Speech Disorders in Right-Hemisphere Stroke

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Clinical practice shows that right-hemisphere cerebral strokes are often accompanied by one speech disorder or another. The aim of the present work was to analyze published data addressing speech disorders in right-sided strokes. Questions of the lateralization of speech functions are discussed, with particular reference to the role of the right hemisphere in speech activity and the structure of speech pathology in right-hemisphere foci. Clinical variants of speech disorders, such as aphasia, dysprosody, dysarthria, mutism, and stutter are discussed in detail. Types of speech disorders are also discussed, along with the possible mechanisms of their formation depending on the locations of lesions in the axis of the brain (cortex, subcortical structures, stem, cerebellum) and focus size.

KEY WORDS: speech function lateralization, speech disorders, right-sided strokes.

At the first stage of examination of a patient with stroke, the neurologist has to determine not only the etiology of the stroke, but also the question of the topical diagnosis of the focal brain lesion. One of the first questions is that of the lateralization of the stroke. The main criteria for identifying the lesioned side is usually the presence or absence of speech disorders and the side of the sensorimotor defect affecting the limbs and face. As a rule, in left-hemisphere strokes, particularly in the acute stage, the right-sided limb deficit is combined with speech disturbances, though the neurologist is not infrequently faced with the situation in which one or another speech disorder is combined with motor or sensory abnormalities in the left limbs. In this situation, the type of speech disturbance and its location along the brain axis (cortex, subcortical structures, stem, cerebellum) are particularly important. The diagnosis of acute cerebrovascular lesions has now been significantly simplified by the introduction of neuroimaging methods into neurological practice. However, cases of speech disorders in right-hemisphere strokes, their causes and clinical features, and the associated questions of the lateralization of speech functions continue to be discussed and this question is very relevant in theoretical and practical neurology.

Existing clinical observations have provided grounds for some re-examination of the stringent theory of the lateralization of brain functions and have provided deeper insights into the organization of speech functions and the structure of speech pathology.

The aim of the present work was to analyze published data addressing speech disorders in right-hemisphere strokes with assessment of the locations and sizes of focal brain lesions, types of speech disorders, and the possible mechanisms of their formation.

The following clinical variants of speech disorders are recognized in neurological practice: aphasia, dysprosody, dysarthria, mutism, and stutter [1]. In this context, we will consider their appearance in right-hemisphere cerebrovascular lesions.

Speech functions and their lateralization. The role of the right hemisphere in speech activity. The functions of speech are to encode thoughts and feelings in the form of language, and to translate external utterances and incoming information into mental concepts [2]. Four main speech modalities

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are distinguished – impressive speech, oral (expressive) speech, reading, and writing. Impressive speech includes perception, understanding of oral speech, and its retention in operative memory. Oral (expressive) speech consists of the formation and expression of thoughts and feelings in the form of spoken grammatically and lexically correct words, phrases, and texts, along with the ability to repeat foreign speech and names of objects. Reading is the visual perception and understanding of text. Writing is the formulation and expression of thoughts and feelings by means of writing words and phrases [3]. Each of these speech modalities is a complex functional system consisting of a multiplicity of components supported by the operation and interaction of different brain areas. Lesioning of any brain area impairs the functional system as a whole, i.e., all its modalities are impaired (to different extents and with qualitative specificity) [4, 5].

Speech functions, like other mental functions, are characterized by hemisphere asymmetry and interhemisphere interactions [2]. During early childhood, the hemispheres are equipotent in relation to speech. Specialization of the hemispheres starts during the second year of life, after which there is a gradual increase in interhemisphere asymmetry, which reaches its greatest extent by adulthood, gradually fading out with further aging [5, 6].

Development of lateralization of individual mental functions to one hemisphere leads to reciprocal inhibition of the areas of the other hemisphere linked with this function, i.e., so-called “tonic inhibition” by the other hemisphere. This reciprocity implies suppression rather than elimination of functions (which is important in relation to the rehabilitation of impaired functions).

There are several methods for determining the functional asymmetry of speech functions [7]. The methods used are dichotic listening and object naming with separate visual stimulation of the visual field. Patients with transection of the corpus callosum or hemispherectomy have previously provided a good model for studies of the speech functions of each hemisphere. The Wada test consists of sequential chemical “exclusion” of the hemispheres by administration of short-acting barbiturates into the carotid arteries [8]. In addition, CT scanning has been used to assess the sizes of the brain lobes, including the size of the “temporal area” [3]. Hemisphere dominance is now identified and speech functions are located using functional neuroimaging studies: fMRI, single-photon emission computed tomography (SPECT), positron emission tomography (PET), and transcranial Doppler scanning, which allow assessment of speech-related changes in cerebral blood flow and metabolism in the hemispheres.

Numerous clinical observations and studies have demonstrated that the left hemisphere is dominant for speech in most people [2, 3]. Only 1–2% of people have right-hemisphere speech dominance. The functional asymmetry of the hemispheres is not global in nature, but is partial and dynamic [9]. Thus, the involvement of the right hemisphere in speech processes increases in left-hemisphere epileptic seizures and during recovery after left-hemisphere strokes.

It is often said that there is a relationship between the location of brain speech areas and right- or left-handedness [10]. In the European population, “pure” right-handers account for about 40% of the total population, 50–55% being ambidextrous, i.e., to some degree left-handed, and 4.5–10% being “pure” left-handers [11]. Among right-handers, 90–96% show left-hemisphere speech dominance [7]. The question of speech representation in left-handers initially evoked strong controversy. However, the suggestion that hemisphere specialization in left-handers was the mirror image of that in right-handers and that the right hemisphere was dominant in speech did not receive support. It is now accepted that about 76% of left-handers also have speech representation on the left, while of the remaining 24%, about 14% have bilateral speech representation, with the right hemisphere being dominant in 10%. Overall, right hemisphere speech dominance is much rarer than left-handedness. At the same time, the probability of right-sided speech dominance is much higher in left-handers than in right-handers.

Apart from left-handers and those with a genetic predisposition, atypical speech lateralization is also influenced by factors such as lesions to the left hemisphere of the brain at the embryonic or early childhood stages of development, which leads to a shift in dominance towards the structurally unharmed right hemisphere [12]. Displacement of the cerebral mechanisms of speech to the other hemisphere may not be identical for speech and the hands. Social and cultural factors such as illiteracy, the use of tonal languages, and hieroglyphic writing also play some role in the incomplete lateralization of speech with a predominance of right-hemisphere dominance [9].

Left-hemisphere speech functions in right-handers have been well studied, as lesions produce profound and distinct speech disorders [4, 13]. Less obvious is the involvement of the right hemisphere in speech processes, though sufficient data have now been accumulated regarding its contribution to speech-thought activity.

The main speech functions of the right hemisphere in right-handers can be identified [3, 14]: regulation, perception, and production of the intonation-melodic aspect of speech, which emphasizes and colors the sense of an oration, the global perception of the schemes of texts, pictures, and life situations, the global understanding of gestures and expressions as components of verbal communication, the operation of speech automatism and stock phrases, the global perception and reproduction of the sound images of words, and the storage of speech automatisms, which are not subject to deconstruction into sound units, in memory.

Thus, right-hemisphere speech production is ordered in nature and is manifest as prepared formulas, in contrast to left-hemisphere speech, with is actively constructed by