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# A CONTRIBUTION TO THE PATHOLOGY AND THERAPY OF DYSARTHRIA DUE TO CERTAIN CEREBRAL LESIONS*

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## I. Introduction

Interest in the speech and the speech development of spastics is increasing all over the country. Recent publications by different writers show that work is being done to improve the methods which are used in their treatment. Helen R. Fagan (**4,5**), Palmer (**13**), Pusitz (**15**), Robbins (**16**), Carlson (**3**), and Zentay (**22**) emphasize the necessity of utilizing all expedients of modern neurology and logopedia in order to balance the sequelae of injuries to the central nervous system. Very impressive are the two self-descriptive articles written by spastics and published in the *Journal of Speech Disorders*, one anonymously (**1**) and the other by McKibben (**11**).

I suggest the use of the term *dysarthric* rather than *spastic* speech, because the spasms of single muscles or muscle fibres are almost regularly mixed with the paretic stage of others. The name spastic does not denote both kinds of signs, and may even be the cause of neglect of the paretic signs. Their combination complicates the treatment, since even a single muscle may be afflicted in its different fibres both spastically and paretically.

For a preliminary orientation some common signs in certain groups of dysarthrias may be enumerated, but not without the restriction that these signs may be modified in the single case. Such modifications may be due to special anatomical or functional troubles. These various possibilities will be subject to later consideration.

In dysarthrias due to lesions of the pyramidal tract the movements of articulation are sluggish and clumsy, and often hyperrhinolalia is obvious. The total impression is that of blurred speech. The voice is sometimes spastically, sometimes paretically, hoarse and weak, and even aphonia may be present.

In injuries of the frontal brain, or of the pathways leading from the frontal brain to the pons, the impulse of the movements is inhibited. The movements may stop before being completed. Monotony and acceleration are characteristic. Sometimes no

*This article is dedicated to the memory of the late Dr. Max A. Goldstein.

articulation is audible on the end of a phrase, but there is a buzzing, occasionally an interrupted buzzing. Concentration on the pronunciation slows the speech down and makes it more distinct.

Combinations with extra pyramidal signs are not infrequent. Together with Schilder I (6) found in such cases a very remarkable deficiency of chest breathing. The pallidum also participates in this picture, producing palilalia and mega- or microphonia. The same is the case in isolated lesions of the striatum pallidum. Palilalia consists in repetitions of syllables, words, and groups of words, especially on the end of a phrase. Megaphonia means shouting, microphonia means a weakness of the voice. Many cases of chorea and athetosis belong to the group of impediments caused by the striatum pallidum, in regard to which Putnam (New York Neuropathological Society, November 11, 1941) certainly is right in saying, as to the question of athetosis and choreo-athetosis, "I find it very difficult to know where one category begins and the other ends."

Another kind of dysarthria is due to injuries of the paths going downwards from the pallidum. Monotony and monorrhythm, signs of fatigue and a blurred articulation are present. Tremor and whispering sometimes complicate the picture. In Wilson's disease the articulation is extremely blurred, and the muscles are of a waxy stiffness.

Cerebellar ataxias are frequently characterized by a rough, compressed monotonous voice. Schilder (6) mentioned as typical for cerebellar injuries adiadochokinesis, in which the degree of contraction rapidly diminishes. On the other hand the patients exaggerate the first impulse and interrupt the impulse too early. Scanned speech is another cerebellar symptom. Lesions of the peripheral nerves, the face, the mouth, the pharynx, and the larynx, naturally influence speech and voice.

The most important peripheral dysarthrias are due to lesions of the pneumogastric and the facial nerve. The former is the motor nerve of the soft palate and the motor as well as the sensory nerve of the larynx. Concerning the paralysis and paresis of the laryngeal muscles (paralysis and paresis of the recurrent nerve) I refer the reader to the laryngological literature. (Numbers 2, 3, and 4 of the *Journal of Speech Disorders*, Volume 7, and Number 2 of Volume 8 contain a bibliography of this topic by C. R. Strother.) I want to mention only a single fact which might be of special interest to the neurologist, namely that there is a possibility of discriminating an acute lesion of this nerve from an old one even if the case history is not reliable. Every case of acute paralysis or paresis of the recurrent nerve shows severe disturbances of speech breathing, as has been proved in cases that acquired the lesion during a goiter operation and whose case histories therefore were reliable. Their waste of air and very frequent inhalings are characteristic. If the physician

simply counts the number of inhalations during one phrase, and finds them not too frequent (as compared with his own breathing when he speaks the same phrase) he may be sure that enough time has passed for compensating the breathing trouble. This compensation takes many months. Such a case, therefore, is chronic. The opposite finding of too frequent inhalings is not indicative of acute cases only, because some chronic ones may not have learned yet to compensate their pathological breathing (**7**, 233-235.)

Paralysis or paresis of the palatal motor nerves hinder either entirely or partly the shifting of the velum. Sometimes only one half is damaged, or is more damaged than the other. In such cases the not damaged, or less damaged, part will still rise completely or rise relatively more than the other. Air will enter and pass through the nose also while non-nasal sounds are pronounced, a fact which becomes especially evident to the listener when he hears voiced sounds. All of them show a component which is similar to the physiologically characteristic property of [m], [n] and [ng], namely nasality. This trouble is generally called rhinolalia aperta, but it seems to me that the name "hyperrhinolalia" is more appropriate. The possibility of an "active hyperrhinolalia" will be mentioned later.

Over-contractions of the tensor and levator veli, frequently joined with similar conditions in certain pharyngeal muscles, produce the clinical picture of hyporhinolalia (rhinolalia clausa). Such a state is often of short duration and may also change with the hyperrhinolalia. Choreatic contractions of the velum sometimes are responsible for hyporhinolalia (as well as for the opposite state). The voice sounds as though adenoids were hindering the normal resonance of the nose.

In facial paralysis affecting the third branch it is the lip sounds that suffer. But since articulation between the lower lip and the edges of the upper incisors is a sufficient substitute for bilabial articulation, the functional result of facial paralysis is frequently very insignificant. (If the patient himself has not found this way of compensation, he can be easily taught to use it.) In unilateral paralysis the plosive sounds [b] and [p] may be too "airy" and therefore resemble the fricatives [f], [v] and [w]. (In such cases the patients should be taught to eliminate also the normal half of the upper lip in pronouncing [b] and [p], and to replace the bilabial by the dentolabial articulation. All such attempts are, of course, indicated only if the paralysis cannot be improved or cured.)

I mentioned above the possibility of a combination of spasticity and paretic stages in different muscles, or in different parts of a single muscle. According to investigations on "spasticity" by Phelps (**14**), the first mentioned fact is a general condition in "spastics." He has found that this combination of spastic and paretic conditions is almost always present, and that not every

permanent or temporary over-contraction of the muscles is due to anatomic pathological changes in the centers corresponding to those muscles. This is to say that some muscles, forced to drag along a paretic mate during a certain work, may gradually come into a state of over-contraction. This also holds true so far as the speech muscles are concerned. It can also be easily understood that the muscles finally tire and become functionally paralyzed under the destructive influence of such efforts.

There may exist also different degrees of paresis in different fibres of the same muscle. That becomes obvious if one asks the patient to hold some corks with his lips. I have chosen a series of corks gradually increasing in size by half a millimeter in diameter. Many of the patients with conspicuous signs of damage to the lips could hold one cork, but could not hold the next larger, or smaller, one. That seems to imply that some fibres, especially fibres of the orbicular muscles, are more afflicted than others. In some cases the lips become hard and stiff holding one cork, but become soft and powerless at an effort to hold the next. This observation seems to corroborate the opinion that some fibres may be affected spastically and others paretically.

Frequently we may find out by tactile examination that some muscles are less spastic than others, or that they are even paretic; but it is difficult to judge the condition of the soft palate, which normally rises in order to touch the pharyngeal wall during the pronunciation of all German and English sounds, excepting [m], [n] and [ng]. In the latter sounds, the so-called nasal sounds, the soft palate hangs down and allows the air to enter the nose. A paretic or paralytic state of the soft palate prevents, as has been shown in a preceding paragraph, the closure between the nose and the mouth, thus causing hyperrhinolalia. My former assistant, Weiss, has found that there may also occur an active intention to prevent the palate from rising ("active hyperrhinolalia").

An attempt to analyze dysarthric speech more accurately reveals the following signs: Many dysarthrics have great difficulties in chewing and swallowing and are unable to speak with a morsel of food in the mouth. If the chewing muscles are affected, moving of the jaw will be difficult. A partial or total paralysis of the tongue will increase the difficulties, because the tongue must turn the food in order to mix it with saliva, and to take it to the entrance of the pharynx where the swallowing reflex rises. Patients sometimes drop the food; fluid returns through the nose and choking is a frequent feature, especially in infants. Eating and speaking movements have a common source and that is why every progress in treatment of one of these functions includes progress in the other. When we treat dysarthria we treat chewing and the accompanying tongue movements at the same time. The experience that progress in one of these two functions in dysarthrics influences favorably the other function proves the

theory of the common origin of speaking and chewing (**7**, 179-180).

A general description of the different forms of dysarthric speech is sufficient neither for diagnostic nor for therapeutic purposes. Profound analytic methods, therefore, are strictly indicated.

## II. Analytic Investigations on the Partial Functions of the Speech Mechanism

*Breathing.* While a person is silent the duration of inhalation and of exhalation are almost the same. In singing and speaking, however, as well as in crying, the ratio between inhaling and exhaling changes remarkably. Inhaling is short and deep, exhaling slow. Gutzman (**9**) described "physiologic incongruity" between thoracic and abdominal movements during speech. The abdominal wall sinks before the thorax. Several writers, Schilling (**19**), for instance, describe a lack of physiologic incongruity in some forms of central dysarthria.

Simple optic observations may inform us about some peculiarities of the respiratory movements. Tactile investigations, however, are more reliable. The investigator touches the thorax with one hand and the abdominal wall with the other. Using this simple method I found, as previously mentioned, a lack of thoracic breathing in some cases of dysarthria after encephalitis lethargica; Schilder (**6**) confirmed my finding. The most exact findings have been obtained by pneumography.

Breathing troubles in central dysarthrias may be present in silence or in speaking. During silence breathing is sometimes very shallow, but sometimes it is abnormally deep. Laryngoscopy reveals some of the underlying causes for those facts, as will be shown in the section on "Voice" which follows presently. Congruities between the curve of the thorax and the abdomen may exist. During reading and speaking normal incongruity may be absent permanently or merely occasionally. Inhaling often starts too early, that is to say before the inhaled air is consumed. However, waste of air and consequently a breathy voice are frequently noticeable. The abdominal wall may show movements opposite in phase to the movements of the thoracic wall, which indicates that diaphragmatic respiratory movements are not congruent to those of the ribs. In addition, a quivering of the muscles can be inferred from the appearance of too many peaks contained in the ascending and descending parts of the pneumographic curves. Breathy voice, disturbed modulation and disturbed loudness and pitch are direct consequences of pathological breathing. Not only the vowels but also the consonants will be affected. Waste of air will frequently result in insufficient breath pressure for producing continuous speech. This factor will be especially harmful to explosive sounds but also to all other sounds and will, of course, influence their loudness. Dropping of the jaw as well as ob-

structions of the nose may prevent nose breathing. Our aim to strengthen the muscles which close the mouth will, therefore, be of general value for the system. The different groups of disturbed functions combined with each other explain the immense variety of symptoms briefly mentioned above.

*Voice.* Attempts to register the movements of the vocal cords with graphic phonetic methods have not been successful as yet. Laryngoscopy is still the most reliable method. The fact that pathological laryngoscopic pictures of dysarthrics do not appear as frequently as would be expected calls for explanation. Everyone not accustomed to a laryngoscopy will move his vocal cords too forcibly. This higher degree of innervation is effective also in cases which normally often fail to give voice. Nevertheless, some pictures valuable for understanding of the pathology have been obtained by laryngoscopy. The movements of the vocal cords during respiration are often abnormal. Normally, exhaling is associated with a triangle-like opening of the glottis with a base of about two to three mm. In our cases this opening is too small in a few instances, but frequently too large owing to flabbiness of the closers or cramps of the openers,or in the first case because of a spasm of the closers and flabbiness of the openers respectively.

Many patients begin an initial vowel explosively, as a result of a too hard closing of the glottis at the beginning of the sound. Physiologists call this hard beginning "hard onset" as compared with a smooth beginning which is called "soft onset."

The voice of a dysarthric can best be judged acoustically. That the pitch is often abnormal and may be either too low or too high, and that there occur deviations from the normal loudness has already been mentioned. Normal inflection is frequently missing and is often exaggerated, especially in states of excitement. West, Kennedy and Carr (**21**) use the word "tenseness" as most descriptive of the quality of these voices.

Systematic examination of the voice is essential. First, one must determine the number of sounds the patient is able to sing. The number of tones, which may be called circumference of the voice, may be very small. The upper resonating cavities, namely, the pharynx, the mouth and the nose influence the pitch and, of course, the timbre. In this connection Dr. D. Weiss' method is very illustrative. A wooden or metallic tube put between one's lips during the singing of a scale will produce a sudden break of voice at a certain pitch. If tubes of different lengths are used, one after the other, the voice will break at different pitches, according to the length of the tube. The tube is nothing but an immobile mouth. This experiment teaches us that the primary tone production can be destroyed or stopped if the tones enter a cavity, the form of which is not fitted to every tone produced. The mouth and the pharyngeal cavity are mobile and adapt themselves instinctively to the momentary pitch. In other words,

these cavities must change their shape for the resonance of different tones. If stiffness or flabbiness of muscles prevents the mouth and pharynx from rapid changes of shape, tones of certain pitches may break or even be destroyed. Therefore, any training of movements of the lips, tongue, palate, and so on will favorably influence articulation as well as voice production. Dysarthrics may benefit from the application of methods used by singing teachers to enlarge the circumference of their students' voices. Those methods serve three common purposes: (a) training of the muscles which stretch and extend the vocal cords, (b) strengthening and regulating exhalation, thus influencing those muscles indirectly, and (c) influencing the function of the vocal cords by improving the shaping of the resonating cavities.

Secondly, we must ascertain whether the patient is able to maintain a certain pitch for a certain time. Different causes may account for a lack of this faculty, such as disturbed respiration, abnormal functioning of the vocal cords or of the resonating cavities, or a combination of these deficiencies.

The so-called "swelling" tones are of the greatest significance in normal speech. A swelling tone is a tone the loudness of which gradually increases or decreases. Many a person with disturbed voice raises or lowers the pitch while increasing or decreasing the loudness. However, the normal swelling tone should not be changed in pitch. Swelling tones are frequently used for emphasis in everyday-life conversation. An unintentional synchronical change in pitch changes the meaning, and must therefore be avoided. Furthermore, dysarthrics frequently lack the ability to jump rapidly from one pitch to another. That the dysarthric cannot sufficiently regulate the loudness of his voice has already been mentioned. The examiner should also ask the patient to give sounds rhythmically in different tempi and at different pitches. A metronome will prove useful for this purpose. Inflection or modulation of the voice is a combination of all the faculties mentioned above and this factor will be very unsatisfactory in spasticity as well as in a condition of flabbiness.

*Articulation.* An analytic examination of the articulative muscles is somewhat easier than one of the respiratory and laryngeal muscles, because simple optic observation furnishes many important findings. (X-rays, as a rule, are superfluous.) This is probably the reason why some neurological symptoms which indicate the condition of these muscles have been detected. Some troubles in muscular activity may be seen at the first look. If the jaw drops and saliva is moistening the skin we will be fairly well-informed about an affliction in the muscles responsible for the closure of the mouth and for deglutition. In order to localize the site of the defect, we must examine in such a case all the sets of muscles involved in the closing of the mouth. It may happen that the patient can raise and drop the jaw fairly well, but cannot close the lips. On the other hand, he may be

able to close the lips firmly when the examiner helps him to lift the jaw. Sometimes a spasm of the digastric muscle is responsible, because it prevents the jaw from rising. The same result, however, may be the consequence of paralysis of the muscles lifting the jaw (masseter muscle and temporal muscle). In spasticity the masseter reflex may be increased and may be clonic. Sometimes the reflex on one side is stronger than on the other, indicating that there exists a difference in the excitability of the two sides, owing to flaccid paralysis on the one side or spasm on the other, or to unequally strong flabbiness or spasms on both sides. The upward and downward movements of the jaw are especially important for speech. Therefore, we will inform ourselves about those functions by directing the patient to raise and lower the jaw. If he is not able to accomplish these movements, we can use a mirror to help him optically. If necessary, we raise the jaw with our hand in order to feel how much power must be added to the patient's effort, which may indicate, for example, how much resistance arises from the digastric muscle. An analogous investigation must be performed to ascertain the patient's ability to drop the jaw both without and with some resistance produced by the examiner's hand. Furthermore, we must examine the downward drawing and raising of the corners of the mouth as well as of the lips, the drawing sideways and narrowing of the corners of the mouth, and finally the protrusion of the lips. If necessary, we use a mirror and assist the patient with our hand in order to inform ourselves about the degree of impairment.

We test the mobility of the tongue by directing the patient to protrude step by step the tongue toward the teeth, the lips, and out of the mouth cavity, to move the tip gradually to the ridges of the upper and under incisors, to the right and left corner of the mouth, to the upper and lower molar teeth, and to turn it backward to the soft palate. If any deficiency becomes obvious, we use a mirror and assist the patient with a spatula in our hand. To measure the degree of paralysis of the protruding muscles we use a handkerchief for holding the tongue and drawing it slightly forward. Thus, we can find out a great deal about the flabbiness or spastic resistance of the muscles involved. Next we are concerned with the faculty of raising the back of the tongue and its backward drawing. If one side of the tongue is paralyzed, or one side is paralyzed more than the other, the tongue deviates toward the weaker side because the stronger half pushes the weaker half towards the side of the latter.

The jaw, lips and tongue should also be examined with regard to their ability to repeat all these movements. The patient must, for instance, be directed to drop or elevate the jaw several times. Thus, we may find that the movement performed once cannot or can only less accurately be repeated a second or third time. There may be a delay in the repetition so that the normal rate

per second may not be reached. This number is five to seven concerning the jaw. Also the power of the different movements during iteration may deviate from the norm. A metronome is very useful for the examination of iterations.

The pharyngeal reflexes are decreased or absent if the sensibility of the area touched is diminished or destroyed. This may be caused peripherally but it is usually due to a central lesion. Another cause of such disturbed reflexes is palsy of the pharyngeal and palatal muscles. If the soft palate does not rise reflexively because of true (not hysterical) paralysis it will not move in speech either. However, it is possible that the function of this organ may be defective in speech and yet react reflexively without delay.

To inform ourselves about the speech function of the soft palate we look into the opened mouth while the patient says "ah." Abnormalities due to dysarthria which occur during speech are the following: (1) no movement of the soft palate; (2) insufficient movement of the soft palate, that is to say, it does not rise enough to close off the mouth from the nose, thus causing hyperrhinolalia; (3) rising of only half of the soft palate or stronger rising of one half. In the latter case the uvula will be drawn toward the stronger side.

Spacity of the soft palate may produce a picture similar to that of active hyperrhinolalia. Schlesinger (**20**)* described a diminution of hyperrhinolalia in the supine position, where, following the law of gravity, the soft palate sinks down towards the pharyngeal wall. This factor, according to my experience, can also be utilized for differentiation between the paretic and spastic states of the soft palate, because in the patient's supine position the spastic palate resists the influence of gravity, causing the opening between the mouth and the nose to persist.

To inform ourselves about the genuine basis of the speech impediment, all relevant anatomical, neurological, and functional investigations must be carried out. Neither optic nor auditive observations on the lips and the tongue are effective enough to reveal all abnormalities. We, therefore, must use graphic methods for minute investigations of the lips and the tongue. I recommend a very simple and inexpensive apparatus for this purpose. A glass tube adjusted to a small rubber ball, such as that used for instillment into the eyes, is adjusted at its smaller end to a rubber tube. The latter is connected with a writing tambour. The walls of the rubber ball must be thin and easily compressible. If one puts the rubber ball between one's lips and compresses it rhythmically and equally, the writing stylus will lift and drop at regular intervals, and every time rise to about the same height. In dysarthria of the lips we find many irregularities concerning rhythm and strength (height of the elevation). Often the stylus

*Robbins (**17**) described, independently of Schlesinger, the same test.

does not move at all, because the patient's lips lack the strength to compress the rubber ball. The latter should be used in different places on the patient's lips in order to indicate whether or not one part works better than another.

To register the force and rhythmical skill of the tip of the tongue we put the rubber ball behind the upper incisors. If a normal person is ordered to compress it only once with the lips or the tongue, the writer will move gradually until the end of the test. In spastics, however, a jittering of the muscles in question will sometimes show. (The same apparatus can also be used for the treatment. If the patient learns to use his muscles better, he will be able to see the progress in stronger and more regular movements of the stylus, which fact will also stimulate his endeavors. Since the patient is able to observe the movements of the stylus in the air, it is superfluous to use a kymograph for this purpose.)

In examining speech sounds, syllables and words we examine the coordination of all three of these functions: namely, the motility of the articulative muscles, the functioning of the larynx and of respiration. Auditive control alone, or else combined with optic observation, is apt to reveal many deviations from the norm. Vowels, for instance, may involve unsuitable positions of the lips, the tongue, and the soft palate; inability to maintain a certain position for any length of time; sudden interruption of the voice; too high or too low a pitch; trembling of the voice; excessive movements of the Adam's apple. In some cases unsuitable movements will cause the patient to replace the vowel asked for by another. For instance, if he is asked to say [ɪ], there will result [a] instead if the jaw and the back of the tongue drop; [u] will be replaced by [o] if the lips cannot be closed sufficiently.

The pronunciation of all plosives, as well as of the three nasals [m], [n] and [ng], depends upon a closure in one of the three zones of articulation. If this closure is not perfect they will be replaced by friction sounds, provided the patient does not altogether stop his attempt. At the beginning the closure may be strong enough; however, an athetotic movement may interfere with it and open it prematurely. As we know, [b] is a voiced sound and accordingly requires a more complicated co-ordination than [p]. Sometimes the simpler co-ordination replaces the more complicated one and [p] will be given instead of [b], but, strangely enough, also the contrary may happen, especially if a voiced sound precedes the [p]. [m] may be unfavorably influenced by athetotic contractions or spasms of the palate, or by any obstruction of the nose. [f] and [v] are normally spoken with an articulation formed between the under lip and the upper incisors. If the jaw drops a little and the under lip fails to touch the upper incisors, a somewhat larger space between the lip and the teeth will not prevent the pronunciation of these sounds; nor will the acoustic result be greatly changed if the under lip is pursed over

the upper teeth. Friction sounds are generally less vulnerable than plosives. Too large an opening will, of course, detrimentally affect pronunciation. As to the voice, the relationship between [f] and [v] is the same as between [p] and [b], and therefore the pathological variations are analogous. Since the pronunciation of [w], otherwise similar to that of [u], takes more time than [u], it may be impaired by a temporary or permanent inability of the patient to maintain sufficiently long articulation, exhalation or voice production. [ʍ], the voiceless consonant, is sometimes replaced by [w] and vice versa, and, in addition, may suffer from all possibilities enumerated for [w] except that concerning the voice. All friction sounds mentioned above are sometimes spoken like plosives if too strong a muscle action occurs.

[d], [t] and [n], which belong to the second zone of articulation, can be changed in a manner analogous to [b], [p] and [m] which belong to the first zone. Moreover, the tongue may be placed between the teeth. This position in itself does not prevent explosion, but if the closure is too feeble owing to dropping of the jaw, a friction sound similar to one of the *th* sounds will result. If the back of the tongue instead of the tip rises, the sound emitted will depend upon the degree of elevation of the tongue. If the back touches the palate, [g], [k], or [ng] will result; if there is a narrow opening left we shall hear the German "posterior" *ch*.

As a rule, all sounds are influenced by the sounds with which they are connected. A patient who, for example, had in mind a vowel following [d] but replaced the [d] by [g] may need more time to bring the mouth organs into the position necessary to pronounce the vowel than he would have taken if he had really pronounced a [d]. It is even questionable whether the patient can emit at all the vowel at which he had aimed. Our ear is very sensitive to any kind of abnormal pronunciation. The example just given is, of course, one out of thousands. Every faulty pronunciation may open an interminable vicious circle.

[d], [t] and [n] may not be changed remarkably if the blade instead of the tip of the tongue articulates sufficiently with the palate. If this closure, however, is incomplete, the consonants will resemble a hard or soft [s]. With [l] the tongue tip may be pressed too hard against the teeth, or may be put between the teeth. In glossoplegia or under other dysarthric conditions the blade of the tongue may become the articulative part. Dropping of the jaw combined with partial palsy of the tongue may completely interfere with the articulation. In this case, as in many others, a substituting sound may be used if the correct articulation is impossible. Sometimes a "lateral" [l], in which the air escapes merely from one side, or from one side more than from the other, will be emitted; it frequently is combined with lateral sigmatism. In these cases [l] happens to be voiceless, thus resembling the Celtic [l] which is unilateral and voiceless. Because of momentary or permanent failing of the voice during formation

of [l], a voiceless [l] will result even if articulated correctly. [r] is often replaced by [d], [t], voiced [s] and uvular [r]. If the motility of the back of the tongue is affected [g], [k] and the plosive part of [ng] will suffer. The explosion may be too feeble owing to insufficient closure between the back of the tongue and the palate. Here again these sounds may be replaced by friction sounds similar to the German *ch*.

The hard onset very frequently is used instead of the plosives of the third zone of articulation. This abuse, joined with a too intensive closure of the glottis, may provoke nodes of the cords. The habit of exerting the closers of the glottis is transmitted to the muscles narrowing the pharynx and to the articulative muscles. In the pathology of voice it is a general experience that a faulty function of one part of the whole apparatus from the diaphragm up to the articulative muscles is, without exception, transmitted to the other parts. This will be so much the more probable if the central condition stimulates the nerves and muscles to strong contractions and to spasms, as is the case in cerebral "palsy." In this way another vicious circle may be initiated. The abnormal shape of the pharynx and the mouth will detrimentally influence the resonance and diminish the loudness of the voice, thus forcing the patient to apply additional strain, in order to make himself heard.

Some examples for double consonant sounds are combinations of [t] and [ʃ], represented in words such as *child, church,* or *latch* and [d] and [ʒ] represented in words such as *ginger, jelly, edge, soldier,* or *age.* It goes without saying that if one or both of the partial sounds are missing or mispronounced the combination will be affected. However, frequently only the combination is omitted, mispronounced or replaced. A delay in the formation of one sound after the other is enough to mar the pronunciation of a double consonant and can cause a wrong psychological reaction on the part of the patient.

The metronome is an almost essential means for the understanding of dysarthria. We can find out the speed of the beats which the patient is able to follow if we direct him to open and to close the jaw, to spread and to round the lips, to lift and to drop the tip and later the back of the tongue, to push the tongue out of the mouth, and to move the tongue tip to both sides, to speak vowels, isolated consonants, syllables and monosyllabic words with the beats of this instrument. In some cases there is not only an upper but also a lower limit. Some dysarthrics, particularly those affected in the frontal brain or the striatum pallidum, have special difficulties in performing a slow rhythm.

In many cases in which even the other parts of the analytic procedure do not reveal much more than the trained ear of the examiner could hear during a simple conversation, the metronome method helps to detect failures which could not be diagnosed otherwise. One example may illustrate the value of the method

in question. An eight-year-old girl who was born without help in normal condition, birth weight seven pounds, had, after ten weeks, some digestive troubles. She never smiled until she was three years and six months old. Sitting up was accomplished at the age of two years, walking began half a year later, and speaking at five years. She frequently was tired without foregoing strain. During the examination some sounds were missing, namely [g], [k] and [ʃ], all of them at the beginning, in the middle and at the end of words. [g] was replaced by [tʃ], [k] by [t] and [ʃ] by [s]. Her speech was very slow. Every syllable during conversation or repeating took half a second on the average. Protruding and spreading of the lips as well as pushing the tongue out of the mouth could be performed in accordance with 192 on the scale of the metronome; that is, about three times per second. Touching the corners of the mouth with the tongue tip was limited to 112; in other words, the speed of this function was reduced to about two-thirds, measured against that of the other functions. There was also a remarkable retardation in touching the upper teeth with the tongue tip (104) while opening and closing, like spreading and protruding the lips, and also lifting the jaw could be performed at the tempo 192. In accordance with this retardation, syllables with an intitial [l] could not be spoken faster than 104, while for instance [b], [p] and [m] reached 160. That [f] had 132 as the upper limit shows that the slight retraction of the under lip, which must touch the edges of the upper incisors in [f] was delayed, as compared with the simple lifting in [b], [p] and [m]. [t] and [n] were affected analogously to [f].

In order to finish this case history it is necessary to anticipate a few words concerning therapeutic procedures for dysarthrics. By training the defective movements systematically, the tempo of [f], [d], [t] and [n] could be gradually brought to 160, and finally a speeding up of the whole speech up to three syllables, occasionally even four, in a second resulted after three months of treatment three times a week.

The unlimited variations possible and the permanent changes in the speech of a single patient corroborate the viewpoint that the analytic approach is the only one to effect orientation in the maze of the disturbed speech found in dysarthria.

## III. Therapy

Though various pictures of dysarthric speech impediments may be presented to the examiner, there is one therapeutic advice which, in my opinion, should never be neglected, namely not to begin with speech exercises before the best possible training of the muscles involved has been achieved. If a speech therapist were to start with speech exercises, thus appealing to all muscles participating in the pronunciation of a single sound, he might increase the unbalanced condition. We therefore must

first take care of the more affected muscles, later of the less affected. This rule applies to the paretic as well as the spastic.

There are some methods which can be used in these conditions for each and every muscle involved in voice and articulation. These methods are: (1) jaw-shaking, (2) the "chewing method," and (3) pushing exercises. Jaw-shaking means a rapid motion of the dropped jaw to both sides. This faculty can be learned from slow to fast only step by step even by non-dysarthrics. It is the pterygoids which perform this movement, but successfully only if the muscles attached to the jaw (mylohoid, geniohyoid, geniohyoglossus, platysma myoides) are not over-contracted. Experience has proved that this condition on the part of all the muscles involved in jaw-shaking works upon the laryngeal muscles, bringing them into a similar state of optimal contraction, and can therefore be used for different functional voice troubles. (Sometimes at the beginning pains may occur in the temporomandibular joint; they are, however, only "gym-pains.")

The chewing method is described in the book, *Practice of Voice and Speech Therapy.* We can chew and speak at the same time without interference of one of these functions by the other. Since the same muscles and nerves are involved in both of them they must be very closely related to each other, if they are not even identical. Association of the idea to speak with the idea that one chews with voice production (as primitive people, in fact, do) has been used successfully for stuttering and many functional voice troubles. Dysarthrics may benefit by it if the chewing aspect is less affected or better trained, which fact sometimes occurs, because the speech aspect frequently is more subjected to psychological complications than the other. The patient to whom the close relationship between the functions has been previously explained is then asked to chew "primitively," namely with opening and closing his mouth, lifting and dropping his tongue, and giving voice at the same time. The result will be a kind of language, provided the patient makes various movements (such as those necessary in chewing food) and does not merely repeat mechanically the same movements. Afterwards he should be directed to use his habitual language, maintaining, however, the idea that also this is nothing but chewing and voice-giving. In this way the patient may become convinced of the fundamental easiness of speaking, and thus eliminate his phobic complications.

Jaw-shaking, as well as the chewing method, is applicable only in cases which suffer from a moderate degree of spasticity in those muscles which are involved in chewing and articulation.

Pushing exercises are effectual almost in any case of paresis, both for the muscles mentioned above and for the muscles of voice production. The patient is advised to clench his fists, to raise them to the nipples, to push them down with great strength, synchronically speaking a vowel, a syllable, shorter and then

longer words, and so on. These exercises are based on the physiologic law that some muscles, though not directly engaged, accompany the work of other muscles with involuntary contractions.

Pushing exercises have been used successfully in hundreds of cases of paralysis of the velum and in cases of functional or organic weakness of the laryngeal muscles. (It may be worth mentioning that they have proved even to be life-savers in severe breathing troubles owing to paresis of the recurrent nerve (7, 237-238.) They can be performed, also, in contrast to the two methods just described above, in severe dysarthric conditions, provided that at least one arm of the patient is freely mobile. Special care of single muscles or single muscle groups, however, will always remain essential, even if one or more of these three kinds of exercises are indicated and applicable. In other words, organic and functional over-contraction, as well as paretic conditions, must be treated also locally. Weakness of the lip muscles, for instance, can be counteracted with bottle corks exercises. If the dysarthric tries, over and over again, to hold those which he failed to hold at the beginning, he may finally succeed. For his first attempts it is advisable that he use a mirror in which he can check the functioning of his lips. Frequently he needs the help of his fingers to assist the weak muscles. This assistance is a frequent feature in our treatment for weakness as well as for choreatic movements and over-contractions. It should be considered a law that the patient should use no more than the absolutely necessary strength for this assistance in order to achieve the greatest possible cooperation of the affected muscles, otherwise they do not recover to such a degree as to do their work without assistance.

Phelps has shown us that one severely damaged muscle may bring some of its mates into a state of hyper- or hypo-activity. Fortunately, the contrary may also occur. An improvement of one or several muscles may favorably influence certain others.

The history of a dysarthric boy, aged 16, may serve as an example. He could hardly close his lips in pronouncing [b], [p] and [m], and showed hyperrhinolalia in syllables with initial lip sounds as well as those with initial tongue sounds. We first treated him with corks, and later, for a few days only, with exercises of lip sounds. Hyperrhinolalia, which had been present previously, was no more noticeable during the exercises. That means that no air passed through the nose while he was speaking lip sounds. However, hyperrhinolalia occurred immediately when he spoke syllables containing sounds of the second zone of articulation, such as [d], [t], [s] and [ʃ], sounds which had not been trained so far. Fig. 1 shows some elevations in the under curve as a result of speaking the syllable *poo* several times into a funnel connected with a tambour. The upper line is almost straight, showing that hardly any air passed through the nose (connected

with the tambour by a glass olive and a rubber tube). Fig. 2 results from an analogous registration of the patient's pronunciation of *too*. Here only a shallow curve is visible owing to the feebleness of air pushes leaving the mouth; the nose curve, however, is very apparent.

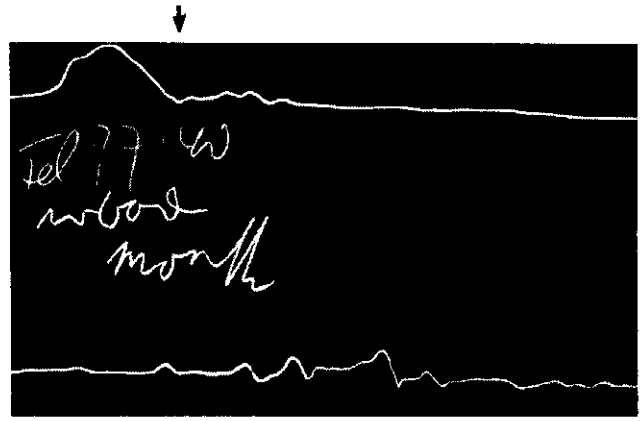

FIG. 1. Record of emission of air from nose (upper line) and mouth (lower line) by a dysarthric boy, aged 16 years, in speaking "poo." Arrow indicates beginning of repeated pronouncing of the syllable.

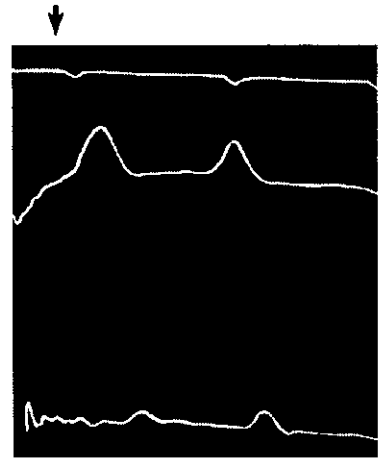

FIG. 2. Record of emission of air from nose (middle line) and mouth (lower line) by the same dysarthric boy represented by Fig. 1, in speaking "too." Arrow indicates beginning of repeated pronouncing of the syllable. Upper line represents time in seconds.

The conclusion to be drawn from these observations seems, as I see it, that systematic training of certain dysarthric muscles is likely to influence favorably other muscles which physiologically collaborate with those first treated—which has also been shown by A. Bullen (**2**) in non-dysarthric cases.

The whole clinical picture is frequently favorably changed by relaxation training of one muscle or one muscle group. This holds true especially with regard to grimaces. A girl, 14 years old, wrinkled the forehead almost with every word spoken, and nodded her head frequently even when she was silent. Important facts of the case history were breech-delivery, delayed walking, asocial behavior towards other children and pulling of the left

FIG. 3. Production of "ah" by a dysarthric boy before treatment.

leg. The neurological diagnosis was a basal-ganglia disease involving the striatum pallidum. Examination in the speech clinic (six years later) revealed no pulling of the left leg; however, there were athetotic movements in both hands, stronger on the left side than on the right, and ataxy in the left hand which was noted also during the finger-nosetip test. Tactile examination revealed hardness of the bottom of the mouth, while the tongue,

the lips and the cheeks showed no peculiarity. The patient then was taught to relax the muscles of the bottom of the mouth first in rest applying tactile self-examination. Then she was ordered to drop the jaw with the slightest possible muscle contraction. Next came prolonged exhalation through the opened mouth, and lifting and dropping the tip and later on the back of the tongue with dropped jaw. Not before all those coordinations were performed without her wrinkling of the forehead, did we proceed to voice-giving and the articulation of sounds, syllables and words. All of these exercises, again and again, demanded tactile checking of the bottom of the mouth. The treatment has not yet been concluded, it has taken more than a year to get as far as that, since the patient visits the clinic irregularly. She is now able to speak for some minutes without any wrinkling of the forehead. If the wrinkling ever does occur, it is far less obvious than it was at the beginning of the treatment.

FIG. 4. Same boy as shown in Fig. 3, showing immediate effect of moving the tongue toward the stronger side.

Two years ago I developed a method of improving the speech function in cases where the tongue was paralyzed only on one side or on one side more than on the other. The tongue deviates toward the paralyzed side or toward the side where the paralysis is more marked. This phenomenon is based on the fact that the two halves of the genioglossus muscle are orientated with their

fibres toward each other, as has been mentioned before. The stronger part, therefore, pushes the weaker sidewards in such a way that a deviation toward the paralyzed side results. If the tongue tends toward the median line for the purpose of articulation, as it physiologically does in all our sounds, the paralyzed half must struggle against the stronger muscles of the other side. This great effort seems to be the cause of the occurrence of the stronger grimaces. These consist of vivid contractions of the muscles which are innervated by one, two, or all three branches of the facial nerve. An attempt was made to push the tongue of such cases with a laryngoscope or a spatula toward the less

FIG. 5. Production of "ah" by same boy as shown in Fig. 3, after ten days of treatment involving relaxation of the stronger half of the genioglossus, first with mechanical assistance, as shown in Fig. 4, and later without such assistance.

paralyzed side. The tendency is to free the weaker side as far as possible from the pressure of the stronger side. Surprisingly, in some of the cases treated up to now, the grimaces vanished immediately during this help. The patients were told to use this mechanical help during their home exercises of articulation. In a short time these patients learned, by relaxing the stronger half of the genioglossus, to hold the tongue more toward this other, namely the stronger, side, even without the mechanical

help. In this way they finally succeeded in articulating without grimaces and without the aid of the spatula. (See Figures 3, 4 and 5.)

In order to make this article not too long, I must refrain from going into more detail concerning the speech treatment of dysarthrics. A few fundamental rules, however, should be mentioned here. Almost every case needs training of the breathing. The exercises are described in detail in *Practice of Voice and Speech Therapy*. With regard to the teaching of new words, as well as sound correction, no rule can be given as to the order in which sounds should be trained. With some restriction one can follow the rule: From the easier to the more difficult one, the words "easy" and "difficult" being used here only with regard to the special case. It frequently proves easier to begin with syllables than with single sounds. Drills for sounds and phrases can be found in books by Stinchfield-Hawk (**18**), Nemoy-Davis (**12**), Gifford (**8**) and many others. Training of rhythm is almost always essential. The metronome is a good help to begin with.

Initial exercises aiming at relaxation and strengthening of certain muscles should be repeated over and over again. Only experience on the single case can teach us how much time a single training period should take. Generally speaking, it has proved better to have the patient practice several times a day for a few minutes only than to extend the exercises over a longer period. It is necessary, therefore, to teach step by step a member of the family or the nurse to supervise the training. Certain improvements can be attained in almost each and every case, to an extent that will, of course, depend both on the anatomic conditions and on the system of treatment. It should not be forgotten that we have three sources from which to bring about favorable results: (1) reserve material in the central and in the peripheral nervous system; (2) elimination of functional troubles which always accompany the organic and (3) psychotherapeutic help consisting chiefly in encouraging the patient and in focusing his attention upon the speech function.

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## PROGRAM COMMITTEE REPORT

As a result of a poll of the Fellowship, the convention of the American Speech Correction Association scheduled to be held in New York City at the Commodore Hotel, December 28-30, 1943, has been cancelled. According to present plans, the convention of the National Association of Teachers of Speech, with which we were scheduled to meet, will proceed as planned. The Program Committee of the American Speech Correction Association is furnishing a general session program for the National Association. A sectional program is also being arranged.

The general session mentioned above will deal with "Speech Correction in War Time." It will include papers on war time speech injuries, general patterns of rehabilitation which are being formulated by national agencies, the rehabilitation activities of the Association, and the place of speech correction in the post-war world.

The Program Committee is hopeful that world conditions will be sufficiently improved so that it will be feasible for the Association to meet in 1944. Preliminary plans for the program of the 1944 meeting are being formulated. These will be announced to the membership in the near future.

RAYMOND CARHART, *Committee Chairman.*