

## THE PECULIARITIES OF LATERALIZATION OF SYLLABLE PERCEPTION IN STUTTERING AND NORMAL CHILDREN.

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### ABSTRACT

The stuttering and normally speaking children of 4-16 years old have been found to show the similar mode of cerebral specialization age development for syllable perception, demonstrating left-hemisphere superiority beginning from 8 years old. This fact allows to suppose that one of the possible reasons of stuttering might be in some functions deficit of the right, but not the left hemisphere.

### INTRODUCTION

The investigation of central mechanisms underlying such disturbance of speech as stuttering is of great importance, and it is seen from a growing body of research and clinical literature of the past two decades. Some writers have supposed that a neurological central dysfunction might be an etiological factor in stuttering or a predisposing or contributing factor to the etiology of stuttering. The theory, that accounts for such dysfunction by the specific features of functional brain asymmetry (FBA) in stutterers, neuropsychological theory, proposes that stuttering is caused by "aberrant interhemispheric relations" [1].

Since stuttering usually appears in childhood, data indicating which disruptions in hemispheric interrelations are present in stuttering children take on particular importance. The hypothesis exists, that stuttering may be induced by an aberrance in the formation dynamics of functional hemispheric specialization during ontogenesis [e.g. 2-4 and some others].

Though there are not very many studies of FBA peculiarities in stuttering children, they are also, as in the case with adult stutterers, rather contradictory. Some of the authors have found certain differences in cerebral laterality between groups of stutterers and fluents both for perception of words

[2,4] and for perception of syllables [e.g. 3], while others have shown that stuttering children do not suffer any significant abnormality in cerebral processing [e.g. 5]. Though the results of these not numerous studies are rather controversial, a discrepancy in the data seems to be not very dramatic. Even the authors who reported the normal (left hemisphere) mode of speech lateralization for verbal perception in stutterers also marked the specific features of FBA for the latter, being of mostly quantitative character. They are: the lower magnitude of laterality degree and the fewer significant right ear advantages (REA) and more left ear advantages (LEA) as compared to nonstutterers [e.g. 3-5]. So the consideration of ontogenetic peculiarities of syllable hemispheric processing appears to be useful for further exploration of the hypothesis of "aberrant interhemispheric relations."

### METHODS

#### Participants.

A total of 55 stutterers and 52 nonstutterers participated in the study. The age of subjects ranged from 4 to 16 years, and they were divided in 6 age subgroups. The stuttering subjects were selected from speech therapy programs of the City Children Hospital and Speech Pathology Department of St.-Petersburg Institute of Ear, Throat, Nose and Speech Diseases, where they were receiving treatment for their stuttering. Normal subjects were selected from ordinary kindergarten and ordinary school. The stuttering severity determined by a physician had moderate or severe ratings. The stuttering subjects met the following selection criteria: (1) right-handed according to a brief handedness test based on Oldfield Handedness Inventory [6]; (2) without traumatic cerebral injuries; (3) with normal hearing according to tonal audiometry

for the frequencies 0.5-4 kHz (4) of average abilities and school achievement. (5) They had no previous research experience of such a kind. All stuttering children were matched with nonstuttering of the same age and other selection criteria. There were approximately equal numbers of girls and boys within each age level.

#### Stimuli and Procedure

The dichotic listening test has been used to reveal the interhemispheric relations. It was composed of 60 pairs of senseless CVC syllables. The experimental program consisted of 5 blocks, comprised of 4 trials. In the first block each trial consisted of one pair of syllables; in the second block each trial consisted of two pairs and so on up to the fifth block, in which trial consisted of five pairs of syllables. An interval of 20 seconds was left between trials for subject's response. The subjects were tested individually in a sound attenuated room. The audio tape was played to subjects at 60 dB SPL. The test items were presented to subjects through lightweight earphones from a reel-to-reel stereo tape recorder. The earphones were reversed to counteract any imbalance in the channels after each 5 blocks. The task of the subject was to identify the dichotically presented pairs of syllables.

The younger children told their identifications to the experimenter who put them in the response sheet and the children of 8-16 years old wrote their answers in the response sheet by themselves.

#### Analysis

Analysis of laterality was carried out. A lateralization degree (LD) was measured by the coefficient of asymmetry (Cas). Cas was derived for each subject using the widespread formula  $Cas = 100(R-L/R+L)$ , where R (or L) is the number of stimuli identifications correctly reported from the right (or left) ear. Using this index Cas values of less than 0 indicate LEA in a given task, and Cas values of greater than 0 indicate REA. Values of 0 indicate no ear difference. The mean Cas scores for each age subgroup

of subjects of both types were calculated. Then to test the statistical significance of the means T-test was used.

### RESULTS

The results obtained show the greater magnitude of LD in normal children as compared to stutterers, but for the age subgroup of the 4-5-year-olds, where significant difference in LD between stutterers and nonstutterers has not been found. The LD is dependent on the age of children of both subject groups. Normal children in the age range of 4-7 years old demonstrate the decrease of absolute value of asymmetry coefficient. Beginning from 8 years old the Cas increases, achieving its maximal value in the 12-year-olds. Stutterers demonstrate the increase of absolute value of Cas in the age range of 4-7 years, then the decrease of it between 7 and 8 years and then as in normals, beginning from the 8 years one can observe the increase of LD with its maximum in 12-13-year-olds. Then in 14-16 year-olds, in both normals and stutterers, the Cas decreases until values, similar to those, obtained for adult subjects [7]. Thus the results show the similarity of LD dependence on the age both in normal and stuttering children.

The analysis of the direction of lateralization discovers the negative values of Cas both for normals and stutterers in the age range of 4-7 years. That is in this age the LEA or right hemisphere dominance is observed. The qualitative change of lateralization takes place between 7-8-9 years in both subject groups. The change of sign in the age of 8 years demonstrates the shift of perception advantage from left to right ear and the REA or left hemisphere dominance remains in all the subsequent age subgroups both for stutterers and fluents.

The advantage of the ear is not absolute because the children of all age subgroups, both normals and stutterers, are shown to be divided in two parts: with the REA and the LEA. The number of children with the REA increases in the age developmental

course. The stuttering children of the 6-7 years old is the exception: in this subgroup the number of children with the REA (13%) decreases as compared to 4-5-year-olds (30%) and the number of children with the LEA increases.

The ear preferences in the subsequent age subgroups both in normals and stutterers are rather stable: the REA is observed in 65-75%, and the LEA in 25-35% of children.

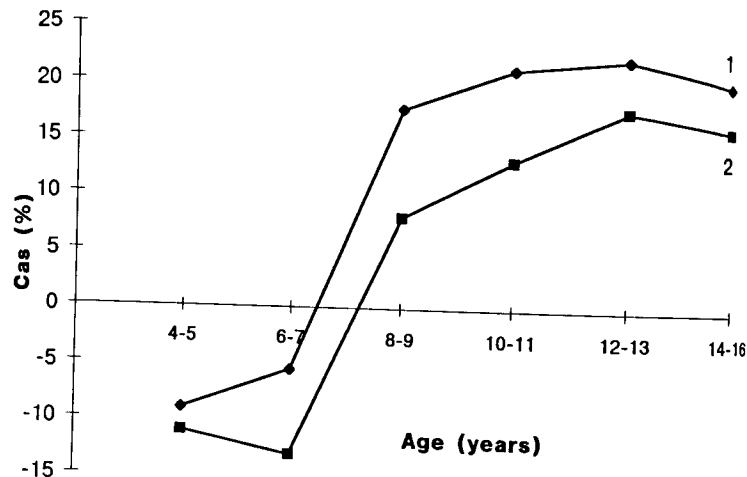


Figure. Changes in cerebral asymmetry over age in two subject groups: nonstutterers (1) and stutterers (2).

#### DISCUSSION.

The results of the present study showed that both normal speaking and stuttering children evidenced similar character of the FBA formation in ontogenesis for perception of syllables. However, some differences were found to exist between the two groups regarding the level of left-hemisphere dominance and the number of children having atypical processing of dichotic syllables and the development of these variables in the age course.

The results obtained for the stuttering children are consistent with the previous literature in which quantitative differences in the age development of functional specialization of hemispheres for the verbal perception have been found [2-4]. The left-hemisphere superiority has been discovered for stutterers beginning from the age of 8 years. The heterogeneity observed in the group of stutterers concerning the number of subjects demonstrating left-or right-ear

preferences is congruent to some extent with the studies of some other authors [e.g. 2,3]. The younger stutterers (6-7-year-olds) manifest fewer significant right-ear preferences than the older ones and they differ significantly in this index from their nonstuttering counterparts. This fact is consistent with the above mentioned studies, but the approximately equal right-ear preferences obtained for stutterers and nonstutterers, beginning from the 8-year-olds are in some disagreement with them. These authors [2,3] reported such data only for the older subgroup.

The present study indicates the similar character of the formation in ontogenesis of interhemispheric relations for syllable perception in stutterers and normals. It allows to suggest that stuttering might be connected not only with the disturbance of the segmental analysis, that is inherent to the left-hemisphere work strategy, but also with the activity of the right hemisphere. The literature suggests that normal right-handed

children exhibit the LEA, i.e. right hemisphere specialization for speech emotional information [8,9]. It has been found also, that in perception of emotional information an inversion of dominance, (i.e. left-hemisphere dominance for perception of emotions in speech), in stuttering children as compared to nonstutterers takes place and remains as the main peculiarity of the FBA in adult stutterers [4]. Thus, the stutterers have been found to demonstrate the qualitative difference in cerebral processing of emotional speech information as compared to normals while such difference has not been revealed for both word and syllable cerebral processing. This may suggest the functions deficit of right, but not left hemisphere in stutterers. The supposed left-hemisphere overload [10] might be caused by this dysfunction. Since speech is a complex performance, composed of multiple components, processed in different hemispheres [4,11] such overload might induce a disturbance in hemispheric competition [12] and as a result, the impaired speech performance - stuttering.

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