

Analysis of Visuospatial Activity in Preschool Children with Attention Deficit Disorder

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Abstract—Parameters of visuospatial components of mental activity were studied in Mexican children aged 5–6 years with attention deficit disorder. The control group (norm) consisted of preschool children of the same age who attended municipal kindergartens. Neuropsychological methods specially developed and adapted for Mexican children were used. The results testified to prominent impairments of the parameters of spatial analysis and synthesis and of the formation level of object imagery, suggesting functional weakness of the posterior associative (TPO) cortical areas of both hemispheres. The results elucidate specific difficulties in cognitive activity and other impairments in children with attention deficit disorder.

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Attention deficit disorder in preschool children is a pressing problem in many countries [1–3]. Specialists are attempting to study the nature of this syndrome with different methods and theoretical platforms. Among them, neuropsychological methods may be noted. These methods make it possible to evaluate the cerebral organization of cognitive functions and cerebral mechanisms of their impairments by analyzing the structure and features of mental activity.

The difference in the resulting conclusions is that, in some cases, every psychological function is associated with a particular area of the brain, while a systemic organization of mental activity is taken into account in other cases, based on the neuropsychological theory of Luria [4] and his followers [5].

Authors who do not belong to Luria's school [6, 7] usually analyze a failure of only one function and interpret it as underdevelopment or dysfunction of a particular brain area. Yet practice shows that, in attention deficit disorder, not only attention is impaired but other components of mental activity, both elementary and complicated, suffer as well. In this case, these impairments are considered to be associated with the attention deficit. Thus, the associated impairments include mnemonic, verbal, motivational, emotional, intellectual, and other difficulties [8]. When only one impaired function is separated by behavioral feature, as is the case with attention deficit disorder [9], it is impossible to detect the effect of such a disorder on other mental processes.

Neuropsychological analysis based on Luria's theory [10] displays the intact and impaired functional branches of mental activity; moreover, several impaired branches can be observed. Such functional branches are not involved in a single particular mental function but determine the character and possibility of all of a child's activity.

The cerebral mechanisms of functional abnormalities in children are difficult to identify, and their analysis requires additional psychophysiological methods. Still, a neuropsychological study may find functional impairments in different mechanisms of mental activity by its own techniques [5, 10, 11].

Our previous studies of children with attention deficit disorder showed a prominent functional impairment of neuropsychological mechanisms of programming and control as well as of the kinetic organization of movements and actions [12]. At the psychological level, these children demonstrated a lack of complicated game activity and verbal regulation [13, 14].

The aim of the present work was to study the features of the visuospatial mechanisms of mental activity in Mexican children of preschool age with attention deficit disorder.

METHODS

A group of 14 preschool children (4 girls and 10 boys aged 5–6 years, mean age 5.27) participated in the study; they had attention deficit disorder and attended municipal centers for children with developmental problems. A neurologist and a psychologist determined this diagnosis independently. The control group included 16 children (5 girls and 11 boys) of the same age (mean age 5.61) who lived in the same social and cultural setting and attended a kindergarten of Puebla.

To study the visuospatial mechanisms of mental activity, we used tests for spatial analysis and synthesis and the formation of object images [15]. These tests are part of a method elaborated at the Neuropsychology Master's Department of Puebla University on the basis of methods proposed by Luria [16] and child neuropsychologists [5, 10, 17, 18]. The method includes tasks

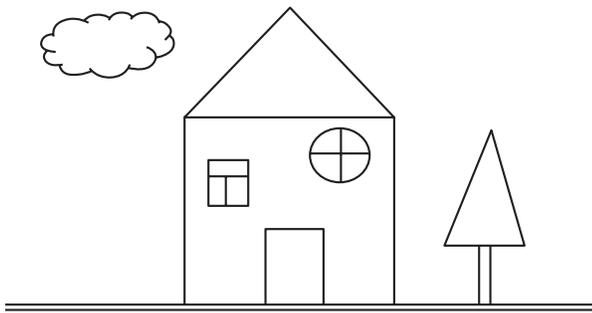


Fig. 1. Example of house for copying.

corresponding to the mental abilities of Mexican children of preschool and elementary school ages [19]. The present study included the following tasks: (1) copying an example of a house (Fig. 1), (2) freely drawing a boy and a girl, (3) copying digits and Roman letters sophisticated in spatial characteristics, and (4) comprehending complicated logical and grammatical constructs (with spatial prepositions).

Here we consider the results of copying a house and drawing a girl and a boy because it was in these tests that we found typical mistakes and significant differences between the groups of children. Both tests assess visuospatial analysis and synthesis.

The evaluation of the difficulty of task performance was based on the analysis of a child's mistakes. The following scores were obtained: 1, correct performance; 2, correction of mistakes by the child him- or herself; 3, mistakes without correction; and 4, inability to perform a task.

A neuropsychological study was conducted during one session (40–60 min) in children of the control group and during three sessions in children with attention deficit disorder.

One-way analysis of variance (ANOVA) was used to evaluate the differences in the parameters characterizing impairments of visuospatial mechanisms of mental activity between the groups of children.

Frequency distribution (%) of scores on the tasks of copying a house and drawing a boy and a girl in the test (attention deficit) and control (norm) groups

| Score | Copying | | Drawing | |
|-------|-------------------|-------|-------------------|-------|
| | attention deficit | norm | attention deficit | norm |
| 1 | 0.00 | 6.25 | 0.00 | 6.25 |
| 2 | 0.00 | 37.50 | 0.00 | 37.50 |
| 3 | 20.00 | 43.75 | 20.00 | 43.75 |
| 4 | 80.00 | 12.50 | 80.00 | 12.50 |

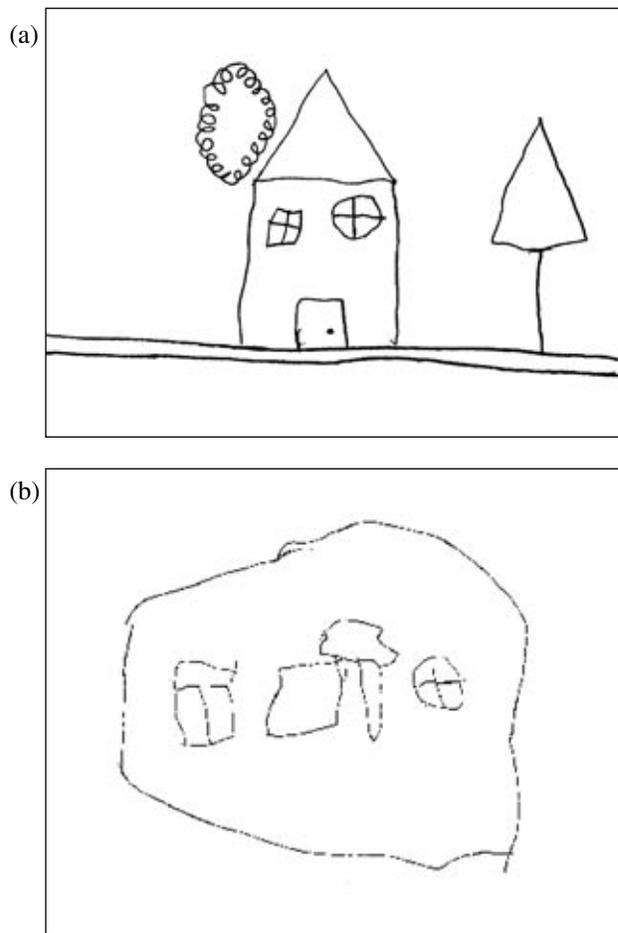


Fig. 2. Example results of house copying by (a) a child from the control group and (b) a child with attention deficit disorder.

RESULTS AND DISCUSSION

The results showed significant differences in the performance of all tasks between the children with attention deficit disorder and the control group. The distribution of scores in the two groups is presented in the table. The percent of pronounced difficulties in visuospatial analysis and synthesis (scores 3 and 4) was higher in the group with attention deficit disorder than in the control group. Statistical evaluation of the differences showed the following results: for copying a house, the differences were significant at $P < 0.004$; for drawing a boy and a girl, at $P < 0.000$.

Figure 2 illustrates the performance of the neuropsychophysiological task involving the mechanisms of visuospatial analysis and synthesis in the children of both groups. Figure 2a shows the example of copying a house by a child of the control group; Fig. 2b presents the performance of the same task by a child with attention deficit.

We observed glaring spatial mistakes in copying of a house: an inadequate arrangement of details, gross

distortion of their sizes and proportion, a loss of details, a distortion of the spatial proportion of the house and the roof, and a lack of parallelism and perpendicularity of main lines and details.

Figure 3 compares the drawings of girls and boys for the two groups. A low stage of drawing a human figure was characteristic of the children with attention deficit disorder. Their drawings corresponded to the ages of 3–4 years rather to the older preschool age [20]. The volume of extremities, important details of the face and clothes, fingers, etc., were lacking in drawings of these children. The drawings of the control group contained fewer such mistakes.

Thus, qualitative analysis of the task performance showed that the visuospatial activity of the children with attention deficit was characterized by significant impairments of the perception and drawing of main forms and details, testifying to a retarded development of both general and elementwise modes of processing visual information.

Numerous neuropsychological studies have revealed difficulties in copying objects and complicated spatial images, free drawing, and designing in adults with damage to posterior structures of the left hemisphere [16, 21]. Especially gross disturbances in block design, drawing, and spatial orientation are observed upon damage to the parietotemporal and temporo-parieto-occipital areas [22]. Simernitskaya [17] has observed the same difficulties in patients with childhood damages and traumas. It has been noted that these difficulties are associated with the inability to define the spatial location of a figure and its parts and to position the global image as well as with a lack of important details.

Neuropsychological studies of children with learning difficulties often detect multiple spatial abnormalities [23]. Akhutina and Zolotariova [24] have shown that left-hemispheric or right-hemispheric spatial insufficiency underlies learning difficulties in writing and mathematics at school. In most cases, children with learning difficulties and visuospatial impairments do not have marked brain lesions; nevertheless, the character of mistakes testifies to a functional impairment of spatial mechanisms.

Recent studies have reported visuospatial difficulties for children with attention deficit disorder [25]. For example, children with attention deficit copy the Rey figures worse than healthy children [25]. Mistakes include a lack of details and preciseness of drawings and an enlargement of details and the entire figure. These symptoms have been associated with functional insufficiency of the right hemisphere.

Our data testify to immaturity of visuospatial mechanisms of mental activity in children with attention deficit disorder. The character of deviations from the age-specific norm makes it possible to assume functional insufficiency of the posterior associative areas of both hemispheres. It is worth noting that these data agree

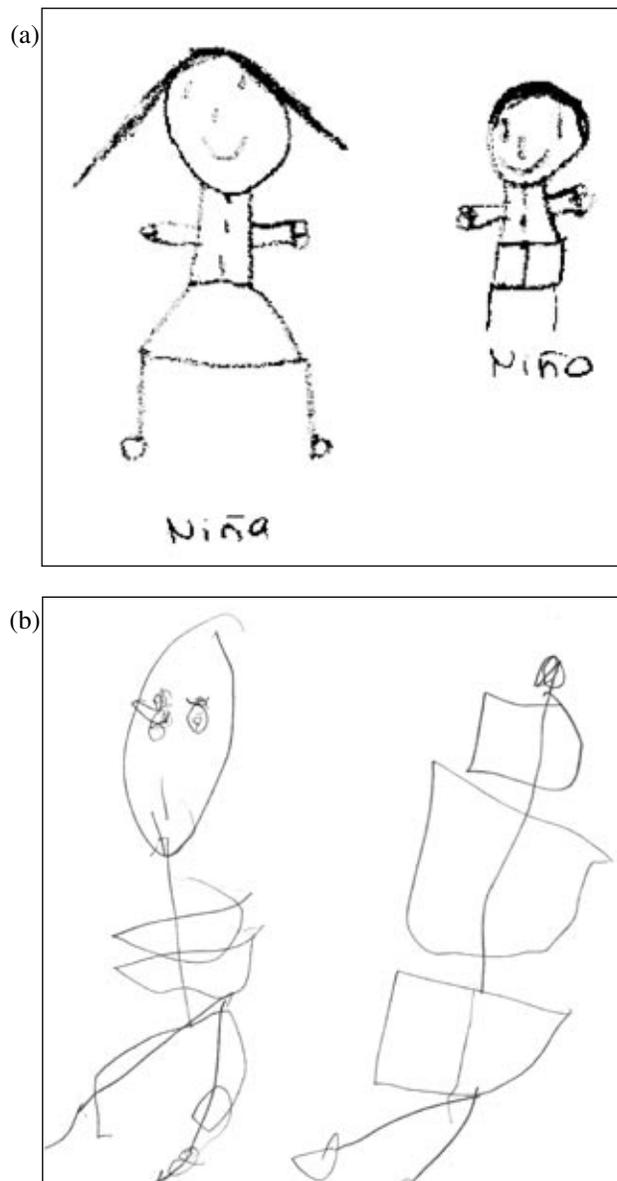


Fig. 3. Example results of drawing of a girl and a boy by (a) a child from the control group and (b) a child with attention deficit disorder.

with electrophysiological findings of Machinskaya and Krupskaya [26], who observed hypersynchronous rhythmic electrical activity in the α and θ bands in the caudal, including parietal, areas of the brain in children with attention deficit disorder. The authors have assumed a general decrease in cortical activation and a nonoptimal state of the occipital and parietal areas of both hemispheres.

CONCLUSIONS

Generally, our data testify to marked impairments of the parameters of spatial analysis and synthesis in children with attention deficit disorder. This finding makes

it possible to assume that the term attention deficit disorder does not reflect all features of psychological development in children with this diagnosis. We consider that it is incorrect to explain multiple difficulties by their association with attention deficit. It is most likely that different neuropsychological syndromes appear at the preschool age for different reasons.

Further studies in different countries will determine the systemic cerebral mechanisms of multiple deviations in the formation of cognitive activity in children of preschool age and elucidate their association with poor progress at school and other developmental and behavioral problems.

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