Consonants.—We now turn from the vowels to the easier subject of the consonants. Here the classifications adopted by recent authors agree in all essentials, differing only in minor details. The classification here adopted is based on that taught by Wyllie, and prefixed to his book, "Disorders of Speech." This is unsurpassed for clearness, and is the best for the purpose of teaching stammerers, and even for giving medical students a good grounding in the physiology of articulate speech; but it has a certain want of precision, due to not fully recognising some of the smaller distinctions. Thus, for instance, the position of Th and S is not differentiated; and the various classes of letters are distinguished by different types, which in my opinion is less satisfactory than giving them separate columns.

Before proceeding to the consideration of individual consonants, it is desirable to look at the various ways in which consonantal phones can be produced. One need only refer to the fundamental division of consonants into "voiced," in which the adventitious noise which characterises the consonant is, so to speak, engrafted upon the laryngeal vibrations, and "voiceless," where the noise produced by the articulatory organs is the sole element in the consonant.

There are four ways in which a consonant can be produced:—

1. By closing the passage through the mouth altogether, and allowing the soft palate to hang down, so that the sound produced by the larynx, and the air issuing from it, pass out by the nose. The consonants thus produced are nasals. Voiceless nasals do not exist; the effort to produce them results merely in an audible nasal expiration, which cannot be differentiated according to the position at which the mouth cavity is blocked, for it is only the resonance of the laryngeal vibrations in the portion of the pharynx and mouth behind the block which differentiates the voiced nasals.

In the other three classes of consonants, the mouth is shut off from the nose by the elevation of the soft palate.

2. There may be complete closure of the buccal passage, followed by a sudden opening, giving exit to the air current and (in the voiced consonants) to the voice. The consonants thus produced are explosives. There is of necessity in them a movement of the articulatory organs.¹

¹ Brücke and Thausing rightly explain that the alphabetic sign for these explosives indicates the position of closure, though this, like all explosives, when
3. In place of complete closure, there may be only narrowing of the mouth passage (to a greater degree than in vowel production), accompanied by the production of a rubbing sound from the air passing over the constriction. Such consonants are fricatives. The current may be mesial, unilateral, or bilateral; and we shall see that the acoustic nature of the consonant is greatly influenced by these variations.

4. In other cases the parts forming the constriction may themselves be thrown into vibration by the issuing air, and thus communicate to it a series of vibrations which are too slow to produce a musical tone. Such consonants are called vibrants.

In considering the individual consonants, we shall follow the order used in the case of the vowels, taking first those which are produced most anteriorly.

Labials.—1. Voiced explosive (B).—This phone is represented by the letter b in all European languages. The lips are compressed together and then allowed suddenly to open, the vocal cords vibrating meanwhile. Arnold introduced the happy term "voice-stop" for this and the analogous letters, using "air-stop" for the corresponding voiceless phones. The only contact is at the lips (Fig. 11), which are brought together along a line of considerable and uniform width.

Coles' b is right as regards the lips; but how the extensive tongue-palate contact-area occurred is difficult to understand. It is plain that complete linguo-palatal contact cannot be due to the vowel sound in the name of the letter (bee). One's first impression is, that the application of the tongue to the roof of the mouth must needs change the character of the phone, and make it D; but it is possible to produce a satisfactory B with the tongue pressed against the palate, because the air escapes around it, and gets between the teeth and cheeks, and its resonance in this space produces the desired effect.

Coles also indicates that the posterior pillars of the fauces touch the posterior pharyngeal wall; I have not succeeded in painting the posterior pillars of my fauces, and have even found fully produced, consists of three distinct parts—(1) the closure of the lips; (2) the maintenance of that closure against pressure; and (3) the sudden opening, to allow the more or less forcible exit of the air. All these are not always present; one must, however, take exception to one statement of Thausing's, that "the production of the closure is perceptible in a final explosive, its abolition is an initial one." This implies that just as the construction of the closure does not form part of the acoustic result in the initial position, so its abolition does not in the final position. But this is erroneous; no one will contend that a true P or B is formed if the word cap or cab be uttered without the separation of the lips after they have been brought into contact. It is possible to form a very imperfect substitute for the B by means of what German authors call the Blähluft; but in the voiceless explosive even this is wanting. Similarly it is found that a true T or D cannot conclude a word without the tongue separating from the palate; nor can a G or K be duly ended with the tongue still touching the palate.
that it required some care and practice to paint my uvula completely. The contact is correct, however, for the nose is shut off from the mouth by the soft palate. The whole question of the presence or absence of palato-pharyngeal contacts, as shown in Coles' diagrams, is very puzzling, and must, I fear, remain unexplained.

An early error (occurring in Wallis's work) in regard to the difference between the mechanism of B and P has been recently revived by so able an author as Fournier, namely, that the air escapes by the mouth only in P, but by nostrils as well as mouth in B. This error probably arose from the fact that in B the laryngeal sound can be prolonged for some time before the explosion occurs, it being therefore supposed that the air which passes through the larynx in this phonation must find exit by the nose. If a knife be held under the nostrils while this phone is uttered, with prolongation of the preliminary laryngeal vibrations, it will be found that neither during the preliminary period nor during the explosion, is there the slightest dimming of the steel. The air which comes through the larynx manifestly passes into the closed buccal cavity, for as soon as the laryngeal sound begins, the pressure of air in the mouth rises, and the cheeks are almost at once puffed out; this goes on until the air in the mouth is at the same pressure as that in the trachea, when of course no more can pass through the larynx, and the vibration of the vocal cords ceases, whether the explosion follows instantly or no. One finds, as might be expected, that this preliminary laryngeal sound cannot be sustained so long in D as in B, and a still shorter time in G; for the point of blocking being farther back in each case, the cavity to be filled is progressively less, and consequently the air reaches its maximum pressure sooner. Experiment on myself shows that, with equal intensity of phonation, the periods during which the preliminary stage can be maintained are in the relation (as nearly as can be observed without elaborate apparatus) of B, 2.5; D, 2.0; G, 1.0. Indeed, if the phonation be energetic, these figures may be taken as the number of seconds during which it can be prolonged.

2. Voiceless explosive (P).—This is represented in all European languages by the sign p. From the fact that there is no voice, it is impossible to make this phone audible till the actual moment of the explosion; hence it and its homologues have been called mutes.

The diagram (Fig. 12) shows that there is a closure of the lip, differing from that of B only in the line of contact being narrower.

1 Sometimes the pharyngeal contact is shown as made by the posterior pillars of the fauces; sometimes the anterior pillars, which scarcely seems possible; and sometimes by both pillars, which is even more impossible, if one may use such a phrase. Moreover, contact is entirely absent in many phones where the nose is certainly shut off from the mouth.
3. *Voiced fricative* (W).—This is the English *w*, about which considerable confusion exists among German writers. Ellis says that this phone is strictly peculiar to English among European languages, being replaced in French and Italian by an *O*³, forming a diphthong.

Instead of altogether closing the lips, they are approximated till only a narrow chink is left between them, and the voice-laden breath is allowed to find exit through this chink. This phone showed much more variation in the different experiments than usual. According to the emphasis with which it was uttered, there was either a perfectly contact-free central space, or this was interrupted by two or three separate points of contact (appearing as black dots), or these dots by increase of contact developed into a moniliform band. It is puzzling to find that in a given experiment the marking on the upper and lower lips is not always of the same character.

The comparison between the lip-contact areas of this phone (Fig. 13) and of *O*³ is instructive, and shows the capabilities as well as the deficiencies of this method of experiment. There is a difference which this method cannot show, for it merely indicates the actual contact, and not the areas where the parts approximate, however close that approximation may be. The central free area, which is in the vowel a distinct opening, is in this phone the merest chink, and this it is which gives it its consonantal character. The smaller aperture increases the pressure of the air, which in turn thrusts out the lips, and tends to separate them from one another. The result of this greater air pressure is indicated in the diagram by the fact that while horizontally the area of contact is practically identical with that of the vowel, vertically (antero-posteriorly) it is much narrower.

The lip-contact is not the only one which occurs in the production of this phone. In order to conduct the air to the strait where the characteristic fricative sound is produced, the tongue is depressed and somewhat hollowed anteriorly, and is compensatingly raised behind, so that it comes into contact with the palate in the region of the two last molars. The area does not differ much from the corresponding one in *O*³, and like it varies much in the different experiments.
4. *Voiceless fricative* (W1).—This, like many of the voiceless fricatives, and also of the voiceless vibrants, is rarely found alone, though it occurs not uncommonly in juxtaposition to the corresponding voiced letter. These sounds may occasionally be found in the interjections of a language, which from our point of view form a separate and special class of words. In the case of this phone, its only occurrence alone in English, as far as I can recall, is in the exclamation *phew*, uttered, for instance, in exhaustion from extreme heat. Here the lower lip is not brought into contact with the upper teeth, as in the ordinary (=E), but the air is expelled between the two lips, so that the action might almost be described as an imperfectly performed whistle. This action, however, is exactly that of *w* without the voice being used. The sound occurs commonly enough in the mouths of Scottish people, and of correctly educated Englishmen, though in teaching it is incorrectly referred to as an *h*, by which letter it is represented in spelling. The combination in *what, when*, etc., is usually described as being really *hw*, but if it be drawled out it is easily seen that the essence of the preliminary sound is an escape of air through the lips precisely similar to the escape of voice-laden air which follows as soon as the *w* sound begins. This sound is said to be that of the German *v*, though Merkel admits that the written *v* is almost always pronounced *F*.

The contact-area (Fig. 14) is very similar to that in the voiced correlative. In W1, however, the central part of the lips is always free from any contact; the lateral area is a trifle broader (somewhat departing from the usual relation between voiced and voiceless consonants). The contact at the back of the tongue, however, conforms to rule, in being slighter than in the voiced consonant, and is reduced to a thin streak barely reaching beyond the last molar.

5. *Voiced vibrant*, and 6. *Voiceless vibrant*.—These two are not used in any of the principal European languages, and cannot be better treated (for the sake of completeness) than in the quaint words of Bishop Wilkins: “Trepidation of the lips, like that sound which is used in the driving of cows, to which there is a corresponding mute, sometimes used as an interjection of disdain.”—Briceke says (on Forster’s authority) that a lip vibrant occurs in a Melanesian dialect.

7. *Nasal* (M).—This is indicated throughout the European languages by the letter *m*.

The lips are in complete apposition over a space of considerable breadth antero-posteriorly. The diagram (Fig. 15) shows only partially one interesting fact, that the impression on the upper lip is somewhat posterior to that on the lower one, indicating that in the articulation of the sound the upper lip is somewhat in advance of the lower one. Coles’ diagram shows a contact between the soft palate and the back of the tongue, which
at first sight seems probable, because we know that the soft palate is not raised so as to shut off the nose in this phone. Careful experiment, however, gives no trace of such contact, and, were it present, it would certainly damp the resonance of the phone by hindering free communication with the resonator. The soft palate, then, is in a middle position, neither raised to exclude the nose, nor entirely dropped to shut off the mouth.

Fournier curiously considers that an essential part of this phone is the opening of the lip closure. That this is not so is easily seen in pronouncing the words *am, come*, etc., when a perfect *m* is produced even if the lips be kept closed after the voice ceases.

**Labio-Dentals.**—1. *Voiced explosive*, and 2. *Voiceless explosive*. These do not occur in European languages, unless the initial *pf* of German be, as Merkel holds, this voiceless explosive, followed by the corresponding fricative. It is difficult (possibly owing to the slight chinks between the teeth) to give a sufficiently crisp explosion to this phone when it stands alone; when it is followed by the fricative this deficiency passes unnoticed.
3. **Voiced fricative (V).—**This is the English *v*, as well as that of French and Italian; the phone is represented in German by *w*.

The upper teeth are placed in contact with the slightly incurved lower lip, and a voice-laden current of air is allowed to issue from the mouth. The tongue is supported at the back of the mouth by resting against the palate in the zone of the wisdom tooth, the contact-area (Fig. 16) extending slightly beyond this zone both anteriorly and posteriorly. The angles of the lips are brought together, restricting the breadth of the exit opening. One important element in the production of this phone has not, so far as I am aware, hitherto been noticed. This is one of the few phones where the air current passes out not mesially but bilaterally. Owing to the tendency (more or less noticeable with all phones, but most marked in those with bilateral air currents) to asymmetry in the position of the organs, one of the lateral currents is generally much decreased or even actually suppressed. The unilateral character of the opening was very evident in one of the F experiments, which is recorded in Fig. 17; the opening is seen to be on the left side. It is impossible, moreover, to produce a *V* or *F* at all, if the lip be kept ever so small a distance apart from the median incisors; that is, a central obstruction is necessary, a central exit for the air fatal, to the formation of this phone. A feather or a thin slip of tissue paper, passed from side to side before the lips, while sustaining this sound, will be strongly blown away from the face at one side, about opposite the second incisor, less so at the other side, and very little if at all centrally.

A corroboration of the bilateral nature of this phone is obtained from the study of a "vicarious" labial *v*, produced by the lips alone without the help of the teeth. We have already seen that the normal labial fricatives are *W* and *W*'; but one can at pleasure produce either these normal sounds or a very distinct *V* or *F*. The difference between the mechanism of the two is that in the former the air comes out through a central opening; in the latter, it appears at first to issue from an extremely narrow horizontal chink; but both by the use of the feather and by the contact investigations this chink is found to be closed for a short space in the middle: this closure it is which gives the resultant phone its *V* character. Here also the opening has a tendency to become unilateral. The central closure and the tendency to become unilateral are both seen in the diagram (Fig. 18) of the phone, as produced by the author, to whom, of course, it is not a native sound.

Coles' *v* shows the whole of the lower lip marked with a broad continuous line. It is probable that the imperfections of the flour-gum medium induced him to interpret the irregular and interrupted area as a continuous one. His line is markedly
broader in the centre, as if he had experienced a firmer contact there.

The usual descriptions of this phone are self-contradictory, e.g., Foster says: “When the constriction is caused by the lip being brought into contact with the teeth so as to reduce the outlet to a narrow space, the vibrations started at the constriction give rise to F.” It is evident that “contact” and a “narrow space” are incompatibles. Arnold, with his usual acuteness, has recognised the defect in the customary descriptions; but he does not arrive at the true solution of the difficulty, saying that the air escapes “through the spaces left by the form and position of the teeth.” Kempelen, who was a quick observer, has an interesting note on this point. “If the upper incisors,” says he, “are widely apart, a clear f cannot be formed. Some people then use the lower incisors, others use the canines, not forming the f mesially, which causes a very remarkable false sound, and an objectionable contortion of the visage.” I have not found an opportunity of hearing the F of any person with widely separated incisors. It is quite easy, however, to produce an excellent F or V by biting
the lower lip on one side up to the median incisor, and allowing
the air to pass out between the lip and teeth on the other side;
this, indeed, is but the extreme case of the unilateral variety of V.

4. Voiceless fricative (F).—This is the f of most European
languages; it is represented also by ph in English, French, and
occasionally in German; but never in Italian. In a few instances
it is spelt gh (rough) in English.

Having been discussed along with the voiced fricative, it is
only necessary to note the differences in the diagrams for the
two. The contact is distinctly less (Fig. 19) in this voiceless one,
but the unilateral character is no less evident.

5. Nasal.—A nasal can be produced at the labio-dental
position. It differs only slightly from M in its acoustic qualities;
and is not, so far as I have ascertained, used in any language.

LINGUO-ACRO-DENTALS.—Before treating of these consonants
individually, we must consider their relation to those produced
at posterior positions. Th has usually been described as the
"aspirate" (fricative) corresponding to T. Writers have been
misled by the English orthography (or rather cacography), which
has substituted th for the Saxon thorn. Possibly the universal
method of teaching this phone (that it is produced in the T-
position) has to do with the difficulty which some foreigners find
in acquiring it. The whole question of the true positions of the
linguo-dentals (Th and S) and anterior linguo-palatals (Sh and T) of
Wyllie's classification requires revising. To place Th and S at the
same spot is to violate the fundamental rule, that two phones of
the same character cannot be produced in the same position.
The relative position of Th and S is seen by a little study of the
diagrams; but it is even more readily demonstrated by a very
simple experiment. Let anyone utter before a mirror the words
Seth, Seth, Seth, and this, this, this, and he will see in the first case
that the tongue is thrust forward at the conclusion of each word,
and in the latter case it is distinctly withdrawn. Clearly, then,
the articulatory position of Th is in advance of that of S. The
relation of T to these two phones can be seen by the same method.
On pronouncing T Th (as in eighth) the tongue is seen to protrude
itself between the teeth after the T; but in uttering TS (as in cats)
there is absolutely no alteration in the position of the tongue.

The error of placing Sh at the same articulatory position as T
is not quite so readily demonstrated, as the position is rather
farther back in the mouth. It is evident, however, that if S be
the fricative with the same articulatory position as T, then Sh
must have a different position. And if an experiment similar to
the former ones be carried out in a good light, with care to keep
the lips slightly wider apart than in ordinary speech, the relation
of the two articulatory positions can be seen. The word sash
suffices to show (what Wyllie admits) that Sh has an articulatory
position posterior to that of S; and a slightly drawling pronuncia-
tion of the words *rust*, *rushed* (especially if the closure of the explosive be maintained for a moment, so as to make plain its actual stop-position) will show that the tongue does not move forward in the former, but does so in the latter. It is clear, then, that the three voiceless fricatives, Th, S, and Sh, have each their own articulatory position, Sh being the most posterior, and Th the most anterior; and also that S is the one which corresponds in position to the normal explosive T. We now proceed to the consideration of the individual consonants.

1. *Voiced explosive*, and 2. *Voiceless explosive*.—These are easily produced, but are acoustically merely varieties of T and D, which are normally produced at the next position, and they are so described by Brücke and Merkel.

3. *Voiced fricative* (Dh).—This phone is very badly represented orthographically. In English it is the *th* of *the*, *that*, *thy*, etc., the same spelling being used as for its voiceless congener. In Welsh it is represented by *dd* (*Prydderch*); in Spanish by *d*, and in modern Greek by *delta*. It does not occur in French, German, or Italian.

The contact-area (Fig. 20), which is not of great width, extends along the inner side of the teeth and the alveolar part of the palate, as far forward as the canine zone. A gap at the anterior molar is of frequent occurrence, but not invariable, and has not been considered typical. The original record of the palate-painting method showed distinct contact half-way up the posterior surface of the upper incisors; but further observations proved that this was due to an impure production of the sound, beginning with a very slight explosive. On one occasion, however, when a pure Dh was uttered, there was a very slight but undoubted contact at the extreme edge of the incisors. It is easily seen in a mirror that the space between the tongue and the upper incisors is very small in any case, so this touch was probably accidental, and has therefore not been considered as part of the type.

It is not always easy to produce a pure Dh; and this fact, which was brought home to me by my experiments, finds confirmation in a passage of Brücke. “When the soft *th* (Dh) begins a word in English,” he says, “the separation of the tongue from the teeth often occurs only when the voice breaks forth, so that we do not hear a pure *Zt*, but a *D巧合Zt* (i.e., not a pure Dh, but a DDh).” Had I read this before my experiments, I should have
probably been inclined to put it down as an error; but I find, on
careful examination, that a very faint and transient explosion not
infrequently occurs.

4. Voiceless fricative (Th).—This is the English th in thin; it
is also the Spanish z, and their c (before i and e). Like its voiced
congener, it is unknown in French, German, and Italian.

The results of the voiced and voiceless phones are in this case
much alike (Fig. 21). The gap at the anterior molar, referred
to in the account of Dh, almost always shows on the palate, but
not on the tongue, so it would seem to be really a narrow area of
lighter contact.

Kingsley has a broad and uniform zone anteriorly of "lighter
approach," as he calls it (not using the word "contact," though his
method is strictly a contact one); but I have never obtained, even
with a slight explosive commencement to this phone, any large
area on the incisors, much less on the corresponding part of the
alveolar margin.

5. Nasal.—This is merely a more cumbersome variety of N, and
does not occur in European languages.

Linguo-Alveolars.—1. Voiced explosive (D).—This is repre-
sented by the sign d in all the chief European languages.

The contact-area (Fig. 22) is a very large one, and is especially
broad in front (about \(\frac{3}{4}\) in.); it extends back to or even behind
the wisdom tooth, thus preventing any leakage of air around or
behind the posterior teeth.

Arnold has, in connection with this phone, one of his careful
observations accompanied by a vague and insufficient explanation.
"D is formed," he says, "on the t plane; only, on account of the
nature of the sound as a vocal stop, the tongue presses on a larger
surface and higher up on the gum and hard palate; the pressure
is less than in t, to permit the resonance to be fully developed."

2. Voiceless explosive (T).—This phone has the same sign, t,
in the chief European languages; in German it is sometimes
represented by d, when that letter comes at the end of a word, e.g.
Hand, und, etc.

The close resemblance between this and the preceding phone
is very striking; comparison of the two diagrams shows that the
contact-area is here (Fig 23) much smaller, and of uniform breadth
throughout.

Kingsley’s area for T and D is much like our area for T, but
extends a little farther back. He either did not get the larger
area for D, or else considered it a departure from normal, though
the difference between the voiced and the voiceless phones is
specially marked and constant in this pair. Merkel says the
tongue touches the hard palate to an extent, sagittally, of 1 in.
This is considerably broader than the contact even of the voiced
phone, according to my experiments, and the T-contact measures
at most only \(\frac{5}{16}\) in.
The *Spielraum* of this phone is considerable. Foster makes a distinction between the English *t* and that of other languages:—“In *t* the interruption which is suddenly removed is caused by the application of the tongue to the front part of the hard palate in the case of the English, to the teeth in the case of most other languages.” Arnold distinguishes between the Welsh *t*, produced against the teeth instead of the gum, the English *t* where the tip of the tongue is pressed against the palate (he would have been more correct had he said gum in this case also), and whose sharpness and crispness is diminished by the application of a larger surface of tongue, and the soft Erse *t* where “instead of the tip the root (?) dorsum) of the tongue is opposed to the palate.” Merkel says that in the usual German *t* the tip of the tongue is bent down and supported by the lower incisors, the front of the dorsum touching the upper incisors and the front of the palate, and the edges of the tongue occupying the space between the two rows of teeth. His second variety, which Brücke considers as the usual one (under the name of alveolar *t*) is the *T* of my results.

3. *Voiced fricative (Z).—This is the English *z*, but may also be represented in English by *s* (*has*), and by *x* (*Xenophon*). In German it is represented by *s*, initial or between two vowels (*so, blasen*). The German *z*, as well as the Italian one, are compound sounds, but the French *z* is this phone.

Experiment reveals the unexpected result that this phone is
asymmetrical to such an extent that the exit of air is strictly unilateral. The contact-area (Fig. 24), except for the exit opening, is nearly the same as in \( t \).

Kingsley's contact-figure shows a central channel narrowing to a small exit in front, and lateral contact-areas which are sharply truncated at the junction of the canine and premolar zones. The area here (as in many cases in Kingsley's diagrams) goes farther back than in my experiments. It seems possible that this is due to the thickness of the plate causing contact over a space where without it there would have been only approximation, not actual contact. Coles (who seems to have named this letter \( zee, \) not \( zed \)) has an extremely small central opening. There is also an area of paint at the base of the inner surface of the lower front teeth. This, which recurs in his diagrams from time to time, is another puzzling point. There can have been no direct contact between this area and the parts (palate and upper teeth) originally painted with gum and flour; the probable explanation is that, after touching the upper teeth with the tongue, he rested it against the tip of the lower incisors, in uttering the vowel portion of the letter name, and thus carried to that surface some of the original mixture.

Chervin holds that the tip of the tongue is supported against the lower dental arch, but adds that Guillaume says against the upper teeth, and that this error is shared by many professors of the Conservatoire. He goes on to state that the dorsum of the tongue is concave, a longitudinal median groove being formed by a slight elevation of the edges, which are supported against the molars. The "groove" is seen in the diagram to be really a wide space, and the support of the teeth against the upper dental arch comes forward far beyond the molars, to the anterior bicuspid on the one side, and actually to the middle line on the other. On the other hand, study of the tongue shows the correctness of Chervin's view as to its tip; the extreme tip (laterally at and for some distance on each side of the aperture) is free of blackening, showing that it has not touched the upper dental arch. Merkel says that the tongue is "flattened out, so that it everywhere, save at the middle incisors, stops the space between the upper and lower teeth." A \( z \) can be produced with the tongue between the teeth, but is less sharply sibilant than that of the type diagram.

4. **Voiceless fricative (S).**—This is the \( s \) of most European languages; in German between two vowels it is represented by \( ss \). In English it may be represented by \( c (cell) \), and so also in French \( ciel, ça \).

The diagram (Fig. 25) shows clearly the unilateral character of the air exit in this as in the voiced phone. The contact-areas are very similar; the exit for air is only very slightly if at all wider; the free area at the tip of the tongue is not so marked.

The opening in Coles' figure looks mesial but is not absolutely so, the contact-area ending opposite the centre of the outer incisor.
on the right, but on the left coming forward to the centre of the middle incisor. There is a repetition on a much larger scale of the puzzling area on the inner surface of the lower teeth.

5. Bilateral fricative, voiced (L).—This very characteristic phone is always represented by the letter $l$.

We have here an apparent exception to the rule that two distinct phones of the same nature cannot be produced at the same articulatory position. It is only apparent, for although both are fricatives, yet one is produced with a single opening, and the other with a pair of openings, and the two are comparable to the two labial fricatives, W and the vicarious V. The contact-area (Fig. 26)

![Diagram of articulation areas](image)

is again very closely related to that of T; but there are lateral openings at the level of the second molar for the exit of the air. Kempelen observed the position of the opening with accuracy. It is possible that the asymmetry of this diagram may be due merely to the defects in the author's denture; and it is also possible that in a person with a perfect set of teeth the point of exit of the air might be different from that shown. Of this, however, I am very doubtful, for the tongue shows very marked power of repairing, as far as speech goes, dental defects.

Kingsley's area is very small, being confined to the incisor and canine zones. In a single experiment I obtained an anterior contact only, without any lateral areas; but even then the area extended throughout the bicuspid zone.
6. Bilateral fricative, voiceless (L').—This is not known in English, nor as far as I know in any of the Teutonic tongues; it occurs in Great Britain in the Welsh ll, in which the first I is this voiceless one, while the second is voiced. I have more than once heard this sound described as "chl in North Wales, and thl in South Wales." These are the nearest sounds to it with which the English and Scottish speech organs are familiar, and probably the supposed difference in the various parts of the Principality is due to dialectic nuances; but neither interpretation is correct. Anyone with an observant ear, even if he be not able to detect the exact nature of the sound, will notice that, as pronounced by a Welshman, it is a far more flowing and euphonious sound than either of the awkward combinations to which it is likened.

Wyllie states that the sound is peculiar to Wales. Probably he is only speaking of the United Kingdom; if intended to have a wider application, the statement is hardly correct, for the same sound occurs in Spanish. In that language the ll again represents the voiced and voiceless consonants, but in reversed order. Here the voiceless one comes first, and to the casual hearer the subsequent voiceless l is like a cross between Y (which it is sometimes said to be) and Sh. My opportunities of observing this Spanish combination have been few, but by producing it as a voiceless l, I have been able to imitate the native pronunciation with a good degree of accuracy. After having made this observation, I find that Wallis had at least a partial knowledge of it; for, after a rather vague and imperfect description of the Welsh ll, he adds: "As far as I know, this sound is not heard among other nations, unless perhaps among the Spaniards."

Bishop Wilkins recognised the exact nature of the Welsh L':—"They seem to form it as the other l, only by abstaining the voice, and more forcible emission of the breath, as is used in all other letters of the spirituous kind." I am inclined to think that the Italian gl (gli, togliere) is the same combination as the Spanish ll, but have not had opportunities of satisfying myself on this point.

This phone is difficult to pronounce for anyone who is not to the manner born; and perhaps even a Welshman would not find it altogether easy to utter without the following voiced L. On account of these two difficulties my pronunciation is in all probability very imperfect, and the diagram (Fig. 27) cannot carry much weight, but I insert it for what it is worth. I notice a strong tendency to become unilateral, though I sometimes have a bilateral exit for the air, and have so represented it in the type diagram. The contact-area is decidedly less in L' than in L, and does not come forward on the tongue.

7. Voiced vibrant (R).—The exact articulatory position of this phone is difficult to define. As far as continuous contact is concerned, it is undoubtedly posterior to Z and L; but if properly pronounced it has an intermittent vibratory contact in the
alveolar region which justifies its being placed here. Like L it is a very strongly characterised phone, and therefore its representation is practically uniform throughout Europe by the letter r.

Its unilateral nature is frequently, though not invariably, marked. In the author's case it is produced on the right side of the mouth. The trilling is done with the tip of the tongue against the posterior surface of the upper incisors. The tongue is supported posteriorly against the molars and premolars, but the amount and character of the contact varies considerably on the two sides. The diagram showing the experiments (Fig. 28) is very instructive in this respect. In the instance where the palate was sprayed the action of the two sides of the tongue was fairly even, as indicated by the areas both on the tip of the tongue and on the back of the incisor teeth. Here, too, the support of the tongue, which is seen most perfectly (as is usual by the spray method) in the palate areas, is fairly even on both sides, though even here there is a broad patch of more size posteriorly on the right side. Comparing the experiment in which the palate was painted, the tongue-tip shows that the trilling was markedly unilateral; and here the support is much more asymmetrical. Along the left side there is a long narrow area of probably moderately firm contact; but on the right side the tongue is free from the palate in front of the level of the first molar, so as to allow of its free vibration in
forming the trill; behind that point there is a strongly marked wide area of contact, acting as a base of support, and thus giving power and accuracy to the vibrations of the anterior part. This is so important that I have purposely embodied this unilateral form in the type (Fig. 29).

Arnold’s accuracy of observation is conspicuous in his account of this phone. “The trilling is formed on the t place, generally on one side. The muscles employed are those at the base of the tongue, to hold it firmly. Usually, also, it is pressed against the right molars for the same purpose. The trill itself is involuntary, and an effect of the voice catching the apex of the tongue and compelling it to vibrate strongly against the gum. If these positions are observed, the trill is better delivered, and quicker. Others do not confine the action to one side of the tongue, but allow all the apex to vibrate. This is the Italian form, and it is slower and softer than the first. Again, others do not confine it to the apex, but allow a considerable part to press against the palate, where it vibrates freely; this is the Irish form.”

This phone requires considerable exertion, and is not easy to produce. Consequently it is produced in a slipshod way by many people; there is no phone which is more frequently affected in lalling than this, L being its most common substitute, though W is very frequent (possibly as an imperfect attempt at the labial vibrant), and Dh also occurs. In ordinary English speech this phone is emasculated, only receiving its true value north of the Border. Thus in monosyllables where it is final, such as are, her, nor, cur, and in those words where it is followed by another consonant, e.g., short, turf, world, etc., there is no trace of consonant left, the only remains of the r being its curious modificatory effect on the preceding vowel, a matter to which we shall return later. Perhaps the best word to exemplify this dropping of the r is such a one as queer, in which the so-called sound of r is really the open e sound (E). Where r precedes a vowel or comes between two vowels, e.g., in brother, hereditary, round, there is of course a true consonantal sound, but it is not a full, pure vibrant. Foster says of it: “In the feeble English r there appear to be no vibrations; the vowel chamber is simply narrowed in front by the tip of the tongue.” Arnold says: “By most it is very imperfectly articulated, being displayed by strong resonance produced in the narrow space left for the passage of the air between the tongue and the palate.”

The author’s R is a variable quantity, as befits a Scots parentage and an English upbringing; the true trilled phone he can produce without difficulty, and the completely emasculated English one also with some care. The results of experiments with the latter are recorded in Fig. 30, and bring out some interesting points. In the first place, there is no trace of vibratory contact anteriorly, either on palate, tooth, or tongue. As a consequence of this, the tip of the tongue not needing special support, the solid
area of support no longer appears behind, but a narrow and almost symmetrical contact area on either side.

The relation of R to the vowels is an interesting study. Looking first at the true trilled R, and experimenting on the nine principal vowel sounds followed by it, it will be found that only the open vowels and the guttural series can be purely pronounced, namely, ore, err, arr(ive), hur(ry), are. The other four vowels suffer a modification which on closer observation will be found to be the interpolation of a very brief E\(^1\). This point has been observed by Murray, and is provided for in his notation of the vowels, where he says: “The half-sized e is similarly used to

derive.

express the non-recognised vowel element developed between \(i, e, o, u, (E^3, E^2, O^2, O^3)\), and \(r\), as in pier, pare, pore, poor, weary.” If an attempt be made to utter these vowels pure before \(r\), it can be done, but only by inserting a momentary hiatus between the vowel and the consonant, thus practically placing the \(r\) in a different syllable from the vowel, under which condition the pure pronunciation is easy, as in the words erode, hay-rick, co-respondent, pewrent. I am not aware that any explanation has ever been given for this phenomenon. It is plain, however, that the front part of the tongue must be musically lax before it can begin to trill the \(r\). This laxity of the tip of the tongue occurs in the open and guttural vowels. Even \(O^1\), however, does not give quite sufficient laxity, and there is a tendency for it to be followed by a very
brief $E_1$ (e.g., pour). $O^2$ is generally, save in the most purist of pronunciation, altered into $O_1$, but $O^2$, $E_2$, and $E^3$ keep their full value, and are merely followed by a very brief $E_1$.

Turning to the smooth English $r$, we find that though it has lost its trill, it has the same effect on the preceding vowel; it therefore has a double influence in spelling. If there is no indication that the preceding vowel is long, then the $r$ alters its sound-value; e.g., $a$ from $A^3$ (hat) to $A^3$ (hart); $e$ from $E^2$ (he) or $E'$ (hen) to $E_1$ (her, hern); $i$ from $E^2$ (chip) to $E_1$ (chirp); $o$ from $O'$ (shot) to $O_1$ (short); and $u$ from $A^2$ (hat) to $E_1$ (hurt). If the vowel be indicated as long (by doubling, by addition of $e$, or in any other way), it keeps its value, but the $r$ adds to it the sound of $E_1$; thus, hay, hair; she, sheer; high, hire; you, your. In the case of $O^2$, however, the vowel itself is altered, the $E_1$ being sometimes added as well—thus, go ($GO^2$), gore ($GO^1E_1$, or more frequently, less correctly, $GO^2$).

8. Voiceless vibrant ($R'$).—This phone is not generally recognised, and rarely occurs apart from its voiced correlative. The only instance of its separate occurrence which I know is that given by Ellis, the final sound in such French words as tendre, genre. The Greek initial $r$ was probably a combination of this and the voiced sound (this being indicated by the rough breathing); the voiceless one no doubt came first, as the combination is much easier to utter thus than in the reverse order. To the conclusion that the voiceless $r$ occurs in Wales I was led by noticing the word Pwllychrochan spelt thus—Pwllyrrochan. This led me to suppose that just as the voiceless $l$ had been described as $ch$, so the $ch$ in this word as usually spelt was really a voiceless $r$. I have been without an opportunity of confirming this, further than by the feeble support of the fact that the word is vastly easier to pronounce with a voiceless $r$ than with a true $Ch$, and that the Welsh Rh (Rhyl) is said by Ellis to be a voiceless $r$.

In this phone again the accuracy of my rendering may be called in question, for the reasons given under $L'$, but I give the results for what they are worth (Fig. 31). The vibration is much more marked, and so produces a larger contact-area, making an apparent exception to the rule that the contact is greater in the voiced member of each pair. The unilateral character is well marked. Owing to the strong vibration, the base of support is also well marked on both sides. One might have expected a space free of any contact between this support and the vibratory contact, but this was not so in the actual result.

9. Nasal. (N).—This phone is uniformly represented by the letter $n$.

Its mechanism is exactly analogous to that of $M$. The tongue closes the mouth in very much the same position as in $Z$ or $T$ (Fig. 32); there is no contact between tongue and soft palate. The contact-area extends markedly behind the wisdom teeth.
In Coles' somewhat complicated diagram the anterior part of the palatal contact corresponds closely with my results; the posterior parts and the complete ring of contact answering to them on the tongue must be due to error, for, were there such a contact-ring, the voice could not find access to the palatal vault where it resonates in the production of this phone. Arnold says that the pressure of the tongue against the palate is more extended towards the soft part than in t, "but this follows from the muscular action required by passing the nasal sound." The diagrams show no such difference, but it may occur in some people, and is again, I believe, a question of air pressure, which is here at its lowest, as escape through the nose is unrestrained; the air at low pressure has but little tendency to separate the parts.

An interesting instance of the way in which the formation of a phone is influenced by others with which it is combined, occurs in the account given by Kempelen of his three "derivative n's." The first and third are absolutely distinct phones, being the Ng and the nasalised vowel respectively. Of the second, which is the French and Italian gn (campagne, signore), he says: "The difference of this sound from the two preceding only consists in a change of the position of the tongue, which here rises not at the point (as in N), nor at the base (as in Ng), but rises at the centre and closes the palate there." There is no doubt that the French and Italian gn is merely NY, and that (as we shall see in the case of Ch) the
position of the phone is modified by the one that follows. In this case the N is formed as far posteriorly (i.e. towards the articulatory position of the subsequent Y) as the limit of its Spielraum. An example of its formation at the other (anterior) extremity of the Spielraum is to be found in such a word as tenth, where, in preparation for the succeeding linguo-acro-dental, the N is formed against the edge of the teeth instead of the alveolar edge of the palate.

Before passing from the numerous group of linguo-alveolar consonants, a few words may be said about their relation to each other and to a vicarious phone which can be formed at this articulatory position. There are three of these phones in which the mouth passage is absolutely blocked, namely, T, D, and N. The rest get their character from the manner in which the air finds exit from the mouth. We have the tip of the tongue touching the alveolar region in L and L¹, the air finding exit at each side; we have the tip of the tongue vibrating against the same region in R and R¹; and we have the tip approximating without touching, and causing a fricative sound at the narrowed spot in S and Z. It is important to notice that another fricative can be produced at this position vicariously, though its clear and normal utterance is linguo-acro-dental—Dh (with, of course, its congener Th). This and not the normal Dh it is which sometimes takes the place of R in lalling speech. It requires special attention to produce it, otherwise the tongue slips into the position for the normal phone. In producing this, and indeed most of the unaccustomed sounds, the results show somewhat more than the average variability, but the type evolved from careful consideration of the various experiments (Fig. 33) very closely resembles that of Z. This indicates that the essential differences between them are not to be recorded by contact methods of observation. A little study of the position of the tongue and teeth in a mirror gives the results indicated in Fig. 34. It is thus seen that the essential difference is that in Z (Fig. 34, A), and in
S, the outgoing air current is directed so as to strike on the edges of the lower incisors, whereas in the vicarious Dh (Fig. 34, b), and Th, the tongue is so laid against these teeth that the air current passes by in front of them and does not strike on their edges. The only indication of this in the contact diagrams is the fact that in Z the tongue shows no contact at its extreme edge (because the tip is bent down below the incisors, which are vertically below the upper ones), while in the vicarious Dh (where the tongue lies overlapping the lower incisors, which are here posterior to the upper ones) the extreme edge shows contact with the palate.

(To be continued.)

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CLINICAL RECORDS.

CASE OF EPITHELIOMA OF THE TONGUE ASSOCIATED WITH TRICHINA SPIRALIS.

By F. W. Hope Robson, M.D., Burscough Bridge, Lancashire.

W. B., an ironworker, was admitted into the Bradford Royal Infirmary suffering from a growth on the left side of the tongue, which presented the usual characters of an epithelioma. As the growth was small and limited to the left side, half of the tongue was removed with the aid of the ecraseur. A portion of the growth was handed to me for microscopic examination, with a view to confirming the diagnosis, when the following very peculiar appearances presented themselves. In addition to an ordinary epithelioma invading the substance of the tongue from the surface, between the muscular fibres, and lying in their long axes, were numerous encysted *Trichina spirales*. The parasites showed evidence of calcification, indicating their somewhat remote advent.

The specimen, besides being a pathological curiosity, is interesting, inasmuch as the irritation caused by the calcified trichinae might prove a factor in the causation of the growth. The specimen was shown at the Bradford Medico-Chirurgical Society, and gave rise to some comment. No history of any illness, such as trichiniasis, could be elicited; and a careful examination of the right half of the tongue failed to demonstrate any signs of disease.