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Affect intensity and gender differences in the functioning of attentional networks in university students

Abstract

Affect intensity (AI) refers to individual differences in the intensity with which people subjectively experience emotions. High AI is an aspect of emotion dysregulation that is present in a variety of mood and anxiety disorders. The present study evaluates the functioning of attentional networks (alerting, orienting, and executive control) for non-emotional stimuli in healthy subjects classified as having High (H-AI) and Low (L-AI) AI levels through clustering methods. A sample of 200 university students (100 women), aged between 18 and 25 years old, completed the Affect Intensity Measure and the Attentional Network Test (ANT). Women obtained higher AI scores than men and were more highly represented in the H-AI cluster. In ANT, mean response time was significantly shorter in men than in women, but men showed a worse functioning of the alerting network than women (which was not observed for the executive control and orienting networks). In addition, H-AI men exhibited a more efficient executive control network than L-AI men. Executive control was negatively correlated with AI in men, but not in women. These results will be discussed in terms of individual differences in emotion regulation and attentional networks.

Keywords

Affect Intensity; Gender differences; Attentional Network Test; Executive Control; Executive Attention

1. Introduction

Affect intensity (AI) refers to individual differences in the strength or intensity — but not frequency — with which people subjectively experience emotions (Larsen & Diener, 1987). The most common tool for measuring AI is the Affect Intensity Measure (AIM), a self-report scale that shows good internal consistency, test–retest reliability, and construct validity (Larsen, Diener, & Emmons, 1986). Research on AI has revealed age and gender differences, indicating that AI levels decrease through the adult life span and are higher in women than in men (Diener, Sandvik & Larsen, 1985). With regard to psychopathology, high AI has been linked to anxiety and depression (e.g., Berenbaum et al., 2012; Flett et al., 1996; Mennin et al., 2007), and bipolar and borderline personality disorders (e.g., Cheavens & Heiy, 2011; Flett & Hewitt, 1995; Henry et al, 2008). In fact, excessive AI has been described as an aspect of emotion dysregulation, which is defined as the inability to flexibly respond to and manage emotions (Carpenter & Trull, 2013). Difficulties in emotion regulation are thought to underlie many types of psychopathology, suggesting that the processes involved in emotion regulation may represent useful transdiagnostic domains for approaching the etiology and treatment of a variety of psychiatric disorders (Werner & Gross, 2007).

Individual differences in attentional efficiency play a role in the degree of successful emotion regulation (Rueda, Posner & Rothbart, 2005). According to the attentional network model proposed by Posner & Petersen (1990), the human attentional system encompasses the following three functionally and anatomically independent networks: alerting, orienting and executive control. The alerting network is involved in achieving (phasic alerting) and maintaining (tonic alerting) optimal vigilance and performance during tasks; the orienting network is focused on the ability to prioritize sensory input by selecting a modality or location; and the executive network allows for the monitoring and resolution of conflict between expectation, stimulus, and response (Petersen & Posner, 2012). The Attention Network Test (ANT) evaluates the efficiency of the three attentional networks for non-emotional stimuli (Fan et al., 2002). A small number of studies have evaluated gender differences in the ANT, indicating that women could have better functioning of the orienting (Liu et al., 2013) or alerting networks (Miró et al., 2015), although more research is needed to confirm these findings.

Previous studies using the ANT have found relationships between dysfunctional emotion regulation strategies or personality traits and the functioning of attentional networks. Cognitive suppression and the tendency to engage in brooding rumination were predicted by increased alertness (hypervigilance) and diminished orienting functioning, respectively (Tortella-Feliu et al., 2014). Hypervigilance was also associated with intolerance to uncertainty (Fergus & Carleton, 2015). On the other hand, extraversion, conscientiousness, state task engagement, and low distress (Five Factor Model) have been associated with superior executive attention (Matthews & Zeidner, 2012). In fact, executive attention, measured by ANT, Stroop or Flanker paradigms, appears to be compromised in several psychiatric disorders characterized by emotional dysregulation, such as posttraumatic stress disorder, major depression and anxiety disorders (Joyal et al., 2019; Leskin & White, 2007; Pacheco-Unguetti et al., 2011; Yu et al., 2018). These results are consistent with the assumptions of Eysenck et al. (2007) and Bishop (2008) regarding the attentional mechanisms involved in anxiety. That is, anxiety impairs general cognitive control capacity, mainly by reducing the efficiency of top-down executive attention to inhibit threat-related distractors. Based on these theories, it is reasonable to expect that individuals showing excessive AI may have lower efficiency in executive attention. However, no previous studies have tested the functioning of executive attention using the ANT in individuals showing high and low AI.

In the present study, we investigated whether healthy individuals with high or low AI exhibit different efficiencies in attentional networks measured by the ANT. In addition, since women tend to report higher AI, we evaluated gender differences in the ANT in relation to AI. We hypothesized that individuals with high AI will show poorer executive attention in the ANT.

2. Materials and Methods

2.1. Participants

Two hundred undergraduate students (100 men and 100 women), aged between 18 and 25 years old, participated voluntarily in the experiment. Participants were recruited through printed and electronic advertisements on notice boards at various University of X sites (X, Spain). All participants were Spanish speakers with no impaired or uncorrected vision and no history of neurological or psychiatric disorders. After statistical analysis, 3 participants were excluded for being outliers in the ANT (see criteria in section 2.3.2) and, therefore, the final sample was composed of 197 participants (97 men and 100 women), with a mean age of 19.7 years (SD=2.02).

2.2. Procedure

The experiment was conducted in the Neuroscience Laboratory of the Department of Psychology at the University of X. The volunteers gave their informed consent to participate, and all procedures were conducted in accordance with the Ethical Principles for Medical Research Involving Humans of the World Medical Association's Declaration of Helsinki.

Participants completed the AIM and the ANT individually in a quiet room, with the help of oral and written instructions, in approximately 30-40 minutes. The ANT was programmed and run in E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). All personal information was treated under the Spanish personal data protection law of the 5th December 3/2018. This study was approved by the Committee on Bioethics in Human Research of the University of X (X, Spain).

2.3. Measures

2.3.1. Affect Intensity Measure

We evaluated AI using a Spanish version of the 40-item IAM (Larsen & Diener, 1987; Soria & Martínez-Sánchez, 1997), which assesses the magnitude or intensity with which an individual experiences positive and negative emotions. The internal consistency of the Spanish version of IAM was good, α=0.85 (Soria & Martínez-Sánchez, 1997), as well as that of our sample (α=0.83).

2.3.2. Attention Network Test

We assessed the functioning of attentional networks with the neuropsychological task ANT (Fan et al., 2002), which is depicted in Figure 1. Participants viewed the stimuli shown on a computer screen and had to identify the direction of the centrally presented arrow (the target) by pressing one button for the left direction (left hand) and one button for the right direction (right hand). The target was flanked on either side by two arrows in the same direction (congruent condition), in the opposite direction (incongruent condition), or by lines (neutral condition). There were four cue conditions: (1) no cue; (2) central cue; (3) double cue; and (4) spatial cue. The whole task consisted of a block of 24 practice trials and three experimental blocks of 96 trials. The response times (RT) from correct trials and accuracy were recorded.

To avoid the influence of outliers, the participants showing high error rates (>20%), and RTs longer than 1500 ms or shorter than 200 ms, were excluded from the analysis (Xiao et al., 2016). Following the procedure proposed by Fan et al. (2002), a set of cognitive subtractions was used to assess the efficiency of the attentional networks. These scores were computed using the RT data from correct trials:

Alerting score = mean RT of the no cue condition – mean RT of the double cue condition.

Orienting score = mean RT of the center cue condition – mean RT of the spatial cue condition.

Executive Control score = mean RT of all incongruent flanking conditions (summed across cue types) – mean RT of congruent flanking conditions.

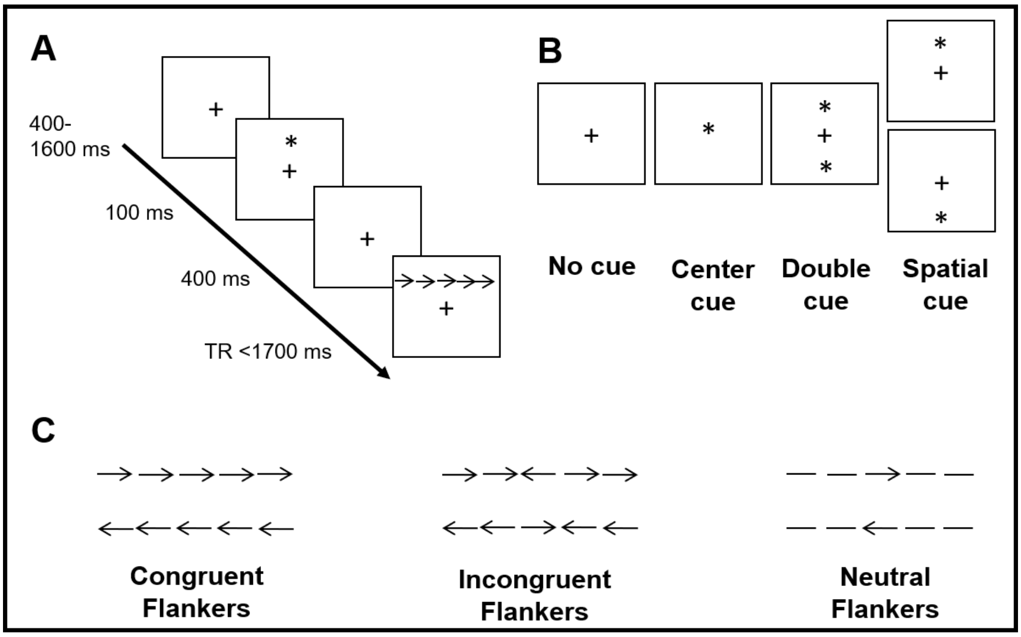

Figure 1. Schematic illustration of the Attention Network Task. A) An example of the procedure. B) The four cue conditions. C) The three flanker conditions.

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2.4. Statistical Analyses

All analyses were computed in SPSS −26. We classified subjects according to their AIM scores through a combination of hierarchical (Ward's method) and nonhierarchical (K-means) clustering methods, as recommended by current theoretical trends (Hair et al., 2010). In ANT, mean RT and errors were analyzed using repeated measures ANOVA, with flanker and cue conditions trials as within-subjects factors, and attention network efficiencies (executive control, orienting and alerting scores) were analyzed using univariate ANOVAs. The between-subject factors were clusters and gender. Post hoc comparisons were made using the Sidak's test. Partial eta squared values (η^2_p) are reported as a measure of the effect size (Cohen, 1988). Statistical significance was set at $p \leq 0.05$.

3. Results

3.1. AI scores and Clustering Analysis

The mean AI scores of the participants was 163.07±1.27. Student's t test revealed that women had higher AI scores (168.1±1.69) than men (157.9±1.75) ($T_{195}=4.172$; $p<0.001$). No differences were found according to age ($F_{7,196}=0.674$; $p=0.694$; data not shown). Figure 2A shows the rescale squared Euclidean distance plotted against the number of clusters, in which the elbow (where the squared Euclidean distance among clusters was smaller) is observed from Cluster 2 onwards. Therefore, the appropriate number of clusters was 2, as can be seen in the dendrogram (Figure 2B). The cluster showing high AI was termed as H-AI and represented 121 of the 197 participants (61%). Women represented 74 of these 121 (61%) and men 47 of 121 (39%) in the H-IA cluster (Figure 2C). The cluster showing low AI was termed as L-AI and represented 76 of the 197 participants (39%). Women represented 26 of these 76 (34%) and men 50 of 76 (66%) in the L-IA cluster (Figure 2C). Univariate ANOVA analysis revealed statistically significant differences between clusters in terms of AI scores (Cluster effect: $F_{1,196}$=350.43; p<0.001; η^2_p=0.645), and no gender differences were observed in each cluster (Cluster x Gender: $F_{1,196}$=0.033; p<0.856) (Figure 2D). Post-hoc analyses indicated that H-AI had significantly higher IA scores than L-AI (p<0.001).

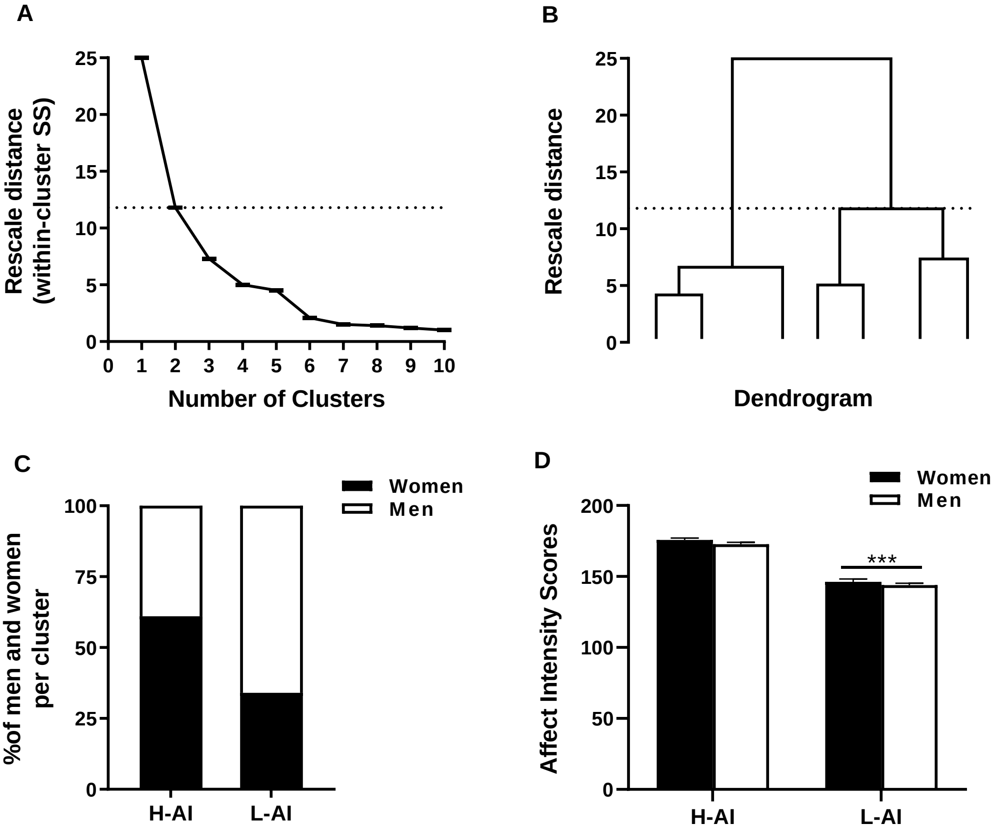

Figure 2. Clustering analyses according to AI Scores. (A) Squared Euclidean distance plotted against the number of clusters for the total sample (n=197) using a hierarchical clustering approach (Ward's criterion). (B) Dendrogram for the application of agglomerative hierarchical clustering. (C) The percentage of men (n=97) and women (n=100) classified as High Affect Intensity (H-AI, n=121) and Low Affect Intensity (L-AI, n=76) using a K-means clustering approach. (D) Mean (±SEM) AI scores in H-AI and L-AI for women and men. ***Statistically significant difference between H-AI and L-AI groups (p<0.001).

3.2. Overall mean RT and errors in ANT according to gender and cluster

We carried out a 4 (cue conditions) x 3 (flanker conditions) x 2 (Clusters) x 2 (gender) ANOVA of the RT data, which revealed that this interaction was not significant

($F_{6,1158}=0.499$; $p=0.810$). Similarly, neither the Flankers x Cues x Gender interaction ($F_{6,1158}=0.373$; $p=0.897$) or the Flankers x Cues x Clusters interaction ($F_{6,1158}=1.814$; $p=0.093$) were statistically significant. However, the Flankers x Cues interaction was significant ($F_{6,1158}=20.994$; $p<0.001$; $\eta^2_p=0.098$; Figure 3A), as well as the main effects of Flankers ($F_{2,386}=1209.6$; $p<0.001$; $\eta^2_p=0.862$) and Cues ($F_{3,579}=692.438$; $p<0.001$, $\eta^2_p=0.782$). Post-hoc analyses of the Flankers x Cues interaction indicated that the neutral flanker condition had lower RT than the congruent flanker on the non-cue ($p<0.001$), central cue ($p<0.01$), double cue ($p<0.01$) and spatial cue ($p<0.05$) trials. Both neutral and congruent flankers had lower RT than the incongruent flanker on the non-cue ($p<0.001$), central cue ($p<0.001$), double cue ($p<0.001$) and spatial cue ($p<0.001$) trials. When comparing cue conditions in each flanker, the spatial cue had the faster RT ($p<0.001$), followed by the double cue ($p<0.01$), central cue ($p<0.01$) and non-cue ($p<0.001$). Interestingly, a general main effect of gender was observed for the mean RT in ANT ($F_{1,193}=12.148$; $p<0.001$; $\eta^2_p=0.059$), indicating that men (489.8±6.7) had a faster RT than women (524.8±7.5) ($p<0.001$), although no main effect of cluster was found ($F_{1,193}=0.00$; $p=0.982$).

We also carried out a 4 (cue conditions) x 3 (flanker conditions) x 2 (clusters) x 2 (gender) ANOVA of the mean error rates, and this interaction was not significant ($F_{6,1158}=0.246$; $p=0.916$). Neither the Flankers x Cues x Gender interaction ($F_{6,1158}=0.203$; $p=0.976$) or the Flankers x Cues x Clusters ($F_{6,1158}=1.268$; $p=0.269$) were statistically significant. No main effect of gender ($F_{1,193}=0.007$; $p=0.936$) or clusters ($F_{1,193}=0.007$; $p=0.936$) was found. However, a statistically significant Clusters x Cues conditions interaction was observed ($F_{6,1158}=6.132$; $p<0.001$; $\eta^2_p=0.031$; Figure 3B), as well as a Flanker effect ($F_{2,386}=133.364$; $p<0.001$; $\eta^2_p=0.409$) and Cue effect ($F_{3,579}=7.90$; $p<0.001$, $\eta^2_p=0.039$). Post-hoc analyses revealed that there were fewer errors on the neutral and congruent trials compared with the incongruent trials ($p<0.001$). No statistically significant differences were found between cues on neutral and congruent trials. However, on incongruent trials, a lower mean number of errors was found on the spatial cue condition in comparison with the central cue ($p<0.001$) and double cue conditions ($p<0.001$), whilst the non-cue condition had a lower mean number of errors than the central cue condition ($p<0.01$).

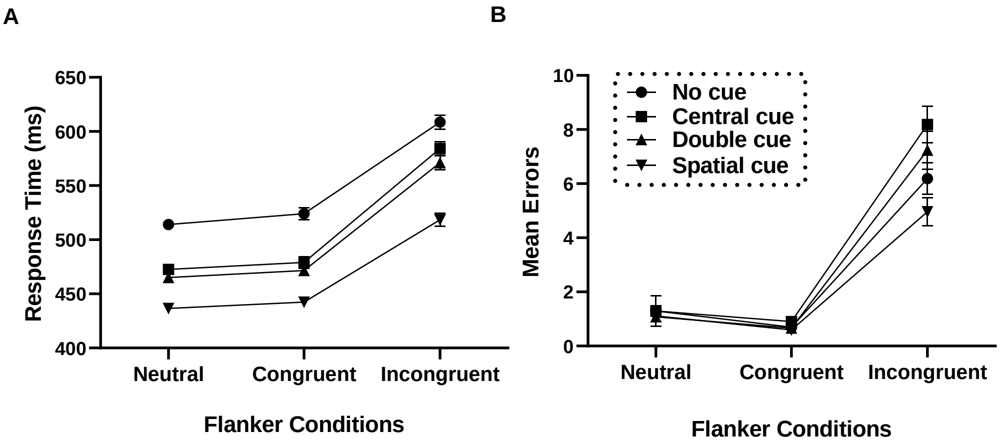

Figure 3. Mean response time (RT) and number of errors according to cue and flanker conditions in the ANT. (A) Mean (±SEM) RT from correct trials for flanker and cue conditions. (B) Mean (±SEM) number of errors for flanker and cue conditions.

3.3. Functioning of Attentional Networks: executive control, orienting and alerting scores

With respect to executive control, a univariate ANOVA did not reveal a statistically significant cluster effect ($F_{1,196}=1.465$; $p=0.228$) or gender effect ($F_{1,196}=0.006$; $p=0.937$), although the cluster x gender interaction approached statistical significance ($F_{1,196}=3.326$; $p=0.07$; $\eta^2_p=0.017$). Post-hoc analysis indicated that H-AI men had a more efficient executive control than L-AI men ($p<0.05$), shown by lower scores reflecting a smaller conflict effect. Whereas women of both clusters showed a similar level of functioning (p=0.682). In addition, no differences were found between men and women in both the H-AI (p=0.121) and L-AI (p=0.272) clusters (Figure 4A).

With regard to orienting, the univariate ANOVA did not reveal a statistically significant cluster effect ($F_{1,196}$=2.019; p=0.157), gender effect ($F_{1,196}$=0.507; p=0.477), or a cluster x gender interaction ($F_{1,196}$=0.328; p=0.567) (Figure 4B).

For alerting, the univariate ANOVA revealed an effect of gender ($F_{1,196}$=6.291; p<0.05; η^2_p=0.032), but neither a main effect of cluster ($F_{1,196}$=0.013; p=0.909) or a cluster x gender interaction ($F_{1,196}$=0.466; p=0.495) was found to be significant. Post-hoc analysis indicated that men exhibited a worse alerting network functioning than women (p<0.05), shown by lower scores reflecting a smaller benefit from the double-cue condition (Figure 4C).

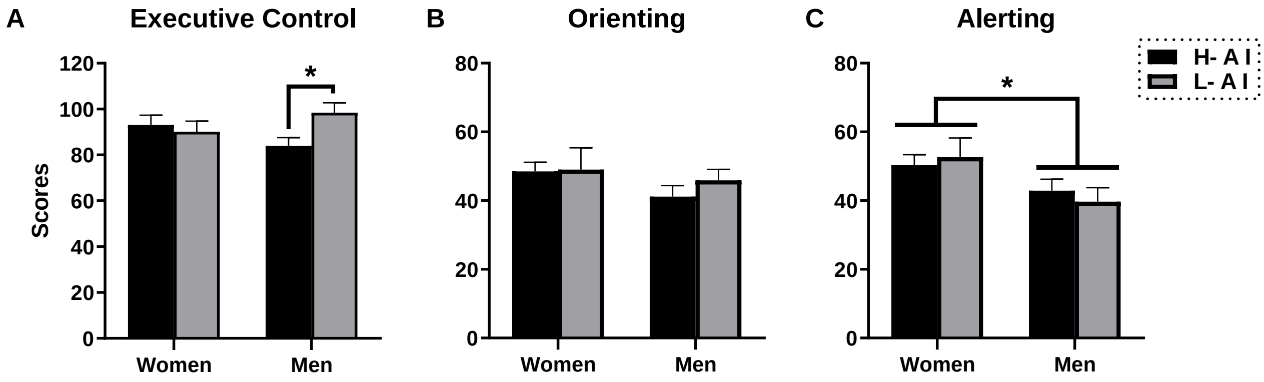

Figure 4. Functioning of Attentional Networks. Mean (±SEM) Executive Control (A), Orienting (B) and Alerting (C) scores in High Affect Intensity (H-AI) and Low Affect Intensity (L-AI) clusters for women and men. *Statistically significant differences (p<0.05).

3.4. Correlation analysis of ANT and AI according to gender

Table 1 shows the Pearson's correlations between the three scores of the attentional networks and the AI scores according to gender. In men, AI scores were negatively associated with executive control scores ($r=-0.31$; $p<0.01$; $n=97$), but not with alerting and orienting scores. This finding reflects that men showing high AI scores had a better executive control than men showing low AI scores. In women, AI scores were not associated with any attentional network. As expected, the three attentional networks were independent and not correlated with each other, except for the positive correlation between executive control and orienting in men ($r=0.29$; $p<0.01$; $n=97$).

Table 1. Pearson's correlations between AI scores and attentional networks scores (Executive control- EC, Alerting and Orienting) according to gender.

	Men (*n*=97)			**Women (*n*=100)**		
	EC	**Alerting**	**Orienting**	**EC**	**Alerting**	**Orienting**
AI	-0.31**	0.06	-0,03	0.07	0.02	0.07
EC	1	-0.08	0.29**	1	0.15	0.03
Alerting	-	1	0.02	-	1	-0.04
Orienting	-	-	1	-	-	1

** $p<0.01$

4. Discussion

The current study investigated whether individuals with high AI — an aspect of emotional dysregulation — would show different functioning of attentional networks, measured through the ANT. More specifically, we hypothesized that individuals with high AI will show poorer executive attention in the ANT. Contrary to our hypothesis, we found that H-AI men had better functioning of the executive control network compared with L-AI men. Moreover, we found that men had a faster overall RT and a worse alerting functioning in the ANT compared with women. We will further discuss the influence of gender and AI in the functioning of attentional networks.

4.1. Gender Differences in the ANT

We found that men generally responded faster and displayed a less efficient alerting network in the ANT. Importantly, the faster overall RT observed in men was not accompanied by a lower level of accuracy that could indicate a more impulsive profile of responding. Previous studies have also found lower RT in men compared with women when performing the ANT (Miró et al., 2015), flanker tasks (i.e. Larson et al., 2011) and RT tasks (Der & Deary, 2006), although the error rates were similar between genders. It therefore appears that these differences in overall RT are related to processing speed, rather than attentional performance.

Further, studies evaluating gender differences in attentional networks through the ANT are scarce and have shown contradictory results. A previous study reported a superior alerting network in women compared with men (Miró et al., 2015), which is in line with our results, whereas another study found no differences in this network (Liu et al., 2013). On the other hand, we found similar executive control scores in men and women, as previous ANT studies have shown (Liu et al., 2013; Miró et al., 2015). In fact, a recent meta-analysis including 46 studies found a similar performance between men and women in a variety of executive control tasks (Gaillard et al., 2020). Nevertheless, the differences in alerting between men and women deserve further investigation using attentional tasks such as the ANT and the Continuous Performance Test (CPT), since Gaillard et al. (2020)'s meta-analysis have shown statistically significant heterogeneity or variation in study outcomes between CPT studies.

4.2. Affect Intensity differences in the ANT

As previously documented in the literature, the mean AI scores of our sample were similar to those reported in a sample of 20-29 year-olds, in which women showed higher scores than men (Fantini-Hauwel et al., 2015; Ferrati et al., 2016). Similarly, the interference effect from flankers and cues in RT and errors has previously been documented (Fan et al., 2002), although this interaction was not significant when including clusters or genders as factors. However, we found that H-AI men had a more efficient executive control than L-AI men, a result that was confirmed by a negative moderate correlation between AI scores and executive control in men (but not in women). These findings are contrary to our hypothesis that H-AI individuals may have poorer executive control, which was based on the assumptions that anxiety impairs the efficiency of top-down executive attention to inhibit distractors (Bishop, 2008; Eysenck et al., 2007), along with the literature showing that people diagnosed with psychiatric disorders characterized by emotional dysregulation exhibit poorer executive attention (i.e. Joyal et al., 2019; Leskin & White, 2007).

In light of these contradictory results, we suggest that researchers should be cautious about the AI construct when investigating emotional dysregulation in a healthy sample instead of a psychiatric sample. Since the AIM scale does not have a clinical cut-off score to identify subjects reaching abnormal levels, the subjects classified as H-AI in our study may not reflect the severity of patients diagnosed with psychiatric disorders characterized by emotional dysregulation. Further, it has been suggested that healthy people with high AI are not necessarily prone to poor personal adjustment because intense negative emotions could be offset by intense positive emotions, whereas psychiatric patients may be less likely to experience positive events (Flett & Hewitt, 1995). Based on our results, a possible interpretation is that healthy H-AI men, compared with L-AI men, had an enhanced level of attention and sensitivity to external emotional cues in the immediate environment, as suggested by Engelberg and Sjöberg (2004). These authors found that AI was partially explained by emotional intelligence, which contributes to the assessment of emotions and its perception. In addition, high AI co-occurred with reports of experiencing more attention to emotion, a facet of emotional intelligence that refers to the extent to which one notices, thinks about, and monitors one's moods (Berenbaum et al., 2012; Thompson et al., 2011). Therefore, the superior functioning of the executive control network in H-AI men could be related to higher emotional abilities to identify and manage one's emotions. In this regard, a recent study found no differences in a Flanker task between high and low emotional intelligence groups, although the gender factor was not considered (Checa & Fernández-Berrocal, 2019). In fact, most of studies using attentional tasks do not report the results according to gender, which makes it difficult to interpret our results. Further research is needed to understand the implication of emotional factors in attentional functioning, as well as to clarify the gender differences observed in attentional tasks.

4.3. Limitations

The interpretation of our findings should be tempered by the limitations of our study. First, we used a sample of university students, which restricts the generalization of the results to other groups with lower levels of education. Second, the ANT evaluates the functioning of attentional networks for non-emotional stimuli. Third, the attentional functioning can also be assessed through other neuropsychological tasks (e.g., CPT, Visual Search task, Trail Making Test, or Stroop task). Further studies could test the relationship between AI and attentional functioning under emotional conditions, as well as replicate our findings with different neuropsychological tasks to have a broader picture of the relationship between AI and attention.

4.4. Conclusions

To conclude, the results of this study provide evidence of the influence of gender and AI on the functioning of attentional networks. Men showed greater processing speed in the ANT and a less efficient alerting functioning. Moreover, men showing high AI had a more efficient executive attention compared with low AI men, whereas the AI clusters did not differ for women. We propose that high AI in healthy individuals may reflect higher emotional abilities to identify and manage emotions rather than being an indicator of emotional dysregulation. Further studies should investigate gender differences and the emotional factors that influence the functioning of attentional networks.

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