Vocalism in Silent Reading

Donald L. Cleland

A continuing controversy has been going on as to whether vocalism in silent reading should be inhibited, encouraged, or just tolerated as part of the reading process. Past experimentation is discussed. Reported here is an investigation to determine the incidence of vocalism during silent reading by two groups of intermediate grade children: reading achievers and reading retardates. A general conclusion is that vocalism is a natural adjunct of the reading process and that at appropriate times all of us use it as a secondary sensory reinforcement.

Many aspects of the art of teaching language skills have remained a controversy over a period that encompasses public education in our democracy. Among these is the topic of vocalism. The fact that it has many synonyms, certainly, has not cleared the education air; but on the contrary has, perhaps, added to the confusion. A search of the literature would reveal such synonyms as implicit speech, inner speech, covert language, inner vocalization, sub-vocalization, silent speech, and vocalism.

The fact that controversy exists, that some say it is part and parcel of the reading process, and others say that techniques should be employed to inhibit its existence, is ample reason that concerted attempts should be made to resolve the problem.

Early judgments concerning the role vocalism plays in the reading process were based on introspection. Two diametrically opposed views may be represented by S. S. Stricker (24) and M. Paulhan (22) who gave their considered opinions during the latter part of the nineteenth century. Stricker and his subjects assert that they could not think of letters or words without experiencing allied speech-motor phenomena. On the other hand Paulhan claimed that he could think of anything without experiencing the corresponding speech-motor phenomena. Bain (3) a physiological psychologist considered thinking

to be more or less restrained vocalization or acting. Egger (12) and Ballet (4), French psychologists investigating aphasia, announced, "To read as a matter of fact is to translate the written word into words to be spoken."

Believing that inner speech may be a detriment to efficient silent reading, O'Brien (21), McDade (19), and Buswell (5) suggested a non-oral method of reading instruction. The results were somewhat inclusive and discouraging. The non-oral method did not eliminate silent speech to any greater degree than did other methods.

Anderson and Dearborn (2) and endorsed by Tinker (26) made a rather revolutionary recommendation that vocalism is a desirable, developmental, learning reinforcement activity, and that its elimination should not be prematurely precipitated. Of interest, at this juncture, is Hollingsworth's (16) theory of cue-reduction or redintegration in which a portion of a complex stimulus would elicit the same response as the original complex stimulus would evoke.

Early attempts at measuring vocalism were crude but rather ingenuous when consideration is given to the methods and equipment available. Curtis (9) placed a tambour on the larynx and recorded its movements while the subjects read "Hiawatha"—silent reading produced more movements than any other mental activity. Only actual whispering produced more. It is interesting to note that four of the experimental cases manifested no movement at all. Parallel to Curtis' work are the results obtained by Courten (8) by obtaining movements of the tongue during the performance of the same activities as Curtis' experimentees. Courten worked with a rubber bulb on the tongue, the bulb being connected to a recording tambour.

Probably the first experiments in which needle electrodes were used to obtain records of muscular action potentials (MAP) from the speech musculature were performed by Jacobson (17) during the early part of the nineteenth century. The electrodes of fine platinum iridium wires, were inserted into the muscles of the tongue or lower lip. The testees in these experiments were instructed to imagine counting from one upward, to imagine telling something to a friend, or think of abstract subjects such as "democracy," "eternity," "electrical resistance," and "Ohm's law," or the meaning of the words such as "incongruous" or "everlasting." The subjects were trained in differential relaxation or the ability to consciously relax individual muscles or groups of muscles.

The recordings of the muscles of the tongue or lower lip of these testees as measured by a galvanometer indicated very nearly no activity when the relaxation was called for, but as soon as a signal was given to perform the tasks listed previously, electrical activity was noted.

Of interest in this connection, also, is the work of Max (18). Surface electrode recordings were obtained from muscles of the arms of 18 deaf mutes, as "the arms and fingers of this group of individuals are the focus of their oral, written, and gestural speech." Comparisons were made with a group of 16 persons with normal speech abilities. The testees were instructed to perform tasks similar to those of Jacobson's study above. In 31% of the control group, muscular activity was noted while in the experimental group, muscular activity was noted in 86% of the cases.

Another study, which certainly is of value to the topic under discussion, was done by Faaborg-Anderson (13) on the functioning of the intrinsic laryngeal muscles in humans. The aim of this study was to determine the degree of activity of these muscles as active in the process of speech, both in the case of healthy persons and in the case of patients with paresis of the vocal cords. Silent speech was accompanied by an increase in electrical activity and action potential of the laryngeal muscles of both groups.

From the above studies it can be concluded with confidence that an increase in electric activity (action potential) in the speech musculature occurs during certain types of mental activity. A question may be posed at this point: "Would there be an increase in muscle action potential (MAP), which can be called a manifestation of silent speech or vocalism, during the process of silent reading?"

The publication, *Silent Speech and Silent Reading* by Ake W. Edfelt, (1960), director of reading research at the University of Stockholm, revealed the only comprehensive, adequately instrumented, and controlled study of implicit speech. In this classical book, Edfelt describes his method of recording implicit speech by a technique called electromyography, the literal meaning of which is electric writing of the muscles. It is premised on the fact that a muscle has a certain electric potential, i.e., a minute electric charge and that this charge will increase as muscles contract. This electric action potential can be measured by either surface electrodes appropriately placed on the

skin or needle electrodes which are placed inside the muscle. General investigators Adrian and Bronk (1) have shown that these electric potentials increase in number as well as frequency when muscular contraction increases.

Edfelt (11), in connection with the reception of new students at the University of Stockholm, gave a series of lectures on the possibilities for bettering a poor ability in reading. An invitation was given to those who wished a further check-up, and, possibly needed advice concerning improvement. Of the 600 new students who attended the lectures, 160 indicated an interest in the program as outlined, and of these 84 were finally selected for the experiment. The investigation of the students who participated included an intelligence test, and the assessment of reading ability by a test in reading speed, a test in reading comprehension and a vocabulary test. Of special interest, however, was that reading comprehension was assessed by means of open-end questions, instead of the more conventional multiple-choice type. Finally three groups of readers were selected: good, medium, and poor. Medium readers were defined as those whose scores fell with plus or minus .5 above and below the mean. Good and poor readers were defined as those who scored above +.5 and below —.5 of the mean.

The students were tested in a Faraday enclosure, reading easy then hard, and clear then blurred material. Benzocaine lozenges were used as a topical anesthetic in preparation of placing needle electrodes in the mylohyoid muscle of the tongue. The results of the experiment may be summed up as follows:

1. Good readers engage in less silent speech than do poor readers.
2. The reading of an easy text results in less silent speech than does the reading of a difficult one.
3. The reading of a clear text results in less silent speech than does the reading of a blurred one.

Implicit in the above is that silent speech occurs in different amounts in all reading. Edfelt has drawn some interesting conclusions from his study; yet these results clearly seem to prove that silent speech cannot have a detrimental effect on reading performance. "Already . . . it was pointed out, as well, that nothing is known concerning reading without silent speech. If these facts are united, it

seems clear that the advisability of direct attempts to eliminate silent speech is highly dubious.

A three-year study conducted by the University of Pittsburgh at the Leech Farm Veterans Hospital and sponsored by the United States Office of Education, Contract No. OE 4–10–056, has yielded some interesting data.

The main purpose of the investigation was to determine the incidence of vocalism during silent reading of two groups of intermediate grade children, i.e., one group which may be classified as reading achievers, and a second group classified as reading retardates. A secondary purpose was to relate methods of beginning instruction (basal vs. basal with supplementary phonics) to the incidence of vocalism during silent reading. Vocalism in this instance is the implicit muscular movements of the musculature of the lips as measured by muscle action potentials (defined elsewhere in this paper). In this investigation, vocalism in silent reading will be measured by counting the output epochs of an electric integrator which transforms the amplified muscle action potentials of the musculature of the lips to oscillographic writing. The main difference between Edfelt's procedure and the one employed by the University of Pittsburgh is that the lip action potentials were picked up by disc electrodes and amplified by a Grass, 10 channel electro-encephalographic recording instrument. The Grass Integrator was used to facilitate the interpretation of the myographic output. Essentially, the integrator is an electrical capacitor or condenser which is connected across the two leads to the ink writing pens. Electrical energy is, therefore, stored in the capacitor. As its peak of capacity is reached, the ink-writing pen gradually deflects, and when the peak has been reached, it discharges and the ink-writing pen returns quickly to its zero position. The gradual deflection (rising) of the ink-writing pen and its sudden return to the zero position constitutes an epoch. The incidence of vocalism can, therefore, be determined by counting the number of epochs over a designated period of time.

The specific elements of the problem are as follows:

1. To determine the incidence of vocalism in silent reading among a selected group of intermediate-grade children.
2. To determine which of two groups of these children has the higher incidence of vocalism in silent reading.

3. To determine the relationship, if any, between the incidence of vocalism in silent reading and reading rate.

4. To determine the correlational relationship between the efficiency of comprehension during silent reading.

5. To determine the correlational relationship between the methods of reading instruction (Basal Approach vs. Basal with Supplementary Phonics) and vocalism in silent reading.

6. To determine the correlational relationship between selected reading and language processes, such as oral reading skills, spelling skills, listening skills, etc., and vocalism in silent reading.

7. To determine, if possible, at which rate of reading there is the minimal incidence of vocalism in silent reading.

8. To determine by which mode of presentation of reading materials (mechanical or non-mechanical) there are fewer incidents of vocalism in silent reading.

A population of 211 intermediate grade children were selected from a total sample of approximately 1,200 students. At the outset of the study a series of five tests were administered to each of the 1,200 children. These tests were:

1. STEP (Sequential Tests of Educational Progress) Listening Test, Part I and Part II.

2. American School Achievement Tests, Intermediate Battery, Arithmetic Computation, Form E, Part II.

3. SRA Primary Mental Abilities Test (PMA) Grades 4–6.

4. Gates Reading Survey Test, Forms I and II.

Based on the first three tests listed above, a regression equation was employed to determine the REL (Reading Expectancy Level) of each child. This regression equation was validated in a study by Toussaint (27).

The actual reading level of each child was determined by averaging the scores obtained from the Gates Reading Survey Test, Forms I and II, each form administered on different days.

Two hundred and eleven subjects were chosen from the total population of 1200 fourth, fifth, and sixth graders. These 211 subjects were placed into one of two groups:

1. Reading Achievers—whose actual reading level was at least +.6 grade level above their REL. (N=116)
2. Reading Retardates—whose actual reading level was at least —.6 grade level below their REL. (N=96)

The following tests, using appropriate sub-sections, were then administered to the selected subjects:

1. The McCullough Word-Analysis Test
2. Spache Spelling Test
3. Wepman Auditory Discrimination Test—Form I
4. Gilmore Oral Reading Test—Form A
5. Stanford Binet Intelligence Scale—Form L–M

With the completion of the testing as described above, the subjects were then ready for the standardized routine of obtaining the electromyograms (EMG).

As a result of a series of preliminary experiments exploring various electrode locations and combinations, the following technique for electromyography was adopted. Three disc electrodes of the conventional electro-encephalograph type modified for attachment with flexible collodion were located around the lips. One was placed midway between the midline and the corner of the mouth approximately 1 cm. above the upper lip line. A second was placed approximately 1 cm. lateral to the corner of the lip. A third was placed midway between the midline and the corner of the mouth approximately 1 cm. below lower lip line. With the patient grounded by a similar electrode attached to an ear lobe, bipolar recordings were made from the three possible pairs of lip electrodes. Two sets of similar recordings were made as follows:

1. Raw EMG's so that, if possible, correlations could be made between EMG patterns and patterns secured through the calibrations.
2. Integrated EMG's to facilitate the quantification of MAP.

In order to assist in the later identification of particular patterns of EMG activity, it was considered desirable to "calibrate" each subject by presenting a standardized list of pictures, words and sentences. For this purpose the Bryngelson-Glaspey speech test cards were produced on 35 mm. film and a graded list of words and sentences ranging from

first to twelfth grades in difficulty were used. During the presentation of these materials, pictures and words presented visually and the sentences auditorially, a key was operated by an observer or by the projector operator so that signal marks are made on the EMG record which allows subsequent identification of the exact material presented to the subject at a time when a particular pattern of EMG activity is recorded. During this phase of the procedure, the subject also counted from one to thirty, each count on signal. This was done both silently and orally.

Following the preliminary "calibration" procedures, reading material was presented mechanically and non-mechanically. Mechanical presentation was by means of a metronoscope, a device which was originally designed to develop phrase reading. On the front there is a small window about seven inches long and one inch high. Reading material, usually of a story type, is printed in sentences on a rotating roll of paper and is shown through the window to the reader. Phrases, therefore, are exposed sequentially from left to right, by three small fluctuating slides in the window. As the last slide of one line of material is shown the roll rotates to the next line. By manipulating the speed of the roll and the fluctuating slides, the operator controls the length of phrase, and rate of reading.

Non-mechanical presentation was by means of graded paragraphs Mimeographed on paper $8\frac{1}{2} \times 11$ inches. The material was selected from stories, the readability of which was determined by the Yoakam (29) Readability Formula. The paragraphs ranged in difficulty from first to twelfth grade.

All the material presented, both mechanically and non-mechanically, was new to the subject. Both easy and difficult materials were presented. Easy material was defined as having a readability level one and one-half grade below the subject ARL (actual reading level); difficult material was defined as having a readability level one and one-half grades above the subjects ARL.

Findings

The findings in this study, as reported in this summary will be related to the seven specific objectives listed heretofore.

1. To determine the incidence of recorded implicit speech among a selected group of intermediate grade children.

It was determined that more implicit speech was manifested during a reading activity than during a non-reading activity. This was noted for both easy and difficult material. There was more recorded implicit speech during the silent reading of operationally defined easy material than during the reading of operationally defined difficult material. Also there was more recorded implicit speech manifested while reading at an operationally slow rate than during an operationally defined fast rate. The differences were significant at the .01 level of confidence.

2. To determine which of two groups of children, the reading achievers or the reading retardates, manifest a higher incidence of recorded implicit speech.

When comparisons were made between the two groups of children, the operationally defined achievers and retardates, the latter group manifested more recorded implicit speech under all experimental conditions. When the material was presented mechanically, both achievers and retardates manifested more recorded implicit speech during the reading of operationally defined easy material. Contrary to this, when the reading material was presented non-mechanically, both achievers and retardates manifested more recorded implicit speech when reading difficult material.

3. To determine the relationship between the incidence of recorded implicit speech and reading rate while reading silently.

The rate at which the reading material was presented varied from approximately 88 words/minute to approximately 200 words/minute. At each thirty-second interval the rate was increased. It was noted, that as the rate was periodically increased there was a decrement in recorded implicit speech. This observation was noted as both achievers and retardates read operationally defined easy and difficult material.

4. To determine at which rate of reading there is minimal incidence of recorded implicit speech.

As may be noted in the above, there was an inverse relationship between recorded implicit speech and the mechanical rate of presentation of silent reading material. A sharp decrement in recorded implicit speech was noted as the rate of presentation was increased from approximately 88 words/minute to approximately 107 words/

minute. From 107 words/minute to 182 words/minute approximately there was slight decrement in recorded implicit speech; however, from this latter rate to the limit of the machine, approximately 200 words/minute, there was little decrement in recorded implicit speech. It can be assumed, however, with a fair degree of confidence that among intermediate grade children, there will be little decrement in recorded implicit speech when they read silently in excess of approximately 180 words/minute.

5. To determine the relationship between the incidence of recorded implicit speech during silent reading and efficiency of comprehension.

It is interesting to note that the mechanical presentation of reading material influenced reading behavior. More implicit speech was manifested, and better comprehension scores were obtained by the retardates when easy reading material was mechanically presented. When difficult material was presented non-mechanically, again the retardates manifested a higher incidence of recorded implicit speech, but the achievers scored higher on comprehension.

6. To determine the relationship between methods of reading instruction (Basal vs. Basal with Supplementary Phonics-Phonetic Keys to Reading) and recorded implicit speech during silent reading.

To explore the relationship between recorded implicit speech and methods of beginning reading instruction, comparisons were made between two groups of children; one taught with the Basal Method and the second taught with a Basal Method supplemented with phonics. When both easy and difficult material were presented at both slow and fast rate mechanically, the children taught by the basal approach manifested more recorded implicit speech than did those taught by a basal approach augmented by a phonics program. When the material was presented non-mechanically, again the children manifested more recorded implicit speech, but the difference was not significant at the .05 level of confidence.

7. To determine the relationship between recorded implicit speech and selected language processes.

Are these relationships negative or positive? Does the mode of presentation influence reading behavior? While it is impossible to draw general conclusions concerning the relationship between re-

corded implicit speech and selected language processes, abstracting relevant data from the study reveals some interesting patterns.

The manner in which the reading material was presented determined whether or not the correlation between mental age, as determined by the Binet, and recorded implicit speech was positive or negative. This fact was true also as pertains to the correlation between words spelled correctly on the Spache Spelling Test and recorded implicit speech. The mode of presentation of the silent reading material had little effect upon the correlation that existed between recorded implicit speech and scores obtained on the following tests: STEP Listening Test, Wepman Auditory Discrimination Reading Test, Arithmetic Computation Part of the American School Achievement Test, McCullough Word Analysis Test, and errors made by the experimentees on the Gilmore Oral Reading Test.

In most instances, negative correlations were found to exist between recorded implicit speech and the language processes as measured by the tests listed above. Exceptions to the above statement were noted with scores on the Spache Spelling Test and Mental Age as determined by the Stanford Binet Intelligence Scale.

Conclusions

One very significant conclusion that was drawn from patterns of scores is that implicit speech, as defined and measured in this study, is a natural adjunct of the reading process, that it is possibly a residue of initially learned oral language patterns, and furthermore that at appropriate times all of us use it as an additional sensory input into cortical functioning or that it is a secondary reinforcing agent.

At least five implications can be drawn from the data collected and observed behaviors of the experimentees, to wit:

1. No inhibitory measures should be taken to cause a decrement in its manifestation, and furthermore that a natural decrement will occur as students acquire maturity in reading skills,
2. That implicit speech may be a frame of reference when we wish to validate written language patterns as being consonant with our own natural rhythmic patterns of oral language,
3. That a psychologically and pedagogically sound method to cause a decrement in the manifestation of implicit speech is to organize the

optimal reading environment, and to judiciously manipulate it so that students will acquire maturity in reading and language skills,

4. That augmenting a basal program with emphasis upon phonics, does not, *per se*, result in an undue manifestation of recorded implicit speech,

5. There is some evidence that when reading material is mechanically presented to readers, more recorded implicit speech is manifested,

6. That implicit speech in silent reading may be a residue of earlier learned oral language patterns,

7. That it may be a reinforcing mechanism or an added sensory input into cortical functioning as the reader comprehends difficult material.

What other implications does this study have—let me think. *I say, says I to myself.* . . .

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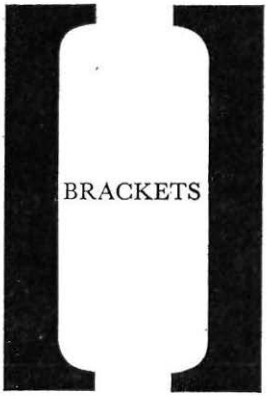

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To hel[p] the poor man,"
And also for putting in facts, such as "He
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Chopped down a [cherry] tree."

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