French adaptation of the Attentional Control Scale: Confirmatory factor analyses and relationship with trait anxiety and efficiency of orienting, alerting, and executive control attentional networks

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ABSTRACT

Background. The Attentional Control Scale (ACS) is a self-report questionnaire that measures individual differences in attentional control.

Objective. This study compared four models of the French version of the ACS and examined its links to trait anxiety and three attentional networks (orienting, alerting, and executive control) measured with the Attention Network Test (ANT).

Results. Confirmatory analyses conducted with a sample of 284 university students supported a two-factor (focusing and shifting) model. For 59 participants who completed the ANT, we found a positive correlation between focusing and the executive control network, while shifting was negatively correlated with alerting and orienting. Trait anxiety was negatively correlated with focusing and the alerting and executive control networks.

Conclusion. Results are discussed with a view to improving the assessment of attentional control, a key executive dimension for emotion regulation and attentional disengagement in anxiety.

Keywords: attentional control, confirmatory analyses, attentional networks, anxiety

Adaptation française de l'échelle de contrôle attentionnel : analyses factorielles confirmatoires et relation avec l'anxiété-trait et les réseaux attentionnels d'alerte, d'orientation et de contrôle exécutif

RÉSUMÉ

Contexte. L'échelle de contrôle attentionnel (ACS ; *Attentional Control Scale*) est un questionnaire auto-rapporté qui mesure les différences individuelles dans le contrôle attentionnel.

Objectif. La présente étude compare quatre différents modèles de la version française de l'ACS et évalue ses liens avec l'anxiété-trait et les réseaux attentionnels d'alerte, d'orientation et de contrôle exécutif mesurés par l'Attention Network Test (ANT).

Résultats. Les analyses confirmatoires ont été réalisées auprès d'un échantillon de 284 étudiants de l'université et ont permis de sélectionner un modèle à deux facteurs (focalisation attentionnelle et déplacement attentionnel). Pour 59 individus de l'échantillon ayant complété l'ANT, nous avons mis en évidence une relation positive entre la focalisation attentionnelle et le contrôle exécutif, tandis que le déplacement attentionnel était associé négativement à l'alerte et l'orientation. Concernant l'anxiété-trait, cette dernière est associée négativement à la sous-échelle focalisation attentionnelle et aux réseaux attentionnels d'alerte et de contrôle exécutif

Conclusion. Les résultats sont discutés dans une perspective d'amélioration de l'évaluation du contrôle attentionnel, dimension exécutive clé pour son rôle dans la régulation émotionnelle et les capacités de désengagement attentionnel observées dans l'anxiété.

Mots clés : contrôle attentionnel, analyses confirmatoires, réseaux attentionnels, anxiété

1. INTRODUCION

Over the past few years, researchers have become increasingly aware of the role that attentional control plays in anxious psychopathology. Derryberry and Reed (2002) highlighted the role of attentional control in the regulation of attentional biases in anxiety, showing that anxious participants with good attentional control were better able to disengage from a threatening location than those with poor attentional control. For their part, Taylor et al. (2016) recently showed that individual difference in attentional control could explain the magnitude of attentional disengagement and social anxiety symptoms. Studies of attentional bias modification techniques have also studied the role of attentional control. For example, Basanovic et al. (2017) demonstrated that two dimensions of attentional control, control of attentional selectivity and control of attentional inhibition, are positively associated with individual differences in the magnitude of attentional bias change. More generally, research in the field of psychopathology has highlighted its role in depression (e.g., Yaroslavsky et al., 2019), negative affectivity (e.g., Vasey et al., 2013), worry (e.g., Hotton et al., 2018), and emotion regulation (e.g., O'Bryan et al., 2017). More specifically, regarding trait anxiety, studies by Judah et al. (2014), Ólafsson et al. (2011) and Reinholdt-Dunne et al. (2013) have shown that the attentional focusing component of attentional control is related to trait anxiety.

According to Cisler and Koster (2010), a deficit in attentional control, defined as "individuals' ability to regulate their attentional allocation" (Cisler & Koster, 2010, p. 209), can explain why anxious individuals have difficulty disengaging attention from threatening information. This difficulty, which emerges from the intersection of automatic (i.e., attention to threat facilitated by threat detection mechanism) and strategic (i.e., attentional avoidance of threat via emotion regulation strategy) processes, is of vital importance, given its potential to maintain and even exacerbate anxiety. To clarify the definition of attentional control, Derryberry and Reed (2002) referred to the attentional systems defined by Posner and Rothbart (2000). These authors distinguished between several systems related to involuntary and voluntary processes. The posterior attentional system, activated by a stimulus from the environment, is a reactive system that moves the attentional spotlight from one location to another. It is made up of subsystems that accomplish this orienting through three operations (disengagement from one location, shifting to a new location, and engagement to the new location). Once these three operations have been completed, this information is facilitated and transmitted to the anterior attentional system. This system is located in frontal regions (anterior cingulate cortex) that are connected to limbic and frontal motivational systems. It is regarded as an executive system that accomplishes more voluntary attentional functions (e.g., inhibiting dominant response tendencies, inhibiting dominant conceptual associations, detecting erroneous responses). The function of this anterior attentional system is to regulate the posterior orienting system, providing "voluntary control, guided by expectations and motives, over the allocation of attention in space" (Derryberry & Reed, 2002, p. 226). For example, this system may help decrease anxiety by enabling individuals to disengage from a threat and engage towards a source of safety. Rothbart and Rueda (2005) point out that this attentional system includes the ability to deliberately focus and shift attention to and from environmental stimuli. This ability to voluntarily direct attention in space (i.e., engage, disengage, or switch attentional focus; Asplund, et al., 2010) allows for successful disengagement from a threatening stimulus, and therefore creates the conditions needed for the deployment of subsequent responses, by releasing attentional resources (previously allocated to the threat) for other, more cognitively challenging tasks. These subsequent tasks can include the use of coping strategies such as cognitive reappraisal or other emotion regulation strategies (Ray et al., 2005).

Two attentional control measures seem to be particularly popular in the literature (Reinholdt-Dunne et al., 2009). The first is the Attentional Control Scale (ACS; Derryberry & Reed, 2002), a self-report questionnaire that was developed to measure individual differences in attentional control (e.g., Bardeen & Orcutt, 2011), while the second is the executive control network evaluated by the Attention Network Test (ANT; Fan et al., 2002).

The ACS comprises 20 items that initially belonged to two separate scales: attentional focusing and attentional shifting (Derryberry & Rothbart, 1988). *Attentional focusing* is defined as "the capacity to intentionally hold the attentional focus on desired channels and thereby resist unintentional shifting to irrelevant or distracting channels", and *attentional shifting* as "the capacity to intentionally shift the attentional focus to desired channels, thereby avoiding unintentional focusing on particular channels" (Derryberry & Rothbart, 1988, p. 966). The authors reported that these scales were strongly related ($r = 0.54$), and the latter were subsequently combined to form the ACS, using the total score as a measure of the ability to control attention. According to Derryberry and Reed (2002, p. 226), factor analyses of the ACS indicate that it measures "a general capacity of attentional control, with correlated subfactors related to the abilities to (a) focus attention (e.g., "My concentration is good even if there is music in the room around me"), (b) shift attention between tasks (e.g., "It is easy for me to read or write while I'm also talking on the phone"), and (c) flexibly control thought (e.g., "I can become interested in a new topic very quickly when I need to"). The ACS has high internal consistency ($\alpha = 0.88$; Derryberry & Reed, 2002). Moreover, high ACS scores are predictive of increased activation in the brain areas associated with top-down emotion regulation (Matthews et al., 2004). More recently, Fajkowska and Derryberry (2010) studied the psychometric properties of the ACS and demonstrated that a one-factor solution is the most representative. All the items are strong markers of this single factor, except for Item 9, which has a very low loading (below .30).

To the best of our knowledge, only three studies have evaluated the factor structure of the ACS, in the wake of Fajkowska and Derryberry (2010) and Derryberry and Reed (2002). The first was carried out in a sample of eight to 18-year-old Dutch children and adolescents (Verstraeten et al., 2010). Results of a confirmatory factor analysis supported the presence of two factors rather than one, with two items being omitted from the analysis (Items 9 and 10). Internal consistency was $\alpha = 0.70$ for the focusing subscale and $\alpha = 0.63$ for the shifting subscale. These two subscales were moderately correlated ($r = 0.41$). The second study (Ólafsson et al., 2011), carried out in an Icelandic sample, also suggested a two-factor solution, with the omission of Item 9. Internal consistency was $\alpha = 0.82$ for the focusing subscale and $\alpha = 0.68$ for the shifting subscale. Internal consistency for the total score was $\alpha = 0.84$. The two subscales were strongly correlated ($r = 0.73$). Moreover, Ólafsson and colleagues showed that higher attentional focusing scores uniquely predicted lower anxiety scores, and that higher attentional shifting scores uniquely predicted lower depression scores. The third study (Judah et al., 2014), carried out among English students, also supported a two-factor solution. Internal consistency was $\alpha = 0.82$ for the focusing subscale and $\alpha = 0.71$ for the shifting subscale. Internal consistency for the total score was $\alpha = 0.83$. The two subscales were correlated ($r = 0.36$). Finally, studies using the total ACS score have reported internal consistency ranging from $\alpha = 0.71$ (Gyurak & Ayduk, 2007) to $\alpha = 0.93$ (Richey et al., 2012).

In the light of this research, our study compared the different models described in the literature, namely the one-factor model of Fajkowska and Derryberry (2010; Model 1), the two-factor models of Ólafsson et al. (2011; Model 2) and Judah et al. (2014; Model 3), and the three-factor model of Fajkowska and Derryberry (2010; Model 4). Although Fajkowska and Derryberry (2010) showed that the three-factor model is a less effective solution than the one-factor model, it continues to attract the attention of researchers (e.g., Tully et al., 2014), which is why we tested it as well.

Attentional control can also be assessed using the ANT's executive control network measure. The latter is a commonly used experimental reaction time task that evaluates the functioning of three attentional networks: alerting, orienting, and executive control. These networks have been differentiated at both neuro-anatomical and cognitive levels (Fan et al., 2003; Posner & Dehaene, 2000). *Alerting* involves frontal and parietal areas, particularly in the right hemisphere, as well as brainstem areas as the locus coeruleus (Posner, 2008). This neural circuit serves to reach and maintain a high state of sensitivity to incoming stimuli, and is linked to performance on tasks that involve both tonic and phasic alertness (see, for example, Posner, 2008). The alerting network is an important source of attention, in the sense that maintaining an adequate level of alertness is decisive for optimum performance. The *orienting* network, closely related to selective visuospatial attention, involves selectively focusing on one or several items out of many potential inputs. It is assessed by the presentation of spatial cues, indicating either the correct location of a target (valid trial), the opposite location (invalid trial), or a neutral location (trial with central cue). The difference between these conditions provide an index of this network's efficiency. The orienting network involves parts of the inferior and superior parietal lobe, frontal eye fields, and subcortical areas such as the superior colliculus of the midbrain and the pulvinar and reticular nucleus of the thalamus. Finally, the *executive control* network is related to monitoring and resolving conflicts in the presence of competing information. It can be assessed with the Stroop, Flanker and Simon tasks (see, for example, Fan et al., 2002), each of which measures an interference index accounting for the efficiency of executive control. This network is also required in higher level mental operations, for example error detection, decision making, planning, and novel or not well-learned responses. This network involves the midline frontal areas (anterior cingulate cortex) and lateral prefrontal cortex.

Several studies have reported links between attentional networks and trait anxiety, but the results are contradictory: for Moriya and Tanno (2009), trait anxiety is associated with the orienting network, whereas Pacheco-Unguetti et al. (2010) and Tortella-Feliu et al. (2014) reported a link with reduced effectiveness of the executive control network. Regarding the relation between ACS and attentional networks, Tortella-Feliu et al. (2014) observed that ACS was associated with the orienting network but not the executive control network, as might have been expected. Finally, in this same study, they found that trait anxiety was negatively associated with ACS.

The present study examined the structure of the French version of the ACS, by comparing the different models present in the literature, and explored its relationships with trait anxiety and the alerting, orienting and executive control attentional networks.
Based on previous factor studies, and contrary to Derryberry and Reed (2002)'s results, we expected to find confirmation of a two-factor model for the ACS (either Model 2 or Model 3), rather than a one-component (Model 1) or three-component (Model 4) one. In addition, we predicted that the ACS total score would be associated with the executive control network. Regarding its subscales, we looked for associations between attentional focusing and the alerting network, and between attentional shifting and the orienting network. Finally, we predicted that trait anxiety would be associated with attentional focusing and the executive control network.

2. METHOD

2.1. Participants

Participants were 284 first-year human sciences students (mean age = 19.36 years, *SD* = 1.89) from Lille University. They all responded to questionnaires on attentional control and trait anxiety (Table 1), and 69 of them also completed the ANT measuring the three attentional networks (alerting, orienting, and executive control). Only native French speakers were included. Participants' anonymity was guaranteed.

Insert Table 1 about here

2.2. Material

2.2.1. Questionnaires

Spielberger's State-Trait Anxiety Inventory-Trait (STAI-T; Spielberger et al., 1983; French version: Bruchon-Schweitzer & Paulhan, 1993) is a 20-item scale designed to assess respondents' general level of anxiety. Items are rated on a Likert-type scale ranging from 1 (*Almost Never*) to 4 (*Almost Always*). The trait anxiety score is obtained by summing the responses to the 20 items. Bruchon-Schweitzer and Paulhan (1993) reported good psychometric and structural properties of the French scale. Cronbach's alpha in a standard sample was 0.84.

The ACS (Derryberry & Reed, 2002; French version: Ceschi et al., 2003) contains 20 items measuring three interrelated sub-dimensions: the ability to focus attention, the ability to shift attention between tasks, and the ability to flexibly control thought. A full list of English scale items and their French translation is reported in Table 2. Items are related on a 4-point scale (*Almost Never*, *Sometimes*, *Often*, *Always*). A higher score indicates better attentional control. The ACS was translated by the authors cited above, and independent back translations were performed to control this translation.

Insert Table 2 about here

2.2.2. Attention Network Test

The ANT assesses alerting, orienting and executive control of attention. We used the version scheduled in E-Prime by Fan et al. (2002). In each trial, participants have to indicate the direction of the center arrow (i.e., whether it is pointing left or right) by pressing the appropriate key as quickly and accurately as possible. There are two arrows (*flankers*) on either side of the target. These flankers may point either in the same direction as the target (congruent condition), or in the opposite direction (incongruent condition) or even be horizontal lines (neutral condition). The target may (cue condition) or may not (no cue condition) be preceded by a cue. This cue may be displayed either in the center of the screen (center cue condition), at the top or bottom where the target is to appear (spatial cue condition), or both the top and bottom (double cue condition). Therefore, whereas a spatial cue precisely predicts where the target will appear, this information cannot be inferred in either the center cue or double cue condition.

The temporal sequence of stimulus presentation (see Fig. 1a) is as follows: (1) central fixation cross (variable, 400-1600 ms), (2) cue for 100 ms (no cue, center cue, double cue, or spatial cue), (3) central fixation cross for 400 ms, (4) target and flanker stimuli simultaneously displayed until participant responds, and (5) central fixation cross until total trial duration of 4000 ms has elapsed (variable, based on first fixation duration).

The ANT comprises 24 practice trials, followed by 288 experimental trials. The trials reflect the combination of the following conditions: warning cue (4: no cue, center cue, double cue, or spatial cue; Fig. 1b); target arrow location (2: top or bottom); target arrow direction (2: left or right); and flanker (3: neutral, congruent, or incongruent). There are six repetitions of each trial type. The experimental trials are presented in a randomized order, and the task takes about 15 min to complete.

The efficiency of the three attentional networks (alerting, orienting, and executive control) is determined by measuring how response times to the flanker displays are influenced by alerting cues, spatial cues, and flanker type (for more details, see Fan et al., 2002). The *alerting index* is calculated by subtracting the mean RT for all double-cue conditions from the mean RT for all no-cue conditions. The double cue alerts participants to the imminent onset of the target, while keeping attention spread across the upper and lower screen. Higher scores indicate greater alerting efficiency owing to the presence of a cue. The *orienting index* is calculated by subtracting the mean RT for all spatial-cue conditions from the mean RT for all center-cue conditions. Both types of cues are alerting, but only the spatial cues direct attention to the location where the target will appear. Higher scores indicated greater orienting efficiency owing to presence of spatially predictive information, while controlling for alerting effects. The *executive control index* is calculated by subtracting the mean RT for all congruent flanking conditions from the mean RT for all incongruent flanking conditions. Higher scores indicate less efficient executive attention or greater conflict interference.

Insert Figure 1 about here

2.3. Procedure

Participants responded to the ACS and STAI-T in a group session. Next, 69 of them volunteered to take part in the following experiment, which consisted in completing the ANT in an experimental box. During the ANT, participants were seated 50 cm from the screen.

3. Results

3.1. Confirmatory factor analyses

Confirmatory factor analyses were computed with LISREL 8.80 software (Jöreskog & Sörbom, 2006) using maximum likelihood estimation. For these analyses, goodness of fit was tested with a χ^2 test (a nonsignificant statistical value corresponded to an acceptable fit). However, this method is sensitive to sample size. Obtaining a statistically nonsignificant χ^2 when performing confirmatory factor analyses on a self-report questionnaire is unusual, even if there is only a small discrepancy between the observed and implied data (Byrne, 1994). We therefore chose to calculate the normed χ^2, a derived fit statistic that is less dependent on sample size, by dividing the χ^2 index by the degree of freedom. A normed χ^2 below 2 usually indicates a good model fit, and a normed χ^2 below 3 an acceptable fit.

Based on Schweizer (2010)'s recommendations, we chose three other adjustment indices for the analysis: Standardized Root Mean square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI). SRMR and RMSEA are both residuals-based, absolute fit measures. The CFI is an additional relative fit measure. The combination of RMSEA and SRMR is valuable because the RMSEA is sensitive to the misspecification of factor loadings, whereas the SRMR is sensitive to the misspecification of factor covariances. If both indices are accepted, the latent and measure model are considered to be well specified. Furthermore, the RMSEA is associated with a confidence interval. RMSEA values below 0.06 have been found to indicate a good fit. SRMR values should stay below 0.08. The CFI indicates a good model fit for values in the interval of 0.95-1.0, whereas values in the interval of 0.90-0.95 signify an acceptable fit. The Goodness of Fit Index (GFI) and the Adjusted Goodness of Fit index (AGFI) were also calculated. The GFI is an absolute fit index, comparable to R^2, and performs better than any other absolute fit index regarding the absolute fit of the data. GFI and AGFI values are between 0 and 1, with 1 indicating a perfect fit. A value of 0.90 is necessary for model acceptance.

3.1.1. Comparison of the four models

To be consistent with previous studies, we tested four structural models with separate confirmatory factor analyses. As a reminder, Model 1 had a single factor (Fajkowska & Derryberry, 2010), Models 2 (Ólafsson et al., 2011) and 3 (Judah et al., 2014) had two factors, and Model 4 (Fajkowska & Derryberry, 2010) had three factors.

The fit indices of these four models are displayed in Table 3. Model 3 had the best fit indices (χ^2/ ddl = 1.85, CFI = 0.89, AGFI = 0.92, GFI = 0.95, RMSEA = 0.052, SRMR = 0.059).

Insert Table 3 about here

3.1.2. Model selection and application of corrections

Modification indices for the Model 3 (two-factor model) revelaled that his fit could be improved by allowing the error terms between Items 6 and 1, 12 and 10, and 19 and 17 to correlate. This adjusted model meets all the requirements for a reasonable model fit (χ^2/ddl = 1.17, CFI = 0.98, AGFI = 0.95, GFI = 0.97, RMSEA = 0.025, SRMR = 0.046), and fits the data significantly better than the previous model ($\Delta\chi^2$ = 39.33, Δdf = 3, p < .001) (Table 4). The two latent factors correlated weakly (r = .26, p < .01). The factor loadings of the model are set out in Figure 2. All items had loadings above .30.

Insert Table 4 about here

Insert Figure 2 about here

Table 5 indicates the impact on internal consistency of deleting each item from the scale and from the two subscales. For each item, the table also indicates the mean, variance, and summed scale for each deleted item. For the total scale, no item suppression was suggested to increase its internal validity. Regarding the focusing subscale, the suppression of Item 12 would have marginally increased its internal validity. The same was true for the suppression of Item 18 for the shifting subscale. However, although the results provided in Table 5 suggested these two modifications, a check showed that they would not have resulted in better fit indices ($\chi 2$/ddl = 1.80, CFI = 0.91, AGFI = 0.93, GFI = 0.96, RMSEA = 0.053, SRMR = 0.056).

Insert Table 5 about here

3.2. Descriptive statistics, internal consistency and relationship with sex, age and anxiety

Internal consistency of the ACS and its subscales was calculated in the total sample. Internal consistency was good for the total score (α = 0.71), and reasonable for the focusing (α = 0.58) and shifting (α = 0.56) factors.

The mean score was 52.89 (*SD* = 6.58) for the ACS, 18.81 (*SD* = 3.06) for the focusing factor, and 13.36 (*SD* = 2.35) for the shifting factor. Table 6 displays the centiles for the overall score and subscores. Results showed that these score distributions were relatively bell-shaped and symmetrical, supporting that these scores appropriately discriminated individuals.

The corresponding mean values for men (*n* = 49) were 53.92 (*SD* = 6.98), 18.78 (*SD* = 3.36) and 13.49 (*SD* = 2.92), and for women (*n* = 233) they were 52.69 (*SD* = 6.51), 18.80 (*SD* = 3.01) and 13.34 (*SD* = 2.37).

T tests did not indicate a sex difference for either the total ACS score, $t(280) = 1.19$, $p = 0.24$, the shifting, $t(280) = 0.39$, $p = 0.69$, and focusing, $t(280) = -0.56$, $p = 0.95$, subscales, or the STAI-T score, $t(274) = -0.89$, $p = 0.38$. Age also did not correlate with the STAI-T score, $r = -0.01$, *ns*, the total ACS score, $r = 0.11$, *ns*, or the focusing subscale, $r = 0.04$, *ns*, although it did weakly correlate with the shifting subscale, $r = 0.13$, $p < .05$.

Insert Table 6 about here

3.3. Correlations between the ACS and other constructs

We calculated Spearman correlations for these analyses and used the Benjamini-Hochberg procedure to hold the false discovery rate at 10% for the 21 correlations (see Table 7).

3.3.1. Correlations between the ACS and trait anxiety

Analyses indicated that trait anxiety was not correlated with the ACS total score ($r = 0.16$, *ns*). It was, however, strongly and negatively correlated with the focusing subscale ($r = -.53$, $p < 0.01$), though not with the shifting subscale ($r = 0.03$, *ns*). As expected, the two subscales correlated moderately and positively with the ACS total score (focusing: $r = .30$, $p < .05$; shifting: $r = .34$, $p < 0.01$).

3.3.2. Relationship between the ACS and the three attentional networks (alerting, orienting, and executive control)

3.3.2.1. Preliminary analyses for ANT reaction times.

RTs for trials with errors (1.3%) and RT outliers (< 250 ms and > 3 *SD*s above each participant's mean; 2.8% of trials) were removed from the analysis. A total of 10 participants were excluded because of a high error rate (≥ 5 %) or a high trait anxiety score (T > 65) corresponding to a very high level of anxiety.

3.3.2.2. ANT parameter analysis

We tested task parameter effects on mean RT using a Cue (no cue, center cue, double cue, spatial cue) x Flanker (neutral, congruent, incongruent) repeated-measures ANOVA. As the sphericity assumption was not satisfied, we applied the Greenhouse-Geisser correction. This analysis revealed main effects of cue, $F(2.528, 146.620) = 197.44$, $p < .0001$, $\eta^2 = .77$ and flanker, $F(1.383, 80.189) = 365.64$, $p < .0001$, $\eta^2 = .86$. Moreover, we found a Cue x Flanker interaction, $F(4.489, 260.388) = 16.98$, $p < .0001$, $\eta^2 = .23$. The pattern of means was very closed to that reported by Fan et al. (2002). Results (with Bonferroni-Dunn correction) showed that RTs were shortest for spatial cues (double cue: $p < .0001$; central cue: $p < .0001$; no cue: $p < .0001$). As expected, RTs for double cue and central cue did not differ (*ns*), and were faster for the central cue than for no cue ($p < .0001$). Regarding Flanker type, RTs were shorter for congruent ($p < .001$) and neutral ($p < .001$) flankers than for incongruent ones, and shorter for neutral flankers than for congruent ones ($p < .001$).

Moreover, as in Fan et al. (2002), the Cue x Flanker interaction, depicted in Figure 3, showed that RTs were longer for incongruent flankers than for congruent or neutral ones, although this effect of incongruent flankers was reduced (RTs were shorter) following spatial cues.

Insert Figure 3 about here

Finally, patterns of correlations among attentional networks were consistent with the usual ANT results, in that these networks were not correlated with each other (Table 8). The results for each attentional network were close to those reported by Fan et al. (2002) and Matthews and Zeidner (2012), with means of 42.61 (*SD* = 27.13) for alerting, 37.55 (*SD* = 22.65) for orienting, and 81.92 (*SD* = 30.69) for executive control.

Insert Table 8 about here

3.3.2.3. Correlations between the ACS and the three attentional networks (alerting, orienting, and executive control)

Table 7 shows the correlations between the ACS and the attentional networks. The total ACS score was not correlated with executive control ($r = .14$, *ns*), but it was positively and weakly correlated with alerting ($r = -.23$, $p < 0.05$), and moderately correlated with orienting ($r = .38$, $p < 0.01$). By contrast, the focusing subscale was moderately and positively correlated with executive control ($r = .31$, $p < 0.05$), but not with either alerting ($r = -0.09$, *ns*) or orienting ($r = .09$, *ns*). Concerning the shifting subscale, it was negatively and weakly correlated with orienting ($r = -.18$, $p < 0.05$), and moderately with alerting ($r = -.31$, $p < 0.05$), but not with executive control ($r = .15$, *ns*).

3.3.3. Correlations between trait anxiety and the three attentional networks (alerting, orienting, and executive control)

The STAI-T score was correlated negatively and weakly with alerting (r = -0.22, $p < 0.05$) and moderately with executive control (r = -.35, $p < 0.01$), but not with orienting (r = 0.42, *ns*).

Insert Table 7 about here

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4. DISCUSSION

The ACS was constructed by combining two scales: attentional focusing and attentional shifting. Our confirmatory factor analyses supported the two-factor model of Judah et al. (2014). The items loading on each factor differed slightly from those in Derryberry and Rothbart (1988)'s model. Our results, which corroborate those of Judah et al. (2014) and those of Ólafsson et al. (2011), did not highlight the nine items that originally belonged to the attentional focusing scale and the 11 items that originally belonged to the attentional shifting scale. In addition, contrary to the results of Derryberry and Reed (2002), our analyses confirmed the presence of two weakly correlated factors, rather than three intercorrelated factors.

We therefore found the first two factors (attentional focusing and attentional shifting), but not the third one (ability to flexibly control thought). For example, Derryberry and Reed (2002) found that the item "I can become interested in a new topic very quickly when I need to" belonged to the flexible control of thought, whereas Judah et al. (2014) and Ólafsson et al. (2011) found it belonged to attentional shifting. This difference could be explained by the fact that this kind of item reflects not only a process (here, attentional shifting), but also a context that may differ depending on cognitive task demand (i.e., low level of cognitive processing, such as shifting between two simple tasks, or high level of cognitive processing, such as finding new ideas). For example, for items measuring attentional shifting, we found two different contexts: shifting attention between tasks (Item 10), and flexibly controlling thought (Item 13). It could be wise in the future to consider the executive function *updating* (Miyake et al., 2000) in the evaluation of attentional control, in order to operationalize task difficulty, as the greater the task's cognitive demand, the more the individual needs to update the incoming and relevant information for the task and update the information in working memory.

In addition, for some items, respondents may be faced with a second problem, concerning the presence of two processes within the same item. For example, Item 17 ("After being interrupted or distracted, I can easily shift my attention back to what I was doing before") could contribute to both factors, whereas Derryberry and Rothbart (1988) only intended it to reflect attentional shifting. On reading this item, we realized that attentional shifting and focusing (i.e., ability to *re-focus*) were both present, so depending on the importance given by respondents to one or other of these processes, the result would differ. In general, the major differences revealed by previous exploratory analyses of this questionnaire (Fajkowska & Derryberry, 2010; Judah et al., 2014; Ólafsson et al., 2011) and the weak internal consistency found in our study for both factors can be explained by the construction of the items and the representations that respondents have of them during their assessment. In future research, in order to carry out a better assessment of attentional control and its subfactors, it may be necessary to use items that only include one process, and ensure that the context in which this process is evaluated is taken into account. In addition, results suggest that it would be more useful to improve the assessment of each attentional control factor, in order to achieve a better overall assessment of attentional control. In this approach, we could draw inspiration, for instance, from the Attentional Style Questionnaire (Van Calster et al., 2018) which takes into account both the type (top down, bottom up) and orientation (internal, external) of attention.

Despite previous criticism of the use of the ACS to measure attentional control, the present study yielded several results that should improve research in this area. First, we observed that the two subscales were related to the attentional networks measured by the ANT, as attentional focusing was correlated with executive control, and attentional shifting with alerting and orienting.

Regarding focusing, as hypothesized, it was associated with the efficiency of executive control. If we go back to Derryberry and Rothbart (1988)'s definition, this "capacity to intentionally hold the attentional focus on desired channels and thereby resist unintentional shifting to irrelevant or distracting channels" (p. 966) allows individuals to perform better in a conflict resolution task. As the efficiency of executive control is measured as the difference in RTs between congruent and incongruent conditions, the participant's ability to focus on the arrow and ignore the flankers (distractors) is clearly associated with the measure of attentional focusing. On this point, Reinholdt-Dunne et al. (2013) found that focusing was associated with a behavioral task requiring the processing of task-irrelevant information to be inhibited. The greater an individual's attentional focusing capacity, the less interference there is faced to conflict, and the more efficient the executive attention. It is therefore important to link this attentional focusing measure with the inhibition function presented by Miyake et al. (2000). This executive function serves to resist to distractor interference and inhibit dominant responses, thereby allowing task goals to be maintained when an individual is confronted with irrelevant stimuli and responses. In future, we could therefore use this executive function, which may partly underlie attentional focusing.

Regarding shifting, while one might have expected it to be associated solely with the orienting network, we found that it was actually associated with both the orienting and alerting networks. More specifically, regarding the alerting network, which corresponds to a general ability to process a target quickly (whether this is preceded by a cue or not), results indicated that the lower participants scored on the shifting subscale, the higher their alerting index score (i.e., participants benefited from the alert given by the double cue to process the target much more quickly). By contrast, the more participants deemed they were able to shift their attention, the more effectively they handled the unexpected arrival of a stimulus in their environment (i.e., they tended to be as fast in the condition with an alert as in the condition without an alert). This result may highlight one of the distinctive characteristics of self-report measures of attentional processes. We can assume that individuals who assess themselves as having weak attentional shifting benefit from cues, whereas individuals who have a stronger assessment do not need the cues to perform well. We return to the assessment of attentional processes via self-report questionnaires when we discuss the limitations of the present study.

Regarding the orienting network, corresponding to the ability to selectively focus on one or several candidate inputs out of many (using a valid cue), results indicated that the lower their attentional shifting subscore, the more participants took advantage of the cues to quickly process the target. By contrast, the higher their attentional shifting subscore, the less useful such cues were for processing the target (i.e., participants tended to be just as fast in the spatial cue condition as they were in the central cue one). These results could be explained in the same way as before for the alerting network. Participants who assessed themselves as having a low attentional shifting ability therefore benefited more from the cue. Another possible explanation for this result is that the measure of this factor did not take the selective visuospatial attention into account. In the context of selective attention, being aware of the location of the stimulus before it appears allows individuals to be better prepared to respond, as they can shift their attention to that location. When we refer back to Derryberry and Rothbart's initial definition of attentional shifting (1988, p. 966) “the capacity to intentionally shift the attentional focus to desired channels, thereby avoiding unintentional focusing on particular channels”, we realize that the use of a basic spatial cue does not really correspond to it. It would be more relevant to use the notion of *attentional disengagement* to account for this factor, as the attentional shifting measure by the ACS assumes that respondents are already engaged on an item of information, and deliberately shift their attentional focus to process a new item of information (this refers to the anterior attentional system). This measure could be carried out in future research in particular thanks to the revised version of the ANT (ANT-R; Fan et al., 2009). If we wanted to make suggestions for items measuring the orienting network as evaluated by the ANT, we would have to get closer to a sentence like "When I hear a noise, I easily direct my attention to the place it is coming from". This proposition is supported by results showing that low attentional control is associated more with difficulty in disengaging attention than with difficulty rapidly engaging toward information (Peers & Lawrence, 2009). Indeed, attentional control is defined as a *top-down* executive function (i.e., directed by the individual's goal) dependent on the anterior attentional system. It is not normally sensitive to the appearance of a stimulus in the environment, the system that is sensitive being the posterior attentional system.

Regarding the ACS total score, as expected, it was associated with the two subscores (i.e., attentional focusing and attentional shifting), but only weakly so, whereas correlations were strong in Ólafsson et al. (2011) and moderate in Judah et al. (2014). Regarding the links between the ACS and the three attentional networks, like Tortella-Feliu et al. (2014), we found that the ACS score was associated with the orienting network, but not with the executive control network. This lack of a relationship with executive control was unexpected, as the ACS by definition measures the voluntary allocation of an individual's attentional resources. For the alerting network, unlike Tortella-Feliu et al. (2014), we found a link with ACS.

Regarding trait anxiety, contrary to Tortella-Feliu et al. (2014), we did not find a link with the ACS total score, but it was specifically related to the attentional focusing subscore, consistent with Judah et al. (2014), Ólafsson et al. (2011), and Reinholdt-Dunne et al. (2013). This result should nonetheless be nuanced, for although several studies among nonclinical populations have highlighted relationships between attentional focusing and anxiety, and between attentional shifting and depression (e.g., Judah et al., 2014; Ólafsson et al., 2011), this result was not corroborated by the recent study by Hsu et al. (2019) in a clinical population. These authors found that attentional focusing was more strongly associated with depressive symptoms and anxiety than attentional shifting was. Regarding the relationship between trait anxiety and attentional networks, trait anxiety was related to alerting and executive control (see Pacheco-Unguetti et al., 2010, 2011). Recent studies have yielded contradictory results on this subject, whereas Moriya and Tanno (2009) showed that trait anxiety is only associated with orienting, our study and those of Pacheco-Unguetti et al. (2010) and Tortella-Feliu et al. (2014) highlighted impaired executive control in trait anxiety, and that of Pacheco-Unguetti et al. (2011) in anxiety disorders. Regarding alerting, it is usually associated with state anxiety (Pacheco-Unguetti et al., 2010). However, two recent studies on the modification of attentional bias (Heeren et al., 2015; McNally et al., 2013) reported a deterioration in alerting and executive control networks in social anxiety, and support our results. They showed an improvement in alerting and executive control networks in patients with social anxiety after they had followed an attentional bias modification procedure.

To summarize, based on our confirmatory analyses, together with literature findings and validity results, we can deduce that it would be relevant in the future to develop a questionnaire that takes account of underlying processes, contexts and level of difficulty, and specifies the type and direction of attention, like the Attention Style Questionnaire (Van Calster et al., 2018). In addition, we highlighted potential avenues for research that would improve attentional control assessment. Thus, it would be relevant to assume that (1) the attentional shifting subscale takes the notion of attentional disengagement into account, (2) the attentional focusing subscale takes the notion of voluntary inhibition of distracting stimuli into account, and (3) these two subscales can consider low-level to high-level cognitive processing contexts in order to operationalize the intensification of *updating*. Finally, if a subscale were to be added, it could be inspired by that initially planned by Derryberry and Reed (2002) on flexibly controlled thought, and should take the notion of cognitive flexibility into account. The latter has a special status, as it involves both the inhibition and shifting components of executive control (Miyake et al., 2000). Much work still remains to be done to improve the understanding of the various executive processes underlying attentional control and its measurement by means of questionnaires and behavioral tasks. The attentional control dimension is also of particular importance because it can be included in a transdiagnostic approach (e.g., Hsu et al., 2015) and is involved in emotion regulation (e.g., O'Bryan et al., 2017).

The present study had several limitations that will have to be considered in future research. First, it is important to discuss the usefulness of a self-report questionnaire for measuring attentional processes. Here, it elicited participants' ability to assess their attentional skills in different life contexts. However, the metacognitive abilities vary, and may be partly responsible here for the disappointing results on the links between the ACS and the ANT. Varying levels of trait anxiety may also affect individuals' ability to assess their attentional capacities (Tortella-Feliu et al., 2014). The literature often reports differences between self-report measures and experimental measures of processes via tested paradigms. For example, many studies have highlighted a difference for the assessment of impulsivity (for a meta-analysis, see Hamza et al., 2015). It would therefore be worthwhile improving this questionnaire so that the self-reported and experimental measures correspond more closely. Future research will need to compare these two types of measure and pinpoint their similarities or differences. Even if this goal is difficult, there are four main advantages to measuring attentional control with a self-questionnaire: (1) the latter is more easily used in a therapeutic context, as it does not require a computer; (2) it can be used to make an initial assessment of a patient to identify present difficulties, and guide the choice of more specific and behavioral measures; (3) it allows patients to visualize their behavior in a given situation; and (4) this information it yields can be useful in the context of a therapeutic intervention, for example, in order to gain a better understanding of how participants behave or interact with their environment, and thence the impact that this can have on their psychological problems.

The second limitation is that we did not evaluate variables that can influence the efficiency of attentional networks, such as sleep disturbance (e.g., Jugovac & Cavallero, 2012), alcohol consumption (e.g., Maurage et al., 2014), level of social anxiety (Heeren et al., 2015), and depressive symptoms (e.g., Lyche et al., 2010). This means that we do not know whether they influenced the study results. Third, a state anxiety evaluation would have allowed us to discuss literature findings regarding its impact on attentional networks (e.g., Pacheco-Unguetti et al., 2010). Fourth, only a small number of participants performed the ANT. Future research will need to focus on better sampling, in order to allow the external validity of a future version of the ACS to be better tested.

Despite its limitations, this study provides a comparison of the different models of attentional control described in the literature. The two-factor model is recommended. The results of the confirmatory analyses, as well as those concerning the ANT and the level of trait anxiety highlighted the need to create new items for this scale. To improve the latter, it would be relevant to use the various executive functions but also specify the process(s) at work, the context, and the type of attention.

Disclosure

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5. REFERENCES

Asplund, C. L., Todd, J. J., Snyder, A. P., & Marois, R. (2010). A central role for the lateral prefrontal cortex in goal-directed and stimulus-driven attention. *Nature Neuroscience*, *13*(4), 507-512. https://doi.org/10.1038/nn.2509

Bardeen, J. R., & Orcutt, H. K. (2011). Attentional control as a moderator of the relationship between posttraumatic stress symptoms and attentional threat bias. *Journal of Anxiety Disorders*, *25*, 1008-1018. https://doi.org/10.1016/j.janxdis.2011.06.009

Basanovic, J., Notebaert, L., Grafton, B., Hirsch, C. R., & Clarke, P. J. (2017). Attentional control predicts change in bias in response to attentional bias modification. *Behaviour Research and Therapy*, *99*, 47-56. https://doi.org/10.1016/j.brat.2017.09.002

Bruchon-Schweitzer, M., & Paulhan, I. (1993). Adaptation française de l'Inventaire d'Anxiété Trait-Etat. Forme Y (STAI Y) [French adaptation of the State-Trait Anxiety Inventory. Form Y (STAY Y)]. Les Editions du Centre de Psychologie Appliquée.

Byrne, B. M. (1994). *Structural equation modeling with EQS and EQS/Windows: Basic concepts, applications, and programming*. Sage.

Ceschi, G., Van der Linden, M., d'Acremont, M., Bonhôte, M., & Russell, A. (2003). *Adaptation française de l'Attentional Control Scale (ACS)* [*French adaptation of the Attentional Control Scale*] (Unpublished manuscript). University of Geneva, Switzerland.

Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review*, *30*, 203-216. https://doi.org/10.1016/j.cpr.2009.11.003

Dennis, T. A., & Chen, C. (2007). Emotional face processing and attention performance in three domains: Neurophysiological mechanisms and moderating effects of trait anxiety. *International Journal of Psychophysiology*, *65*, 10-19. https://doi.org/10.1016/j.ijpsycho.2007.02.006

Derryberry, D., & Reed, M.A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology*, *111*, 225-236. https://doi.org/10.1037/0021-843X.111.2.225

Derryberry, D., & Rothbart, M. K. (1988). Affect, arousal, and attention as components of temperament. *Journal of Personality and Social Psychology*, *55*, 958–966. https://doi.org/10.1037/0022-3514.55.6.958

Fabrigar, L. R.,Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*, 272-299. https://doi.org/10.1037/1082-989X.4.3.272

Fajkowska, M., & Derryberry, D. (2010). Psychometric properties of Attentional Control Scale: The preliminary study on a Polish sample. *Polish Psychological Bulletin*, *41*(1), 1-7. https://doi.org/10.2478/s10059-010-0001-7

Fan, J., Gu, X., Guise, K. G., Liu, X., Fossella, J., Wang, H., & Posner, M. I. (2009). Testing the behavioral interaction and integration of attentional networks. *Brain and Cognition*, *70*(2), 209-220. https://doi.org/10.1016/j.bandc.2009.02.002

Fan, J., McCandliss, B., Sommer, T., Raz, A., & Posner, M. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience*, *14*, 340-347. https://doi.org/10.1162/089892902317361886

Fan, J., Raz, A., & Posner, M. I. (2003). Attentional mechanisms. In *Encyclopedia of neurological sciences*. Academic Press.

Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment*, *7*, 286-299. https://doi.org/10.1037/1040-3590.7.3.286

Gyurak, A., & Ayduk, Ö. (2007). Defensive physiological reactions to rejection: The effect of self-esteem and attentional control on startle responses. *Psychological Science*, *18*, 886-892. https://doi.org/10.1111/j.1467-9280.2007.01996.x

Hamza, C., Willoughby, T., & Heffer, T. (2015). Impulsivity and nonsuicidal self-injury: A review and meta-analysis. *Clinical Psychology Review*, *32*(6), 482-495. https://doi.org/10.1016/j.cpr.2015.02.010

Heeren, A., Lievens, L., & Philippot, P. (2011). How does attention training work in social phobia: Disengagement from threat or re-engagement to non-threat? *Journal of Anxiety Disorders*, *25*, 1108-1115. https://doi.org/10.1016/j.janxdis.2011.08.001

Heeren, A., Maurage, P., & Philippot, P. (2015). Revisiting attentional processing of non-emotional cues in social anxiety: A specific impairment for the orienting network of attention. *Psychiatry Research*, *228*(1), 136-142. https://doi.org/10.1016/j.psychres.2015.04.030

Heeren, A., Mogoaşe, C., McNally, R. J., Schmitz, A., & Philippot, P. (2015). Does attention bias modification improve attentional control? A double-blind randomized experiment with individuals with social anxiety disorder. *Journal of Anxiety Disorders*, *29*, 35-42. https://doi.org/10.1016/j.janxdis.2014.10.007

Hotton, M., Derakshan, N., & Fox, E. (2018). A randomised controlled trial investigating the benefits of adaptive working memory training for working memory capacity and attentional control in high worriers. *Behaviour Research and Therapy*, *100*, 67-77. https://doi.org/10.1016/j.brat.2017.10.011

Hsu, K. J., Beard, C., Rifkin, L., Dillon, D. G., Pizzagalli, D. A., & Björgvinsson, T. (2015). Transdiagnostic mechanisms in depression and anxiety: The role of rumination and attentional control. *Journal of Affective Disorders*, *188*, 22-27. https://doi.org/10.1016/j.jad.2015.08.008

Hsu, K. J., Forgeard, M., Stein, A., Beard, C., & Björgvinsson, T. (2019). Examining differential relationships among self-reported attentional control, depression, and anxiety in a transdiagnostic clinical sample. *Journal of Affective Disorders*, *248*, 29-33. https://doi.org/10.1016/j.jad.2019.01.017

Jöreskog, K., & Sörbom, D. (2006). *LISREL 8.80* (computer software). Scientific Software International.

Judah, M. R., Grant, D. M., Mills, A. C., & Lechner, W. V. (2014). Factor structure and validation of the attentional control scale. *Cognition & Emotion*, *28*(3), 433-451. https://doi.org/10.1080/02699931.2013.835254

Jugovac, D., & Cavallero, C. (2012). Twenty-four hours of total sleep deprivation selectively impairs attentional networks. *Experimental Psychology, 59*(3), 115-123. https://doi.org/10.1027/1618-3169/a000133

Lyche, P., Jonassen, R., Stiles, T. C., Ulleberg, P., & Landrø, N. I. (2010). Attentional functions in major depressive disorders with and without comorbid anxiety. *Archives of Clinical Neuropsychology*, *26*(1), 38-47. https://doi.org/10.1093/arclin/acq095

Matthews, A., Yiend, J., & Lawrence, A. D. (2004). Individual differences in the modulation of fear-related brain activation by attentional control. *Journal of Cognitive Neuroscience*, *16*, 1683-1694. https://doi.org/10.1162/0898929042947810

Matthews, G., & Zeidner, M. (2012). Individual differences in attentional networks: Trait and state correlates of the ANT. *Personality and Individual Differences*, *53*(5), 574-579. https://doi.org/10.1016/j.paid.2012.04.034

Maurage, P., de Timary, P., Billieux, J., Collignon, M., & Heeren, A. (2014). Attentional alterations in alcohol dependence are underpinned by specific executive control deficits. *Alcoholism: Clinical and Experimental Research*, *38*(7), 2105-2112. https://doi.org/10.1111/acer.12444

McNally, R. J., Enock, P. M., Tsai, C., & Tousian, M. (2013). Attention bias modification for reducing speech anxiety. *Behaviour Research and Therapy*, *51*(12), 882-888. https://doi.org/10.1016/j.brat.2013.10.001

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. (2000). The unity and diversity of executive functions and their contributions to complex ‘‘frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, *41*, 49-100. https://doi.org/10.1006/cogp.1999.0734

Moriya, J., & Tanno, Y. (2009). Dysfunction of attentional networks for non-emotional processing in negative affect. *Cognition and Emotion*, *23*, 1090-1105. https://doi.org/10.1080/02699930802335018

O'Bryan, E. M., Kraemer, K. M., Johnson, A. L., McLeish, A. C., & McLaughlin, L. E. (2017). Examining the role of attentional control in terms of specific emotion regulation difficulties. *Personality and Individual Differences*, *108*, 158-163. https://doi.org/10.1016/j.paid.2016.12.015

Ólafsson, R. P., Smári, J., Guðmundsdóttir, F., Ólafsdóttir, G., Harðardóttir, H. L., & Einarsson, S. M. (2011). Self-reported attentional control with the Attentional Control Scale: Factor structure and relationship with symptoms of anxiety and depression. *Journal of Anxiety Disorders*, *25*, 777-782. https://doi.org/10.1016/j.janxdis.2011.03.013

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., & Lupiáñez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychological Science*, *21*(2), 298-304. https://doi.org/10.1177/0956797609359624

Pacheco-Unguettia, A. P., Acosta, A., Marqués, E., & Lupiáñez, J. (2011). Alterations of the attentional networks in patients with anxiety disorders. *Journal of Anxiety Disorders*, *25*, 888-895. https://doi.org/10.1016/j.janxdis.2011.04.010

Peers, P. V., & Lawrence, A. D. (2009). Attentional control of emotional distraction in rapid serial visual presentation. *Emotion*, *9*, 140–145. https://doi.org/10.1037/a0014507

Posner, M. I. (2008). Measuring alertness. *Annals of the New York Academy of Sciences*, *1129*, 193-199. https://doi.org/10.1196/annals.1417.011

Posner, M. I., & Dehaene, S. (2000). Attentional networks. In M. S. Gazzaniga (Ed.), *Cognitive neuroscience: A reader*. Blackwell Publishers.

Posner, M. I., & Rothbart, M. K. (2000). Developing mechanisms of self-regulation. *Development and Psychopathology*, *12*, 427–441. https://doi.org/10.1017/S0954579400003096

Ray, R. D., Ochsner, K. N., Cooper, J. C., Robertson, E. R., Gabrieli, J. D. E., & Gross, J. J. (2005). Individual differences in trait rumination and the neural systems supporting cognitive reappraisal. *Cognitive, Affective and Behavioral Neuroscience*, *5*, 156-168. https://doi.org/10.3758/CABN.5.2.156

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2009). Effects of anxiety and attention control on processing pictorial and linguistic emotional information. *Behavior Research and Therapy*, *47*, 410-417. https://doi.org/10.1016/j.brat.2009.01.012

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2013). Attention control: Relationships between self-report and behavioural measures, and symptoms of anxiety and depression. *Cognition & Emotion*, *27*(3), 430-440. https://doi.org/10.1080/02699931.2012.715081

Richey, J. A., Keough, M. E., & Schmidt, N. B. (2012). Attentional control moderates fearful responding to a 35% CO_2 challenge. *Behavior Therapy*, *43*, 285-299. https://doi.org/10.1016/j.beth.2011.06.004

Rothbart, M. K., & Rueda, M. R. (2005). The development of effortful control. In U. Mayr, E. Awh, & S. W. Keele (Eds.). *Developing individuality in the human brain: A tribute to Michael I. Posner* (pp. 167-188). Washington, DC: American Psychological Association. https://doi.org/10.1037/11108-009

Schweizer, K. (2010). Some guidelines concerning the modeling of traits and abilities in test construction. *European Journal of Psychological Assessment*, *26*(1), 1-2. https://doi.org/10.1027/1015-5759/a000001

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P.R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press.

Taylor, C. T., Cross, K., & Amir, N. (2016). Attentional control moderates the relationship between social anxiety symptoms and attentional disengagement from threatening information. *Journal of Behavior Therapy and Experimental Psychiatry*, *50*, 68-76. https://doi.org/10.1016/j.jbtep.2015.05.008

Tortella-Feliu, M., Morillas-Romero, A., Balle, M., Bornas, X., Llabrés, J., & Pacheco-Unguetti, A. P. (2014). Attentional control, attentional network functioning, and emotion regulation styles. *Cognition & Emotion*, *28*(5), 769-780. https://doi.org/10.1080/02699931.2013.860889

Tully, L. M., Lincoln, S. H., & Hooker, C. I. (2014). Attentional control mediates the relationship between social anhedonia and social impairment. *Frontiers in Psychology*, *5*, 1384. https://doi.org/10.3389/fpsyg.2014.01384

Van Calster, L., D'Argembeau, A., & Majerus, S. (2018). Measuring individual differences in internal versus external attention: The attentional style questionnaire. *Personality and Individual Differences*, *128*, 25-32. https://doi.org/10.1016/j.paid.2018.02.014

Vasey, M. W., Harbaugh, C. N., Mikolich, M., Firestone, A., & Bijttebier, P. (2013). Positive affectivity and attentional control moderate the link between negative affectivity and depressed mood. *Personality and Individual Differences*, *54*(7), 802-807. https://doi.org/10.1016/j.paid.2012.12.012

Verstraeten, K., Vasey, M. W., Claes, L., & Bijttebier, P. (2010). The assessment of effortful control in childhood: Questionnaires and the Test of Everyday Attention for Children compared. *Personality and Individual Differences*, *48*, 59-65. https://doi.org/10.1016/j.paid.2009.08.016

Yaroslavsky, I., Allard, E. S., & Sanchez-Lopez, A. (2019). Can't look away: Attention control deficits predict rumination, depression symptoms and depressive affect in daily Life. *Journal of Affective Disorders*, *245*, 1061-1069. https://doi.org/10.1016/j.jad.2018.11.036

Figure 1. Sequence of Attention Network Test. (a) Trial sequence of events in a spatial-cue and incongruent condition. (b) The cue conditions. (c) The target and flanker conditions.

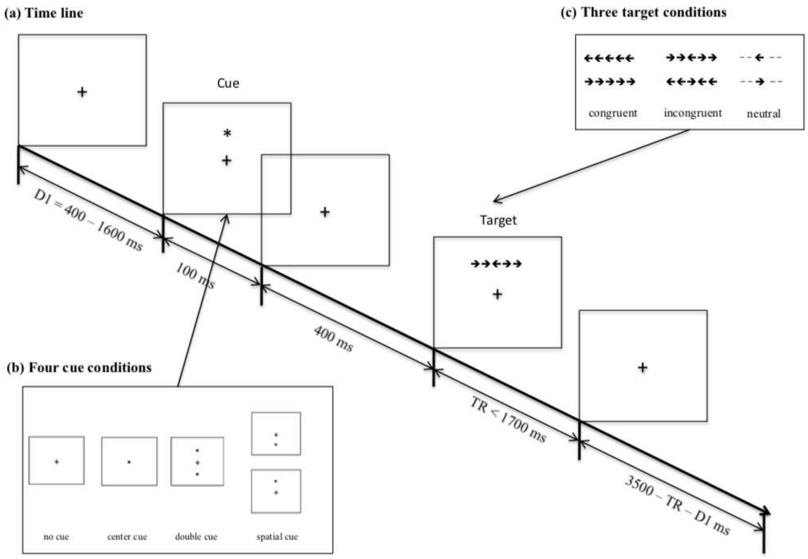

Figure 2. Path diagram depicting the two-factor solution (model 3 corrected) of the French version of the Attentional Control Scale.

Note : ** p < .01

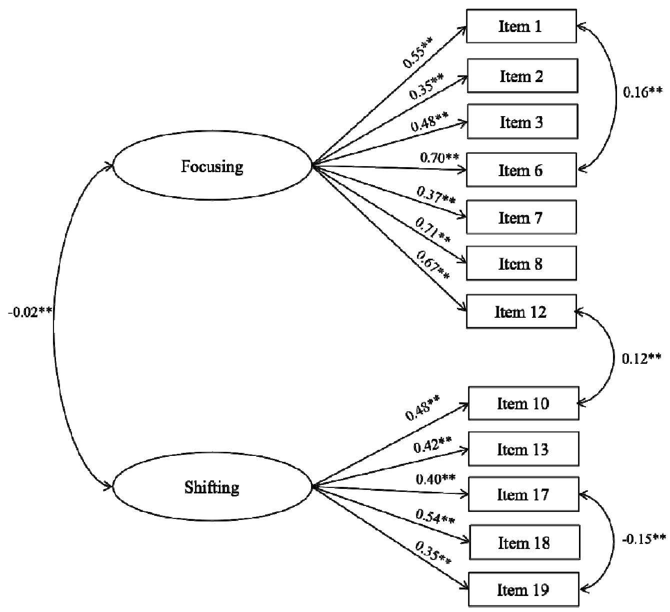

Figure 3. Mean Reaction Time as a function of cue (neutral, congruent, or incongruent) and flanker type (no cue, central cue, double cue, or spatial cue). Error bars represent standard errors of the mean.

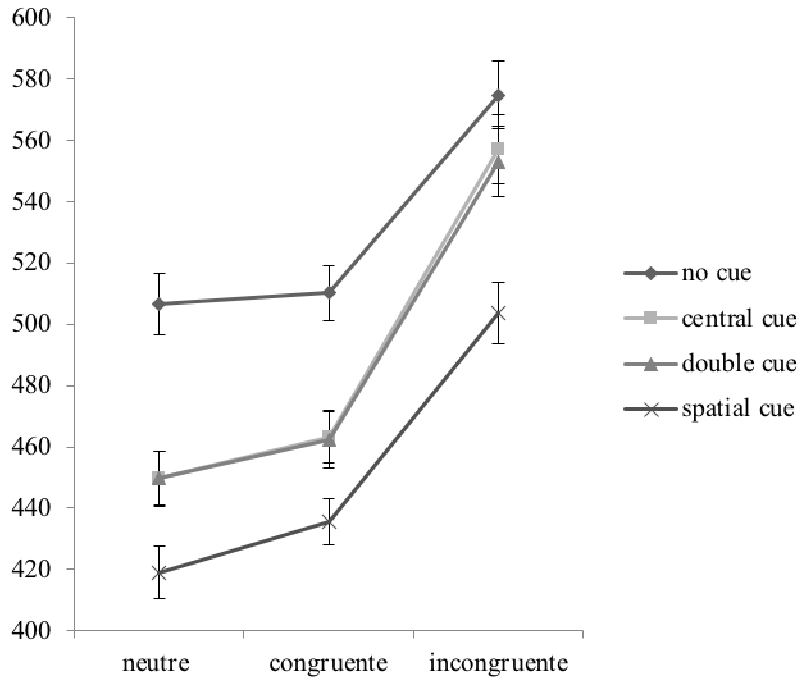

Table 1. Descriptive statistics of the sample.

	Size			Mean age and standard deviation		
	Total	Man	Woman	Total	Man	Woman
Sample	284	49	233	19.36 (1.89)	19.61 (1.64)	19.30 (1.93)

Table 2. Items of the original version of the Attentional Control Scale and their French translation

Item	Original version	French version
1	It's very hard for me to concentrate on a difficult task when there are noises around.	J'ai beaucoup de mal à me concentrer sur une tâche difficile lorsqu'il y a du bruit autour de moi.
2	When I need to concentrate and solve a problem, I have trouble focusing my attention.	Lorsque j'ai besoin de me concentrer pour résoudre un problème, j'ai du mal à focaliser mon attention.
3	When I am working hard on something, I still get distracted by events around me.	Lorsque je suis en train de travailler dur sur quelque chose, je me laisse quand même distraire par les événements qui se passent autour de moi.
4	My concentration is good even if there is music in the room around me.	Ma concentration est bonne même s'il y a de la musique autour de moi.
5	When concentrating, I can focus my attention so that I become unaware of what's going on in the room around me.	Lorsque je me concentre, je peux focaliser mon attention de façon à ne plus m'apercevoir de ce qui se passe dans la pièce autour de moi.
6	When I am reading or studying, I am easily distracted if there are people talking in the same room.	Lorsque je lis ou j'étudie, je suis facilement distrait(e) s'il y a des gens qui parlent dans la même pièce.
7	When trying to focus my attention on something, I have difficulty blocking out distracting thoughts.	Quand j'essaie de focaliser mon attention sur quelque chose, j'ai du mal à supprimer des pensées perturbatrices.
8	I have a hard time concentrating when I'm excited about something.	J'ai de la peine à me concentrer quand je suis excité(e) par quelque chose.
9	When concentrating I ignore feelings of hunger or thirst.	Lorsque je me concentre, j'ignore la sensation de faim ou de soif.
10	I can quickly switch from one task to another.	Je peux passer rapidement d'une tâche à une autre.
11	It takes me a while to get really involved in a new task.	Ça me prend un peu de temps avant d'être réellement impliqué dans une nouvelle tâche.
12	It is difficult for me to coordinate my attention between the listening and writing required when taking notes during lectures.	J'ai du mal à partager mon attention entre le fait d'écouter et d'écrire lorsqu'il faut prendre des notes pendant un cours ou une conférence.
13	I can become interested in a new topic very quickly when I need to.	Je peux m'intéresser très rapidement à un nouveau sujet quand c'est nécessaire.
14	It is easy for me to read or write while I'm also talking on the phone.	Il est facile pour moi de lire ou d'écrire tout en étant au téléphone.
15	I have trouble carrying on two conversations at once.	J'ai du mal à tenir deux conversations en même temps.
16	I have a hard time coming up with new ideas quickly.	J'ai du mal à trouver rapidement de nouvelles idées.
17	After being interrupted or distracted, I can easily shift my attention back to what I was doing before.	Après avoir été interrompue(e) ou distraite(e), je peux facilement ramener mon attention sur ce que j'étais en train de faire

		auparavant.
18	When a distracting thought comes to mind, it is easy for me to shift my attention away from it.	Quand une pensée perturbatrice me vient à l'esprit, je peux facilement en détourner mon attention.
19	It is easy for me to alternate between two different tasks.	Il est facile pour moi d'alterner deux tâches différentes.
20	It is hard for me to break from one way of thinking about something and look at it from another point of view.	J'ai du mal à changer ma façon de considérer une chose et de l'envisager d'un autre point de vue.

Note: The ACS was translated by Ceschi et al. (2003).

Table 3. Fit index values for the four different tested models.

Model	χ^2	*p*	ddl	χ^2/ ddl	CFI	AGFI	GFI	RMSEA	SRMR
1	381.56	<.001	170	2.24	0.76	0.84	0.87	0.072	0.073
2	310.58	<.001	151	2.06	0.81	0.86	0.89	0.065	0.072
3	98.1	<.001	53	1.85	0.89	0.92	0.95	0.052	0.059
4	336.30	<.001	167	2.01	0.81	0.86	0.89	0.061	0.073

Note, n = 284; Comparative Fit Index (CFI); Adjusted Goodness of Fit Index (AGFI); Goodness of Fit Index (GFI); Root Mean Error of Approximation (RMSEA); Standardized Root Mean Squared Residual (SRMR).
All confirmatory analyses were carried out with a maximum likelihood estimation method; the choice of fit indices and the presentation of the results follow the suggestions of Schweizer (2010).

Table 4. Fit index values for the model 3 corrected.

Model	χ^2	*p*	ddl	χ^2/ ddl	CFI	AGFI	GFI	RMSEA	SRMR
3 corrected	58.77	=.018	50	1.17	0.98	0.95	0.97	0.025	0.046

Note, n = 284; Comparative Fit Index (CFI); Adjusted Goodness of Fit Index (AGFI); Goodness of Fit Index (GFI); Root Mean Error of Approximation (RMSEA); Standardized Root Mean Squared Residual (SRMR). All confirmatory analyses were carried out with a maximum likelihood estimation method; the choice of fit indices and the presentation of the results follow the suggestions of Schweizer (2010).

Table 5. Item-total, item-focusing and item-shifting descriptive statistics

Item	M	SD	Scale mean if item deleted	Scale variance if item deleted	Alpha if item deleted	Subscale mean if item deleted	Subscale variance if item deleted	Subscale alpha if item deleted
1	2,18	,756	50,71	40,190	,689	16,63	7,951	,575
2	3,11	,672	49,79	39,816	,682	15,70	7,638	,530
3	2,78	,800	50,12	40,421	,692	16,03	7,183	,519
4	2,34	1,012	50,55	38,686	,687			
5	2,37	,886	50,53	39,282	,686			
6	2,41	,918	50,49	38,046	,675	16,40	6,609	,497
7	2,82	,845	50,07	38,019	,672	15,99	6,618	,475
8	2,31	,882	50,59	41,042	,701	16,50	7,608	,579
9	2,26	1,027	50,64	39,744	,697			
10	2,89	,753	50,01	40,459	,691	10,48	3,953	0,507
11	2,84	,857	50,05	39,343	,685			
12	3,21	,846	49,69	39,926	,690	15,60	7,852	,589
13	3,07	,737	49,83	40,412	,690	10,30	3,877	,482
14	1,92	,970	50,97	38,593	,683			
15	3,01	,947	49,88	40,353	,699			
16	3,11	,710	49,79	40,203	,687			
17	2,65	,851	50,25	38,405	,676	10,71	3,604	,485
18	2,22	,753	50,68	40,891	,695	11,14	4,378	,587
19	2,54	,785	50,35	38,469	,673	10,82	3,738	,477
20	2,87	,935	50,0	41,194	,705			

M = Mean; SD = Standard Deviation; Alpha = Cronbach's alpha

Table 6. Centiles of the distribution of overall score and subscores (*N* = 248).

ACS	Centiles						
	5e	10e	25e	50e	75e	90e	95e
Overall score	42	44	48.25	53	57	61	64
Focusing	14	15	17	19	21	23	24
Shifting	9.25	11	12	13	15	16	17

ACS = Attentional Control Scale. A centile is the value of a variable below which a certain percentage of observations fall.

Table 7. Spearman correlations between STAI-T, ACS and these subscales (focusing and shifting) and the three ANT indices (alerting, orienting, and executive control).

	STAI-T	ACS	Focusing	Shifting	Alerting	Orienting	Executive Control
STAY-Y	1	.16	-.53*	.03	-.22*	.04	-.35**
ACS		1	.30*	.34*	-.23*	.38**	.14
Focusing			1	-.02	-.09	.09	0.31*
Shifting				1	-.31*	-.18*	0.14
Alerting					1	.04	-.09
Orienting						1	.14
Executive control							1

ACS = Attentional Control Scale (total score); STAI-T = State-Trait Anxiety Inventory-Trait (total score).
* Correlations significant at $p < .05$, corrected for multiple correlations using the false discovery procedure (Benjamini-Hochberg procedure).

Table 8. Pearson correlations between the three ANT indices.

	Alerting	Orienting	Executive Control
Alerting	1	.04	.06
Orienting		1	.14
Executive control			1