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Discussion of the Anatomy, Physiology and Pathology involved in Dysarthria and Apraxia

ABSTRACT: The articulation of the speech sounds depends on the coordination and the movements of the articulator's muscles, the oral sensation and the overall sensory information (feedback mechanism) about the articulator's performance. When something is wrong with one or more parts of those units, phoneme misarticulations may occur.

Dysarthria and apraxia are disorders of speech due to lesion that affect the coordination and the movements of the articulator's muscles. We are going to discuss the anatomy, physiology and pathology involved in those two kinds of speech disorders.

A DYSARTHRIA:

Articulation of the speech sounds is the result of the bilateral muscle movement of the articulators. This process involves the motor system, the coordination centers, some cranial nerves, some cortico-spinal nerves and a great numbre of muscles.

The motor system is formed by the pyramidal and extra pyramidal tracts. The nerve fibers come from the precentral gyrus, in both hemispheres, travel downward by the pyramidal tracts, and after decussation of the axons of the pyramidal tract in the medulla, those axons concerned in articulation by the way of some cranial nerves, such as the trigeminal (V), the facial nerve (VII) an the hypoglossol (XII) innervate the muscles responsible for the movements of some articulators such as: the lips, the tongue, the velum, the larynx.

The process of speech utilizes the respiration process and the cortico-spinal nerves that are concerned in the movements of the thoracia cage. The respiration process is important to phonation, resonation and articulation.

The cerebellum, whose white matter includes three bundle of projection fibers connecting it to other parts of the brain, and the basal ganglia in the diencephalon are the centers for coordination and regulation of the processes involved in speech such as the articulation of the sounds.

The muscles involved in speech production and, mainly, those responsible for the movements of the articulators are related to dysarthria: muscles of phonation, of the pharynx, the velum, the tongue and some facial muscles.

When some of these structures are damaged, dysarthria may occur. The varieties of dysarthria depend on the damage or damages to a structure, but it may also occur a combination of dysarthrias, related to lesions in more than on structure. The lesions are related to pre-natal or para-natal or post-natal periods. The causes of brain demages are various. There are some lesions that the child is born with, the congenital ones. Others occur during the birth process-para-natal lesions. Most of these lesions are due to anoxia. A child that is normal at birth, but by some diseases or accidents has brain demage and an adult that contracts sclerosis or muscular distrophy are examples of natal lesions.

The bilateral lesion of the precentral gyms or the pyramidal tracts, or the basal ganglia cause dysarthria. As articulation depends on both side movements, when there is an unilateral lesion, dysarthria may occur, lent it is not as sereve as in case of bilateral dysarthria. In case of bilateral pyramidal lesions related to articulatory muscles, the tongue may appear firmer and shorter than the normal, the palatal and pharyngeal reflexes are exagerated, the articulation of the consonants, especially the labials and dentals are affected.

Lesion of the extra-pyramidal tract may cause muscular rigidity, immobility of lips and tongue and intelligibility. The pitch of the voice may be monotonous.

When the cerebellum or the basal ganglia are damaged, the speech is explosive, with separate syllables, irregular pitch (excessively low or high) and incoordinated respiratory movements may occur.

Lesion of the cranial or the cortico-spinal nerves or of the muscles cause weakness of the muscles of the articulators, affecting the movement of the lips (labial sounds), of the tongue (affecting dentals and gutturals), of the velum or/and the pharynx (bringing nasality) or of the larynx.

Lehiste (1965) described all speech deviations observed in dysarthria individuals and divided them in different features which characterize the speech of these individuals. He classified those features into three parts:

— Dysarthric deviations due «to lack of control over the activity of the velum», such as denasalization of initial or/and final consonants, nasalization of the syllabe nuclei or of non nasal consonants;

— Dysarthric deviations due to misarticulations such as, palatalization, retroflexion of no retroflex sounds, or vice-versa, devoicing of initial plosives, misplacements, distortions in manner of articulation, distortions in syllability and others;

— Dysarthric deviations due to insufficient control of activity of the vocal folds; such as laryngealization of consonants or syllable nuclei, breathy segments, voiceless transitions, devoicing of initial or/and final resonants.

Those deviations may be due to one or more lesions.

B. APRAXIA:

Apraxia is an inability to perform certain voluntary actions with conservation of the power of movement.

Apraxia was first described by Hughlings Jackson in 1866 (Brown, 1972):

«A patient will be unable to put out his tongue when we ask him, although he will use it well in semi-in-voluntary actions-for example, eating and swallowing. He will not make the particular grimace he is told to do, even when we make one for him to imitate. There is power in his muscles and in the centers for coordination of muscular groups, but he — the whole man, the «will» — cannot set them agoig».
(Lord Brain, 1965 p. 160).

This disorder was called differently «phonetic desintegration» by Alapouanine et al. (1939), «cortical dysarthria», (Bay, 1962) and «apraxia dysarthria» (Nathan, 1947), (Schuellis, 1975).

Apraxia is not related to automatic movements and is «not a separate entity related only incidentally through anatomical connections, but is the result of the interference in the genesis of voluntary movements». (Brown, 1972). This movement involves connections between the conceptual and motoric forms, as well as the sensory system. The development of an voluntary action, generally involves idea, kinaesthetic factors and sensation, which are largely unconscious processes, depend on the act, are organized in space and time and each new stage starts after the preceding one has been completed. In other words, each of those components of the voluntary movement shares constant correspondence between «the deep and surface mechanism» (Brown, 1972), whose correspondence gives the sequence of the act. The voluntary act, generally, involves visual and auditory sensations. It does not mean that both have to be present in all the action. Some acts may envolve vision, other audition, other both, and it may happen that other senses may be present in the acts. The process of speech, for example, involves an idea, motor movements, auditory sensations and sometimes, visual sensations. The «conceptual» language area is located in the parietal lobe at the level of the cerebral cortex. The Liepman's localization of the voluntary movement extended region is also located in the parietal cortex plus the precentral gyrus of the frontal lobe and is related to the language's area.

Apraxia is a disturbance of these areas: conceptual area of language that underlyes the voluntary movement area in the cerebrum, that affects the «lowest level (...) of a motor pattern which regulates the selection of appropriate muscles» (Lord Brain, 1965) for speech.

Apraxia is also related to lesion or lesions in the corpus colossum. Different types of apraxia exist, according to the location of the lesion.

The three major types were proposed by Liepmann in 1920 (Brown, 1972). They are:

— Limb — kinetic apraxia, which involves the lowest level of the motor system, causing a clumsiness of movement. This disorder is always limited to one side of the body or one limb and may occur in case of precentral lesions;

— Ideational apraxia is a result of lesion of the parietal lobe of the dominant hemisphere. The individual can not perform a complex movement because he does not have an «idea of the body parts to be used, the speed, rythm and sequence of movements». (Brown, 1972);

— Ideamotor apraxia, the individual can not organize the movements in space and time. He may perform automatic acts but not the voluntary ones. This type of apraxia may be present on both sides of the body, on the right side only or on the left side only. This type may occur when the parietal lobe of the dominant hemisphere is damaged. «If the lesion is somewhat further forward it may produce ipsilateral apraxia and contralateral hemiplegia» (Lord Brain, 1965).

If the lesion is of the corpus colossum other types of apraxia may occur or a combination of lesions of this part and of the cortex may also occur.

This is also a Liepman's classification: The «sympathetic dyspraxia» may occur in case of cortical and subcortical lesion of the left frontal part of the corpus colossum. It may occur with lesions of the right frontal cortex. It consists of apraxia of left arm and leg in patient with right hemiparesis. The corpus colossum lesion occur with left apraxia, and the subcortical lesion of the right side of the corpus colossum may bring the left side apraxia. (Brown, 1972). The Liepman's divisions were the basis for other studies and more specific types of apraxia are found and generally their names indicate its localization or its function. They are: facial apraxia, trunk apraxia, apraxia for dressing and constructional apraxia.

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