The causes of stuttering.

The structure of the process of speech production which lie starting with his end result – the speech signal is that the acoustic parameters of the speech signal determined by the shape of the vocal tract, shape of its walls and boundary conditions at its ends, and shape of stimulating pulses generated by the voice and other sources. The shape of the vocal tract and its changes are created because of the movement of articulatory organs: the tongue, lips, palatal curtain, the lower jaw, and the length of the vocal tract can be varied by lifting or lowering of the larynx. Move the articulatory organs are due to muscle contractions, and tongue and lips themselves are composed of muscles and their shape depends not only external but also internal muscles. The degree and sequence of muscle contraction and partly the dynamics of their reduction are determined by the characteristics of the peripheral and Central control systems. The interaction between the elements of the management system is very diverse. Muscle stiffness affect the speed of transient processes in the movements of articulatory organs and the frequency of the fundamental tone. Relaxation processes in the change of stiffness of the muscles are the cause of some features of movement of the articulatory organs. Muscle stiffness, in turn, can be changed by action of the Central nervous system either directly or reflexly in response to the activity of muscles-antagonists. In some cases, as, for example, for the lower jaw, the dynamic characteristics of the articulatory organ are largely determined by the elastic characteristics of the control muscles. The control system of articulation that provides the required position and shape of the articulatory organs at certain moments, must reckon with the mechanical characteristics of the vocal apparatus, and code properties of speech.

In some studies on modeling of stuttering experiments were conducted with a delay of perception of their speech and the gaps in perception (by means of microphone, headphone, computer, and special programs). For the first time such experiments were described in Lee B. S. Effects of delayed speech feedback - JASA, 1950, N 22, p. 824. It was found that with increasing time delays returned to headphones speech to 50-80ms. (in different sources different) the person begins to stutter, repeating individual phonemes, and when the delay to 1 s. repeats whole words. The maximum effect occurs at a delay of 200ms., moreover, this interval does not depend on the length of the word, i.e. the context. On the contrary, the stammering speech of the people is smoother in case of delay of acoustic signal or a masking white noise. Induced stuttering is accompanied by phenomena different from the phenomena observed during natural stuttering. In particular, check the electrical activity of the muscles of the larynx in experiments with delayed perception shows the oscillation of muscle activity, not like the oscillations during natural stuttering.

Famous experiments for the modeling of stuttering by artificial rupture of speech perception. The modeling technique of stuttering was based on the understanding of the speech process as a continuous "voice of the circle". A modeling diagram: Normal speech studied healthy \microphone \computer \short (0.2-0.5 s. at an average frequency of 1 break per 4 seconds for 30min.) artificial tears speech, provide a special program \earphone \the perception of broken speech \induced stuttering. Correction of speech was carried out using a DAF(delayed audio feedback), CAF(acoustic feedback, the filter breaks

the "speech circle"). If you decrease the duration of breaks to 0.05 seconds 20% of the subjects could compensate for artificial tears speech round without breaks of speech. The subjects have appeared periodic involuntary, spasmodic contraction of the muscles of the face and neck, its characteristics are similar to twitching stuttering.

First of all, you can pay attention to the differences in the electrical activity of muscles and external perception of speech in the simulation and stuttering natural stuttering. This observation suggests that experiments with short breaks perceived speech in the simulation of stuttering was not quite correct.

Based on the above research begs the question: Where not hypothetically, but in reality, there are gaps of perception of speech or the so-called unstable "speech circle"?

Pay attention to the temporomandibular joints. They are located in the vicinity of the ear canal. Dysfunction of the temporomandibular joint appear fairly noticeable noises (clicks) in the temporal region. Comparing the results of known studies given above, we can assume the existence of a relationship between dysfunction of the joints of the lower jaw, which is expressed in the form of noise in the joint, and the emergence of speech disorders stuttering.

This approach to the explanation of stuttering there is a need for more detailed consideration of the muscular system and the kinematics of the mandible in articulation.

MECHANICS OF ARTICULATION

THE LOWER JAW

MUSCULAR SYSTEM AND KINEMATICS

The lower jaw has a complex three-dimensional form and is able to rotate about two axes and also to move forward, backward and sideways. Compared to most other dynamics of the articulatory organs of the lower jaw can be described by a relatively simple model, since the lower jaw and its associated passive tissues represent a system with lumped diameters. Based on this assertion, we can conclude that the movement of the lower jaw while moving the joint to irregularities, we are interested in, can only be caused by the simultaneous work of several muscles that control the movements of the lower jaw. The dependence of the voltage of individual muscles during the articulation does not determine the position of the mandible, as movements are coordinated by several groups of muscles simultaneously. In such a complex system of movements adaptive reaction of the organism to the irregularities of the joint is not able to work steadily. Movement of the lower jaw are controlled primarily by muscles (Fig.1): temporal, chewing, outer and inner wing, front and rear dobrydney, the hyoid-lingual, chin-lingual and oral hyoid. In table.1 pros the particular muscles in any movement, and minuses — the lack of visible activity.

Fig.1. The muscles that control the movements of the lower jaw:

1 — temporal; 2 — the external pterygoid; 3 — the internal pterygoid; 4 — better; 5— posterior digastric; 6 — hypoglossal-lingual; 7 — maxilla-hyoid; 8 — anterior digastric; 9 — chin-hyoid.

Table 1.

Muscles. The involvement of muscles in movement of the lower jaw.

Up. Down. Forward. Ago.

Chewing + — + —

The temporal + — — +

The internal pterygoid + — + —

External pterygoid — + + —

Digastric — + — +

Chin-hyoid. — + — +

The hypoglossal. — + — +

On the radiograph (1.Theory of speech production which lie Sorokin V. N. p. 84-85) during articulation of consonants, s and sh, the lower jaw produces a movement in the horizontal plane with almost the same amplitude, which occurs in the vertical plane. On the basis of (Fig.1) we can conclude that the muscles to some extent duplicate each other in respect of any direction of movements of the mandible. In such a complex and interdependent system of control of movements extremely difficult to have stable articulation, besides, it should work adaptive mechanism that does not allow travel in the direction of the irregularities of the joint. In (Fig.2) you can see a direct correlation of rapid articulatory movements from displacement of the mandible in the horizontal plane. In the second and third case, when fast speech exhibits the greatest displacement on the horizontal axis, and, therefore, compliance, there is a noise (clicking) in the joint.

The position which the lower jaw is in the process of articulation depends on the context. In table. 2 shows the deviation of the lower jaw (in centimeters) from the initial condition with closed jaws. The first line of this table — the results of the measurements to the film and x-rays, and speech material consisted of isolated sounds — labials B, M, P, B, f, prednazone D, W, 3, N, s, T, W, sanaatana G, K, X, and vowels are divided into two groups, And, Oh, um, which corresponds to the first figure in the column "vowels", and S, And which corresponds to the second digit in this column. Lower jaw drops just below during the articulation of open vowels, whereas closed vowels are characterized by approximately the same degree of lowering with consonants. For perednezadny consonants lower jaw in a higher position.

Table 2.

Method of measuring the Deviation of the lower jaw, see, from the neutral position for the sounds.

Consonants. Vowels.

Labial. Perednezadny. Velar.

Movie roentgenochemical. 0.34 0.24 0.39 0.88 0.39

Optical. The norm. 0.22 0.25 0.22 0.24

Optical. Quickly. 0.19 0.21 0.19 0.24

Film and x-ray measurements show, however, that the same sounds in the other syllables are indicators of the position of the mandible. For example, in the syllable of HELL the position of the mandible for the first And is 0.8 cm, and D is 0.3 cm; the syllable YEAH for a first-And — 0,88 cm, for G — 0,88 cm; the syllable ABA for the first A — 1 cm, and for B — 0,62 cm On the basis of these measurements it is safe to say that the lower jaw has always played an active role during speech activity, regardless of its movements on any plane. The fact that dysfunction of the temporomandibular joint, for education in this noise, not necessarily producing large jaw displacement, it is enough to redistribute the tension of certain muscle groups. This would be enough for small movements of the mandibular joint in the horizontal direction and the gap "speech circle" for a short consonant sound.

In articulatory models, taking into account the position of the lower jaw, is usually taken into account only its rotation on the horizontal axis. Along with this movie x-ray measurements indicate the existence of horizontal displacement, forward or backward, so that in the sagittal plane, any point of the lower jaw describes an ellipse. From the testimony of film and radiographs for two positions of articulation of the consonants s and sh, it is seen that there is a shift of the mandible in the horizontal direction, and the magnitude of the shift is approximately equal to 0.2—0.3 cm, comparable to the degree of its vertical displacement for these sounds. In General, the lower jaw can play in processes of articulation is very important, especially for perednezadny sounds and an accelerated rate of articulation, as will be seen below.

Fig.2 the Dependence of the rate of movement of the lower jaw of the amplitude of the displacements.

1.- A slow rise.

2.- Quick upgrade.

3.- Express down.

4.- Slow down.

The known experimental facts, which indicate that in the artificial limitation of movements of the mandible, causes adaptation, which is expressed in increasing the mobility of the other muscles involved in speech activities. When working in conditions of limitation of mandibular movements some muscles to some extent substitute for her work during the articulation. Why stuttering does not happen like this adaptation? Does research data on the intentional limitation of movement of the lower jaw and results in the study of stuttering, and also, what is the relationship between a stable articulation, and noises in the joints of the lower jaw? The fact is that during the articulation of the lower jaw produces a precisely coordinated movements, and adaptation to the irregularities of the joint must develop a mechanism movements. In the case of the stuttering that is not possible, because of the limitation of mandible movements during adaptation of the organism to the conditions of work in the natural stuttering does not have a rigid framework (noise can be observed at different positions of the lower jaw). It is therefore not possible to adapt to the concerted action of the movement of the jaw muscles, tongue, and lips in dynamics with articulation. In human life there are moments when it is required for very clear articulation (including in childhood, when the formation of speech). However, he is forced to produce movement of the mandible with greater amplitude (so, gradually, throughout life, developing a mechanism of certain movements of the lower jaw). Followed by adaptation, which is stored in the form of stuttering.

The joint head in the joint will have limited movements during speech activity as speech activity associated with the perception of sounds, while the joint is trying to gain a foothold in a pathological situation, the same muscles with the articulation adapt to work without causing any noise in the joint. When chewing the same food, the stress on the joint of the lower jaw to the maximum, so the offset of the articular head relative to the glenoid cavity and irregularities in the joint is minimal. It is with the articulation of the jaw muscles that work hard during the chewing of food involved is less, so the load on the temporomandibular joint is somewhat reduced, while the articular head begins to move with greater amplitude, causing it to shift with respect to the irregularities of the joint.

From experiments it follows that when you reduce breaks speech up to 0.05 seconds 20% of the subjects could compensate for artificial tears speech round without breaks of speech. This fact can be

explained. In the experiment, the perception gaps were positioned randomly relative to the spoken sounds. Speech disorders with such short breaks is possible only under the condition that noises will be produced in a precisely defined point in time at a certain position of the joint of the jaw and a certain position and muscle tension. When breaks the “speech circle” begins to work as an adaptive mechanism which adjusts the movements of the lower jaw and the muscles engaged in articulation. After adjusting again the pronunciation of any sound on which the new adaptation of ruptures of speech, whereby there is a new adaptation, and so on to infinity. In this cycle of adaptive mechanisms stable articulation impossible. Thus, gradually developing a distinct mechanism of motion during articulation. Factor of tension in the muscles when moving the jaw also plays a role: the more tense the muscles of the lower jaw at the articulation, the clearer become the noise in the joint. This factor requires a person to speak more loudly, to recover the feedback and implement stable language processes. Most likely, this is in the early stages of the emergence of stuttering. The fact that the noise produced at a certain point, suggests that breaks in the speech range occurring on a particular sound in human speech, that is what prevents him from making clear, consistent and stable articulation.

Will conduct logical analogy. For example, a person says some phrase:

1. Carl from Clara stole corals. (The underlined letters it breaks the natural stuttering).

2. Carl from Clara stole corals. (The underlined letters it ruptures in experiments on modeling of stuttering(0.2-0.5 seconds with an average frequency of 1 break per 4 seconds for 30min)).

You may notice that in sentence N2 breaks the so-called "voice of the circle" produced randomly on certain sounds, while in sentence N1 of perception are eliminated precisely defined sounds. So, the perception with artificial tears “speech circle” still periodically restored, and the person hears the spoken passages of speech. This intermittent speech is not homogeneous, that is, the perception gaps do not occur on a particular sound in speech, and constantly changing in time. This means that they are unable to provide a stable gap for a certain sound. That is, in experiments on modeling of stuttering was missing one very important factor that under no circumstances it is impossible to simulate outside of the body. This factor represents a clear and at the same time constantly changing interdependence of mandible movements with the muscles producing its motion, and Vice versa, and the role of adaptive mechanisms that produce the management and coordination of speech activities. These adaptive mechanisms do not allow for the implementation of the articulation of how to implement movement, leading to noises in the joint, and the right to adjust the dynamics of movement.

Although the increase in artificial tears and is more stable the result (the gap of voice range), but it turns out only because of the perception eliminates all possible information, and from recoverite certainly excluded periodically restore points.

The treatment with DAF (delayed audio feedback), really, can reduce speech rate and improve the human condition, however, during long training occurs simple adaptation to the new perception. This is because movement of the jaw, tongue and lips should be agreed, and their pathological condition even prevents them from using acoustic feedback to implement language processes. In connection with the adaptation of the (perhaps psychological) from any sounds in the joints, the movements of the lower jaw are driven into the “uncertain” framework, under which all the time is finding the right movements.

There is another known feature in the articulation of people suffering from stuttering. This feature is reflected in the complexity of pronunciation that is consonants, while for vowels any difficulty arises. It is easy to explain. The fact that the pronunciation of vowel sounds, the movements of the lower jaw is

practically not observed, the more they are pronounced without the formation of so-called bows, and therefore the simultaneous tension of the two muscle groups. 1.muscles coordinating the movements of the lower jaw 2. Muscles of articulation (tongue, lips, etc.). Pronunciation of consonants occurs in the formation of the so-called "bond". Stable job "bows" (the pronunciation of any consonant sound) is only possible with a clear fixation of the mandible during pronunciation. In Fig.1 can be noticed that the fixation of the lower jaw is only possible if simultaneous operation of several muscles:

1. Temporal.

2. The external pterygoid.

3. The internal pterygoid.

4. Chewing.

5. Back digastric.

6. Hyoid-lingual.

7. The hypoglossal.

8. Anterior digastric.

9. Chin-hyoid.

On consonants always occur the so-called “explosion of bows”, which always is observed only when the coordination of multiple muscles, this is not to forget about the fixation of the lower jaw. For timely implementation of the "bows" during the articulation of a necessary relaxation of the relevant muscles involved in the pronunciation of certain sounds (it could be a couple of muscles when pronouncing the closing of the lips or tongue muscles when the bow in the palate), the jaw at this time must remain "temporarily stationary over time". That is, during the formation of each bond's jaw still performs the preparatory movement before its formation. This is due to the alternation of sounds in a word or phrase. These preparatory movements are often movements of the jaw in the horizontal direction "up". The feature of motions of the lower jaw lies in the fact that the vertical movements there is a slight displacement of the jaw at the same time and in the horizontal direction, which leads to a small displacement of the joint relative to the irregularities. That is, the vertical movement cannot occur without movement in the horizontal direction. You notice that the time of pronunciation of the sound when "the explosion bond" is extremely short (>> 0.05 seconds), which is based on the experimental data allows to speak with confidence about the break-up "speech circle" at consonants in the speech, as the time of pronunciation of vowels takes more time (<< 0.05 seconds). Besides the pronunciation of vowel sounds, jaw movements are observed only in phrases or syllables. So, to implement the bond in the pronunciation of consonants requires a clear fixation of the muscles of the lower jaw. However, with short-term fixation of the mandible to form a "bond" during continuous articulation is a constant change in its provisions, it is impossible to keep the jaw from moving in a horizontal plane, which leads to displacement of the articular head relative to the irregularities of the joint. That is why problems with the pronunciation most often appear on the consonants.

From the above studies of the kinematics of movements of the mandible should be that a clear dependence between movements of any individual muscles and movements of joints relative to no unevenness. Dynamic movements of the mandible can be described by a model with lumped diameters,

each of which in varying degrees able to influence the movement of the mandible relative to the irregularities of the joint.

Again, this refers to the time when there is an adaptation wrong, (it happens in childhood), later any noise in the joint is not observed. Moreover, to adapt to them, also not possible, so there are spasmodic movements of the lower jaw, with the speech, and not in the chewing of food (as it is associated primarily with the perception and correction of sounds).

How are the perception gaps:

Immediately upon the perceived distortion of sounds (work breaks perception of speech). Known cases of violation of speech because of the noise from the rhythmic sounds of the clock mechanism, and when talking to several people at once. The same occurs when the noise in the joint (they are sharp and clear). In noise in the joint is distorted sound signal of speech, resulting in lost information on the perceived sound and there is a "misalignment of the action and expected result." Therefore, a search for such movements, which do not lead to any noises in the joint, that is, when it produced a reflex in which there are periodic involuntary twitching of muscles of face, neck and lower jaw.

Degree speech disorders may also be determined by the nature of the joint dysfunction.

There are a few factors that also need to be explained. For example, clicking in the temporomandibular joint can occur in the absence of teeth on one side of the jaw, arthritis or arthrosis. These facts can also be explained. Arthritis or osteoarthritis of any noises in the joint are observed not only in articulation, but also during chewing movements, as they occur due to damage to the cartilage in the joint. In the case of the stuttering damage the cartilage of the joint may not occur, and there is only dysfunction in the movements of the joint. Especially in the later stages of development of arthritis and osteoarthritis appear pain in the joints. Stuttering is also necessary to clicks in the joint occurred regardless of the particular position of the mandible, they should not have the rigid structural component. This requires the participation of another binding factor, namely, a certain muscle tension in the implementation of speech activity (articulation). So now there are multiple interrelated factors. 1.The sounds in the joints are observed only when articulatory muscle tension. 2. The sounds in the joints cease only at adaptation, which is expressed in spasmodic movements of the lower jaw and articulatory muscles. Taken together, these two mutually exclusive factors are the desired cause that under no circumstances can not afford to provide stable voice process.

Conclusions.

Proceeding from the presented reasoning, we can draw several conclusions:

1. Stuttering can be seen not only as a result of unstable operation of the "speech circle", but also as constantly changing in time adaptive work of the body in unstable conditions. Unstable conditions are expressed in variable interdependence articulation movement of the mandible.

2. Development of adaptation and implementation of stable articulation in the presence of a number of interdependent factors, which in varying degrees influence, as speech activity, and directly on top of each other, under no circumstances not possible.

3. The sounds in the joints are observed only when articulatory muscle tension.

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