactivity	9.1	8.9 - 9.2	0.61

The present study

The present study is based on a re-analysis of the data used in du Rocher et al. (2021), which forms a larger sample than that used by Dolatyar and Walker (2020). This study tests the relationship between the rRST constructs and mindfulness as indexed by the five mindfulness facets, and also includes AC in the analysis.

The main hypotheses for the present study were based on Dolatyar and Walker (2020). Specifically, it was hypothesised that BAS-GDP would positively predict *describing* and *non-reacting*. It was also hypothesised that the present larger sample would render significant the statistical trend reported by Dolatyar and Walker (2020), that BAS-GDP positively predicted *non-judging*. It was also hypothesised that BAS-RI would negatively predict *non-judging*, and that the present larger sample would also render significant the statistical trends towards BAS-RI and BAS-RR positively predicting *observing* (see Dolatyar & Walker, 2020). It was also hypothesised that BAS-I would negatively predict *acting with awareness*, and that BIS would negatively predict *describing*, *acting with awareness*, *non-judging*, and *non-reacting*, but not *observing*. The present study also tested whether the relatively larger sample would render significant the trend towards FFFS positively predicting *non-reacting*, (see Dolatyar & Walker, 2020). It was also hypothesised that AC would correlate positively with all of the dispositional mindfulness facets, with the strongest correlation for *acting with awareness* (cf. MacDonald & Olsen, 2020).

METHOD

Participants

Participants were those described in detail in du Rocher et al. (2021). The original analysis focused on a different question, concerning disordered eating, and as such the mindfulness facets were not analysed at all in that earlier study. Thus, no salami slicing of data has taken place. Of the 641 participants (mean age = 29.7) included in the analysis, 166 were male, and 177 reported a previous history of psychiatric problems. Departmental ethical approval was received for the original study and is detailed in du Rocher et al. (2021). Data collection for the original study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Therefore, all participants gave their informed consent prior to taking part in the original study.

Measures and procedure

The data were collected via an online survey. Use was made of the following three self-report measures. These measures have been described in du Rocher et al. (2021) except for the mindfulness subscales. The relevant statistics are given in Table 1.

RST-PQ-S. The Reinforcement Sensitivity Personality Questionnaire short version (Vecchione & Corr, 2020 was used to assess BIS, BAS-RI, BAS-I, BAS-RR, BAS-GDP, and FFFS. It is a shortened version of the RST-PQ (Corr & Cooper, 2016), as was used by Dolatyar and Walker (2020).

ACS. The Attentional Control Scale (Derryberry & Reed, 2002) was used to assess AC.

FFMQ-15. The Five Facet Mindfulness Questionnaire (Baer et al., 2008) was used to assess dispositional mindfulness. The FFMQ-15 contains five subscales that correspond to the mindfulness facets of *observing*, *describing*, *acting with awareness*, *non-judging*, and *non-reactivity*. This measure was also used by Dolatyar and Walker (2020).

RESULTS

A series of five multiple regression analyses were used to analyse how BIS, FFFS, BAS-RI, BAS-I, BAS-RR and BAS-GDP, as well as AC, predict scores on the five separate mindfulness sub-facets (*observing; describing; acting with awareness; non-judging; non-reactivity*), when controlling for sex, age, and psychiatric group (previous diagnosis

Table 2. The zero-order correlations between the mindfulness, attentional control and rRST measures

	1	2	3	4	5	6	7	8	9	10	11
FFMQ-15 (mindfulness)											
1: Observing	—										
2: Describing	0.04	—									
3: Acting with awareness	-0.09*	0.19***	—								
4: Non-judging	-0.13***	0.38***	0.42***	—							
5: Non-reactivity	0.16***	0.18***	0.01	0.15***	—						
ACS (attentional control)											
6: ACS	0.01	0.38***	0.36***	0.43***	0.20***	—					
RST-PQ-S (reinforcement sensitivity)											
7: BAS-RI	0.13**	0.24***	0.05	0.08	0.17***	0.28***	—				
8: BAS-GDP	0.13**	0.26***	0.10**	0.08*	0.07	0.26***	0.49***	—			
9: BAS-RR	0.10*	0.20***	-0.07	-0.02	0.02	-0.01	0.34***	0.37***	—		
10: BAS-I	0.12**	-0.08*	-0.29***	-0.22***	0.04	-0.18***	0.25***	0.03	0.16***	—	
11: BIS	0.18***	-0.30***	-0.45***	-0.64***	-0.19***	-0.43***	-0.07	-0.04	0.14***	0.22***	—
12: FFFS	0.05	-0.05	-0.14***	-0.11**	-0.15***	-0.26***	-0.10*	0.04	0.26***	-0.05	0.25***

Table 3. Standardised estimates (beta) and p-values for the independent variables entered into each of the five hierarchical multiple regression models including observing, describing, acting with awareness, non-judging, or non-reactivity as the dependent variable.

	Observing		Describing		Acting with awareness		Non-judging		Non-reactivity	
	beta	*p*	beta	*p*	beta	*p*	beta	*p*	beta	*p*
Model 1										
Sex	-0.047	0.241	-0.050	0.202	**0.127**	**0.001**	-0.021	0.559	-0.060	0.127
Age	0.003	0.939	**0.228**	**<0.001**	**0.177**	**<0.001**	**0.328**	**<0.001**	**0.105**	**0.008**
Psychiatric group	0.045	0.261	-0.011	0.774	**-0.124**	**0.001**	**-0.315**	**<0.001**	**-0.125**	**0.002**
Model 2										
Sex	-0.052	0.199	**-0.091**	**0.014**	**0.093**	**0.013**	-0.054	0.113	0.043	0.278
Age	-0.010	0.807	**0.116**	**0.003**	**0.084**	**0.031**	**0.238**	**0.001**	0.057	0.167
Psychiatric group	0.053	0.199	0.051	0.180	-0.073	0.054	**-0.265**	**0.001**	**-0.098**	**0.015**
ACS	0.043	0.322	**0.361**	**<0.001**	**0.297**	**<0.001**	**0.291**	**<0.001**	**0.155**	**<0.001**
Model 3										
Sex	-0.040	0.336	**-0.091**	**0.015**	**0.076**	**0.039**	**-0.084**	**0.006**	-0.007	0.871
Age	0.024	0.565	**0.135**	**<0.001**	0.058	0.123	**0.212**	**<0.001**	0.071	0.090
Psychiatric group	0.011	0.799	**0.095**	**0.010**	-0.006	0.877	**-0.167**	**<0.001**	**-0.096**	**0.018**
ACS	0.076	0.124	**0.215**	**<0.001**	**0.145**	**0.001**	**0.094**	**0.009**	0.063	0.191
BAS-RI	0.066	0.184	0.047	0.280	-0.003	0.950	-0.004	0.905	**0.117**	**0.016**
BAS-GDP	0.085	0.072	**0.129**	**0.002**	0.062	0.138	0.027	0.431	-0.011	0.807
BAS-RR	0.008	0.865	**0.170**	**<0.001**	-0.009	0.822	0.050	0.127	0.027	0.544
BAS-I	0.071	0.096	-0.022	0.553	**-0.188**	**<0.001**	-0.050	0.102	0.054	0.194
BIS	**0.188**	**<0.001**	**-0.227**	**<0.001**	**-0.305**	**<0.001**	**-0.511**	**<0.001**	**-0.116**	**0.009**
FFFS	0.014	0.758	-0.014	0.729	-0.005	0.899	0.002	0.946	**-0.098**	**0.025**

Note: Sex was coded as 1 = female and 2 = male. Psychiatric group was coded as 1 = no previous diagnosis and 2 = previous diagnosis. Model 1 included the three control variables, whereas model 2 added ACS, and model 3 added the six rRST variables. Significant effects (where $p < 0.05$) are in bold.

group compared to no previous diagnosis group). In all five analyses sex, age and psychiatric group were entered in model 1, AC was added in model 2, and the rRST variables were added in model 3. As the re-analysis in the present study differs from that conducted in du Rocher et al. (2021) a new series of visual inspections were conducted to verify that the assumptions for multiple regression were not violated. Specifically, in each of the five analyses where either *observing, describing, acting with awareness, non-judging, or non-reactivity* were included as the dependent variable, inspection of histograms and P-P plots suggested that the residuals of the regression models were approximately normally distributed. In each of these five analyses levels of multicollinearity were low, and in each of the five analyses visual inspection of a scatterplot of residuals versus predicted values gave no obvious indication of any violation of the homoscedasticity assumption.

The zero-order correlations in Table 2 show the relationships between the mindfulness, AC and rRST measures. Notably, BIS was positively correlated with *observing*, and negatively correlated with *describing*, *acting with awareness*, *non-judging*, and *non-reactivity*. FFFS was negatively correlated with *acting with awareness*, *non-judging*, and *non-reactivity*. BAS-RI was positively correlated with *observing*, *describing*, and *non-reactivity*. BAS-GDP was positively correlated with *observing*, *describing*, and *acting with awareness.* BAS-RR was positively correlated with *observing* and *describing*. BAS-I was positively correlated with *observing*, *acting with awareness, and non-judging.*

Table 3 shows the standardised estimates that were derived from the five separate multiple regression analyses with each of the five mindfulness facets as dependent variables. These standardized estimates are a scale free indication of the effect-size for each relationship that each predictor variable shares with each of the dependent variables (Kim, 2011). The standardised estimates in Table 3 show that BAS-RI shared a significant positive relationship with *non-reactivity* (when sex, age and psychiatric group were controlled for), but it was not significantly related to scores for any of the other mindfulness facets. Both BAS-GDP, and BAS-RR, shared a positive relationship with *describing* (when sex, age and psychiatric group were controlled for), but they were not significantly related to any of the other mindfulness facets. BAS-I shared a negative relationship with *acting with awareness* (when sex, age and psychiatric group were controlled for) but was not significantly related to any of the other mindfulness facets.

The standardised estimates in Table 3 show that FFFS sensitivity shared a negative relationship with *non-reactivity* (when sex, age and psychiatric group were controlled for) but it was not significantly related to any other mindfulness facet. The standardised estimates in Table 3 also show that BIS shared a positive relationship with *observing*, and a negative relationship with *describing, acting with awareness, non-judging*, and *non-reactivity* (when sex, age and psychiatric group were controlled for). The standardised estimates in Table 3 also show that AC shared a positive relationship with *describing, acting with awareness, non-judg-*

Table 4. The model summaries for each of the five hierarchical multiple regression analyses that included either observing, describing, acting with awareness, non-judging, or non-reactivity as the dependent variable.

	Model 1	Model 2	Model 3
Observing	adjusted $R^2 = 0.000$, $F(3) = 1.0$, $p = 0.373$	adjusted $R^2 = 0.000$, $F(4) = 1.0$, $p = 0.392$	adjusted $R^2 = 0.051$, $F(10) = 4.4$, $p < 0.001$
Describing	adjusted $R^2 = 0.049$, $F(3) = 12.0$, $p < 0.001$	adjusted $R^2 = 0.157$, $F(4) = 30.9$, $p < 0.001$	adjusted $R^2 = 0.248$, $F(10) = 22.0$, $p < 0.001$
Acting with awareness	adjusted $R^2 = 0.073$, $F(3) = 17.7$, $p < 0.001$	adjusted $R^2 = 0.145$, $F(4) = 28.2$, $p < 0.001$	adjusted $R^2 = 0.260$, $F(10) = 23.5$, $p < 0.001$
Non-judging	adjusted $R^2 = 0.231$, $F(3) = 64.9$, $p < 0.001$	adjusted $R^2 = 0.301$, $F(4) = 69.6$, $p < 0.001$	adjusted $R^2 = 0.502$, $F(10) = 65.5$, $p < 0.001$
Non-reactivity	adjusted $R^2 = 0.033$, $F(3) = 8.2$, $p < 0.001$	adjusted $R^2 = 0.051$, $F(4) = 9.7$, $p < 0.001$	adjusted $R^2 = 0.082$, $F(10) = 6.7$, $p < 0.001$

ing, and *non-reactivity* when sex, age and psychiatric group were controlled for.

Table 4 contains the overall model summaries for each of the five analyses. The regression summaries in Table 4 show that for the mindfulness *observing* facet analysis, model 1 and model 2 were not significant. However, model 3 was significant, but it explained just 5% of the variance in *observing*. In the mindfulness *describing* facet analysis, all three models were significant. Model 1 explained almost 5% of the variance in *describing*, whereas model 2 explained almost 16%, and model 3 explained almost 25% of the variance. The *acting with awareness* analysis was significant for all three models. Model 1 explained 7% of the variance in *acting with awareness*, model 2 explained almost 15%, and model 3 explained 26% of the variance. In the *non-judging* analysis, all three models were significant. Model 1 explained 23% of the variance in *non-judging*, model 2 explained 30%, and model 3 explained 50% of the variance. Table 4 also shows that in the *non-reactivity analysis*, all three models were significant. Model 1 explained just 3 % of the variance in *non-reactivity*, model 2 explained just 5%, and model 3 explained 8% of the variance.

The ACS has been shown (Ólafsson et al., 2011) to contain two subscales that correspond to factors of attentional focusing and attentional shifting. These subscales were used in the analysis by MacDonald and Olsen (2020). In the present study the attentional focusing and attentional shifting subscales were strongly positively correlated ($r = 0.61$, $p < 0.001$), which is consistent with the results of the study by MacDonald and Olsen. In the present study we repeated the five hierarchical multiple regression analyses described above, this time including either the ACS focusing subscale as a predictor, or the ACS shifting subscale as a predictor, as a replacement for the total ACS score as a predictor in model 2.

When the ACS attentional focusing subscale was included as a predictor in model 2 in each of the five hierarchical regression analyses, the analyses showed that, as with the analyses with the total ACS score, the relationship between attentional focusing and *observing* was not significant (beta = -0.006, $p = 0.881$), whereas the relationships between attentional focusing and *describing* (beta = 0.271, $p < 0.001$), *acting with awareness* (beta = 0.333, $p < 0.001$), and *non-judging* (beta = 0.283, $p < 0.001$) were significant. However, in contrast to the analysis with the total ACS score the relationship between attentional focusing and *non-reactivity* did not quite reach the threshold for statistical significance (beta = 0.070, $p = 0.097$).

When the ACS attentional shifting subscale was included as a predictor in model 2 in each of the five regression analyses, as a replacement for the total ACS score, the analysis showed that the relationship between attentional shifting and *observing* did not quite reach the threshold for statistical significance (beta = 0.076, $p = 0.070$). This is in contrast to the null result with this comparison in the analyses that included either the total ACS score, or the ACS focusing subscale score as a predictor. However, the relationships between attentional shifting and *describing* (beta = 0.377, $p < 0.001$), *acting with awareness* (beta = 0.205, $p < 0.001$), and *non-judging* (beta = 0.250, $p < 0.001$) were all significant and similar to those found in the analyses including the total ACS score, or the ACS focusing subscale score as a predictor. The relationship between attentional shifting and *non-reactivity* was significant (beta = 0.192, $p < 0.001$), which is consistent with the analysis including the total ACS scale score as a predictor.

DISCUSSION

In the present study BAS-RI shared a positive relationship with *non-reactivity* but not with the other mindfulness facets when sex, age, and psychiatric group were controlled for. This is inconsistent with previous research which showed that BAS-RI negatively predicted *non-judging* and showed a trend towards positively predicting *observing* when sex and age were controlled for (Dolatyar & Walker, 2020). However, it is notable that in the present study BAS-RI did share a positive zero-order correlation with *observing* and *describing* as well as with *non-reactivity*.

Both BAS-GDP and BAS-RR shared a positive relationship with *describing* but not with other mindfulness facets, when sex, age, and psychiatric group were controlled for. However, BAS-GDP shared a weak positive zero-order relationship with *observing*, *describing*, and *acting with awareness*, whereas BAS-RR shared a weak positive zero-

order relationship with *observing* and *describing*. In previous research BAS-GDP positively predicted *describing* and *non-reactivity*, and showed a trend towards positively predicting *non-judging*, whereas BAS-RR showed a trend towards a positive relationship with *observing* (when sex and age were controlled for: Dolatyar & Walker, 2020).

BAS-I shared a negative relationship with *acting with awareness* but not with the other mindfulness facets (when sex, age and psychiatric group were controlled for). This is consistent with the study by Dolatyar and Walker (2020), and their interpretation that impulsivity reflects a mindless and immediate response to reward, and as such does not require acting with any awareness. In the present study, BAS-I also shared a weak positive zero-order relationship with *observing*, and a negative relationship with *non-judging*.

The regression analysis also showed that FFFS shared a negative relationship with *non-reactivity* but was not significantly related to variability in scores for any other mindfulness facet (when sex, age, and psychiatric group were controlled for). The negative relationship between FFFS and *non-reactivity* is interesting as in rRST the FFFS is an avoidance system that facilitates escape from punishment (Gray & McNaughton, 2000). Thus, not-reacting to one's own thoughts and feelings in certain situations may facilitate a reduction in FFFS mediated fearfulness. Taken at face value, the relationship between FFFS and *non-reactivity* may have implications for the design of therapy to reduce fear of specific stimuli or of specific situations. However, the direction of the FFFS relationship with *non-reactivity* in the present study is notably inconsistent with previous research. That is to say, using a smaller sample than in the present study Dolatyar and Walker (2020) found that self-reported FFFS sensitivity showed a trend towards positively predicting *non-reactivity* (when sex and age were controlled for). In the present study FFFS also shared weak negative zero-order correlations with *acting with awareness* and *non-judging.*

The zero-order correlational analysis showed that BIS was positively correlated with *observing*, and negatively correlated with *describing, acting with awareness*, *non-judging*, and *non-reactivity*. Moreover, in the regression analysis BIS also shared a positive relationship with *observing*, and a negative relationship with *describing*, *acting with awareness*, *non-judging*, and *non-reactivity* (when sex, age, and psychiatric group were controlled for). These effects are generally consistent with previous research where BIS sensitivity negatively predicted *describing*, *acting with awareness, non-judging*, and *non-reactivity* (when sex and age were controlled for; Dolatyar & Walker, 2020). However, in the study by Dolatyar and Walker, BIS sensitivity did not predict *observing*. The effects of BIS in the present study are consistent with the notion that elevated BIS sensitivity may lead to the increased likelihood that a stimulus is perceived as being related to punishment, which may reduce the ability to be non-judgemental concerning one's thoughts and feelings and reduce the likelihood of inhibiting reactions to negative thoughts and feelings (Dolatyar & Walker, 2020). In rRST elevated BIS activity would also predict increased levels of anxiety (Gray & McNaughton, 2000).

In adult samples longitudinal research has shown that variability *in describing, acting with awareness, non-reactivity,* and *non-judging* predict anxiety (and depression). However, only increases in *acting with awareness* and *non-reactivity* predict a decrease in anxiety (and depression) over time (Prieto-Fidalgo et al., 2021). The results of Prieto-Fidalgo et al. support a focus on increasing *acting with awareness* and *non-reactivity* in mindfulness interventions for anxiety and depression. In the present study BIS and BAS-I shared a negative relationship with *acting with awareness*, BAS-RI shared a positive relationship with *non-reactivity*, and BIS and FFFS shared a negative relationship with *non-reactivity*. Future research might test whether self-reported levels of BAS-RI, BAS-I, BIS and/or FFFS sensitivity are modulated (or are not modulated) by any mindfulness intervention that increases *acting with awareness* and *non-reactivity*, and successfully reduces anxiety and depression. This would help to understand how closely related the reinforcement sensitivity personality constructs are to the mindfulness facets *acting with awareness* and *non-reactivity*, in cases of anxiety and depression. Such an analysis could be important as the mindfulness facet *acting with awareness* explains 20% of variability in self-reported psychological distress, and the mindfulness facet *non-reactivity* explains 25% of variability in self-reported mental well-being (Roemer, Sutton, Grimm, & Medvedev, 2021).

Longitudinal research suggests that although higher BAS-GDP may increase *acting with awareness* over time, higher *acting with awareness* may also increase BAS-GDP over time. This suggests that a reciprocal relationship may exist between BAS-GDP and *acting with awareness* (Karl, Fischer, & Jose, 2021). However, it is notable that in the present study BAS-GDP did not share any meaningful relationship with *acting with awareness* when sex, age, and psychiatric group were controlled for, and the zero-order correlation between BAS-GDP and *acting with awareness* was weak.

This study offers a detailed insight into how self-reported dispositional reinforcement sensitivity relates to self-reported dispositional mindfulness and has extended the literature by using a different measure of rRST than those used in previous studies. Notably, the effect of BIS on *describing*, *acting with awareness*, *non-judging*, and *non-reactivity* was consistent across the present study and that by Dolatyar and Walker (2020). The effects of BAS-I were also consistent across the two studies. By contrast, the effects of FFFS were inconsistent across the two studies. The present study measured reinforcement sensitivity using the RST-PQ-S (Vecchione & Corr, 2020) which is a shortened version of the RST-PQ (Corr & Cooper, 2016), which was used by Dolatyar and Walker (2020). Therefore, it seems likely that the consistent effects across the present study and that of Dolatyar and Walker are reliable indicators of how personality constructs based on rRST relate to dispositional levels of mindfulness. It is possible that the inconsistent effects across the two studies give some insight into where reinforcement sensitivity personality constructs and the components of mindfulness, as indexed by the five facets, are not reliably related. However, the inconsistent effects across the two studies may also be due to the two rRST measures lacking convergent validity (even though one rRST measure was derived from the other), to differences in the sample size and/or demographics, or to a combination of these issues.

The present study also demonstrates that AC shares a positive relationship with *describing*, *acting with awareness*, *non-judging*, and *non-reactivity*, when sex, age and psychiatric history are controlled for. This may have implications for the development of mindfulness interventions for psychiatric disorders. For example, it has been proposed that increasing AC might reduce thoughts that lead to disordered eating in anorexia nervosa (Mercado et al., 2020). It may be possible to do this by using an intervention that increases the *acting with awareness*, *non-judging*, and *non-reactivity* components of mindfulness. The present study also shows that attentional focusing and attentional shifting relate in a similar way to the mindfulness constructs of *describing, acting with awareness*, and *non-judging*. Attentional shifting was a more reliable predictor of *non-reactivity* than attentional focusing. This might be due to the ability to shift one's attention away from unpleasant thoughts and feelings having a facilitatory effect on the ability to not act upon the unpleasant thoughts and feelings. This might have implications for the development of attentional control-based interventions designed to reduce reactions to specific maladaptive thoughts and feelings. For example, some individuals high in anxiety can be particularly affected by both internalised threat-related stimuli such as worried thoughts, and/or external threat-related stimuli such as social situations (Eysenck et al., 2007). Thus, increasing attentional shifting and the *non-reactivity* component of mindfulness, may enable those high in anxiety to inhibit reacting to either internal or external threat-related stimuli.

Limitations

We measured self-reported BIS, BAS, and FFFS sensitivity, but we did not test how well these self-ratings reflect biological activity in the brain-behavioural systems described by Gray and McNaughton (2000). We also measured AC with a self-report measure, thus future replications may benefit from administering a battery of behavioural measures of AC alongside the self-report measures. The sample was a non-clinical sample, thus a replication with patients with a range of affective disorders would be beneficial. There were more female participants than male participants, but sex was controlled for in the analysis. No causal relationships between variables can be implied based on this cross-sectional correlational design. Moreover, the cross-sectional design prohibits any meaningful tests of mediation pathways (Roe, 2012).

Conclusion

The present study examined how dispositional BIS, BAS, and FFFS sensitivity relates to dispositional mindfulness. In the present study BIS shared a negative relationship with *describing, acting with awareness, non-judging*, and *non-reactivity*, which is consistent with the study by Dolatyar and Walker (2020). In the present study BAS-I shared a negative relationship with *acting with awareness* which is also consistent with the study by Dolatyar and Walker (2020). The consistent effects across the two studies should be reliable indicators of how self-reported personality constructs based on reinforcement sensitivity relate to dispositional mindfulness, as indexed by the separate mindfulness facets.

ACCOUNTS

Ethics statement

This study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All persons gave their informed consent prior to their inclusion in the study.

Conflict of interest

No organization sponsored the research.
The author declares that he has no conflict of interest.

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