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The role of performance beliefs in the difference between self-report and behavioural measures of attentional control and their relationship with anxiety

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ABSTRACT

While empirical findings closely link poor attentional control with elevated anxiety, this relationship is more consistently evident and stronger when attentional control is measured through self-report than through behaviour. One possible explanation for these diverging findings is that people lack insight into their attentional control capabilities, and people with elevated anxiety hold more negative beliefs about their level of attentional control, resulting in lower self-reported levels of attentional control. In two studies, participants (N = 78 and N = 207) completed the attentional control scale, the attentional network test (ANT), a questionnaire measuring beliefs about attentional control in the ANT, and a measure of anxiety. In both studies, no significant associations were present between beliefs about attentional control in the ANT and participants' performance on the ANT, suggesting a lack of insight in attentional control capabilities. Both studies further demonstrated that only beliefs about attentional control but not performance in the ANT were related to self-reported attentional control and anxiety. We thus show that evidence supporting the relationship between self-reported attentional control and anxiety is driven by biased beliefs about ability to control attention in people with heightened anxiety, and not by behavioural indices of attentional control.

1. Introduction

Attentional control refers to the ability to exert voluntary control over attention. It includes the ability to ignore distractions and focus attention on the task at hand as well as the ability to shift attention between tasks. Over the past decades, poor attentional control has been implicated in a variety of psychological problems, including depression (e.g., Koster et al., 2011) and anxiety (e.g., Eysenck et al., 2007). The Attentional Control Theory (Eysenck et al., 2007; Eysenck & Derakshan, 2011) is one of the most influential theories relating attentional control to anxiety. At the core of the Attentional Control Theory lies the assumption that anxiety impairs the functioning of a goal-directed attentional system, and thus impairs attentional control. A recent meta-analysis of 58 studies broadly supported this assumption: People with elevated levels of trait, state, and/or social anxiety had significantly poorer attentional control than people with lower levels of anxiety (Shi et al., 2019). However, while the overall effect size was medium to large (Hedges' $g = -0.58$), Shi et al. (2019) also found a substantial difference between studies measuring attentional control via subjective self-report and studies measuring attentional control via objective behavioural paradigms, such as the Attentional Network Test (ANT; Fan et al., 2002) or the antisaccade task (Hallett, 1978). The effect of anxiety on self-reported attentional control was large (Hedges' $g = -0.87$), but the effect of anxiety on behavioural measures of attentional

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control was only small to medium (Hedges' $g = -0.39$). While Shi et al. (2019) suggest that this apparent difference between self-reported and behavioural indices of attentional control may be due to the superior reliability/stability of self-report measures, an alternative possibility is that biased responding on self-reports may artificially inflate the relationship between attentional control and anxiety.

Research using self-report measures of attentional control has relied heavily on the Attentional Control Scale (ACS; Derryberry & Reed, 2002). However, studies examining the degree of association between the ACS and behavioural indices of attentional control have raised questions about the validity of the ACS (for a review, see Clarke & Todd, 2021). To our knowledge, seven studies have looked at the relationship between scores on the ACS and behavioural indices of attentional control in adult samples. Reinholdt-Dunne and colleagues were the first to address this issue in three partially overlapping studies (Reinholdt-Dunne et al., 2009; Reinholdt-Dunne et al., 2012; Reinholdt-Dunne et al., 2013). In an analysis covering all three studies and including 164 participants, Reinholdt-Dunne et al. (2013) found a significant but small correlation of 0.16 between one out of four (subscale) scores of the ACS and the executive attention control score from the ANT.[1] The three other correlations were non-significant and smaller than 0.14. In a subset of 50 participants, Reinholdt-Dunne et al. (2012) found a non-significant correlation of −0.03 between the ACS score and performance on the antisaccade task. A study by Judah et al. (2014) yielded similar results: In a sample of between 41 and 43 people (depending on the outcome measure), they correlated four ACS (subscale) scores with six outcomes from the antisaccade task. Only five out of these 24 correlations were significant, and all correlations were between −0.15 and 0.35, indicating that the relationship between self-reported attentional control and behavioural indices of attentional control is small to medium, at best. More recently Quigley et al. (2017) correlated six ACS (subscale) scores with four outcomes from the antisaccade task and found that none of these 24 correlations were significant in a sample of 125 participants (all *r*s between −0.04 and 0.22). In a similar vein, Williams et al. (2017) found small (all *r*s between −0.10 and −0.06; N = 315) and non-significant correlations between four ACS (subscale) scores and the executive attention control score from the ANT. Finally, Todd et al. (2022) also failed to find any evidence in support of an association between self-reported and behavioural measures of attentional control: In a sample of 207 participants, none of six ACS (subscale) scores correlated significantly with performance in the antisaccade task (all *r*s between 0.02 and 0.12).

In sum, there is consistent evidence that the ACS and behavioural indices of attentional control show little to no convergence (Clarke & Todd, 2021). The poor convergence between the ACS and behavioural indices of attentional control not only raises questions about the fundamental validity of the ACS, but it also highlights potential issues with the apparent relationship between attentional control and anxiety. As described by Shi et al. (2019), the relationship between attentional control and anxiety is much stronger if attentional control is measured via subjective self-reports than if attentional control is measured via more objective behavioural paradigms. In the present paper, we contrasted two accounts that could explain these apparently inconsistent findings.

A first account, which we refer to as the 'Accurate Insight Account', assumes that genuine attentional control ability is associated with individual differences in anxiety, and that people have sufficient insight into their attentional control abilities to accurately self-report about their attentional control ability. If these assumptions are correct, variations in ACS scores represent true variations in attentional control ability. Therefore, the apparent lack of correlations between self-report (i.e., ACS-based) and behavioural measures of attentional control in the studies discussed above could be explained as both modalities measuring different aspects of attentional control, with only the aspects measured in self-reports relating to individual differences in anxiety. For instance, according to the Attentional Control Theory, inhibition, shifting, and updating are the three main components of attentional control, but anxiety has been mostly linked with impaired inhibition and shifting. As such, it is possible that the relation between anxiety and attentional control is only apparent when specific sub-components of attentional control are involved in the attentional control measurement.

The Accurate Insight Account generates the prediction that because people have accurate insight in their attentional control, variations in performance in attentional control tasks will be strongly related to variations in their self-reported beliefs about this performance. If this is the case, and there is a relationship between ACS scores and anxiety, this suggests that the relationship between ACS scores and anxiety is based on genuine variations in attentional control. In addition, the absence of a relationship between ACS scores and a behavioural measure of attentional control would then suggest that the behavioural measure does not assess the aspect of attentional control that is implicated in anxiety.

An alternative account, which we refer to as the 'Biased Beliefs Account', was first proposed by Quigley et al. (2017). Given the observation that there is little relationship between self-report and behavioural measures of attentional control, they argued that self-report measures of attentional control, like the ACS, may reflect people's *beliefs* about their attentional control, rather than their objective level of attentional control. Crucially, a key characteristic of elevated anxiety is that beliefs about the self tend to be negatively biased (e.g., Beck & Dozois, 2011; Clark & Wells, 1995; Rapee & Heimberg, 1997). Consequently, if people with elevated anxiety hold strong negative self-beliefs, they would be more likely to self-assess their cognitive abilities as poor, leading to artificially strong correlations between self-report measures of attentional control and anxiety. The Biased Beliefs Account thus predicts that because people do not have sufficient insight into their attentional control capabilities, there will only be a weak association between variation in performance in attentional control tasks and variations in their self-reported beliefs about this performance. If these inaccurate beliefs about performance are strongly associated with anxiety and scores on the ACS, this then suggests that the observed association between ACS scores and anxiety is more function of variation in beliefs about attentional control, rather than of variation in genuine attentional control. Stated differently, high anxious individuals' beliefs about their attentional control are biased to be more negative than low anxious individuals' beliefs about their attentional control.

The central aim of our current paper was to contrast the predictions made by these two accounts.[2] To do so, we asked participants to complete an ANT as a behavioural measure of attentional control, the ACS as a self-report measure of attentional control, and the anxiety subscale of the Depression Anxiety Stress Scale (Lovibond & Lovibond, 1995) as a measure of anxiety symptomatology. In addition, we also asked them to complete a newly developed self-report measure, the AC-Beliefs-ANT, which was designed to assess participants' beliefs about their performance in the ANT. If the Accurate Insight Account is true, we would expect strong positive correlations between ACS scores and anxiety, and between performance in the ANT and AC-Beliefs-ANT scores, but no (or weak) correlations between ACS scores and both performance in the

[1] The 20-item ACS has a total score and two subscale scores (shifting and focusing). However, some studies have questioned the validity of certain items (e.g., Judah et al., 2014; Ólafsson et al., 2011), leading to additional (total and subscale) scores based on subsets of items.

[2] Prior to testing these accounts, we ran a pilot study in which we replicated the previously observed finding that anxiety is associated with self-report measures of attentional control but not with behavioural measures of attentional control, and that self-report and behavioural measures of attentional control are unrelated. Full results of this pilot study are reported in the online supplementary materials, and raw and transformed data of this pilot study are available on https://osf.io/msbvk/.

ANT and AC-Beliefs-ANT scores. Alternatively, if the Biased Beliefs Account is true, we would expect no (or weak) correlations between performance in the ANT and both AC-Beliefs-ANT and ACS scores, and strong and positive correlations between the AC-Beliefs-ANT, ACS, and anxiety scores.

2. Study 1

2.1. Method

2.1.1. Participants

Eighty participants who had not participated in the pilot study were recruited via MTurk. The data of two participants were excluded because their error rates on the ANT deviated more than 3*SD*s from the group mean (group $M = 95.53$ % correct, $SD = 5.93$, participants' scores = 67.36 and 70.83), resulting in a final sample of 78 participants (34 women; $M_{age} = 43.33$, $SD_{age} = 12.37$). A sensitivity analysis using G*Power (Faul et al., 2007), with conventional values of 0.80 for power and .05 for alpha (two-tailed), showed that our sample was large enough to detect medium-sized correlations of 0.31 and larger (Cohen, 1992).

2.1.2. Behavioural measure of attentional control: attentional network task

We used the Inquisit (Millisecond Software, 2018) test library script of the original ANT as developed by Fan et al. (2002) as a behavioural measure of attentional control. On each trial of the task a fixation cross was presented in the centre of the screen for a duration selected randomly from 100 ms increments between 400 and 1600 ms. Next, either no cue was presented (no cue trials, the fixation cross remained on the screen for another 100 ms) or a cue was presented for 100 ms. The cue could consist of a single asterisk presented in the centre of the screen (centre cue trials), one 9 mm above and one 9 mm below the fixation cross (double cue trials), or a single asterisk presented either 9 mm above or below the fixation cross, predicting the location of the target arrow (spatial cue trials). Upon cue offset, the fixation cross remained visible for 400 ms, after which one of three different arrow configurations was presented either 9 mm above or 9 mm below the fixation cross. On neutral trials, a single target arrow (i.e., ← or →) was presented. On congruent trials, the central target arrow was on both sides flanked by arrows pointing in the same direction (i.e., → → → → → or ← ← ← ← ←), while on incongruent trials, the flanking arrows pointed in the opposite direction as the central target arrow (i.e., → → ← → → or ← ← → ← ←). Arrows were 5 mm wide and 3 mm high, and the distance between flanking arrows was 0.5 mm. On each trial, participants responded as fast and as accurately as possible to the direction of the target arrow, using the E or I key of their keyboard, respectively. The screen was cleared as soon as participants responded or when a 1700 ms response window had elapsed. There were thus 12 different trial types, reflecting all combinations of cues (no cue, centre cue, double cue, or spatial cue) and arrow configurations (neutral, congruent, or incongruent). Across all different trial types, target arrows pointed equally often to the left and to the right, and they were presented equally often above and below the fixation cross.

The task consisted of a practice block and three test blocks. The practice block consisted of 24 trials, with each combination of cue condition and arrow configuration presented twice, and error feedback on incorrect responses. The three test blocks each consisted of 96 trials, and each combination of cue condition and arrow configuration was presented eight times per block, resulting in a total of 24 observations for each trial type over the entire task. No error feedback was given in the test blocks, and participants were allowed to take a self-paced break between blocks.

2.1.3. Questionnaires

2.1.3.1. Self-reported beliefs about ANT performance (AC-Beliefs-ANT).

We created our self-report measure of participants' beliefs about their level of attentional control in the ANT by reformulating items from the ACS such that they probed how well participants believed they had controlled attention during their performance of the ANT. The questionnaire consisted of 20 items, each scored on a 4-point Likert scale (1 = none of the time, 2 = some of the time, 3 = most of the time, 4 = all the time). Example items are "It was easy for me to alternate between the different task conditions" and "When I needed to concentrate on the task, I had trouble focusing my attention". Instructions and all items are presented in Appendix 1. The AC-Beliefs-ANT showed good internal consistency (Table 1).

2.1.3.2. Attentional Control Scale (ACS; Derryberry & Reed, 2002).

We used the ACS to measure self-reported attentional control. The ACS consists of 20 items, and each item is scored on a 4-point Likert scale. Internal consistency of the scale in our study was good (Table 1).

2.1.3.3. Depression Anxiety Stress Scale (DASS21; Lovibond & Lovibond, 1995).

We used the 7-item anxiety subscale of the DASS21 as a measure of anxiety. In addition to anxiety, the scale also contained 7-item subscales of depression and stress, which are not included in this report. Each item was scored on a 4-point Likert scale, and the internal consistency of the anxiety subscale was good (Table 1).

2.1.4. Procedure

Participants were informed about the nature of the tasks and stimuli before providing written informed consent. Next, they completed the ANT, the AC-Beliefs-ANT, the ACS, and the DASS21, in this fixed order.[3] Upon completion, participants were debriefed and compensated with USD 5. The entire procedure was approved by the Human Research Ethics Office of the University of Western Australia (ref. number RA/4/1/5243) and took about 30 min to complete.

2.1.5. Outlier analysis and scoring

For the ANT, we removed errors (3.80 %) and trials with outlying reaction times (3.51 %), using the criteria of 2.5 times the absolute deviation around the median described by Leys et al. (2013). From the remaining data, we calculated the individual attentional network indices (Fan et al., 2002) of alerting (*M* RT on no cue trials minus *M* RT on double cue trials, irrespective of arrow configuration), orienting (*M* RT on centre cue trials minus *M* RT on spatial cue trials, irrespective of arrow configuration), and executive attention control (*M* RT on incongruent arrow configuration trials minus *M* RT on congruent arrow configuration trials, irrespective of cue condition). To estimate the reliability of these scores, we used the splithalf R-package (Parsons, 2020) to calculate Spearman-Brown corrected reliabilities using 5000 random splits (Table 1). Only the executive attention control score demonstrated good reliability. As such, for critical analyses relating to attentional control performance, we considered the executive attention control score as our main outcome.

2.2. Results

To determine the relationships between self-reported and behavioural indices of attentional control, beliefs about performance in the ANT, and anxiety, we calculated Spearman's ρ correlation coefficients (Table 1). Correlations between self-reported and behavioural measures of attentional control were mostly small and non-significant, suggesting that both tools measure different constructs. The correlation between

[3] The procedure also included a 6-item self-constructed measure of general ANT performance, containing questions unrelated to attentional control (e.g., "I was not able to do this task very well"). This questionnaire was completed after the AC-Beliefs-ANT and before the ACS and DASS21. In the interest of brevity, we have omitted this questionnaire from this manuscript.

Table 1
Descriptive statistics and correlations between measures of anxiety, self-reported attentional control, behavioural attention scores from the attention network test, and self-reported beliefs about performance in the attention network test in Study 1.

	M	*SD*	1.	2.	3.	4.	5.	6.
1. DASS21 Anxiety	1.91	3.85	0.916	−0.427**	−0.028	−0.173	−0.081	−0.513**
2. ACS	61.60	10.30		0.916	0.261*	0.222	0.004	0.612**
3. ANT Alerting	33.88	18.93			0.081 [−0.234, 0.373]	0.147	0.196	0.134
4. ANT Orienting	37.31	20.87				0.271 [−0.037, 0.509]	−0.079	0.005
5. ANT Executive Attention Control	99.34	31.59					0.829 [0.751, 0.887]	0.087
6. AC-Beliefs-ANT	70.32	6.43						0.799

Note: N = 78 for all variables. DASS21 = Depression Anxiety Stress Scale - short; ACS = Attentional Control Scale; ANT = Attention Network Test. The diagonal presents reliability estimates (Cronbach's alpha for self-report measures, Spearman-Brown corrected reliability using 5000 random splits for the ANT scores, 95 % confidence intervals between square brackets). Correlations are Spearman's ρ. * $p < .05$, ** $p < .01$.

the ACS and anxiety was significant, negative, and medium-sized (−0.427), confirming that poor self-reported attentional control is associated with elevated levels of anxiety. Inversely, none of the correlations between behavioural indices of attentional control in the ANT and anxiety were significant, confirming that the relationship between attentional control and anxiety is moderated by the nature of the assessment of attentional control (self-reported or behavioural). Comparing dependent correlations with one variable in common (Lee & Preacher, 2013), we found that the correlation between anxiety and the ACS was significantly stronger than the correlation between anxiety and the executive attention control score, $z = -3.33$, $p < .001$, further strengthening the conclusion that anxiety is related to self-reported rather than behavioural indices of attentional control.[4] Crucially, scores on the AC-Beliefs-ANT correlated positively with self-reported attentional control (0.612) and negatively with anxiety (−0.513), but they did not correlate significantly with any of behavioural indices of attentional control. The correlation between the AC-Beliefs-ANT and the ACS was significantly stronger than the correlation between the AC-Beliefs-ANT and the executive attention control score, $z = 4.97$, $p < .001$. These findings indicate that people's beliefs about how well they were able to control their attention during the ANT were unrelated to their actual task performance, thus supporting the Biased Beliefs Account.

2.3. Discussion

The pattern of correlations between the ACS, anxiety, and behavioural indices of attentional control in Study 1 replicated the pattern of correlations reported in the literature and in our pilot study. Specifically, we observed non-significant or weak correlations between self-reported and behavioural indices of attentional control, a robust negative relationship between self-reported attentional control and anxiety, and non-significant correlations between behavioural indices of attentional control and anxiety. In addition, beliefs about performance on the ANT were uncorrelated with behavioural performance on the ANT, indicating that participants could not accurately self-assess their capacity to control attention while performing the ANT. As such, our findings are in direct contrast to the prediction made by the Accurate Insight Account, according to which people can accurately report on their ability to control their attention. The strong and consistent pattern of correlations between scores on the ACS, AC-Beliefs-ANT, and anxiety thus supports the Biased Beliefs Account, indicating that negatively biased beliefs about attentional control rather than deficits in attentional control ability underpin the relationship between self-reported attentional control and anxiety. However, our sample size was relatively modest, only allowing for the detection of significant correlations of 0.31 and larger. To counter this potential limitation and because replication in psychology has been noted as an important goal for transparency and verifiability of findings (Cumming, 2014; Pashler & Wagenmakers, 2012), we conducted a second study in which we aimed to replicate the findings from Study 1 using a larger student sample.

3. Study 2

3.1. Method

3.1.1. Participants

Two hundred and twenty-four participants who had not participated in Study 1 were recruited from an internal participant pool of undergraduate students at the University of Western Australia and completed the study. Eleven participants who scored below chance level on the ANT were excluded from all analyses, as were 6 participants whose error rate on the ANT deviated more than 3*SD*s from the group mean (group $M = 94.45$ % correct, $SD = 7.27$). This resulted in a final sample of 207 participants (126 women, 79 men, 2 non-binary/preferred not to say; $M_{age} = 20.29$, $SD_{age} = 4.97$). A sensitivity analysis using G*Power (Faul et al., 2007), with conventional values of 0.80 for power and.05 for alpha (two-tailed), showed that our sample was large enough to detect small- to medium-sized correlations of 0.19 and larger.

3.1.2. Procedure

All measures and the general procedure were identical to the measures and procedure adopted in Study 1. Upon completion of the study, participants were debriefed and were compensated with partial course credit. The procedure was approved by the Human Research Ethics Office of the University of Western Australia (ref. number RA/4/1/5243) and took about 30 min to complete.

3.1.3. Outlier analysis and scoring

For the ANT, we removed errors (4.47 %) and trials with outlying reaction times (4.64 %), and we calculated alerting, orienting, and executive attention control scores as we did in Study 1. Again, only the executive attention control score demonstrated good reliability (Table 2), which is why we considered the executive attention control score as our main index of behavioural attentional control.

3.2. Results

To determine the relationship between self-reported and behavioural indices of attentional control and anxiety, we calculated Spearman's ρ correlation coefficients (Table 2). Replicating our findings from Study 1,

[4] Because in the executive attention control score, lower values represent a smaller flanker effect and therefore better attentional control (or better resistance to distractor interference), we inverted the correlations involving executive attention control for comparisons involving this score, so that their interpretations matched the ACS (i.e., higher scores = better attentional control).

Table 2
Descriptive statistics and correlations between measures of anxiety, self-reported attentional control, behavioural attention scores from the attention network test, and self-reported beliefs about performance in the attention network test in Study 2.

	M	*SD*	1.	2.	3.	4.	5.	6.
1. DASS21 Anxiety	5.35	4.85	0.868	−0.306**	0.019	−0.099	0.092	−0.321**
2. ACS	50.43	8.42		0.853	0.071	−0.038	−0.026	0.526**
3. ANT Alerting	40.68	21.27			0.297 [0.110, 0.450]	0.021	0.191**	−0.111
4. ANT Orienting	33.35	20.70				0.233 [0.034, 0.401]	0.049	0.051
5. ANT Executive Attention Control	97.69	28.64					0.774 [0.708, 0.826]	−0.104
6. AC-Beliefs-ANT	60.89	9.13						0.892

Note: N = 207 for all variables. DASS21 = Depression Anxiety Stress Scale - short; ACS = Attentional Control Scale; ANT = Attention Network Test. The diagonal presents reliability estimates (Cronbach's alpha for self-report measures, Spearman-Brown corrected reliability using 5000 random splits for the ANT scores, 95 % confidence intervals between square brackets). Correlations are Spearman's ρ. * $p < .05$, ** $p < .01$.

correlations between self-reported and behavioural measures of attentional control were again small and non-significant, confirming that both tools measure different constructs. The correlation between ACS scores and anxiety was again significant, negative, and medium in size (−0.306), confirming that people with elevated anxiety report having poorer attentional control. None of the correlations between anxiety and behavioural indices of attentional control in the ANT were significant, and the correlation between anxiety and the ACS was significantly stronger than the correlation between anxiety and the executive attention control score, $z = -2.22$, $p < .05$. These results further emphasize that anxiety is related to self-reported rather than behavioural measures of attentional control. Finally, and central to our main aim of this study, scores on the AC-Beliefs-ANT correlated positively with self-reported attentional control (0.526) and negatively with anxiety (−0.321), but they did not correlate significantly with any of behavioural indices of attentional control. The correlation between the AC-Beliefs-ANT and the ACS was significantly stronger than the correlation between the AC-Beliefs-ANT and the executive attention control score, $z = 4.73$, $p < .001$. This again demonstrates, now in a larger student sample, that people's beliefs about how well they were able to control their attention during the ANT were unrelated to their actual task performance.

3.3. Discussion

The pattern of results in Study 2 was a very close replication of our findings in Study 1, using a larger student sample. Consistent with the literature, we found non-significant correlations between self-reported and behavioural indices of attentional control, and a significant negative relationship between anxiety and self-reported but not behavioural indices of attentional control. Contradicting the Accurate Insight Account, beliefs about performance on the ANT did not correlate significantly with behavioural performance on the ANT, indicating that participants could not accurately self-assess their capacity to control attention while performing the ANT. In line with the Biased Beliefs Account, we again found a consistent pattern of correlations between scores on the ACS, AC-Beliefs-ANT, and anxiety, suggesting that the relationship between self-reported attentional control and anxiety is driven by negatively biased beliefs about attentional control rather than deficits in actual attentional control ability.

4. General discussion

In two studies, we investigated the difference between self-reported and behavioural indices of attentional control and their relationship with anxiety and sought to determine whether negatively biased beliefs about attentional control could explain this discrepancy. In both studies, we found that self-reported attentional control was negatively related to anxiety, but behavioural indices of attentional control were not related to either self-reported attentional control or anxiety. In addition, we found that participants' beliefs about their performance in an attentional control task were related to both self-reported attentional control and anxiety, but not to actual performance in the attentional control task. This implies that people cannot accurately self-assess their level of attentional control ability, suggesting that the relationship between self-reported attentional control and anxiety is best explained as an artefact of negatively biased beliefs about attentional control in people with heightened anxiety symptoms.

Our findings concerning the differences between self-reported and behavioural indices of attentional control are largely consistent with previous findings: Self-report and behavioural measures of attentional control do not or only weakly converge (Judah et al., 2014; Quigley et al., 2017; Reinholdt-Dunne et al., 2012, 2013; Todd et al., 2022; Williams et al., 2017; for a review, see Clarke & Todd, 2021). We extend these findings by showing that this poor convergence is likely not due to the ACS being too general to correlate meaningfully with more specific behavioural outcomes, because the task-specific AC-Beliefs-ANT also did not correlate meaningfully with behavioural outcomes. This finding, that not even task-specific self-reports of beliefs about attentional control performance correlated with actual performance on the attentional control task, contrasts with other domains where individuals do appear to be able to self-report on their cognitive processes when these self-reports concern specific processes. For example, research has shown that task-specific self-reports of memory self-efficacy are more closely related to behavioural measures of memory performance than global self-reports of memory self-efficacy (Beaudoin & Desrichard, 2011). Our results instead suggest, directly conflicting with the Accurate Insight Account, that people cannot accurately self-assess their level of attentional control, even when the attentional control processes they are asked to report on are highly specific. This raises important questions concerning the appropriate use of the ACS. Given the low correlations between the ACS and the behavioural indices of attentional control in the ANT, indicating poor convergent validity, it can reasonably be considered inappropriate to use the ACS when the aim is to assess objective differences in attentional control capability. Instead, our results support the alternative proposition put forward by Quigley et al. (2017) that the ACS should be used only to measure differences in people's *confidence* in their ability to control attention, which seems to be unrelated to variations in their actual ability to control attention.

In line with the meta-analytic findings of Shi et al. (2019), our findings also confirm that the relationship between attentional control and anxiety is stronger when attentional control is assessed through self-report and is much weaker (or in our studies even non-significant) when behavioural indices of attentional control are used. Our findings further extend previously obtained effects by demonstrating that dissociations between self-reported and behavioural indices of attentional control and anxiety are best explained by people with elevated anxiety's biased beliefs about their performance on the attentional control task (Quigley et al., 2017). As such, our results qualify the basic assumptions of the

Attentional Control Theory (Eysenck et al., 2007). While this theory proposes that anxiety is associated with impaired attentional control, our paper shows that this is consistently the case only when attentional control is measured via self-report, and is not necessarily true when attentional control is measured using the ANT. Of more fundamental importance, our results indicate that the relationship between self-reported attentional control and anxiety is best explained by inaccurate and negatively biased beliefs about one's performance in the ANT. It is not as much impaired self-reported attentional control, but rather cognitive distortions regarding attentional control ability, driven by negatively biased beliefs, that characterize elevated anxiety. While our current results do not negate the validity of prior findings of a relationship between behaviourally assessed impaired attentional control and anxiety reported in other studies (e.g., Todd et al., 2022), they do suggest that if present, this relationship is relatively weak at best, and the overall medium to large meta-analytic effect reported by Shi et al. (2019) is likely inflated by biased self-reports of attentional control. In sum, our present findings invite the conclusion that heightened anxiety is principally characterised by low confidence in one's ability to control attention, rather than by a genuine impaired ability to control attention.

Our current findings also raise questions for future research. First, in most studies on the relation between attentional control and anxiety to date, both attentional control and anxiety have been assessed through self-report. Using similar procedures to measure different constructs from one source often gives rise to method bias (Podsakoff et al., 2012), which could have further inflated the reported correlations between self-reported attentional control and anxiety. In our current study, we also assessed attentional control beliefs using self-report, thus suffering from the same risk of method bias. Future studies may therefore use more varied measures of anxiety (e.g., including observational or physiological measures), or they may want to measure attentional control beliefs more implicitly (e.g., using a relational responding task, which has been recently proposed as an implicit measure of beliefs, see De Houwer et al., 2015). The same recommendations hold for any other research into hypothesized correlates of self-reported attentional control. Second, in our current studies, we measured behavioural attentional control using a computer task that was performed in relatively quiet and relaxing settings. It is possible that anxiety-linked impairments in behavioural attentional control only manifest themselves in more ecologically valid and motivationally salient contexts. For instance, relative to non-anxious participants, anxious participants may struggle more to control their attention in a behavioural assessment when they feel stressed or when their performance on the task can lead to unwanted outcomes. Future studies may thus want to measure behavioural attentional control in more stressful or evaluative settings.

Our studies have a number of limitations. First, we relied exclusively on the ANT as a behavioural measure of attentional control. In both studies, both the alerting and the orienting scores of the ANT yielded poor reliability estimates. However, the executive attention control score did show high internal consistency. This score is equivalent to the flanker index (Eriksen & Eriksen, 1974), and thus involves inhibition in the sense of resistance to distractor interference. However, resistance to distractor interferences is only one aspect of inhibition, in addition to prepotent response inhibition (Friedman & Miyake, 2004). Moreover, in the ACT, inhibition is one central component of attentional control, in addition to shifting, or the ability to shift attention between tasks/stimuli and remain focused on task-relevant information (Eysenck et al., 2007). As such, while the executive attention control score from the ANT is a reliable index of resistance to distractor interference, it is possible that relations between anxiety and impaired attentional control become apparent when attentional control is derived from tasks involving the inhibition of prepotent responses (e.g., Stroop task) and/or the shifting function (e.g., task switching paradigms). Second, we investigated anxiety only as a trait, and we did not include measures of state anxiety. While in the ACT there is "a focus on individual differences in anxiety as a personality dimension, typically assessed by measures of trait anxiety" (Eysenck et al., 2007, p. 336), Eysenck et al. also specify the possibility that impairments in attentional control are particularly present when trait and state anxiety interact (i.e., when both trait and state anxiety are high). As noted above, given that we did not assess state anxiety, we cannot exclude the possibility that high trait anxious participants who also experienced elevated levels of state anxiety had reduced levels of behavioural attentional control.

Despite these limitations, our paper elucidates the relationships and differences between self-reported and behavioural measures of attentional control and anxiety. In both of the two reported studies, we found that only self-reported attentional control is related to anxiety, and behavioural indices of attentional control are related to neither anxiety nor self-reported attentional control. We also demonstrated that inaccurate and negatively biased beliefs about performance on the attentional control task correlated positively with self-reported attentional control in the ACS and anxiety. The present results therefore suggest that the apparent strong relationship between self-reported attentional control and anxiety can be explained by people with elevated anxiety's negatively biased beliefs about their attentional control ability, rather than by genuine deficits in their attentional control ability.

CRediT authorship contribution statement

Bram Van Bockstaele: Conceptualization, Methodology, Software, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Jayden Greenwell-Barnden:** Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Jemma Todd:** Conceptualization, Writing – review & editing. **Patrick J.F. Clarke:** Conceptualization, Writing – review & editing. **Colin MacLeod:** Conceptualization, Methodology, Writing – review & editing, Supervision. **Lies Notebaert:** Conceptualization, Methodology, Software, Investigation, Writing – review & editing, Supervision.

Declaration of competing interest

The authors report no conflict of interest.

Data availability

The raw data, outlier analysis description, transformed data, and the analysis output are available on the following OSF-page: https://osf.io/msbvk/.

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Appendix 1. Self-reported beliefs about performance in the ANT

Directions: In the following questionnaire, you will see a number of statements concerning the attention task that you just performed. Read each statement and then click on the appropriate response to indicate how representative the statement was of your experience *IN THIS ATTENTION TASK*.

1. It was very hard for me to concentrate on the task because there were noises around me
2. When I needed to concentrate on the task, I had trouble focusing my attention
3. While I tried to focus on the task, I still got distracted by events around me
4. I managed to concentrate well even though there were some distractions in the room around me

5. While concentrating on the task, I managed to focus my attention so that I became unaware of what was going on in the room around me
6. While performing the task, I was easily distracted by noises around me
7. When trying to focus my attention on the task, I had difficulty blocking out distracting thoughts
8. I had a hard time concentrating on the task because I was thinking about something else
9. When concentrating on the task I could ignore other feelings
10. I managed to respond quickly and accurately in different conditions of the task (e.g. responding left/right, ignoring flanking arrows, focusing on the location of the star, etc.)
11. It took me a while to get really involved in the task
12. It was difficult for me to coordinate my attention between different aspects of the task
13. I quickly managed to perform well in this new task
14. It was easy for me to do this task while other things popped up in my head
15. I had trouble trying to be both accurate AND fast during the task
16. I had a hard time learning how to do the task
17. While I was sometimes interrupted or distracted, I could easily shift my attention back to the task
18. When a distracting thought came to mind while doing the task, it was easy for me to shift my attention away from it
19. It was easy for me to alternate between the different task conditions
20. It was hard for me to restart the task after having had a short break

Appendix 2. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2022.112047.

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