

## TACTUAL INTERPRETATION OF ORAL SPEECH

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In a paper read before the American Psychological Association a year and more ago I stated that a subject in our laboratory at Northwestern University had learned to recognize seven spoken words when he had no criteria to go by excepting the vibrations of the speaker's vocal apparatus conducted through an air column in a tube 14 feet long to the palm of the subject's hand. In May, 1923, I added a footnote to the paper when proof was being corrected for the *Journal of Abnormal Psychology and Social Psychology*, saying that up to that time 34 words had been learned, together with a great number of sentences made up of those words in various combinations. In fact he was able to get the sense of any such sentence. Furthermore, he had learned to distinguish high and low tones provided there was a difference of an octave at least between them. This result was obtained in the course of 78 periods, one a day. Actual practice never occupied more than 35 minutes at a sitting.

The subject in this case was a normal hearing young man, a sophomore in the University. The situation was so arranged that he could not hear. The speaking tube I have referred to extended through two walls and the intervening room. At the subject's end it terminated in a double pine box, the outside dimensions of which are 2 by 2 by  $2\frac{1}{2}$  feet approximately. The space between the outer and the inner wall, five inches deep, is packed with cotton waste. At the front end of the box is an aperture surrounded by a rubber collar.

The subject thrusts his hand through the aperture and holds his palm closely over the end of the tube. In this position the rubber collar grips the forearm and the whole apparatus is, for our purposes, sound proof. Additional precautions against hearing were introduced as follows:—First, the experimenter muffled his face in a feather cushion and spoke through a narrow aperture in it into a funnel upon his end of the tube. Second, the subject plugged his ears with soft putty and cotton batting, covered his ears with a heavy bandage, and kept an

electric motor humming at his side. Even without these precautions it was impossible for any one of about twenty-five students and for several disinterested visitors who are competent critics of experimental work to hear what was going on.

Visual stimuli were employed as aids whenever a new word was being added to the tactual vocabulary. When the subject saw the word "Ray", for example, displayed upon a card, he knew that the next tactual impressions upon his palm would be such as arise from speaking that word into the tube. The visual tactual connection was repeated as often as necessary to establish the association, and new words were added as rapidly as possible.

At the end of the academic year the subject had attained an accuracy of from 88% to 95% in the recognition of 200 word impressions. (Each word in the vocabulary repeated several times.)

Up to this time practice had been only with the right hand. On the last day of April, which was the last day of practice, the left hand was employed as the right one had been used theretofore, and recognition proved to be quite as accurate as with the other hand. This result suggests that we are not dealing here with an absolute increase in sensitivity but with a control of attention directed toward small differences in tactual stimulation. On the same day we made another crucial test at the suggestion of Professor McDougall. A list of eight monosyllabic words was prepared upon no one of which the subject had practised. He recognized six of the eight. This indicates, I believe, that the vowel sounds in these words had become isolated in the course of the development of the vocabulary of 34 words, even though no specific attempt had been made in that direction.

Four months after the last test in April, 1923, after a summer of no practice, the subject was tested again by the method with which he had become familiar. On this day he recognized 71% of the 200 tactual stimuli: a loss of 30.5% on the basis of his maximum record in April. The stimuli and method employed in this test were those that were in use on the last day of practice in April.

The query has been raised in some quarters whether the subject in these experiments has not the advantage of bone conduction. I think not, for the following reasons:

(1) The tactual stimuli are so slight that it is inconceivable that they can escape being absorbed by the cushions of flesh in the palm and in cartilage in the joints intervening between the palm and the brain center.

(2) The subject persistently denies that his experience is auditory. This he could not do if bone conduction were a fact.

(3) If bone conduction were involved the subject would not be compelled to learn the meaning of the impression more than you have to learn the meaning of the impressions you receive when the receiver of your telephone is held against your chest. But there has been learning and it was a tedious process.

I am indebted to Mr. George Crane, Assistant in our department, for indispensable aid in conducting this experiment, and to his brother, John Crane, for having given his time as a subject without academic credit.

In view of our success with the speaking tube it occurred to us to substitute for it an acousticon device such as is used for the aid of the partially deaf. It is well known that if one holds the ear piece of such a device in the hand, one can sense its vibration occasioned by the speaker's voice, against the transmitter at a distance. The question is: "Can a subject learn to interpret these vibrations against the skin in a situation in which hearing is out of the question?"

Through the generosity of the Dictograph Products Corporation of New York City, we were provided at the close of the last academic year, and repeatedly since, with the necessary apparatus.

It was our expectation to begin experimentation with the present year, following essentially the same method as that which proved successful last year, but with two modifications:

(1) Stimulation should be applied not to the palm, but directly to the tip of a finger resting lightly against the diaphragm of the receiver.



(2) Instead of employing isolated words as stimuli to be later framed into sentences, we would begin with sentences forthwith and later arrive at isolated words and their phonetic elements. We should thus parallel an approved method of teaching reading.

On October 29, the subject who succeeded with the speaking tube last year was tried out, without previous drill upon the acousticon. He recognized 58 out of 100 impressions, the stimuli being selected from among those with which he had become familiar last year.

The experimenter and the subject in work with the acousticon are separated by from 30 to 60 feet. The receiver lies within the sound-proof box, and the subject's hand, grasping it, is enclosed as in the earlier experiments. The additional precautions against hearing, already described, are employed in this case also.

In preliminary experiments in which the writer was subject, four short sentences were used as stimuli:

Jack did like teacher.

Henry did not begin.

He did like work.

Say, did Jack accept?

No well-defined principles led to the choice of these sentences. Many others would have served as well. They contain a considerable variety of vowel values. It was our expectation that, after considerable practice, these vowel values would begin to emerge in the tactual sense.

Work began with the fourth week in October. The tip of the index finger of the subject's left hand was held lightly against the diaphragm of the receiver. Practice was had four days each week, extending over from 45 to 90 minutes daily. Owing to limitations due to other engagements on the part of experimenter and subject, it was impossible to distribute the time in an ideal manner, as is required by the law of distribution of time in the chapter on learning.

At each sitting, for purposes of drill, the experimenter pronounced the four sentences into the transmitter in an order known to the subject, ten times in succession. The same sentences were then pronounced in orders not

known to the subject during the remainder of the day's period of experiments. Notes were compared after each reading of the four sentences.

After two weeks—eight sessions—the subject had attained an average accuracy of approximately 70% on the four sentences, each of which was presented 50 times. The fourth sentence he recognized in 86% of cases. It began to be apparent to the subject, however, that up to this time his criteria of judgment were tempo, emphasis, number of syllables in a sentence—not the quality of the stimulations. We therefore framed new sentences, using the old words, to test the question whether any more intrinsic quality of the words was beginning. The result was disappointing. Previous practice had given the subject no noticeable advantage in learning the new word groupings.

The subject then began holding the receiver with the aperture disclosing the diaphragm toward the palm. In this case the vibration of the diaphragm is conducted through a cushion of air to the palm and the tactual area stimulated is less restricted than in the earlier practice. By this method, in six sittings the subject attained a confident mastery of the four original sentences and the new ones. These trials carried us up to the end of the first week in the present month.

Up to that time we had drawn the conclusion that success in the interpretation of tactual stimuli arising from oral speech will depend upon the stimulation of a fairly wide area or pattern of tactual organs.

On December 10, we began practice upon the long vowel sounds and continued through the 11th and 12th. We spent approximately one hour on each of these days at drill alone. The order of presentation was always known to the subject, and in the course of every period each vowel was presented 30 times, or 90 times during the three days. Our method of procedure from the 13th to the 19th, inclusive, was as follows:

- (1) The experimenter recited the vowels five times in a known order.

- (2) He recited 15 series of unknown order, 10 in each series (each vowel occurring twice), the subject writing

down what vowel each impression seemed to him to represent.

(3) The subject and experimenter checked up and the experimenter repeated the series for drill.

(4) After this a new unknown series was presented.

Beginning with the 20th each vowel in the series of 10 was pronounced three times instead of once. Otherwise the method remained the same as before. This modification of procedure is apparently producing good results.

Experience up-to-date satisfies me that it is possible to learn to interpret oral speech by tactual impressions.

I have not yet made a learning curve for each vowel. **I** is most easily learned with **A** and **O** close seconds. **E** and **U** are easily confused. As nearly as I can describe the criteria they are as follows:

**A** is a long, heavy, steady impression.

**E** is long and steady, but not so heavy as **A**.

**I** gives two impressions. The first is quick and sharp. The second is prolonged, rather heavy and smooth.

**O** has a roll about it that may be mistaken for two distinct impressions such as **I** affords.

**U** is short, light, and smooth.