Mr. Hogewind and myself, experimented independently, and whenever during the experiment, she could also give us her valued opinion. We, whisper, detach the do exactly what she was asked to do, e.g. produce the different kinds of advantage so far that she could insert the instrument with much ease, and, owing to her thorough schooling in phonetics in the sense of Sweet, she could, but slightly, if at all, the position and condition of the organs of the larynx. Another drawback of the instrument is that strong retraction of the tongue, as in the so-called back vowels, prevents observation of the larynx almost entirely.

In the Hague, I have experimented with Prof. Russell's "Phonolaryngoscope". And hard-of-hearing children, and Dr. F. Hogewind, speech doctor, both at the school for little children. We suggest as a possible explanation what I stated on another occasion 1), viz., that the two plates of the thyroid in question. With regard to the latter circumstance I may remind you of another investigations, the vocal ligaments were slightly dark at the inner edges and for the rest translucent on the lowest note, and that they became darker and darker towards the thyroid wall as the singer ascended the scale. The same effect was produced if the torch was pressed against the trachea immediately below the crico-thyroid cartilage. This difference we at first attributed to the possibility that other investigators had experimented on males, but our observations with a gentleman as subject led to the same result. We suggest as a possible explanation that the dark edges are owing to the density of the sloping ligamentous wall of the subglottal passage, and that, as the larynx-note rises, the progressive contraction and consequent thickening of the external thyro-arytenoid muscle bulges the internal one inwards. The consequence is that the sloping ligamentous sides of the subglottal passage become more and more perpendicular, and present with the gradually thickening thyro-arytenoid muscles a denser and denser mass which becomes less and less translucent to the light from the torch. The slight relaxation of the vocal ligaments consequent upon the contraction of the thyro-arytenoid muscles is counteracted by the tilting backwards of the cricoid cartilage which regulates the necessary tension and length of the ligaments in question. With regard to the latter circumstance I may remind you of what I stated on another occasion 2), viz., that the two plates of the thyroid

cartilage are farther apart in phonation than in the state of rest, and that they tend to move slightly inward as the note rises, thus contributing to the stretching of the vocal ligaments. What I have presented as a possible explanation attains to a high degree of probability by the result of our further experiments, viz., the transillumination of the larynx in deep breathing and in the falsetto voice. It can easily be ascertained that in deep inhalation the glottis is much wider than in ordinary inhalation. The reason of this difference appears to be that in the former case we try to make the entrance to the trachea as wide as possible, so as to admit a maximum of air. Consequently, the thyro-arytenoid muscles are moved outward by the action of the arytenoid cartilages, the ligamentous wall of the subglottal passage slopes outward as much as possible, and the vocal ligaments become translucent, except at their edges. In ordinary inhalation, on the contrary, the vocal ligaments are pretty dark all over with darker edges, all this, no doubt, owing to the fact that the vocal muscles sag, thus bulging the wall of the subglottal passage inward.

The case of the falsetto voice is very interesting, too: the vocal ligaments are very dark over their whole breadth, only the borders present each a lighter shade separated by the still lighter line of the glottis. This would seem to show that the wall of the subglottal passage is all but perpendicular, and that the edges of the vocal ligaments are exceedingly thin and sharp.

As the practice of identifying voiceless and whispered sounds seems to be spreading among phoneticians, we studied the condition of the larynx in whisper (Fig. 13, 1); and found it to be in the main as follows: the cord-glottis is all but closed and very short, and between the arytenoids there is a small triangular aperture, the cartilage-glottis. The false cords cover about one third or one half of the true ones in their full length. The epiglottis slopes more backward than in ordinary voice, and the cushion of the epiglottis bulges very much; hence, the whole aspect of the larynx is smaller than in the case of voiceless and voiced sounds.

This description also holds good for stage whisper (Fig. 13, 2), only in a more marked degree: the epiglottis slopes more backward, the cartilage-glottis is smaller, the glottis is shorter, and the false cords leave a smaller portion of the cords proper visible, so that the whole aspect of the larynx is more compressed than in ordinary whisper.

In voice sounds (Fig. 13, 5) the glottis is a very narrow slit which opens and entirely closes as the cords vibrate, and varies in length and width with the vowel. The cartilage-glottis is quite closed. The position of the epiglottis varies a great deal, and the false cord are always well out of the way, so that the ventricles of the larynx are distinctly visible.

Then follows the glottal open consonant (Fig. 13, 4), usually represented by the letter k in ordinary writing. As it is best to be studied with the instrument in combination with the vowel i: we have investigated successively i:hi: and i:iti:, both voiced and whispered. With your permission I shall only describe the two most important, viz., voiceless and voiced k between two voiced vowels. In voiceless k the glottis is an elongated, slightly fusiform or spindle-shaped

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1) What is called "tief" in German, e.g. by Musenhof. The glottis is a pentagon.
2) This was confirmed by the stroboscope.
apart, with less force in clear beginning. Immediately afterwards the cords close again for phonation.

When the voiced iː begins gradually, the true cords come slowly together, touching but lightly, and remain in that position for phonation. The arytenoid glottis is also shut, the false cords are motionless in their normal position, and the epiglottis is erect and motionless.

When the whispered vowel iː begins gradually, the laryngeal organs glide into the required position. The epiglottis is less erect than in the voiced vowel.

It was not without satisfaction for me to find corroboration of my conclusions published elsewhere 1) that in whisper and phonation each of the vowels has its own particular glottis area, its own particular epiglottis position, in fact its own particular laryngeal aspect, that e.g. when they are pronounced on the same note, the epiglottis slopes more and more downward in the order iː, eː, aː. Also, as a firm believer in the possible tenseness and laxness of vowels I was glad to observe that the difference is distinctly noticeable in such pairs as biet and bier, bm and beer, nu and muur, deun and dear. The latter of each pair is produced with a slightly lower epiglottis, which corresponds with the higher note of the back resonance cavity, just as eː of beet has a slightly more sloping epiglottis and a correspondingly higher back note than iː of biːt 2).

In the whispered vowels followed by r, which in my opinion are all lax ones, the cartilage glottis appears to be slightly longer drawn out, and that because the vocal cords are not so firmly closed as in the other cases. Further we found that the cartilage glottis is very small in iː, yː, larger in eː, gː, aː, still larger in i, largest in aː. This is quite in accordance with what I have stated elsewhere. 3)

In voiced vowels the difference between tense and lax is also manifest, for in the lax ones the epiglottis slopes more downward. The true cords, besides being slightly narrower, are blunt-edged and convex, whereas in the tense vowels they are sharp-edged and flat. The glottis is in both cases only a very narrow slit, but it is somewhat wider in the lax vowels 3). This is but natural, for a wider opening corresponds to the higher back note of these lax vowels.

Though in the so-called back vowels the root of the tongue all but prevents the observation of the larynx, yet, as regards these, too, the instrument affords a proof of the existence of tenseness and laxness, for in oː, uː of boot, boat, the entrance to the larynx is a very narrow horizontal slit which becomes wider in the vowel of boar and boer. In that of boar it even is so wide that the middle portion of the glottis with the arytenoids tipped forward becomes visible 4). This difference is evidently owing to the fact that the root of the relaxed tongue does not weigh down so heavily on the epiglottis.

As regards the consonants the use of the instrument is naturally very limited. We found that the condition of the glottis is largely dependent on the accompanying vowel. What I have said about h between two vowels and h pronounced by itself also obtains for p and f. Whereas p and f pronounced


2) ZWAARDEMAKER en EIJKMAN, Leerboek der Phonetiek, p. 103.


4) See in this connection The Area of the Glottis in Vowels, p. 54.

When the subject pronounced what we considered the vowels of English good and bone (the first part), the tongue was so far relaxed and consequently the epiglottis so far raised that the cords were partly visible.
by themselves have a comparatively wide glottis, though less wide than in breathing, they show it as a narrow fusiform slit in $f$ of $i$:$\phi$: (Fig. 13, 6), and a little wider one in $f$ of $i$:$\phi$: This slit is of course still narrower during the phonation of the accompanying vowels. The ventricles of the larynx are distinctly visible, in other words, the false cords are well out of the way.

In this connection I may be allowed to state a peculiar difference which we noted in the pronunciation of $pi$: (with voiceless glide after $p$) and $fi$: In $pi$: the vocal cords assume the position required for the vowel at the moment of explosion, whereas in $fi$: not $i$:$\phi$:; the narrow glottis first becomes slightly wider and then immediately afterwards narrows again for phonation. We suggest as an explanation that in preparing to say $pi$: the subject anticipates the formation of the vowel closes the glottis, but the force of the air-stream causes the cords to fly apart again for a moment. The same happens in German $phi$: with voiceless glide and in $fi$: with whispered voice. On the other hand, in Dutch $pi$: there is only air-pressure in the closed mouth, but no air-stream at the moment when the vowel begins.

In conclusion, I wish to say a word about the action of the false cords. As is well-known, they stand out in the vestibule of the larynx like two stage-wings. They have acoustic significance, in as much as they assist in keeping up and regulating the vibrations of the vocal cords proper. Apart from this function, they may in a few cases influence a speech sound by wholly or partially covering up the cords proper.

As far as they can be seen with our instrument, the false cords are perfectly quiet during a voiced vowel and voiced $h$ flanked by voiced vowels. They tend to approximate during the clear beginning of whispered and voiced vowels. They partly cover the true cords in $h$ flanked by whispered vowels, and during a whispered vowel, in a greater measure the stage-whispered. Finally, they cover the cords proper almost entirely or entirely during the glottal stop introducing both whispered and voiced vowels, as also during stage-whispered $i$:$\phi$:. Hence, the difference between clear beginning and glottal stop is in this connection the degree of closure of the false cords.

**Discussion:**

Professor G. O. Russell: I am indebted to Mr. Eijkman, for the work he has done with my fonofaryngoskop. In this type of experiment it is not necessary for the subject to see his own interior larynx, I should prefer my Non-Gag Glottoskop, since it uses a tube no bigger than a match in diameter, all front vowels as well as the back are unhindered and sound natural and distinct. Since its back lens lies so well back against the laryngeal wall, one can see into the larynx on such vowels as $o$, $u$, $\sigma$ and even $\alpha$, when the view might be shut off in the first due to the position of the tongue and epiglottis.

Now I should like to call attention to the pulvinar as shown in these experiments of Mr. Eijkman. I seem to have been the first to note its function: twelve years ago I reported the same. You will note that in the vowels, pitch and voice-quality changes as well as in the glottal stop, coughing, gagging, swallowing, defaecation, etc., it moves towards the cartilage of the cartilage of Wirsberg in varying degrees of approximation or even complete closure. In other words it operates as a part of the sphincter-like closure mechanism Dr. Neutz later designated.