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Asymmetrical Visual-Spatial Attention in College Students Diagnosed With ADD/ADHD

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Abstract

Objective—Research indicates that individuals with attention deficit disorder (ADD)/attention deficit hyperactivity disorder (ADHD) may exhibit left-right asymmetric spatial attention, with deficient processing of stimuli in the left visual hemisphere. However, there is controversy as to when this phenomenon can be observed.

Background—People with ADD/ADHD do not have obvious spatial bias when performing everyday tasks. Visual cancellation tasks have demonstrated behavioral asymmetry in ADD/ADHD, but results have not been consistent across studies. Children and older adults with ADD or ADHD have been assessed, but previous studies of college students with ADD/ADHD are not available.

Method—We tested 24 students with ADD or ADHD and 24 control students on a verbal and nonverbal cancellation task.

Results—The ADD/ADHD group made significantly more left-sided omission errors than controls on a letter cancellation task. This group difference was not observed for a shape cancellation task, however.

Conclusions—These results support possible left visual inattention in college students with ADD/ADHD. Studies of functional correlates of these attentional phenomena are needed.

Keywords

ADD/ADHD; unilateral neglect; visual inattention

In the human brain, the 2 hemispheres interact to distribute attention appropriately for adaptive visuomotor behavior in the normal environment. The right hemisphere may critically support coordination of perception, attention and action, not only to the contralateral left hemisphere, but also, although to a lesser extent, to the ipsilateral right hemisphere.¹ A right cortical-temporal-parietal-limbic-frontal-subcortical network may provide the substrate for bottom-up and top-down spatial attention.^{2,3}

Spatial neglect is the failure to report, orient, or respond to stimuli in the side of space opposite a brain lesion¹ associated with functional deficits.⁴ When asked to bisect a horizontal line, patients with spatial neglect after a right hemisphere lesion may err to the right of the midpoint.

³ They also omit targets on the left when asked to cross out stimuli such as lines or letters in an array.⁵

An attentional disorder not usually identified as causing spatial attentional problems is attention deficit disorder (ADD) or attention deficit hyperactivity disorder (ADHD). The individuals with this syndrome are usually considered by clinicians to have primary difficulty with vigilance, distraction, persistence, or inhibition rather than spatial bias, and are not usually observed to manifest pathologically asymmetric behavior on functional tasks. However, several studies support spatial bias as part of impaired perceptual-attentional-action coordination in ADD/ADHD. The earliest of these involved children 7 to 12 years of age with ADD who completed a letter cancellation task similar to the one described above, and made over twice as many errors as controls, and also more left-sided errors.⁶

Some later researchers reported consistent results.^{7–10} Garcia-Sanchez et al⁷ used multiple visual-spatial tasks intended for right hemisphere processing assessment in children from 14 to 16 years old, and reported results consistent with right hemisphere dysfunction⁸ reported in adults from 19 to 53 years (mean age, 32.9) that people with ADHD were again impaired on a letter cancellation task. Individuals with ADHD demonstrated a higher mean left-sided omission rate than controls.

However, some researchers reported conflicting results. When investigating the performance of normal children and children with ADHD on a free-viewing chimeric faces task, Klimkeit et al¹¹ did not find any differences between the groups. Interestingly, both groups of children showed a leftward bias unlike the rightward bias observed by Voeller and Heilman.⁶ Ben-Artsy et al¹² attempted to replicate Voeller and Heilman's⁶ study in boys 7 to 10 years old with diagnosed ADHD performing the line bisection and target cancellation tasks. Contrasting to previous research, the children with ADHD did not differ from controls.

In the present study, we focused on young adults with ADD/ADHD, as they may be the group in whom rightward bias may be the most atypical.¹³ Additionally, college-aged adults are at high risk for other causes of attentional abnormalities (traumatic brain injury, driving accidents, sleep deprivation) compared with older adults, and spatial asymmetry in this group of ADD/ADHD sufferers may have increased functional significance. We investigated college students with ADD/ADHD and compared their ability to perform a visual cancellation task compared with healthy controls.

We hypothesized that students with ADD/ADHD would make more overall omissions, and more omissions in left hemispace, compared with right hemispace, than would controls. Additionally, we expected that people with ADD/ADHD might spend less time on the task than did controls.

MATERIALS AND METHODS

Participants

Twenty-four Elizabethtown College students with documented ADD/ADHD and 24 controls without ADD participated in the study. With the help of the director of the Learning Services department, students on file with a documented attention deficit were contacted for participation in the study. A disorder was considered documented if it was diagnosed by a medical doctor or psychologist before enrollment at the college. Students were offered the chance to be entered into a raffle for 2 gift certificates as an incentive. To make an appointment, students contacted the director of Learning Services so that confidentiality could be maintained. The students ranged in age from 17 to 22 years ($M = 19.29$, $SD = 1.12$) and we tested 13 women and 11 men.

Control participants were recruited from the introductory psychology courses and participated to fulfill a course requirement. Students who reported having been diagnosed with an ADD in the past were excluded from the study. The control group ranged in age from 18 to 21 years ($M = 18.63$, $SD = 0.92$) and was matched for sex (13 women and 11 men) and handedness.

Materials

Visual Target Cancellation Test¹⁴—Participants completed the random letter and shape cancellation tests of this standardized cancellation test (visual target cancellation test). The letter cancellation task consisted of a random array of letters including targets and distractors. There were 60 target letter A's and 300 distractor letters randomly distributed on a white landscape orientation (296×210 mm) sheet of paper. Each quadrant of the page contained 90 shapes, 15 of which were the target stimuli. The sheet was aligned with the midline of the participant and the subjects were asked to circle all the target letters. Different colored pencils were given after every 10 letters circled so the origination and method of searching could be analyzed. Although there was no time limit for the task, participants were told to work as quickly as they could because they were being timed. The shape cancellation task consisted of a random array of geometric shapes. The target was an open circle with a slanted line through it. The layout of the task was similar to the verbal cancellation task and it was administered the same way.

Procedure—Participants with ADD/ADHD were tested individually in a small room in the Learning Services suite to protect their identities. Control subjects were tested individually in a psychology laboratory. The experiment lasted approximately 10 minutes. After a brief description of the experiment, participants were asked to provide their age, sex, year in college, handedness, and whether or not they were on medication for their disorder (only for the attention deficit group). Participants then completed the verbal cancellation task followed by the nonverbal cancellation task. The tests were administered as described above.

For both cancellation tasks, the time for completion was recorded in seconds. Additionally, omissions on the right and left halves of the page were recorded. Omissions were measured as the total number of missed targets on 1 side out of the possible 30 targets for that side. After the testing, the participants were given a brief description of the expected findings and received an e-mail describing the results after the study was completed.

RESULTS

We hypothesized a priori that ADD/ADHD subjects would make more omission errors than controls. A 2-tailed, independent samples t test indicated that the ADD/ADHD group ($M = 2.25$, $SD = 2.79$) omitted almost twice as many targets as controls ($M = 1.21$, $SD = 1.10$), but this did not reach significance, [$t(46) = 1.70$, $P = 0.09$]. The power of this comparison may have been limited by our small sample size. As predicted, the ADD/ADHD group ($M = 1.17$, $SD = 1.55$) omitted significantly more left-sided targets on both of the cancellation tasks than controls ($M = 0.42$, $SD = 0.50$), [$t(46) = 2.25$, $P = 0.03$]. There was no significant difference between the groups in the total targets omitted on the right half, [$t(46) = 0.72$, $P = 0.47$, ns] (Fig. 1). However, when we examined the letter and the shape cancellation tasks separately, the ADD/ADHD group made more left-sided omissions on the letter cancellation task than controls [$t(46) = 2.57$, $P = 0.01$], but there was no significant difference between groups on the shape cancellation task [$t(46) = 1.05$, $P = 0.30$, ns]. Finally, against prediction, the ADD/ADHD group ($M = 177.40$, $SD = 42.88$) spent more time on the 2 tasks than controls ($M = 167.65$, $SD = 31.50$), but this did not reach significance [$t(46) = 0.92$, $P = 0.36$].

DISCUSSION

Before obtaining data, it was hypothesized that participants with ADD/ADHD would make more overall omission than controls, and they would make significantly more errors on the left half of the visual target cancellation tasks. Results were consistent with these hypotheses. The ADD/ADHD group made almost twice as many overall omissions as the control group. When considering only the left half of the task, as expected the ADD/ADHD group made significantly more omissions than controls. Participants with ADD/ADHD spent more time than controls completing the 2 cancellation tasks, but this did not reach significance. Our findings are consistent with a right spatial bias/left spatial inattention in college students with ADD/ADHD.

Visual target cancellation tasks have been used to identify a possible form of spatial neglect occurring in ADD/ADHD, in children,⁶ and also in adults.⁸ College students arise as an interesting group to study in regard to this topic because of the high demands of higher education and the attentional risk factors of this age group. We replicated previously reported results in college-age adults with ADD/ADHD who performed more asymmetrically on cancellation tasks than did their matched control counterparts.

Previous researchers reported that people with ADD/ADHD may demonstrate a typical leftward, rather than rightward bias.¹¹ However, this study did not concern spatial function, but rather the interpretation of emotional facial expressions. It is possible that spatial attentional factors are independent of visual identification, which processing may be important for classifying faces in people with ADHD. Just as “what” and “where” visual streams are dissociable in the adult brain,¹⁵ identifying faces and objects (shape cancellation) may not draw upon the same spatial resources that are impaired in left hemispace in ADD/ADHD.

Although the current study provides additional support to the argument proposed by Voeller and Heilman,⁶ conflicting evidence still remains. Future research on this topic is needed to elucidate its relationship with face processing and object recognition. However, it is also very important to understand what the pragmatic implications of spatial bias may be on the lives of adults with ADD/ADHD. As college students are driving, subject to sleep deprivation, and at risk for other disorders compromising attention (eg, head trauma), environmental correlates of right-biased spatial performance would be important to ascertain. Further research in this area is needed.

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FIGURE 1.

Comparison of total number of omissions on the left and right half for ADD/ADHD and control groups. ADD indicates attention deficit disorder; ADHD, attention deficit hyperactivity disorder.