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Full length research paper

Line Bisection Judgments in Untreated and Under-treatment ADHD Children

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The present study tries to investigate the differences in spatial attention between untreated ADHD children and under-treatment, drug therapy and psychotherapy, ADHD children. In order to do this study, nine untreated ADHD subjects (mean age: 8.2 ± 3.6) were compared to tenunder -treatment subjects (mean age: 9.6 ± 2.3) using line bisection task in paper form, introduced by Hausmann *et al*. 2003. For comprehending whether there are differences in spatial attention between groups, one way ANOVA(p<0.05) was used. And the results showed that the difference in the mean deviation of subjective midpoint of total lines of task was a statistical significant difference (F= 22.93, P<0.001). Also in right margin lines (F=10.614, P<0.005) and middle lines (F=8.289, P<0.01), the differences between two groups were statistically significant, where as such differences are not considered in left lateralized lines (F= 0.552, P<0.468). The results suggested that the left bias errors in under treatment ADHD children were the same errors considered in neurologically normal children and adults. On the other hand significant rightward errors were related to abnormality in un-medicated ADHD children's hemispheric function and spatial attention.

Keywords-- ADHD, Spatial Attention, Line Bisection Task

INTRODUCTION

One of the neurodevelopmental disorders is attention deficit hyperactivity disorder (ADHD), characterized by three main subtypes according to Diagnostic and Statistical Manual of Mental Disorders (4th edition: DSM-IV):ADHD- Predominantly Inattentive type, ADHD-Hyperactive-Impulsive type, and ADHD-Combined type (American Psychiatric Association, 2000).Almost half of the children with ADHD persist their symptoms and deficits until their adulthood (Mannuzza *et al*., 2003). Children with ADHD diagnosis often show behavioral, emotional, and educational problems, but disruption of cognitive functions especially attention is related to their learning process and commonly considered by neuropsychologists and education psychologists (Brown *et al*., 2001).Assessment and investigation spatial attention using line bisection task has been increased in recent years. Using line bisection task, clinical psychologists determine the hemispheric function (Jodzio *et al*. 2002). The line bisection task is a neuropsychologic test being consisted of some horizontal black lines, and subjects were asked to put a mark in the midpoint of each line. The line bisection task shows clearly meaningful differences between normal right handed people's cognitive process and patients who suffer from neurologic and psychoneurologic diseases (Waldie and Hausmann 2010). It is detected in 80 decade that normal subjects bisect lines to the left of the middle which is related to dominance of the right hemisphere (Bowers and Heilman1980). Bisect line to the left (leftward bias) called right pseudoneglect and implies tendency to neglect the right (Bradshaw *et al*., 1987). Left hemineglect is described as a phenomenon in patients with lesions in their right hemisphere which made them to neglect left and bisect lines with deviation to the right of the true middle point (Hausmannand Waldie 2003). Clinical evidence show that corpus callosum, right or left handed, size of the brain lesions, personality and sex are determinant factors in line bisection errors (Jewell and McCourt2000). For example Hausmann and his colleagues stated that stronger or larger posterior corpus callosum in women results left bias with either hand, whereas the bias with the left hand in men reflects less stronger interhemispheric connectivity (Hausmann *et al*. 2002).Some researchers have reported changes in children's performance in line bisection task related to their age (vanVugt *et al.,* 2000, Dellatolas *et al.,* 1996). Rightward bias from objective midpoint is observed in young children. Older children bisect lines to two equal and more accurate parts and finally left bias appears. It is the same adult's pattern (Hausmann *et al.,* 2003). The neurologic base of these changes is corpus callosum maturation that shows contralateral shift to right hemisphere control (Hausmann *et al*. 2003).Previous neuropschological and neuroimaiging studies suggestedthat the pathogenesis of deficits in cognitive functions in patients with ADHD is based on right hemisphere dysfunction (Sandson *et al*. 2000, Sheppard *et al.,*1999).

The present study investigated the differences in spatial attention between untraeted ADHD children and under-treatment ADHD children.

MATERIALS and METHODS

Participants

Participants were children who were selected from a psychiatric clinic, from Medical Science College in Esfahan, Iran. The children who were received drugs and psychotherapy treatment, family training, or child behavior modification were selected randomly (N=10, mean age: 9.6 ± 2.3, 3 girls). These children were under treatment during 12 months before their participation in this study.

Using random sampling method, another group of children (N=9, mean age: 8.2 ± 3.6, 3 girls)with ADHD diagnosis, according to the DSM-IV criteria by psychiatrists and clinical psychologists, were selected. All children's family who met the DSM-IV criteria were asked questions pertaining medical and drug treatment to control ADHD symptoms. If there were medical or psychological treatments, the child was excluded from the study. All the children were Persian and they did not suffer from other psychiatric disorders except ADHD.

INSTRUMENTS

The instrument that was used in this study for collecting the data was line bisection task. The line bisection task (paper form) was introduced by Hausmann *et al*. (2003). There are 17 lines on an A4 (21 cm × 30 cm) white sheet of paper. The lines are horizontal, black, 1 mm wide and 100 to 260 mm length (M= 183.5 mm). Three positions are considered for lines: middle in the sheet, left margin and right margin. Seven lines are appeared in the middle of the sheet, and for each of left and right margins five lines are appeared. With a fine pencil and without time restrictions, participants were asked to bisect all lines. All participants bisect lines using right hand at first, and then using left hand they marked middle of lines on another test sheet.

Hausmann *et al.,* (2003) andHausmann(2005) introduced a formula for calculate the percentage deviations to the left or the right. Using their formula, the deviation was computed for each line. This is the formula: [(measured left half – true half) / true half] × 100.

The mean score of deviation for each line was determined. It is noticeable that left bias, using above formula, are negative values and right bias are positive values (Waldie and Hausmann2010). A level of $p<0.05$ was considered as statistically significant.

PROCEDURE

In test room each child was asked to mark the midpoint of lines. The tests were performed between 8:30 am to 13:00 pm. To compare the mean score of deviation from midpoint in both groups, SPSS software version 16 was used.

RESULTS

The mean score of deviation from subjective midpoints in two groups based on line position (the right lateralized lines, the left lateralized lines and the middle lines) are indicated in the figure 1-3.As mentioned in previous part, negative values are related to left bias and positive values are related to right bias. The positive mean scores in figure 2 indicated deviation to the right and these scores in under-treated children are different from the other scores of them. The other mean scores are often negative value in this group both in middle and right margin lines (see Fig. 1 and 3).Figure 4 is consists of the total mean of deviations. It can be predicted by considering figures 1 to 3 that the total mean in left margin lines will be positive values in both groups, but under-treated children and untreated children perform differently in the other lines. Also the total mean deviations in all 17 lines of the task in both groups show a wide difference from -65.66 mm bias from midpoint in under-treated children to +61.01mm deviation from midpoint in untreated ADHD children. Mean deviations are in left, right and middle margin lines and all the lines were compared between under-treated and untreated ADHD children. In order to compare the data of mean deviations in two groups, one way ANOVA was used (See table 1). The results, in left lateralized lines, show that there is not statistical significant difference between two groups ($F= 0.552$, $P<0.468$). Such differences are not considered in bisection right margin lines ($F=10.614$,

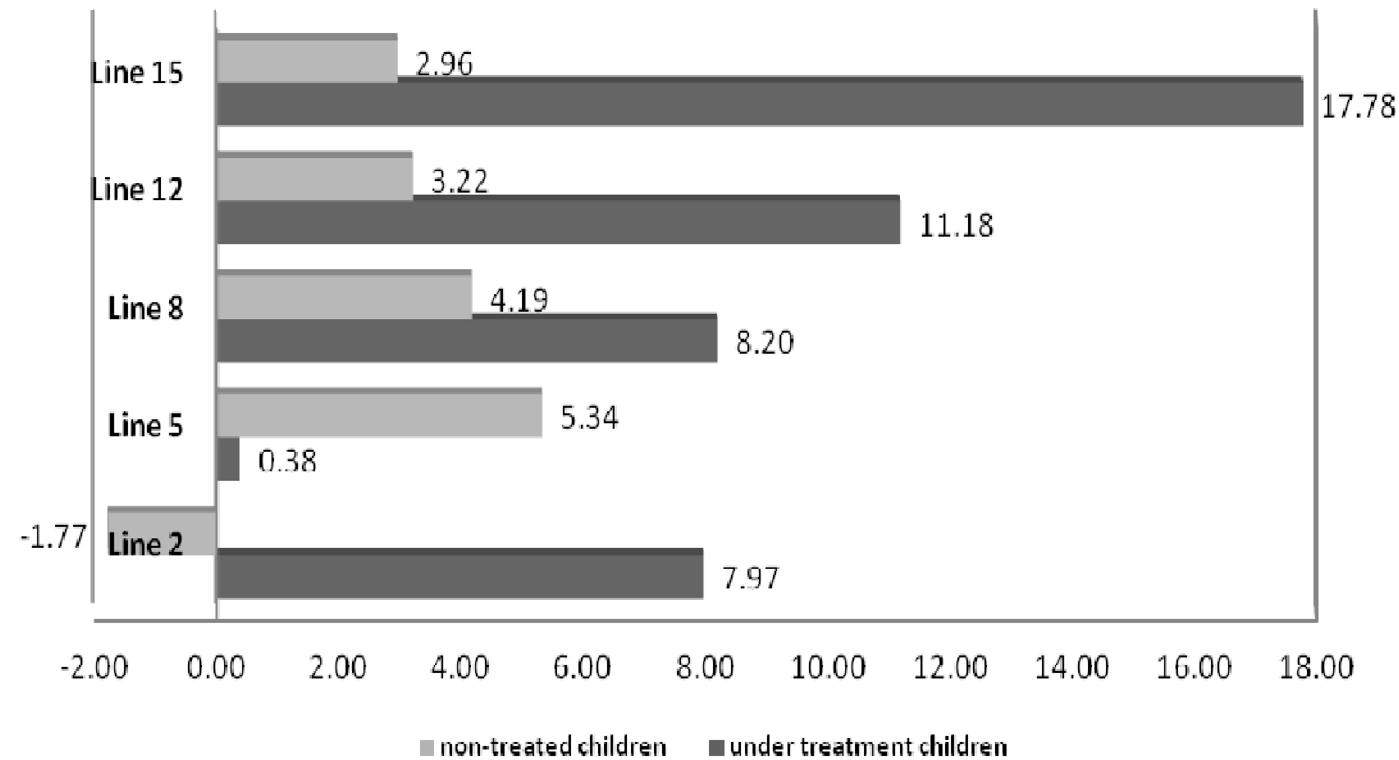

Figure 1. Mean deviation from the midpoint in left lateralized lines (mm) in both under-treated and untreated ADHD children

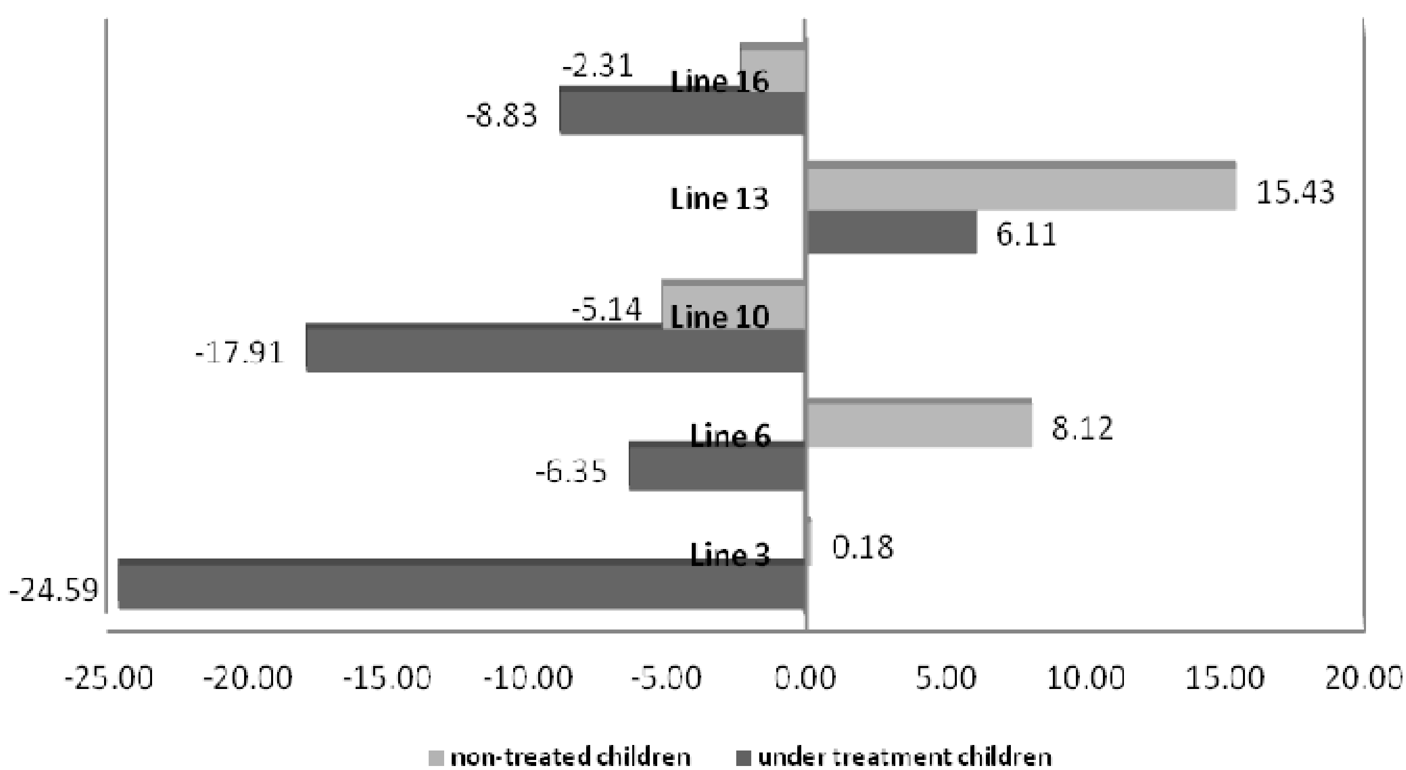

Figure 2. Mean deviation from the midpoint in right lateralized lines (mm) in both under-treated and untreated ADHD children

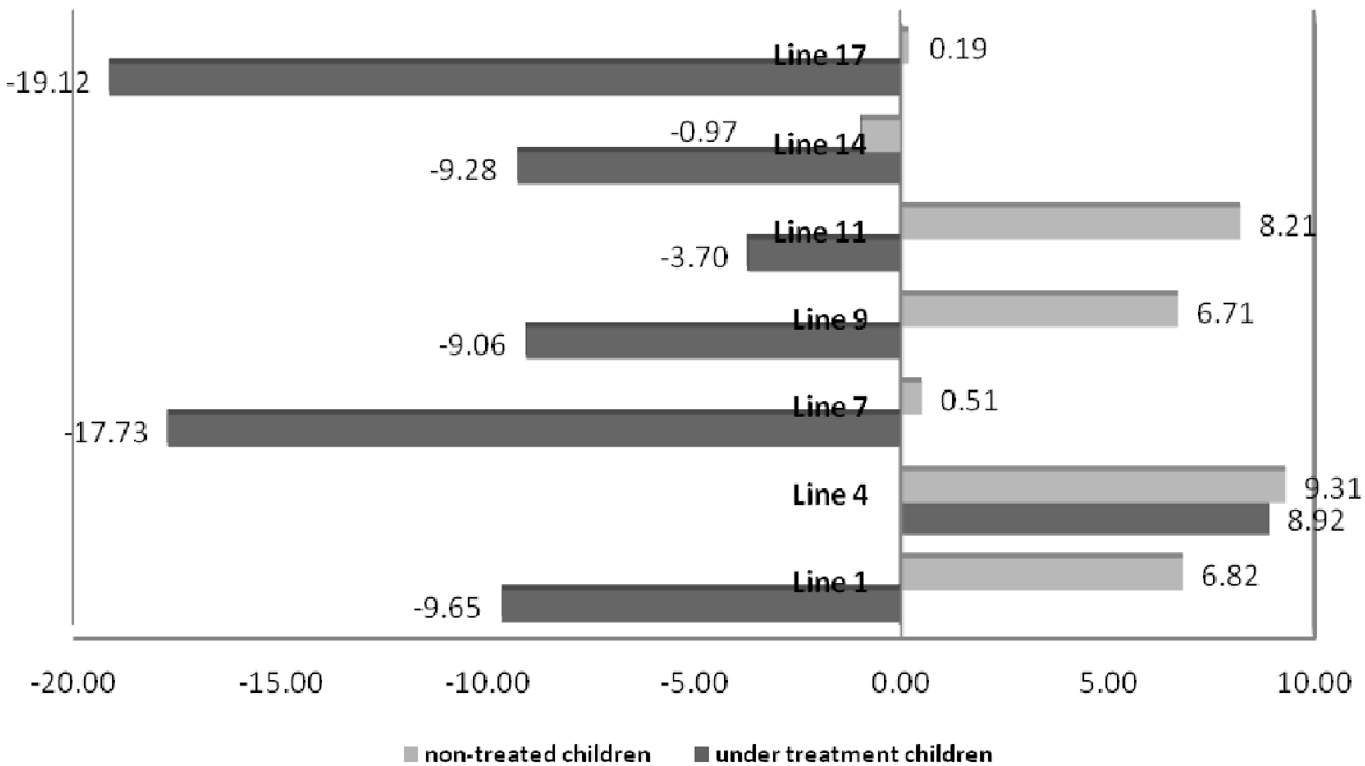

Figure 3. Mean deviation from the midpoint in middle margin lines (mm) in both under-treated and untreated ADHD children

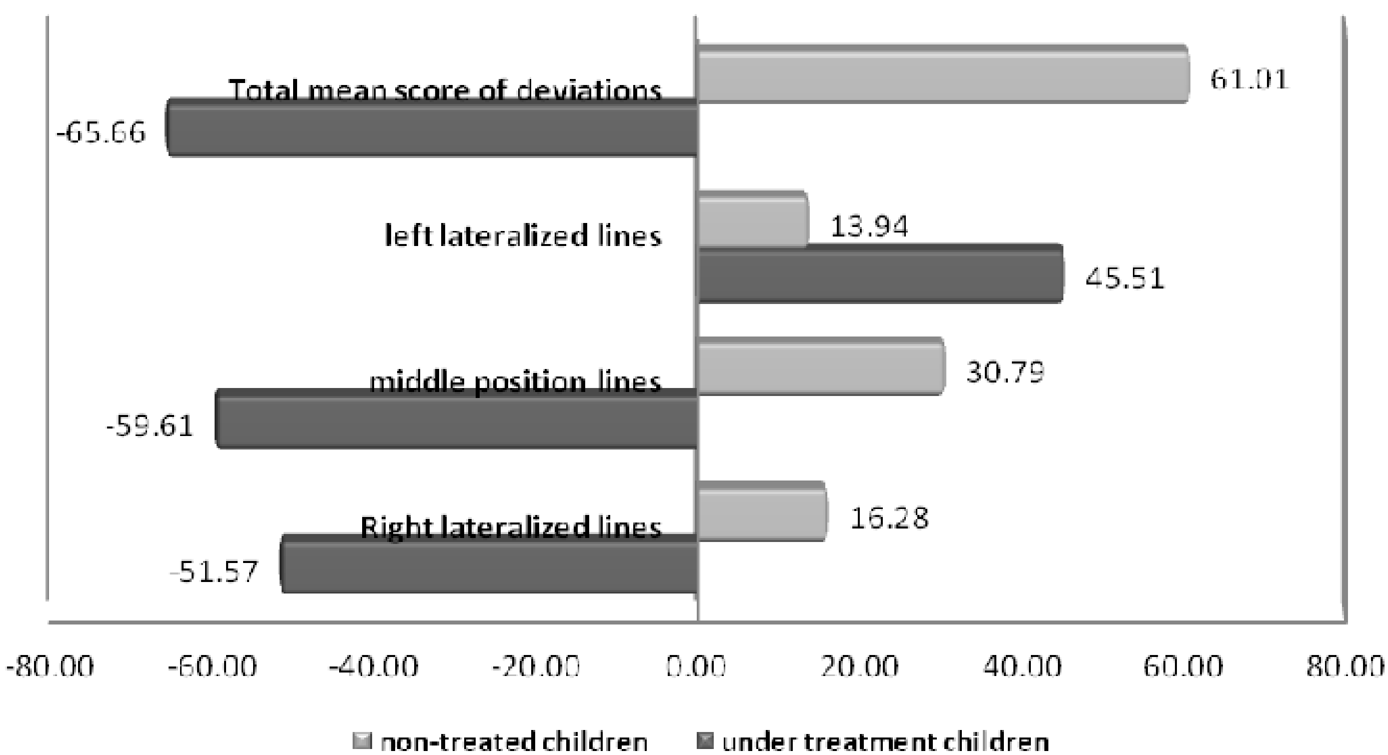

Figure 4. Mean deviation from the midpoint line (mm) in both under-treated and untreated ADHD children

Table 1: One-way ANOVA: mean deviations in left, right and middle margin lines between two groups

		Sum of squares	df	Mean squares	F	Sig
Left lateralized	Between groups	4722.547	1	4722.547	.552	.468
	Within groups	145571.507	17	8563.030		
	Total	150294.053	18			
Middle	Between groups	38705.759	1	38705.759	8.289	.010
	Within groups	79383.921	17	4669.642		
	Total	118089.680	18			
Right lateralized	Between groups	21807.253	1	21807.253	10.614	.005
	Within groups	34928.849	17	2054.638		
	Total	56736.102	18			
Total lines	Between groups	76004.864	1	76004.864	22.930	.000
	Within groups	56349.993	17	3314.705		
	Total	132354.857	18			

P<0.005) and middle lines (F=8.289, P<0.01). Also, the difference in the mean deviation of total lines of task was a statistically significant difference (F= 22.93, P<0.001).

DISCUSSION

This study investigated differences between under-treatment ADHD children and untreated children with ADHD in line bisection task. The results of this study revealed significant differences in spatial attention between two groups. It was previously determined that neurologically normal subjects bisect lines to the left of the middle which is related to their dominance of the right hemisphere (Hausmann *et al*. 2003, He *et al*. 2010, Bowers and Heilman1980). The findings of this study showed that untreated children perform differently from under-treated children in line bisection task and under-treated children bisect lines to the left of the subjective midpoint. The rightward bias is a well-known pattern in bisect lines in ADHD children(Hausmann *et al.,* 2003, Waldie and Hausmann 2010, Carter *et al.,* 1995, Sheppard *et al*., 1999,VoellerandHeilman1988) and it is probably related to right fronto-parietal hemisphere dysfunction in children with ADHD.

The leftward bias in under-treated ADHD children is the same bias that Waldie and Hausmann (2010) observed in normal children (mean age 10 years).It appears that treatment, spatially drugs, may change brain function toward more normal function in ADHD. Although there are some evidences that emphasize on no major effect of treatment on functional-lateralization in some psychotic disorders(Eaton *et al*. 1979, Mohr *et al*. 2001, Bertolino *et al*. 2004), some studies did not imply it (Tomer and Flor-Henry, 1989).The observed differences between two groups in right lateralized lines and middle lines, and their similarity in left lateralized lines are noticeable findings in present study. The bias in left lateralized lines could not discriminate the differences of brain function and spatial attention of two groups. It is probably related to the position of the line and writing direction in Persian. The school age children learn to write from right to left in Persian writings and use of right hand is encouraged by teachers and parents. Hence in left lateralized lines it is possible that writing style makes more rightward bias in two groups.

In sum the results of the present study suggest that the significant rightward errors are related to dysfunction of cognitive process and abnormality in unmedicated ADHD children's hemispheric function and on the other hand, left bias errors in treated ADHD are the same errors considered in normal adults and neurologically normal children. Results from this study indicated the effect of treatment (spatially long time medication) on spatial attention in ADHD children and it can be suggested that the line bisection judgment may be used as an easy way to test ADHD treatment effect.

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