

The Relationship Between Right Hemi-Space Visuospatial Attention Disturbance and Anger in Antisocial Individuals



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SUMMARY

Objective: Evidence suggests that individuals with antisocial personality disorder (APD) exhibit a less asymmetric pattern than healthy controls during auditory and visuospatial attention tasks characterized by a right hemispheric advantage; however, the association between attention asymmetry and symptomatology is not clear. The present study aimed to examine the relationship between visuospatial attention in the right and left hemispaces, and various dimensions of anger in individuals with APD.

Materials and Methods: We compared visuospatial attention performance in the right and left hemi-spaces during a computerized Line Bisection Test (LBT) in individuals with APD (n = 52) and healthy controls (n = 34). We also administered the Multi-Dimensional Anger Scale (MDAS) to both groups.

Results: Subjects in the APD group made larger bisection errors than healthy controls only during the right hemi-space condition and had higher scores than those in the control group on all MDAS dimensions of anger. The severity of anger symptoms and thoughts were predicted by right hemi-space visuospatial attention disturbance in the APD group, whereas no such association was observed in the control group.

Conclusion: The present findings either suggest a left hemisphere neuropathology or a disturbance in inter-hemispheric transmission in the APD group. Right hemi-space-specific visual attention disturbance may mediate the relationship between neuropathology, and somatic and trait dimensions of anger in APD.

Keywords: Antisocial personality disorder, attention, anger, cerebral asymmetry

INTRODUCTION

Antisocial personality disorder (APD) is classified as a cluster-B personality disorder and is characterized by a long-standing pattern of disregard for other people's rights, and frequent crossing the line and violation of those rights (American Psychiatric Association 1994). Criminal behavior is associated with APD. In the US the prevalence of APD ranges from 50% to 80% among those in prison (Hare 2003); therefore, studies on the etiopathology of APD are important for gaining an understanding of the mechanisms that incline such individuals to criminal behavior and for establishing new treatment options.

There is a considerable overlap between attention deficit hyperactivity disorder (ADHD) and APD. Both disorders may share a similar etiopathology and comorbidity rates are high (Retz and Rössler 2009); however, individuals with APD do not generally demonstrate a marked impairment in cognitive functions. Individuals with APD and intact cognition were described as wearing a mask of sanity by Cleckley (1976). Nevertheless, subsequent studies reported mild impairment, especially in attention (Hiatt et al. 2004). It was proposed that individuals with APD might experience difficulty shifting their attention to peripheral or implicit punishment cues (Newman et al. 1997; Newman 1998). Although there is consensus regarding the presence of attention deficits in APD, a

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clear understanding of attentive functioning in psychopathic individuals has been hampered by inconsistent findings and a lack of systematic research (Hiatt et al. 2004).

Structural asymmetry in the human brain has been studied extensively since the seminal discoveries of Paul Brocca, and although the exact cause is unclear, structural asymmetry may play a role in the specialization of sequentially processing computational cognitive networks (Nadeau 2010). Thus, functional and structural asymmetries are interrelated, and loss of asymmetry has been associated with psychopathology (Oerthel-Knöchel and Linden 2011). Examination of the relationship between loss of functional asymmetry and the symptoms of some disorders is critically important, because such an association may point to the neuropathologic pathways behind such symptoms.

There is evidence that loss of cerebral asymmetry may play a role in the etiology of psychopathology. Jutai and Hare (1983) observed loss of asymmetry in auditory attention during dichotic listening that is exhibited as a right hemispheric advantage in psychopathic individuals. Hare (1993) suggested that psychopathology might be associated with abnormal inter-hemispheric transmission. Mayer and Kosson (2000) supported this notion by showing loss of asymmetry in handedness (i.e. decreased rates of right hand dominance) in psychopathic individuals. Loss of asymmetry was also observed via electrophysiological methods; Kiehl et al. (1999) reported that event-related P300 amplitude was significantly lower in the left hemisphere in antisocial individuals. Few studies have focused on asymmetry of visuospatial attention in APD. Kosson (1998) observed that antisocial individuals make more classification errors when the target stimuli (letters and numbers) are presented in the right hemi-space. Similarly, Llanes and Kosson (2006) showed that visuospatial performance deficits in psychopathic offenders were specific to conditions priming left hemisphere resources asymmetrically during a divided attention task using color stimuli. Such studies consistently report a loss of asymmetry in attention manifesting with a right hemispheric advantage and/or left hemispheric dysfunction in the etiology of antisocial behavior; however, the clinical correlates of such loss of asymmetry are not clear.

The DSM-IV-TR criteria for APD are largely based on aggressive behavior. In fact, these criteria have been criticized because they grossly over-identify people, particularly those with offense histories, as meeting the criteria for the diagnosis (Ogloff 2006). Anger and aggression are closely related concepts (Spielberger et al. 1995). Anger was described as a strong feeling oriented towards the removal of disturbing impulses that arise in response to a real or virtual threat, or injustice (Biaggio 1989). Definitions of anger generally emphasize the planless, but on-target nature of the feeling that is expressed by aggression (Balkaya and Sahin 2003). On the

other hand, it was proposed that the process that leads to perceiving environmental stimuli as threatening might in fact be an attention bias (Bushman 2002; Smith and Waterman 2003). Considering (i) the on-target nature of anger and its relationship with (ii) aggressive behavior and (iii) attention, the present study aimed to assess the relationship between anger and visuospatial attention in antisocial individuals.

To the best of our knowledge this is the first study to assess the relationship between visuospatial attention asymmetry and several dimensions of anger in individuals with APD. In light of the above-mentioned findings, we hypothesized that individuals with APD would exhibit an asymmetrical pattern in visuospatial attention and that the degree of this asymmetry (right hemispheric advantage/left hemispheric dysfunction) would be associated with anger.

MATERIALS and METHODS

This case-control study compared the relationship between visuospatial attention asymmetry and several dimensions of anger in individuals with APD ($n = 52$) to that in healthy control subjects ($n = 34$).

SAMPLE

The APD group consisted of consecutive male military recruits that were referred by military counseling centers to the psychiatry department of a military hospital. These individuals were informed about the study by a non-military psychologist. The individuals that provided oral and written consent were evaluated in terms of the inclusion and exclusion criteria via extensive psychiatric and neurologic evaluation, and the APD module of the Structured Clinical Interview for DSM-III-R Axis-II Disorders (SCID-II) (Spitzer et al. 1989). Handedness was assessed using the Handedness Questionnaire (HQ), which was developed by Chapman and Chapman (1987) and reported to be valid for use in Turkey by Nalcaci et al. (2002). The APD module of the SCID-II Turkish version, which was translated by Sorias et al. (1990) and reported to be reliable for use in Turkey by Coskunol et al. (1989), was used to confirm the diagnosis of APD.

Inclusion criteria for the APD group were as follows; right handedness, familiarity with using a computer mouse, SCID-II-confirmed diagnosis of APD, and provision of oral and written consent to participate in the study. Exclusion criteria were as follows; any comorbid Axis-I psychiatric disorder, history of head trauma, substance abuse during the week prior to assessment, any ophthalmologic disorder other than corrected refractive defects that may interfere with sight, and any general medical or neurological disorder. In all, 52 of 94 consecutive individuals that were referred to the psychiatry department

were eligible to participate in the study and joined the APD group.

The control group ($n = 34$) consisted of healthy male military recruits that were performing mandatory military service at the same time as those in the APD group and volunteered to participate in the study. Inclusion criteria for the control group were as follows; right handedness, familiarity with the use of a computer mouse, not diagnosed as APD (according to SCID-II), and provision of oral and written consent to participate in the study. Exclusion criteria were the same as for the APD group. The study protocol was approved by the Ankara University and military hospital ethics committees. The socio-demographic characteristics of the 2 groups are presented in Table.

ASSESSMENTS

All the participants were evaluated using the same instruments. Sociodemographic characteristics were determined based on a data collection form prepared by the researchers. The Multi-Dimensional Anger Scale (MDAS) was administered to evaluate the dimensions of anger. Visuospatial attention was measured using a computerized version of the Line Bisection Test (LBT).

Assessment of anger dimensions

MDAS is a self-report, 5-point likert-type scale developed by Balkaya and Sahin (2003) to measure the dimensions of anger, specifically within the context of Turkish culture. The MDAS-symptom dimension measures the physical expressions of anger (i.e.; teeth gnashing, clenching, sense of pulsating in the head) based on 14 items by asking "When you get angry, how frequently do you feel the following?". The MDAS state dimension assesses the intensity of anger in response to 42 virtual circumstances. The MDAS thought dimension evaluates the intrusiveness of 30 automatic thoughts associated with anger. The MDAS-reaction dimension measures the frequency of behavior towards a person that is the source of anger using 47 items. The MDAS behavior dimension measures the frequency of behaviors in response to a situation that evokes anger using 26 items. While other anger scales generally include 1 or 2 of these dimensions, MDAS was structured to assess 5 independent dimensions simultaneously (Balkaya and Sahin 2003). In a non-clinical sample the internal consistency of the scale was 0.64-0.95 (Balkaya and Sahin 2003).

Assessment of visuospatial attention

The LBT is used to measure visuospatial attention, and has been used to evaluate the phenomenon of neglect associated with parieto-temporo-occipital lesions and physiological

pseudoneglect. Individuals with right hemisphere lesions neglect the left hemi-space and misbisect lines from the right. The tendency of neurologically intact individuals to slightly misbisect horizontal lines is referred to as pseudoneglect (Heilman and Van Del Abel 1980).

The present study used a computerized version of the LBT that was developed at Ankara University, School of Medicine, Physiology Department. The classical pencil and paper version of the LBT was reported by Güneş et al. (2002) to be valid and reliable for use in Turkey. The computerized version of LBT consists of the presentation of 10 black horizontal lines varying in length (80, 90, 100, 110, 120, 130, 140, 150, 160, and 170 mm) on a white background that appear on the right and the left sides of a 17" computer monitor. The lines were shown 40 times and were randomized in terms of length and side of the monitor they appeared. The participants were seated 50 cm away from the monitor and were expected to bisect the lines at the midpoint as quickly and precisely as possible using their right hand. In contrast to the pen and pencil version of LBT, the computerized version shows only 1 line per trial and a computer mouse is used to bisect the lines; the inter-stimulus interval was 0.5 s.

In all, 3 sets of LBT data were used in the present study: 1. Right hemi-space absolute error (RAE): the mean bisection error (mm) for the lines that were shown on the right hemi-space. Higher RAE indicates more severe disturbance in visuospatial attention circuits in the left hemisphere; 2. Left hemi-space absolute error (LAE): the mean bisection error (mm) for the lines that were shown on the left hemi-space. Higher LAE indicates more severe disturbance in visuospatial attention circuits in the right hemisphere; 3. General absolute error (GAE): the mean of all errors made in both hemi-spaces, which is a general measure of visuospatial attention.

Statistical analysis

Sociodemographic characteristics, MDAS total and subscale scores, and LBT RAE, LAE, and GAE scores were compared between the 2 groups using the independent samples t test. MDAS scores were not normally distributed; therefore, Spearman's correlation analysis was used to explore the relationship between MDAS and LBT scores. Regression analyses were used to determine the weighted contribution of LBT LAE and RAE scores to MDAS scores in both groups. MDAS scores that were correlated with LBT scores were employed as dependent, and LBT RAE and LAE scores were employed as independent variables.

RESULTS

Total MDAS score in the APD group (390.17 ± 78.78) was higher than that in the control group (304.89 ± 78.22) and the

Table. Comparison of sociodemographic characteristics, MDAS anger dimensions, and visuospatial attention (independent samples t test) in the APD and control groups.

	APD Group (n = 52)	Control Group (n = 34)	
Age (years)	20.96 ± 2.33	21.64 ± 2.71	t = -1.24, P = 0.22
Level of education (years)	7.96 ± 2.40	8.88 ± 2.69	t = -1.65, P = 0.1
MDAS total	390.17 ± 78.78	304.89 ± 78.22	t = 4.92, P < 0.001*
MDAS symptom subscale	32.48 ± 9.71	21.32 ± 10.67	t = 5.01, P < 0.001*
MDAS state subscale	117.38 ± 23.90	104.20 ± 23.56	t = 2.51, P = 0.014*
MDAS thought subscale	68.26 ± 22.47	38.52 ± 22.11	t = 6.03, P < 0.001*
MDAS reaction subscale	111.88 ± 31.56	89.05 ± 30.67	t = 3.31, P = 0.001*
MDAS behavior subscale	60.15 ± 12.06	51.76 ± 15.09	t = 2.85, P = 0.005*
LBT GAE (mm)	3.74 ± 1.14	3.06 ± 0.73	t = 3.07, P = 0.001*
LBT RAE (mm)	3.55 ± 1.32	2.48 ± 1.02	t = 3.98, P < 0.001*
LBT LAE (mm)	3.95 ± 1.49	3.65 ± 1.10	t = 1.02, P = 0.311

Data is presented as means ± standard deviation. *Statistically significant (P = 0.05).

difference was statistically significant ($t = 4.92$, $P < 0.001$). The results were similar for all MDAS subscale scores; the MDAS symptom, MDAS state, MDAS thought, MDAS reaction, and MDAS behavior scores were higher in the APD group than in the control group (Table).

LBT GAE, which is a measure of decreased visuospatial attention, was significantly higher in the APD group (3.74 ± 1.14 mm) than in the control group (3.06 ± 0.73 mm) ($t = 3.07$, $P = 0.001$). In other words, those in the APD group made larger absolute LBT bisection errors than those in the control group. Those with APD also made larger errors for right-sided stimuli (APD group: 3.55 ± 1.32 mm; control group: 2.48 ± 1.02 mm; $t = 3.98$, $P < 0.001$); however, individuals in both groups made similar bisection errors for left-sided stimuli (APD group: 3.95 ± 1.49 mm; control group: 3.65 ± 1.10 mm $t = 1.02$, $P = 0.311$) (Table).

In order to examine the correlation between anger and visuospatial asymmetry in the left and right hemi-spaces, Spearman's correlation analysis was used to evaluate the correlation between MDAS total score, and LBT RAE and LAE scores, but a statistically significant correlation was not observed.

Correlations between the 5 MDAS subscale scores, and LBT RAE and LAE scores were examined in order to determine the relationship between visuospatial attention asymmetry and MDAS dimensions of anger. In the APD group there was a positive correlation between LBT RAE score, and MDAS symptom subscale score ($r = 0.36$, $P = 0.009$) and MDAS thought subscale score ($r = 0.37$, $P = 0.007$); however, there

wasn't a statistically significant correlation between LBT scores and the 3 other MDAS subscale scores. In the control group there wasn't a statistically significant correlation between LBT scores and any of the MDAS subscale scores.

Stepwise linear regression analysis was performed in both groups in order to determine the relationship between visuospatial attention asymmetry, and anger symptoms and the severity of anger thoughts. MDAS symptom and MDAS thought subscale scores were taken as the dependent variables, and LBT RAE and LAE scores were taken as the independent variables in the regression analysis. In the APD group 11% of the total variance in the severity of anger thoughts ($R^2 = 0.112$, $\beta = 5.68$, $SD = 2.26$, $P = 0.015$) and 12% of the total variance in the severity of anger symptoms ($R^2 = 0.123$, $\beta = 3.03$, $SD = 3.01$, $P = 0.001$) were explained by right hemi-space visuospatial attention deficit. The LBT LAE score, which is a measure of left hemi-space visuospatial attention deficit, was excluded from both models. In the control group, neither the severity of anger symptoms nor the severity of anger thoughts was explained by visual attention related to the right and left hemi-spaces.

DISCUSSION

The present study's findings show that right hemi-space visuospatial attention was lower in the APD group than in the control group; however, left hemi-space visuospatial attention was similar in both groups, which indicates that visuospatial attention performance was asymmetric in the control group (physiologic pseudo neglect) and this asymmetry was

disturbed in the APD group (Table). These findings are in agreement with those of previous studies that reported a decrease in attention asymmetry in patients with APD (Hare and Jutai 1988; Kiehl et al. 1999; Llanes and Kosson 2006). The literature contains just 1 study on LBT performance in individuals with APD (Wang and Wang 2003), which reported that there wasn't a difference between the patients and controls. The study was small ($n = 16$ APD subjects) and visual attention was not tested using stimuli in both hemi-spaces, but only from the middle and the results might have been affected by methodological limitations or a type-II error.

The decrease in visuospatial hemispheric asymmetry in antisocial individuals suggest a deficit in neuro-anatomical pathways specific to the left hemisphere or disturbed transmission between the 2 hemispheres, rather than a general disturbance in the pathways associated with visuospatial attention. In fact, Weber et al. (2008) reviewed neuroimaging studies that included antisocial individuals and reported that there weren't any structural abnormalities specific to the left hemisphere; therefore, the decrease in attention asymmetry may be due to a difference in inter-hemispheric transmission. Raine et al. (2003) observed an increase in the quantity of white matter in the corpus callosum and suggested that there is an increase in transmission between the 2 hemispheres in antisocial individuals. The present study's findings highlight the need for volumetric and functional analysis in the left hemisphere and the corpus callosum in imaging studies designed to investigate the etiology of antisocial behavior.

The present study observed that there was a relationship between right hemi-space associated visuospatial attention deficit, and anger symptoms and thoughts in the APD group. The relationship between visual attention deficit and impulsive behavior was previously reported, but asymmetry was not evaluated; Stroop interference was used as a measure of visual attention in these studies (Spieler et al. 1996; Stern and Prohaska 1996). The present study did not use an indirect visual attention task such as the Stroop Test, which is based on the evaluation of conflict resolution. As such, the present findings regarding the relationship between attention deficit and antisocial behavior indicate that there might be other factors that mediate the relationship between attention and anger in APD.

Balkaya and Şahin (2003) reported that MDAS was valid and reliable in a healthy population, and suggested the need for further research with clinical samples. Antisocial individuals in the present study had higher MDAS subscale scores than the controls, which support the validity of the scale.

In the APD group some dimensions of anger (i.e. anger symptoms and thoughts) were associated with right-sided hemi-spatial neglect. The MDAS symptom dimension consists of the early symptoms of anger, which are associated with

activation of the sympathetic nervous system. In the APD group the prediction of the MDAS symptom dimension by right-sided hemi-spatial attention deficit suggests the role of a biological abnormality associated with visual attention in the early stages of anger.

The MDAS thought dimension differs from the other MDAS dimensions, as it measures thoughts that are not only present during anger states, but are continuous and represent a trait (e.g. mistrust, being patronized, being wronged by others). The relationship between these thoughts and visuospatial attention may be related to the trait characteristics of these thoughts. Similarly, Wilkowski and Robinson (2008) investigated the cognitive processes associated with the trait components of anger in healthy individuals and reported that attention is impaired even before deciding whether or not the environment is threatening. Our results support this notion for the individuals with APD.

In the present study the MDAS state, behavior, and reaction dimensions were not associated with visuospatial attention. The MDAS state dimension measures the level of anger in response to certain anger-provoking situations. According to social learning theory, evaluation of such situations is associated with past experiences; therefore, the link between biological parameters such as visuospatial attention may be weaker. On the other hand, the MDAS behavior and reaction dimensions measure the frequency of behavior directed towards persons and situations that provoke anger. These dimensions evaluate the responses that occur during the later stages of cognitive processing (later than sympathetic activation) and might therefore be more distant to pathology regarding the early stages of data processing such as attention.

The present study has some limitations. For example, the study included only right-handed males; therefore, the findings cannot be generalized to females or left-handed individuals. In addition, the study was conducted in a military setting. Although the control group also included recruits, military education is based on behavior control and this may have caused observation bias. In other words, the antisocial individuals may have self-rated their anger symptoms to a lesser degree than what they actually were; however, such a bias would be expected to lead to a type-II error and the direction of such underreporting would strengthen - rather than exclude - our interpretations. Another limitation of the present study is that only the APD module of SCID-II was administered during the diagnostic interview procedure; therefore, other personality disorders were not excluded. The presence of other personality disorders might have affected the findings. Furthermore, we evaluated the presence of substance abuse based on self-reports and did not employ biochemical confirmation; however, as the study was conducted in a military setting, we think that the restricted environment may have reduced the possibility of any related confounding

effects. Despite these limitations, the present study has several strengths. The APD and control groups were similar in terms of age, sex, lifestyle, and habitat. Anger is a culturally bound emotion; therefore, we administered MDAS that was developed for use in Turkey. Moreover, use of the LBT to evaluate visuospatial attention asymmetry may have improved the internal validity of the study, because when compared to other attention tasks, LBT performance is independent of working memory performance and verbal abilities that are asymmetrically represented in the brain.

To the best of our knowledge the present study is the first to investigate the relationship between anger and visuospatial attention asymmetry in antisocial individuals. The present findings show that visual attention impairment in the right hemi-space was associated with the trait and somatic dimensions of anger in the APD group. The present findings also indicate that there is left-sided neuropathology or disturbed inter-hemispheric transmission in APD. Furthermore, we think that visual attention impairment in antisocial individuals may mediate the relationship between such a neuropathology and anger behavior, and may be considered a target of treatment in individuals with APD.

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