

No evidence of perceptual pseudoneglect in Alexithymia

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Neuroscience research links alexithymia, the difficulty of identifying and describing feelings and emotions, with a left hemisphere preference and/or a right hemisphere deficit. To provide a behavioral evidence to neuroscientific results, we explored the relationship between alexithymia and performance in a line bisection task, a standard method to evaluate visuospatial attention in relation with the functioning of the right hemisphere. 222 healthy participants completed a version of the TAS-20 scale, which measures alexithymia, and were asked to mark (bisect) the center of a 10 cm horizontal segment. The results document a significant rightward shift of the line center in borderline and manifest alexithymic participants, as compared to non-alexithymic individuals. Moreover, the higher the TAS-20 score the greater the rightward shift in the line bisection task. This finding supports the right-hemisphere deficit hypothesis in alexithymia and suggests that visuospatial abnormalities may be an important component of their profile.

Keywords: Alexithymia, Right hemisphere, Line Bisection, Pseudoneglect

Alexithymia is as a stable personality characteristic (Taylor & Bagby, 2012; Martínez-Sánchez, et al., 2003) characterized by a disturbance of affective-emotional processing that causes difficulties in identifying and describing feelings and emotions verbally (Craparo et al., 2016), and might be associated with somatic sensations that accompany emotional arousal, and can cause somatic illness (Martino et al., 2020a, 2020b).

Neuroscience research has provided a brain basis for this affective deficit, by showing that alexithymia may be characterized by a left hemisphere preference and/or a right hemisphere deficit (Bermond et al., 2006). Neuroimaging investigations have shown a broad network of cortical and subcortical regions, including regions that do not fall within the canonical circuit of emotion processing. This is the case of the parietal cortex, a cortical region involved in several cognitive skills including spatial attention (Shomstein, 2012) and magnitude processing (Walsh, 2003, Vicario et al., 2012; Vicario et al., 2013). For example, Kano et al. (2003) reported that alexithymics show less activation in the right inferior parietal and frontal cortex and greater activation in the left inferior parietal cortex, compared to non alexithymics individuals. Moreover, a negative correlation was found between alexithymia severity and the activation of the right inferior parietal lobe (Sturm and Levenson, 2011). More recently, Imperatori et al. (2016) have found a decrease of alpha connectivity between right parietal lobe and right temporal lobe.

In the literature, reduced activity of the right parietal cortex is frequently associated with spatial attention deficits. In humans, a lesion of the right infero-parietal cortex is frequently associated with hemispatial neglect (Husain and Nachev, 2007), a syndrome characterized by reduced or absent awareness for contralesional space (i.e., the left spatial side) and an attentional bias to the right side. In line bisection task, an ideal test to assess visuospatial and attentional deficits (Fischer, 2011), this patient identifies and marks the center of the segment in the direction of the damaged hemisphere

(i.e., the right hemisphere) (e.g., Albert, 1971). Similar deficits have also been found for lesions of the right frontal lobe (e.g., Maeshima et al., 1994). In contrast to this rightward spatial attention bias, the literature on healthy individuals documents a leftward spatial attention bias. Neurologically normal individuals generally err to the left of the true center when dividing horizontal lines (Jewell and McCourt, 2000). This behavioral phenomenon, called pseudoneglect (Bowers and Heilman, 1980), has been associated with right-hemisphere dominant neural network encompassing several brain regions including the intraparietal sulcus (Chen et al., 2020) and the inferior frontal gyrus (Zago et al., 2017).

Given the close relationship between the level of activation of the right fronto-parietal network, the performance in the line bisection task, and the evidence of right fronto-parietal cortex hypoactivation in alexithymia, we tested whether this personality trait (Taylor & Bagby, 2012) predicts spatial representation in healthy individuals. According with the right hemisphere deficit hypothesis in alexithymia (Bermond et al., 2006) we predicted a reduced or even absent pseudoneglect in individuals with this mental condition.

Participants

226 healthy subjects took part in this study (113 females and 113 males, age range between 18 and 30 years). The average age was 23.58 years \pm 2.98 Standard Deviation (SD). All participants gave their written informed consent prior to inclusion in the study and were naïve to its purpose. The data were anonymously collected. The study was approved by the local ethics board and was conducted in agreement with the principles of the Declaration of Helsinki.

Materials and measures

- *TAS-20 (20 item-Toronto Alexythymia Scale):*

The TAS-20 is a self-report scale used to measure alexithymia. It is composed of three subscales: (a) Difficulty to identify feelings; (b) Difficulty to communicate feelings to others; (c) External oriented thought; Bagby et al. (1994) have proposed three cut-off scores for the classification of individuals: alexithymic subjects (≥ 61), borderline (score range between 51 to 60), and non-alexithymic subjects (≤ 50). In this study, the Italian version of the Toronto Alexithymia Scale (20 items, TAS-20) was used, which was validated by Bressi et al. (1996, Cronbach's alpha 0.75).

Line bisection task

Participants were asked to use their preferred hand to mark with a pen the center of a 10 cm horizontal line printed in a A4 sheet.

Data analysis

Statistical analysis was carried out by STATISTICA software, version 8.0. Data were entered in a one-way ANOVA to identify differences between the three groups (alexithymic, borderline, non-alexithymic) regarding bisection line performance and demographics variables. Bonferroni-corrected *Student's* t-tests were conducted in case of significant results of the ANOVA. For all analyses, the level of statistical significance was set to $p < 0.05$. Pearson correlation analysis was performed to investigate the association between TAS-20 scores and bisection line performance.

Results

Four participants were removed from the final analysis as their bisection line performance was $\pm 3SD$ from the average. Our final sample was composed by N= 37 alexithymic, TAS-20 score: $M=66.48 \pm 0.927$; N=72 borderline, TAS-20 score: $M=55.44 \pm 0.664$; N=113 non-alexithymic, TAS-20 score: $M=39.29 \pm 0.927$. The TAS-20 score was statistically different between the three groups [$F(2, 219)=392, p<0.001, \eta_p^2=0.781$]. No significant difference was reported for the gender [$F(2,$

219)=1.99, $p=0.138$] and the age [$F(2, 219)=0.403$, $p=0.668$] variables between the three groups. The ANOVA documented a significant group difference in the bisection line performance [$F(2, 219)=10.46$, $p<0.001$, $\eta_p^2=0.087$]. Post-hoc comparison documented lower line bisection score in non-alexithymic participants ($M=4.784$ cm \pm 0.032) compared with borderline ($M=5.005$ cm \pm 0.041, $p<0.001$) and alexithymic ($M=4.983$ cm \pm 0.057, $p=0.008$) participants. On the other hand, no difference was reported between Borderline and Alexithymic participants ($p=1.000$). See figure 1 for details.

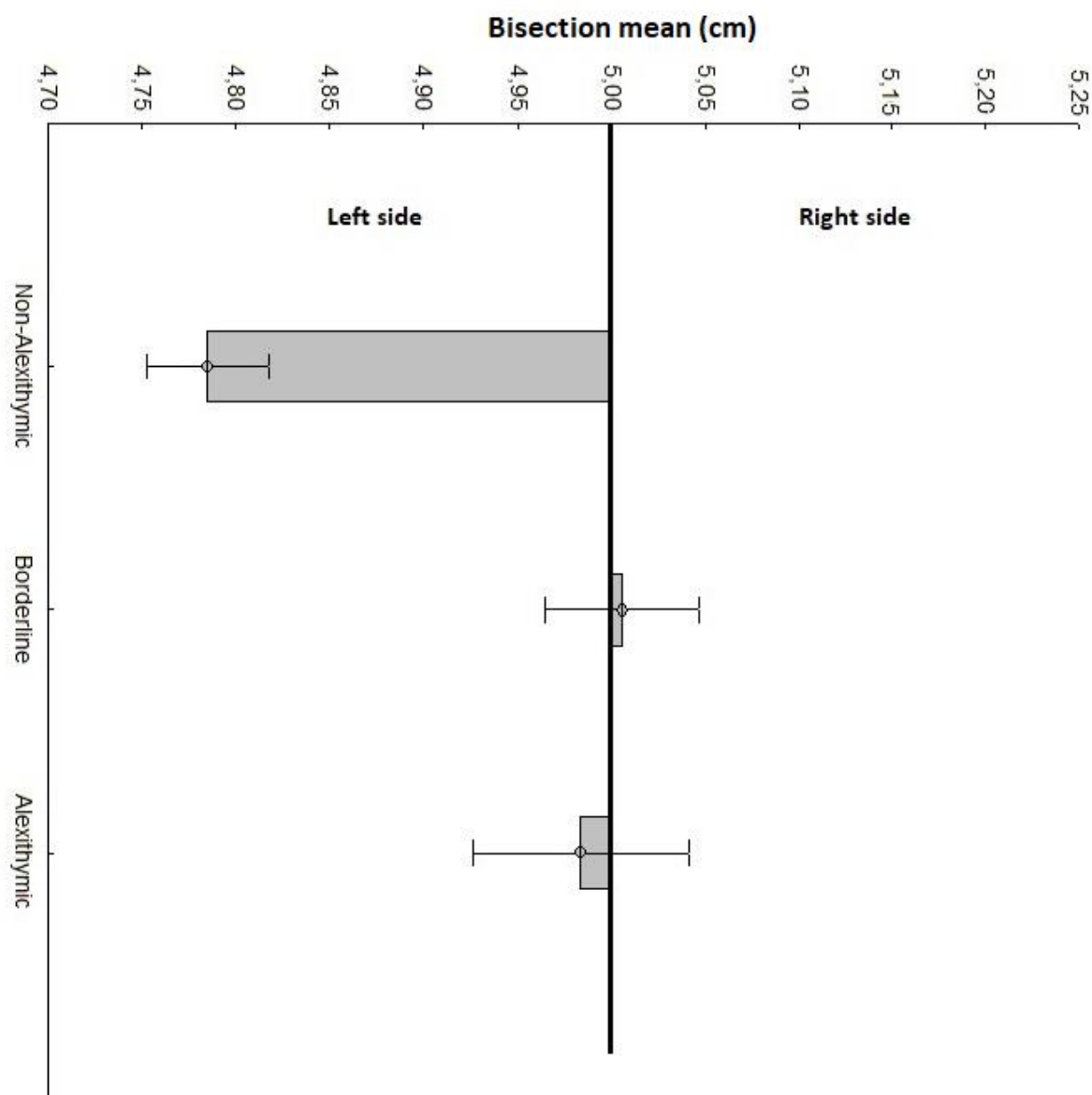


Figure 1. Performance in the line bisection task of alexithymic, borderline and non-alexithymic participants. Deviations from the central vertical line indicate the mean bisection shift of the three

groups of participants for the 10 cm segment. Scores below 5 cm indicate a deviation to the left (i.e., pseudoneglect); scores greater than 5 cm indicate a deviation to the right. Vertical bars indicate standard error.

The correlation analysis provides further support to the ANOVA results. We found a positive correlation between TAS-20 and line bisection scores ($r=0.329$, $p<0.001$). Therefore, the higher the TAS-20 score the larger the rightward shift in the line bisection task (figure 2).

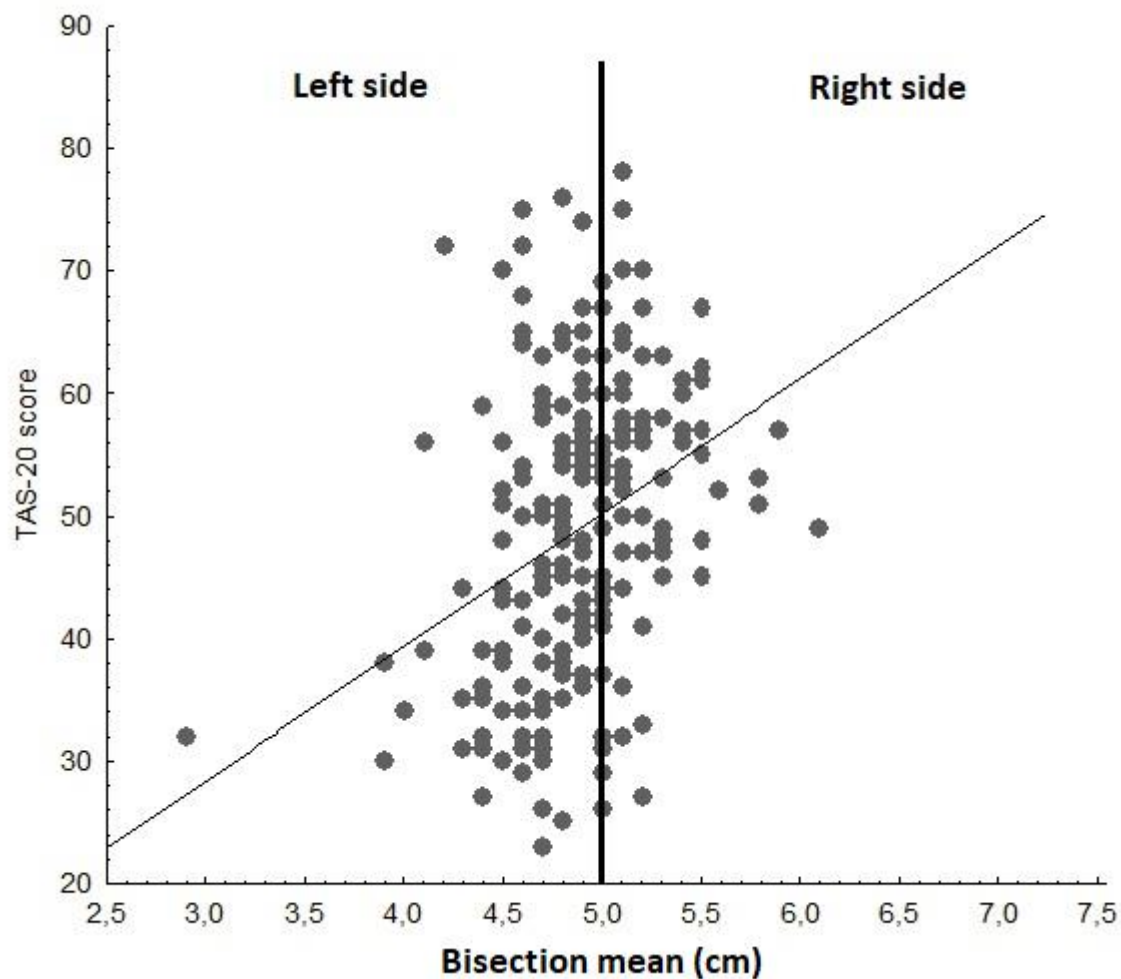


Figure 2. A plot of TAS-20 scores and line bisection performance of all participants. The figure shows a positive correlation between TAS-20 scores and rightward bias.

Discussion

Motivated by neuroimaging evidence (Kano et al., 2003; Sturm and Levenson, 2011; Imperatori et al., 2016) of reduced activation of right fronto-parietal network in Alexithymia, in the current

research we used the line bisection task to provide a behavioral evidence to this functional asymmetry. As expected, the results of our sub-group of non alexithmic participants replicate the pseudoneglect bias (i.e., leftward shift in line bisection) reported in previous studies on neurologically normal individuals (e.g., Jewell and McCourt, 2000). We also confirmed our research hypothesis of no pseudoneglect in participants classified as manifest alexithymic, compared to non-alexithymic participants. Interestingly, the absence of pseudoneglect was confirmed also for participants borderline TAS-20 scores. This result is furthermore corroborated by the overall positive correlation between TAS-20 and the rightward bias. Therefore, the higher the severity of the alexithymia trait, the greater the tendency to mark the center on the right side of the presented segment.

Overall, our results are in line with neuroimaging evidence of reduced right fronto-parietal activation in this mental condition and, more in general, with models proposing a left hemisphere preference and/or a right hemisphere deficit (Bermond et al., 2006) in alexithymia.

The evidence of reduced or even absent pseudoneglect in alexithymia provides new insights for understanding this mental condition, as it suggests that this personality trait is also characterized by non-emotional features. Moreover, it adds new evidence to the findings of altered cognitive processing in alexithymia (Koven and Thomas, 2010) by documenting the abnormal representation of space in this mental condition.

Although we investigated the relationship between alexithymia and line bisection in healthy participants, the results of our study may be useful to the interpretation of altered pseudoneglect (i.e., rightward bias) in mental illnesses such as Schizophrenia, Attention Deficit Hyperactivity Disorder (ADHD) (see Ribolsi et al., 2015). Schizophrenia is a severe psychiatric illness frequently associated with Alexithymia (e.g., O'Driscoll et al., 2014). Moreover, there is evidence of a link between Alexithymia and ADHD (Donfrancesco et al., 2013). The evidence of a rightward bias in healthy individuals with borderline/manifest alexithymia, in absence of psychiatric conditions,

suggests that the origin of the rightward shift in the above-mentioned clinical populations (i.e., Schizophrenia and ADHD) may be linked, at least in part, with this personality trait.

This calls into question the suggestion that an alteration of the pseudoneglect is to be considered an endophenotype of schizophrenia (e.g., Ribolsi et al., 2013). However, this question remains to be investigated as no research has explored the mediation role of the alexithymia trait in the line bisection performance of the above-mentioned clinical populations. Therefore, future investigations in the field might wish to explore this hypothesis in dedicated studies.

In conclusion, this is the first evidence of abnormal spatial representation in individuals with borderline and manifest alexithymia. Given the close relationship between space and numbers (Hubbard et al., 2005; Dehaene and Brannon, 2010; Vicario, 2012), as well as, between space and time (Vicario et al., 2011; Vicario et al., 2009; Vicario et al., 2013), future investigations are needed to clarify whether current results can be replicated using paradigms involving the representation of time and of mental number line, for which a pseudoneglect-like effect in healthy individuals is well known (Loftus et al., 2009; Schwan et al., 2018). Moreover, it would be interesting to explore the existence of any dissociation between near and far space, which seem to be subserved by different neural networks (i.e., the dorsal stream for the bisection of lines placed in the near space and the ventral stream for the bisection of lines placed in the far space Weiss et al. (2000)).

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