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Effects of Disrupted Taction on Certain Dimensions of Speech in an Adventitiously Deafened Individual

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EFFECTS OF DISRUPTED TACTION ON CERTAIN DIMENSIONS OF SPEECH IN AN ADVENTITIOUSLY DEAFENED INDIVIDUAL

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The automatic control system described by Fairbanks (1954) and Mysak (1966) as necessary for an adequate human speech output utilizes several monitoring or feedback systems. Auditory sensors monitor bone and air conducted feedback of the acoustic signal, while kinesthetic and tactual sensors monitor the movements and contacts of the speech mechanisms.

Van Riper and Irwin (1958) believe that in the beginning stages of speech development, infants depend primarily on auditory feedback to monitor the accuracy of their speech output. As utterances are repeated, however, certain kinesthetic and tactual cues become associated with the auditory cues. Eventually the kinesthetic and tactual cues assume the dominant role.

McDonald (1968) speculates that defective articulation is the result of defective activation or monitoring, or of an improperly controlled audible movement. The relationships, however, between adequate feedback and verbal output and between inadequate feedback and verbal output are imperfectly understood.

The interaction and mutually supplementary nature of the feedback channels have contributed to certain diffi-

culties in the interpretation of many previous studies. It is extremely difficult to study one channel in isolation, for example, without the possibility of other channels intervening. Research has not as yet differentiated where tactual feedback physically ends and kinesthetic feedback begins in the tongue, lips, palate, cheeks, and the other articulators. These problems have caused confusion and distortion in past research and intensify the need for additional investigation.

When the auditory channel is disrupted by means of auditory masking or auditory delay, a distorted air-borne feedback signal is introduced to the subject. When a distorted auditory signal is present the compensatory tactual and kinesthetic cues of the articulators may differ from those cues present when the auditory signal is eliminated.

Related Studies

Attempts to assess the importance of the feedback channels for monitoring of speech have included studies which sought to observe speech behavior when some or all of the feedback has been impeded in some fashion. Feedback has been altered through the use of local and/or topical anesthetization of the oral cavity and the articulators, delayed or masked auditory feedback, and some combinations of the above.

McCroskey (1958-59) investigated the effect of disrupted tactual and auditory feedback on progress of speech (mean phrase duration in seconds), articulatory accuracy, and intelligibility. Each of six speakers read three word lists under four experimental conditions: 1) control; 2) delayed (0.18 seconds) air-borne side tone; 3) anesthetized articulators; 4) delayed side tone plus anesthesia. McCroskey's anesthetization procedures were described in the following way:

> Bilateral mandibular blocks of the inferior alveolar nerves at the mandibular foramen were performed. The lingual and buccal nerves were anesthetized with the same injection at different depths of needle insertion. The buccal nerve is located just beneath the surface of the mucosa at the apex of the retromolar triangle while the lingual nerve is medial and anterior to the inferior alveolar at the level of the mandibular foramen. Anesthesia of these three pairs of nerves eliminated sensory innervation of the lower lip and cheek, buccal and lingual gingivae, and the anterior two-thirds of the tongue as well as the entire alveolus and teeth. The upper lip was anesthetized by bilateral infraorbital foramen injections from an intraoral approach. A total of approximately 4 cc of 2 per cent Xylocaine (Lidocaine Hydrochloride with 1:50,000 epinephrine) was used for each subject, injecting 1.5 cc for each mandibular block, and 0.5 cc for each infraorbital injection (p.85).

McCroskey found that the rate of speech was affected most under the delayed air-borne side-tone conditions. Articulatory accuracy (judged number of correctly articulated

words) was affected most under those conditions involving anesthesia of the articulators. Intelligibility with listener error scores as the criterion measure, was affected most by loss of tactile cues. McCroskey concluded that:

> ...tactile feedback is of prime importance since the loss of this channel resulted in a statistically significant reduction in the number of words correctly spoken and in the per cent correct responses by listeners. This conjecture is further substantiated by the fact that there was no difference between normal and delayed side-tone, with respect to accuracy of articulation and intelligibility, when the stimuli were presented in both quiet and noise.
>
> When a speaker experienced a 0.18 second delay in his air-borne side tone, his rate of progress of speech was significantly retarded; however, when the speaker's sensory pathways from the oral region were anesthetized to eliminate tactile cues, without interfering with the motor pathways, there was no significant change in duration from that obtained under a condition of normal side-tone. Both of the experimental conditions involving delay showed significantly greater duration scores than either normal side-tone or anesthesia alone; whereas, both of the experimental conditions involving tactile losses exhibited significantly reduced word accuracy and intelligibility when heard by listeners in quiet. Auditory side-tone appears to be a major factor in determining the rate of progress of speech, and tactile feedback seems to be a greater importance to the accuracy with which words are spoken (pp. 89-90).

The modality of feedback that McCroskey actually assessed may be open to question. He may have disrupted kinesthetic

feedback in addition to tactual feedback if we use Kaplan's (1960) definition of kinesthesis. "Kinesthetic sensibility ... involves consciousness of muscle movement, position and tension (p. 10)" whereas, tactual feedback involves the awareness of touch.

In a study by McCroskey, Corley and Jackson (1959-60) the identical equipment, stimulus material and method of eliminating tactual cues reported in the study by McCroskey (1958-59) were used. Six speakers were recorded as they read stimulus words under two conditions: normal monitoring and disrupted tactual cues. Two judges transcribed the recordings into phonetic symbols and compared their transcriptions with transcriptions of how the same words normally are spoken. The authors analysed the articulation errors in terms of omissions, additions, substitutions, and distortions, and described the frequency of occurrence of these errors in the initial, medial and final positions in words. They found that under conditions of tactile loss, the speakers made more frequent errors than they did under normal conditions. Substitution errors accounted for about 38 per cent of all errors, with most errors occurring in the initial position of words. More errors were recorded in the final position than in the medial. Distortions accounted for 36 per cent of the errors, with more of these errors occurring in the final position and fewer in the initial position. Additions

accounted for ten per cent of the errors, with the majority in the medial position and the fewest in the final position. The remaining errors were omissions. There appeared also to be greater variety in the sounds for which substitutions were made than for the sounds omitted, added, or distorted. Lingual alveolar sounds were most frequently in error, but they also appeared more frequently in the word list. In two instances error-frequency did not correspond to occurrence-frequency. The /f/ and /v/ sounds were produced inaccurately more than expected and the /s/, /z/, /ʃ/ and /ʒ/ were correctly produced more often than one would have expected by observing their frequency of occurrence. McCroskey, Corley and Jackson attempt to explain this by saying that:

> "... the stopping point in the upward movement of the mandible—for the labio-dental sounds—may depend almost entirely upon tactile sensation to establish that physical relationship between lip and teeth which permits the production of these fricatives. On the other hand the arrival at a terminal position for the production of the sibilants does not seem to be as dependent upon the 'feel' of the articulators (p.59).

Errors in phonemic classes from most to least frequent were as follows: plosives, fricatives, semi-vowels, nasal, affricatives, and aspirates.

Just as in the case of McCroskey's (1958-59) earlier study it seems possible that both kinesthetic and tactual feedback cues were disrupted in this study by McCroskey,

Corley and Jackson (1959-60).

Ringel and Steer (1963) studied articulation, duration, average peak level (energy peaks of the recorded sentences above the base of 60 dB SPL which differed from the preceding peaks by at least 5 dB) and fundamental frequency of the speech of 13 female subjects under the following conditions:

> (a) control; (b) binaural masking; (c) topical anesthetization of the oral region by application of Xylocaine HCL 4%;(d) local anesthetization of the oral region by bilateral mandibular and infra-orbital nerve block techniques employing Xylocaine HCL 2%; (e) simultaneous administration of conditions b and c; (f) simultaneous administration of conditions b and d (p. 369).

In condition (d) the technique described by McCroskey (1958-59) was used. Under topical anesthesia, the average peak level of speech increased significantly in relation to the level obtained under controlled conditions. The application of topical anesthetization of the oral region did not result in mean fundamental frequency values which were significantly different from those obtained under the controlled condition. Syllable length and word per minute rate were not significantly altered by topical anesthesia itself. Ringel and Steer also concluded that topical anesthesia alone does not significantly impair articulation although local anesthetization affected articulation more severely than did any of the other experimental conditions.

While Ringel and Steer's findings with the use of nerve block anesthesia tend to agree with the findings of McCroskey (1958-59) and McCroskey, Corley, and Jackson (1959-60) their report of only minimal speech disturbances under the condition of a topical anesthesia might be viewed as further basis for questioning whether nerve block injections impair kinesthetic as well as tactile feedback. The elimination of tactual feedback by a topical anesthetic may be the least contaminated way of defining the effects of taction.

Ringel and Steer also concluded that simultaneous use of topical anesthetic and binaural masking resulted in an average peak level that is substantially greater than that obtained for either condition separately. High level masking noise, white noise (94dB re.0002 dyne/cm^2), did significantly increase the mean fundamental frequency of speech. The masking noise did not alter the word per minute rate significantly, but it did increase the phonation time of the speech. Speaking rate was not significantly retarded under any of the experimental conditions. Syllable prolongations were observed under conditions involving masking noise. Masking noise alone did not impair articulation but when presented with topical anesthesia, the articulation was affected.

Schliesser and Coleman (1968) did a study to determine the effectiveness of auditory masking and intra-oral

anesthetics on speech under four conditions: "(1) auditory masking and oral anesthesia, (2) oral anesthesia alone, (3) auditory masking alone, and (4) normal.(p. 275)." A topical anesthetic was applied to the entire surface of the hard palate and a bilateral mandibular nerve block along with a nerve block in the area of the incisive foramen of the anterior hard palate was administered employing Xylocaine HCL 2 per cent. Auditory masking consisted of white noise and sawtooth noise, the sawtooth noise being ten dB more intense than the white noise. Oral stereognosis testing was employed using ten plastic geometric objects during condition four and after condition two to assess the degree of reduction of tactile sensations by anesthesia. Assessment of the restricted motility of the speech musculatures was assessed by having the subject repeat accurately /m∧/, /d∧/, /g∧/ and /p∧, t∧, k∧/ as fast as possible for three trials of ten seconds each. The subjects were asked to repeat this procedure along with tongue lateralization activities under conditions two and four. Each subject tape recorded 42 sentences. A 15 second segment of the speech of each subject was compared by a panel of judges to a standard speech sample which represented a moderate speech problem by clinical standards.

Stereognostic testing revealed that total intra-oral insensitivity was accomplished. Based on the assessment of the motility of the speech musculature, very little if

any interference with the motor innervation of the speech musculature was judged to have occurred from the anesthesia in the study. Speech was judged to be least adequate under the condition which combined auditory masking and anesthesia. The intelligibility of the subjects' speech did not deteriorate.

Grossman (1964) evaluated the oral surface sensation of three teenage male and female athetoid cerebral palsy patients and 30 normal male and female subjects by placing ten plastic geometric forms on the mid-dorsal surface of the subject's tongue. The subjects first identified the ten forms with only lingual and palatal action in order to assess lingual and palatal taction. Next the subjects elevated the test objects against the posterior hard palate with the tongue and placed the tongue tip against the palatal surface of the maxillary anterior teeth; thereby, assessing posterior lingual and palatal taction. These procedures were repeated after: 1) the hard palate had been covered with a prosthesis and 2) after bilateral lingual nerve blocks, anesthesia with 2 per cent Lidocaine hydrochloride with 1/100,000 epinephrine, had been injected. Also, two point discrimination was performed on the tongue tip, lateral margins and dorsum section of the tongue.

The neurologically impaired patients responded inconsistently and the normal subjects identified 70 per cent of the objects except when the objects were held by the

mid dorsal surface of the tongue against the posterior hard palate. The objects were not identified after anesthetization if they did not contact the teeth or lips. Grossman points out that the findings indicate that oral discrimination depends primarily on the anterior lingual surfaces. One may generalize and speculate by saying that the anterior and tip of the tongue could serve as the primary lingual taction areas.

Weber (1961) assessed the effect of masking and anesthetization of the oral structures upon articulation and voice characteristics of normal adult speakers under four experimental conditions: 1) normal feedback; 2) masked; 3) anesthetized; 4) a combination of 2 and 3. "The anesthesia condition consisted of four injections of 2% Lidocaine Hydrochloride containing epinephrine at a strength of 1/100,000 (p. 19)." Two mandibular injections were administered bilaterally to the inferior alveolar nerve at the mandibular foramen, one injection to the inferior alveolar nerve and one injection into the lingual and buccal nerves. The terminal branches of the infra-orbital nerve were also anesthetized. Weber's subjects read a list of words which contained all but one of the English consonants and a paragraph in which all consonants were represented. In the normal condition distortions accounted for 66.67 per cent of the errors and omissions accounted for 33.33 per cent of the errors. In the anesthetized condition distor-

tions accounted for 51.12 per cent of the errors, substitutions 38.88 per cent of the errors and omissions accounted for 10 per cent of the errors. In the combined condition distortions account for 52.63 per cent of the errors, substitutions 35.97 per cent of the errors and omissions accounted for 11.40 per cent of the errors. The mean reading time for each of the four conditions were: 1) normal, 16.5 seconds; 2) masked, 18.2 seconds; 3) anesthetized, 18.5 seconds; 4) combined, 19.3 seconds. The judges reported that under each condition of disrupted feedback the pitch, loudness and rate deviated from the normal condition. Weber concludes with the following remarks:

> In the two conditions containing disruption of the non-auditory channel (anesthetized and combined), there were significantly more articulation errors than in the normal condition. The masked condition was not significantly different in number from the normal condition. The elimination of auditory and non-auditory channels simultaneously did not lead to a significant increase beyond the number of errors found by a summation of the effects of single channel elimination. There was a significant difference in the type of articulation errors caused when the auditory and non-auditory feedback channels were disrupted. In the normal and masked conditions, the errors were about two-thirds distortions, one-third omissions, and very few substitutions. In the anesthetized and combined conditions, the errors were about one-half distortions, three-eighths substitutions, and one-eighth omissions.
>
> Non-auditory feedback cues seem to be of greater importance to the

> correctness of articulation than auditory feedback cues. Disruption of the auditory feedback channel seems to cause different types of articulation errors than caused by disruption of the non-auditory channel. Auditory feedback cues seem to be more important in the monitoring of loudness and pitch than non-auditory feedback cues. Rate is only slightly affected by disruption of either auditory or non-auditory feedback cues. There seems to be very little interrelationship or interdependence between the auditory and non-auditory channels (pp. 58-60).

Using six subjects Guttman (1954) attempted to eliminate auditory cues and sensations of the oral cavity while trying to define their role in the speech control system. The subjects read a passage under six conditions: 1) normal; 2) reading with thermal noise; 3) reading with delayed auditory feedback of .2 second at a level of 30 dB over normal conversational loudness; (4-6) each of these three conditions repeated with anesthetization of the oral cavity. Masking consisted of a flat noise spectrum from 100-7000 Hz at a sensation level of 80 dB. Anesthetization was accomplished by means of a bilateral nerve block of the inferior portion of the fifth cranial nerve, including the alveolar, lingual and mandibular portions, with Xylocaine HCL as the agent. This consisted of 2 per cent Lidocaine and 1/50,000 parts adrenalin. Guttman reported that spraying the oral cavity with Cocaine had no effect on speech and was of short duration. Lidocaine without adrenalin delayed the time of onset of the agent by 15

minutes and the depth of anesthesia was not as strong as the solution which contained adrenalin. Guttman assessed articulation by judging whether a word was uttered correctly or incorrectly. A correct word was defined as a word said in the proper serial order without internal phonemic deviations. The mean number of correct words in a 55 word reading passage for Guttman's subjects in the unanesthetized condition was 50.7 while in the anesthetized condition the mean number of correct words was 40.8. With auditory masking the mean number of correct words was 49.3 under the unanesthetized condition and 41.7 under the anesthetized condition. Guttman summarizes the results of his study by stating that:

> ... certain of the oral structures were anesthetized with the intention of reducing non-auditory feedbacks from the articulatory mechanism. Performances under this condition under widely different auditory conditions were characterized by few correct words, increased duration and decreased correct word rate, but sound pressure did not change significantly. No evidence of auditory and non-auditory interaction was obtained (pp. 166-167).

Weiss (1968) investigated the tongue placement and mandibular excursions of eight normal children in seven conditions. In conditions 1, 2, and 3, the subjects produced nine front-of-the-mouth phonemes, /θ/, /ð/, /s/, /z/,/n/, /l/, /ʃ/, /ʒ/, and /ɝ/ in isolation, in words, and in sentences. These were recorded on tape. In

condition 4, there was no disrupted taction and the nine phonemes were produced in words while cinefluorographs (X-rays) were taken. Experimental conditions 5, 6, and 7 were the same as the first three except taction was disrupted. Weiss disrupted taction of the anterior two-thirds of the tongue and the contiguous portions of the hard palate and the alveolus with HCL 4% topical Xylocaine. Weiss concluded that lingual taction of the anterior two-thirds of the tongue and of the contiguous portion of the hard palate and alveolar did not contribute sensory information toward maintaining articulation of the subjects studied. In order to assess the effect of disrupted taction on the phonemes, Weiss had judges identify each phoneme before and after disrupted taction and found no differences. He also concluded that disrupted lingual taction tends to decrease precision of lingual placements and increases the range of mandibular excursions. The results were obtained from X-raying the tongue and measuring mandibular displacement while producing the stimulus material before and after disrupted taction. More specifically Weiss says that:

> The highest part of the tongue was typically in the posterior segment of the oral cavity during productions of the nine phonemes before and after disrupted taction. A range of lingual and mandibular placements can be specified for phonemes produced in isolation and in words; the range usually is within ten millimeters, which has obvious therapeutic implications (pp. 5-6).

Locke (1968) used nine normal adults in an investigation to assess possible motor impairment resulting from local anesthetic injections under the conditions of local anesthesia, topical anesthesia and in the absence of anesthesia. His subjects produced five CV syllables, /dʌ/, /bʌ/, /vʌ/, /zʌ/, and /gʌ/ as rapidly as possible for five seconds. Conditions of local anesthesia produced the lowest number of productions for all CV syllables. Locke focuses on a pertinent question, i.e., the methodology employed in studying kinesthetic feedback. According to Locke, "...the proximity of sensory and motor nerves is such that individual differences among subjects, human error and/or drug diffusion could lead to motor impairment (p. 699)," in trying to eliminate kinesthetic feedback by local injection. Locke then suggests that conventional methodology employed to assess kinesthetic feedback may be based on inappropriate evidence. If local injections can lead to kinesthetic and/or motor impairment of the articulators then assessment of tactual feedback may have been contaminated.

Zemlin (1968) points out that all nerves are mixed, that is, they contain both afferent or sensory neurons and efferent or motor neurons. Yet, on a functional basis many nerves are either afferent or efferent while still containing the property of the other. When kinesthetic or tactual feedback is disrupted by an injection there is

a possibility that enough efferent neurons are disrupted to contaminate the assessment of the feedback.

The results of the studies by Guttman (1954), McCroskey (1958-59), McCroskey, Corley, and Jackson (1959-60), Weber (1961), Ringel and Steer (1963), and Schliesser and Coleman (1968), may have been influenced by kinesthetic and/or motor impairment resulting from a locally injected anesthetic. To the extent that this is the case, their results may reflect the assessment of sensory modalities other than tactual feedback. Locke (1968) appears to have reinterpreted the earlier studies by stating that they assessed the role of reduced kinesthetic feedback on articulation.

Schliesser and Coleman (1968) and Locke (1968) assessed rate of articulation of CV syllables and reported conflicting results. Schliesser and Coleman found no difference in mean rate when their subjects repeated /m ʌ/, /d ʌ/, /g ʌ/, and /p ʌ t ʌ k ʌ/ for ten seconds each, during the normal and anesthetized condition. McCroskey, Corley, and Jackson (1959-60), Weber (1961) and Ringel and Steer (1963) assessed misarticulations as to substitution, distortion, omission or addition type error and the position of the error in the words. McCroskey (1958-59) assessed number of correctly articulated words. Schliesser and Colemen (1968) assessed articulation deviations, and Guttman (1954) assessed articulation in terms of judging a word as being

uttered correctly or incorrectly.

From the foregoing studies, it was also reported that where topical anesthesia alone was employed in anesthetizing the articulators, articulation was not adversely affected. Ringel and Steer (1963) and Weiss (1968) found that articulation was not significantly impaired. Locke (1968) also reported that topical anesthetization of the oral cavity did not significantly impair the rate of production of CV syllables.

In addition to the problem of eliminating the appropriate sensory modality in dealing with kinesthetic and tactual feedback, the problem of complete elimination of auditory feedback confronts the researcher. The conventional means of attempting to alter auditory feedback consists of introducing the subject to an auditory masking signal or delayed auditory feedback. This is done in order to assess the importance of auditory feedback in maintaining the appropriate speech output. Several questions arise concerning the alteration of a subject's auditory feedback through auditory masking or auditory delay. When subjects have been masked auditorily, has the auditory feedback been eliminated completely, thus filtering out all auditory speech feedback? What type of auditory distortion results from auditory masking and from auditory delay? To what extent is auditory bone conduction feedback altered in studies which concern themselves with either of the

methods of disrupting air-borne side tone?

Statement of the Problem

In view of the kinds of problems and questions which arise when auditory feedback is masked or delayed and the lack of agreement regarding the role of tactual feedback in speech, there is a possible advantage in studying the effects of reduced taction in the absence of auditory feedback.

This study was designed to investigate the extent to which disruption of tactual feedback, through administration of a topical anesthetic, affects various dimensions of speech in an adventitiously deafened individual. Certain dimensions of the subject's speech were studied: 1) articulation; 2) reading rate; 3) intelligibility.

Specifically, the following questions were asked:

1. Does the frequency with which misarticulations occur on syllable releasing consonants in the anesthetized condition differ from the frequency with which misarticulations occur on syllable releasing consonants in the normal condition?
2. Does the frequency with which misarticulations occur on syllable arresting consonants in the anesthetized condition differ from the frequency with which misarticulations occur on syllable arresting consonants in the normal condition?

3. Does the frequency of substitution errors in the anesthetized condition differ from the frequency of substitution errors in the normal condition?

4. Does the frequency of distortion errors in the anesthetized condition differ from the frequency of distortion errors in the normal condition?

5. Does the frequency of omission errors in the anesthetized condition differ from the frequency of omission errors in the normal condition?

6. Does the oral reading rate in correct words per minute in the anesthetized condition differ from the oral reading rate in correct words per minute in the normal condition?

In addition, a preliminary observation was made of the relative intelligibility of single utterances under normal and anesthetized conditions.

CHAPTER II

PROCEDURES

Description of Subject

A 21-year-old male speaker served as the subject for this study. An examining physician reported that the subject had sustained a bilateral basilar skull fracture in a car accident in the latter part of August, 1967 (approximately 15 months previous to the present study) and that he was apparently totally deafened. In addition to the deafness there was a reported complete loss of labyrinthine function. A pure tone hearing test administered by the examining physician in September of 1967 showed a response in the left ear for bone conduction at 50 dB (ISO-1964) for 500 Hz and 70 dB for 750 Hz. The right ear responded to a bone conducted tone at 55 dB for 500 Hz. The report also indicated that these probably were responses to tactile rather than to auditory sensations. No responses were reported for air conducted tones.

A hearing test was administered at the Western Michigan University Speech and Hearing Clinic in the latter part of January, 1969, with a Bekesy audiometer, model E-800 Grason-Stadler, using pulse tone stimuli and fixed frequency tracings for one minute at each frequency. The results of

this test are shown in Table 1. The subject reported no response in the left ear to air conducted tones at the limits of the audiometer below 500 Hz, from 1200 Hz-1400 Hz, or 2400 Hz and above. The subject responded to an air conducted tone in the left ear of 500 Hz at 110 dB (ISO-1964), 600-800 Hz at 110 dB, 1000 Hz at 115 dB, 1500 Hz at 115 dB, 1600 Hz at 110 dB, 1700 Hz at 105 dB, 1800 Hz at 110 dB, 1900-2000 Hz at 105 dB, 2300 Hz at 110 dB. The subject reported no response in the right ear to air conducted tones at the limits of the audiometer below 200 Hz or for 650 Hz and above. The subject responded in the right ear to an air conducted tone of 200 Hz at 90 dB, 250 Hz at 95 dB, 300 Hz at 100 dB, 400-500 Hz at 105 dB, and for 500 Hz at 115 dB. In this testing situation the subject was instructed to respond to what he remembered as a sound. The subject was also asked to respond to the sound when he felt any vibratory sensation. He did not respond.

The subject was given a conventional pure tone bone conduction hearing test with a Beltone audiometer, model 14-A, during the early part of March, 1969. The results of the discrete frequencies tested are also shown in Table 1. The subject reported no responses in the left ear to bone conducted tones at the limits of the audiometer for 1000 Hz and above. The subject responded to a bone conducted tone

TABLE 1. SUMMARY OF SUBJECT'S RESPONSES TO PRESENTATIONS OF AUDIOMETRIC PURE TONES

Frequency	Response Threshold Level in dB (ISO-1964)			
	Air Conduction		Bone Conduction	
Hz	RIGHT EAR	LEFT EAR	RIGHT EAR	LEFT EAR
125	*NR	NR		
200	90	NR		
250	95	NR	NR	40
300	100	NR		
400	105	NR		
500	105	110	55	55
600	115	110		
650	**NR_1	110		
800		110		
1000		115	NR_1	NR_1
1200		NR		
1300		NR		
1400		NR		
1500		115		
1600		110		
1700		105		
1800		110		
1900		105		
2000		105		
2300		110		
2400		NR_1		

*NR = No response at limits of audiometer
**NR_1 = No response at limits of the audiometer for remaining frequencies

in the left ear of 250 Hz at 40 dB (ISO-1964), and to a tone of 500 Hz at 55 dB. The subject reported a response in the right ear to a bone conducted tone of 500 Hz at 55 dB but did not respond to any other frequency.

Selection of the Anesthesia

Xylocaine (Lidocaine 10% w/w, Celylpyridinium Chloride 0.01% w/w, and Alcohol, absolute, 7.13% w/w) was the anesthetic agent selected for this investigation. Xylocaine has proven to be an effective and safe intra-oral topical anesthetic in previous studies. Dripps, Eckenhoff, and Vandam (1967) report that the major advantages of Lidocaine (Xylocaine) are its rapid onset and its freedom from local irritative effects. Its potency and duration are moderately greater than many of the other intra-oral topical anesthetics.

Application of Topical Anesthesia

The hard palate, anterior two-thirds of the superior and inferior surfaces of the tongue including the lateral margins, bilateral buccal mucous membrane, internal mucous membrane of the lips and of the maxillary and mandibular alveolar processes and the connecting mucous membrane were sprayed and swabbed with the anesthetizing agent. These surfaces were first swabbed dry to minimize dilution of the

agent. The anesthetic was applied by an attending orthodontist highly experienced in the use of oral anesthetics.

Speaking Task

The subject was required to read aloud, first under normal conditions and then in the anesthetized condition, a list of 42 words and a 300 word paragraph. Seven phonemes, /θ, ɹ, s, z, n, l, ʃ/, were produced as syllable releasing and syllable arresting consonants. Each consonant appeared in three different words as a releasing consonant and three different words as an arresting consonant with each word appearing in the paragraph only once. The identical words were used in the sentences which were used in the word list. The investigator developed the word list and the paragraph (see Appendices A and B). The following instructions were given to the subject:

> I will hand you a set of cards with a word printed on each card. Please read each word aloud only once and place the card on the table beside you. When you have finished with all the cards I will hand you a paragraph to read. Please read the paragraph aloud.

The subject read the paragraph silently six times prior to the oral reading in the normal condition in order to become thoroughly familiar with its content. Both conditions were completed the same day and in the same experimental environment.

The subject remained in an Industrial Acoustic

Corporation's (IAC) testee sound booth, seated in a stationary chair with an adjustable head rest, for both testing sessions. A microphone was placed 22 inches from the subject's mouth and this was connected to an Ampex tape recorder, model AG-350, located in an adjacent IAC tester sound booth.

lection of Data

Articulation accuracy was judged during the reading of the single words and paragraph using the following criteria: when a consonant was articulated correctly and represented an average degree of precision in articulation it was assigned a value of 1; when a consonant was articulated correctly, but not with the precision of average articulation it was assigned a value of 2; when a consonant was distorted an X symbol designated the misarticulation; when a consonant was omitted, a dash (—) symbol designated the misarticulation; when an incorrect consonant was substituted for a correct consonant, the substitution was reported. The judges, five graduate students in Speech Pathology and Audiology with at least one year of professional experience, judged the subject's articulation of the recorded material. Only the specific seven consonants, which functioned as either releasing or arresting consonants, were judged in the word list and in the paragraph.

The 42 words recorded in the normal and anesthetized

conditions were randomly mixed and dubbed onto a single tape which was presented to the judges. There was at least a six second delay between word presentations. The judges recorded the articulatory accuracy of the consonants in the word list on a specially prepared response sheet after receiving specific instructions (see Appendix C). In judging the first session and the third session the judges recorded the articulatory accuracy of the consonants from the paragraphs read in the normal and anesthetized conditions on a specially prepared response sheet after receiving specific instructions (see Appendix D).

Intelligibility of the words recorded under the normal condition and anesthetized condition was assessed by having judges listen to the same taped word list as prepared for assessing the articulated accuracy of the consonants. Twenty-five undergraduates were introduced to this task by listening to a ten word practice task. These ten words did not appear in the word list used for testing purposes. The judges then listened to the taped word list and recorded the words on a specially prepared response sheet after receiving specific instructions (see Appendix E).

The subject's word utterance rate and reading rate in correct words per minute were obtained by having two graduate students in Speech Pathology and Audiology judge each 300 word reading passage recorded in the normal condition and anesthetized condition. The judges reported all words

which contained a misarticulation. A misarticulated word consisted of a word which was agreed upon by the two judges to contain a substituted, distorted, or omitted phoneme. The number of misarticulated words was substracted from 300 to obtain the number of correctly articulated words under each condition. The subject's rate of utterance was obtained by timing the reading of the paragraph in each condition. This time was divided into the total number of correctly articulated words. The quotient was multiplied by 60 in order to obtain the reading rate in correct words per minute.

CHAPTER III

RESULTS AND DISCUSSION

Each consonant occurrence was classified by each judge in the manner previously described. The number of judgments for either condition, then, was 210; for each function, 105; and for each consonant in each function, 15. Reports of articulatory accuracy represented simple summations of these judgments. Only the results of intelligibility judgments were statistically analyzed.

Connected Speech

Articulatory characteristics

In connected speech (as may be seen in Table 2) the subject was judged more frequently, 174 times, to have articulated consonants correctly in the anesthetized condition than in the normal condition, 162 times. If we consider the judges' choice of articulatory correctness as being a combination of both number 1 and number 2, normal condition, 198, and anesthetized condition, 202, on the articulatory judging scale, then the difference of four between the two conditions is minimal. There were more judged misarticulations in the normal condition, 12, than in the anesthetized condition, eight. There were also more articulations judged number 2

Table 2. SUMMARY OF 105 JUDGMENTS OF ARTICULATORY ACCURACY FOR SEVEN RELEASING AND ARRESTING CONSONANTS PRODUCED IN THE PARAGRAPH IN THE NORMAL AND ANESTHETIZED CONDITIONS.

	RELEASING		ARRESTING		TOTAL	
Judgment*	Normal	Anesthetized	Normal	Anesthetized	Normal	Anesthetized
1	93	97	69	77	162	174
2	10	7	26	21	36	28
X	2	0	4	2	6	2
—	0	0	3	4	3	4
Sub.	0	1	3	1	3	2

*Judgments of accuracy are represented by 1, 2, X, —, Sub.
1 = consonant articulated correctly, representing an average degree of precision in articulation
2 = articulated correctly but with less than average precision
X = distorted
— = omitted
Sub. = substitution of an incorrect consonant

in the normal condition, 36, than in the anesthetized condition, 28. No strong patterns of difference between the normal condition and the anesthetized condition appeared in the total of the articulation judgments.

Condition and function

The greatest number of correctly articulated consonants was judged to have occurred in the case of syllable releasing consonants produced in the anesthetized condition as seen in Figure 1. The second most frequent instance of correctly articulated consonants occurred in the case of releasing consonants produced in the normal condition. The arresting consonants in the anesthetized condition were next in frequency of correct articulations, and the least frequently correct articulations occurred in the case of the consonants in the normal arresting position.

In other words, the judges assigned a number 1, from most to least frequently, in the following order: 1) anesthetized condition releasing consonants, 97; 2) normal condition releasing consonants, 93; 3) anesthetized condition arresting consonants, 77; 4) normal condition arresting consonants, 69. The judges assigned a number 2, from most to least frequently, in the following order: 1) normal condition arresting consonants, 26; 2) anesthetized condition arresting consonants, 21; 3) normal condition releasing consonants, ten; 4) anesthetized condition releasing con-

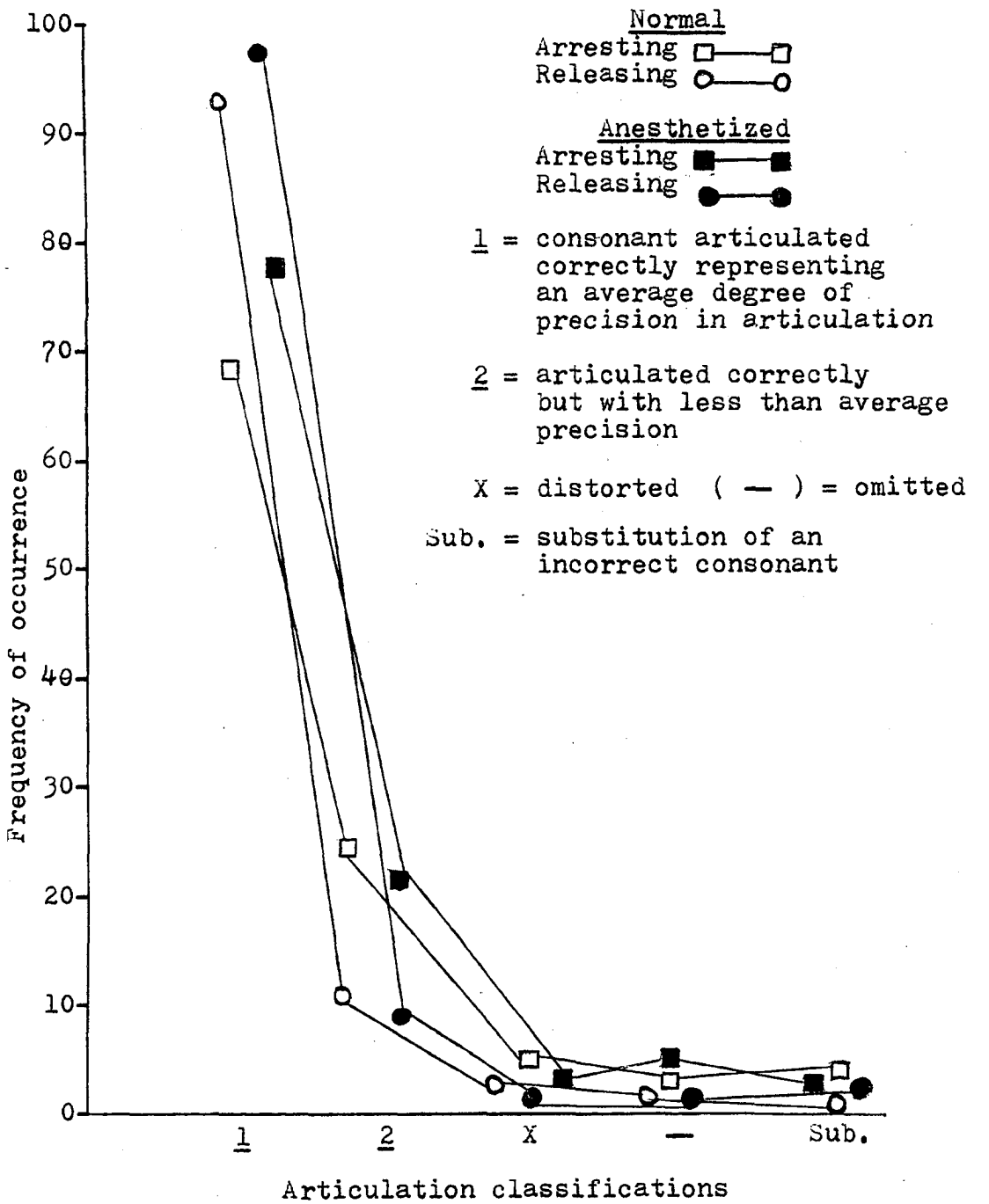

Figure 1. Summary of 105 judgments regarding the articulatory classifications of seven phonemes which functioned as releasing and arresting consonants in the paragraph in the normal and anesthetized conditions.

sonants, seven.

Distortion type errors occurred most frequently in the normal condition arresting consonants, four. Normal condition releasing consonants and anesthetized condition arresting consonants were distorted an equal number of times, two, and anesthetized condition releasing consonants were never judged as distorted. Omission type errors occurred from most to least frequently, in the following order: 1) anesthetized condition arresting consonants, four; 2) normal condition arresting consonants, three. Consonants in the normal releasing and anesthetized releasing conditions were never judged omitted. Substitution type errors occurred, from most to least frequently, in the following order: 1) normal condition arresting consonants, three; 2) anesthetized condition releasing consonants and anesthetized condition arresting consonants were substituted for an equal number of times, one. Normal condition releasing consonants were never judged to have been substituted for by an incorrect consonant.

More consonants in the anesthetized condition than in the normal condition were judged to have been articulated correctly. More arresting consonants then releasing consonants were judged with a number 2 in both the anesthetized and normal condition. More misarticulations were judged to have occurred in the arresting consonants than in the releasing consonants in both the normal and anesthetized

conditions. More misarticulations were judged to have occurred in the normal condition arresting consonants than in the anesthetized condition arresting consonants. More distortion type errors and substitution type errors were judged to have occurred in the normal condition arresting consonants than in the anesthetized condition arresting consonants. There were more omission type errors judged to have occurred in the anesthetized condition arresting consonants than in the normal condition arresting consonants. There were more distortion type errors judged for the normal condition releasing consonants than for the anesthetized condition releasing consonants and more substitution type errors were judged to have occurred for the anesthetized condition releasing consonants than for the normal condition releasing consonants.

Condition and accuracy of individual consonants

Of the seven consonants the releasing /θ/, /n/, and /l/ were judged with a 1 by all judges in the normal condition. The /z/ was the only consonant which was distorted. The seven consonants were never judged to have been omitted, nor were substitution errors reported in the normal releasing condition. In the anesthetized condition releasing consonants, the /n/ and /l/ were judged with a 1 by all judges. The /z/ was the only consonant for which an incorrect consonant was judged to have been substituted. The

seven consonants were never judged to have been distorted or omitted in the anesthetized releasing condition.

Of the seven consonants the /ʧ/ was judged with a 1 by all except two of the judges in the normal arresting condition. The /θ/, /z/, and /l/ were all judged to have been distorted. The /θ/ and /l/ were judged to have been omitted. The /z/ was the only consonant for which an incorrect consonant was judged to have been substituted. Of the seven consonants the /n/ was judged with a number 1 by all except two of the judges in the anesthetized arresting condition. The /θ/ was the only consonant judged to have been distorted. The /θ/ and the /l/ were the only consonants judged to have been omitted and the /n/ was the only consonant for which an incorrect consonant was judged to have been substituted in the anesthetized arresting condition.

The consonants and their frequency of number 1 judgments in the normal releasing condition were: 1) /θ, n, l/ most frequently and an equal number of times; 2) /ʃ s, z/ were judged second most frequently and an equal number of times; and 3) /ʧ/ least frequently as seen in Figure 2. The consonants and their frequency of number 1 judgments in the anesthetized releasing condition were: 1) /n, l/ judged most frequently and an equal number of times; 2) /ʃ, s, θ/ were judged second most frequently and an equal number of times; 3) /ʧ/ was judged third most frequently; and 4) /z/

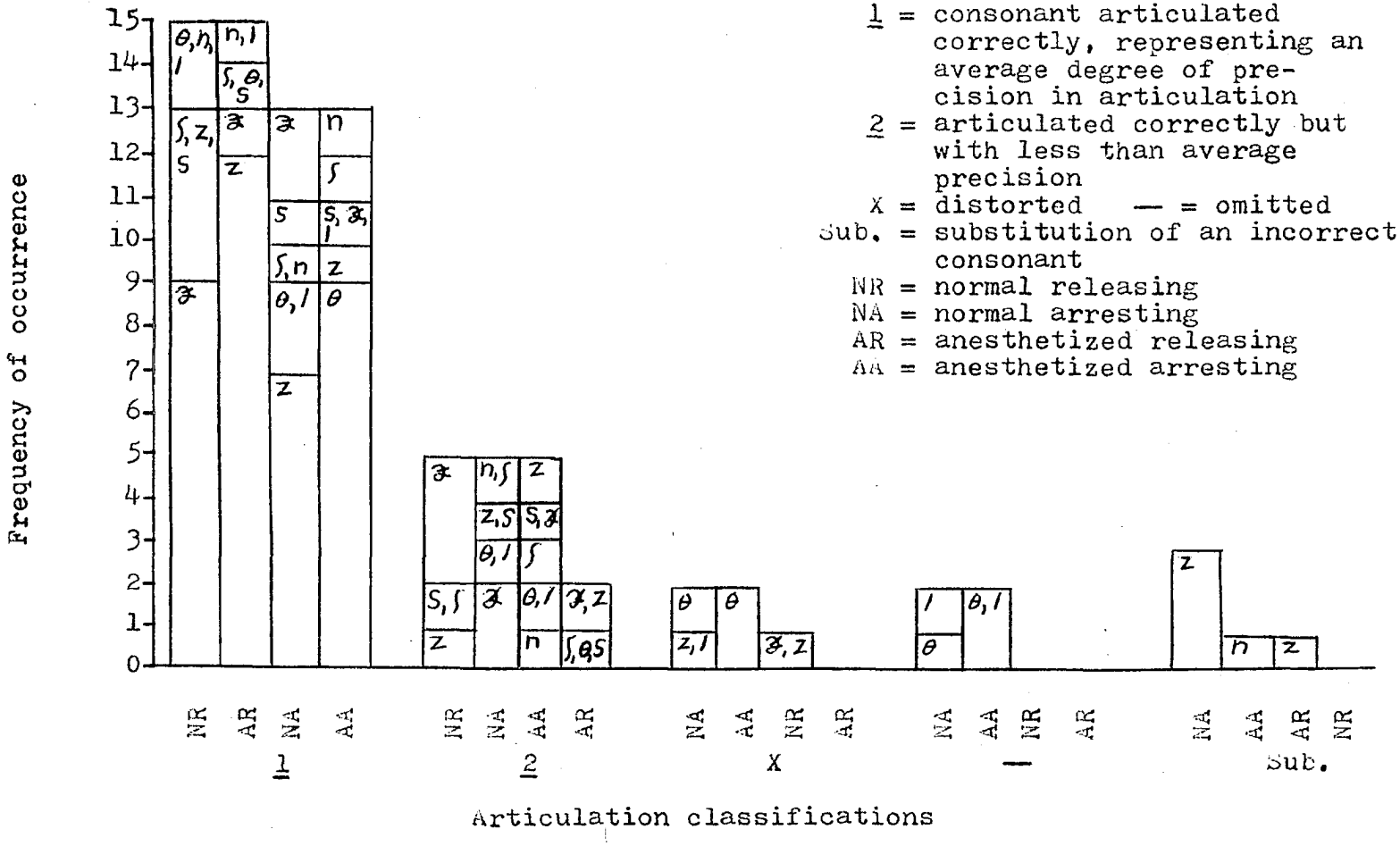

Figure 2. Summary of the frequency of occurrence for the five classifications of articulation for the releasing and arresting consonants produced in the paragraph under the normal and anesthetized conditions.

was judged the least frequently. The consonants and their frequency of number 1 judgments in the normal arresting condition were: 1) /ʒ/ judged the most frequently; 2) /s/ was judged the second most frequently; 3) /ʃ, n/ were judged third most frequently and an equal number of times; 4) /θ, l/ were judged fourth most frequently and an equal number of times; and 5) the /z/ was judged the least frequently. The consonants and their frequency of number 1 judgments in the anesthetized arresting condition were: 1) /n/ judged the most frequently; 2) /ʃ/ was judged the second most frequently; 3) /l, s, ʒ/ were judged third most frequently and an equal number of times; 4) /z/ was judged fourth most frequent; 5) /θ/ was judged least frequently.

In other words, the seven consonants were judged with a number 1, from most to least frequently, in the following order: 1) normal condition releasing consonants, /θ, n, l/, 15, /ʃ, s, z/, 13 and the /ʒ/, nine; 2) anesthetized condition releasing consonants, /n, l/, 15, /ʃ, θ, s/, 14, /ʒ/, 13, and the /z/, 12; 3) normal condition arresting consonants, /ʒ/, 13, /s/, 11, /ʃ, n/, ten, /θ, l/, nine, and the /z/, seven; 4) anesthetized condition arresting consonants, /n/, 13, /ʃ/, 12, /l, s, ʒ/, 11, /z/, ten, and the /θ/, nine.

The seven consonants were judged with a number 2, from most to least frequently, in the following order: 1) normal

condition releasing consonants, /ʒ/, five, /s,ʃ/, two, and the /z/, one, the /n, l,θ/ were never judged with a number 2; 2) anesthetized condition releasing consonants, /ʒ, z/, two, /ʃ,θ, s/, one, the /n, l/ were never judged by a number 2; 3) normal condition arresting consonants, /n,ʃ/, five, /z, s/, four, the /θ, l/, three, and the /ʒ/, two; 4) anesthetized condition arresting consonants, /z/, five, /s,ʒ/, four, /ʃ/, three, /l,θ/, two, and the /n/, one.

Distortion type errors occurred, from most to least frequently, in the following order: 1) normal condition releasing consonants, /ʒ, z/, one, the /θ, l, n, ʃ, s/ were never judged to have been distorted; 2) anesthetized condition releasing consonants, the /s, z, n, l,ʒ,θ,ʃ/ were never judged to have been distorted; 3) normal condition arresting consonants, /θ/, two, the /z, l/, one, the /ʒ,ʃ, s, n/ were never judged to have been distorted; 4) anesthetized condition arresting consonants, the /θ/ was the only consonant judged to have been distorted, two.

Omission type errors occurred, from most to least frequently, in the following order: 1) normal condition releasing consonants, the /s, z, n, l,ʒ,θ,ʃ/ were never judged to have been omitted; 2) anesthetized condition releasing consonants, the /s, z, n, l,ʒ,θ,ʃ/ were never judged to have been omitted; 3) normal condition arresting consonants, /l/, two, /θ/, one, and the /s, z, n,ʒ,ʃ/

were never judged to have been omitted; 4) anesthetized condition arresting consonants, /θ, l/, two, the /z, s, n, ʃ, ʒ/ were never judged to have been omitted.

Substitution type errors occurred, from most to least frequently, in the following order: 1) normal condition releasing consonants, the /s, z, n, l, ʒ, θ, ʃ/ never were judged to have been substituted for by an incorrect consonant; 2) anesthetized condition releasing consonants, the only consonant substituted was the /dz/ for the /z/, one; 3) normal condition arresting consonants, the only consonant substituted was the /ʒ/ for the /z/, three; 4) anesthetized condition arresting consonant, the only consonant substituted was the /ŋ/ for the /n/, one.

An examination of Table 3 revealed that under the normal releasing condition and the anesthetized releasing condition, the /n/ and /l/ were judged to have been articulated with average precision and accuracy on all trials. The /θ/ was judged to have been articulated with less than average precision only once. The /ʒ/ was distorted once and judged to have been articulated with less than average precision five times, making it the least well articulated of the seven normal releasing consonants. The /z/ was judged to have been distorted once in the normal releasing condition. A substitution of /dz/ was made for the /z/ in the anesthetized releasing condition. All other trials for the /z/ was judged as correct. There were no omissions in

Table 3. SUMMARY OF THE RESPONSES OF FIVE JUDGES TO THE ARTICULATORY ACCURACY OF SEVEN PHONEMES APPEARING AS THREE RELEASING AND AS THREE ARRESTING CONSONANTS IN THE PARAGRAPH IN THE NORMAL AND ANESTHETIZED CONDITIONS.

Judgment*	NORMAL RELEASING							ANESTHETIZED RELEASING						
	θ	ð	s	z	n	l	ʃ	θ	ð	s	z	n	l	ʃ
1	15	9	13	13	15	15	13	14	13	14	12	15	15	14
2	0	5	2	1	0	0	2	1	2	1	2	0	0	1
X	0	1	0	1	0	0	0	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub.	0	0	0	0	0	0	0	0	0	0	1	0	0	0

	NORMAL ARRESTING							ANESTHETIZED ARRESTING						
	θ	ð	s	z	n	l	ʃ	θ	ð	s	z	n	l	ʃ
1	9	13	11	7	10	9	10	9	11	11	10	13	11	12
2	3	2	4	4	5	3	5	2	4	4	5	1	2	3
X	2	0	0	1	0	1	0	2	0	0	0	0	0	0
—	1	0	0	0	0	2	0	2	0	0	0	0	2	0
Sub.	0	0	0	3	0	0	0	0	0	0	0	1	0	0

*Judgments of accuracy are measured by: 1, 2, X, —, Sub. 1 = consonant articulated correctly representing an average degree of precision in articulation; 2 = articulated correctly but with less than average precision; X = distorted; — = omitted; Sub. = substitution of an incorrect consonant.

the normal releasing and anesthetized releasing conditions. The /z, ʒ/ were judged to have been distorted in the normal releasing condition.

A study of the normal and anesthetized arresting consonants in Table 3 revealed more substitutions, omissions and distortions and a change in the consonants which were most often judged to have been correctly articulated under the normal and anesthetized releasing conditions. No arresting consonant achieved a rating of all 1's. The /n/, rated most frequently articulated with average precision as a releasing consonant, was, as an arresting consonant, judged with a number 1 ten times by the judges under normal conditions and 13 times under the anesthetized condition. The /l/, also judged with a perfect rating when used as a releasing consonant, under the normal arresting condition was judged with a 1, nine times; a number 2, three times, and was distorted once and omitted twice. The /l/ was omitted twice under the anesthetized condition, articulated with less than average precision twice and with average precision 11 times. The / ʒ/ in the normal arresting condition was judged to have been articulated correctly with average precision most frequently, in direct opposition to its accuracy of articulation as a releasing consonant. Under the anesthetized arresting condition the /ʒ/ was rated number 1, 11 times and number 2, four times. The least frequently correctly articulated consonants in the

arresting group, for both the anesthetized and normal conditions were the /θ/, /z/ and /l/. The /l/ was discussed above. The /θ/ in the normal condition was articulated with normal precision nine times, and with less than normal precision three times, distorted twice; and omitted once. In the anesthetized condition, the /θ/ again was articulated poorly, judged as omitted twice, distorted twice, articulated with normal precision nine times and with less than normal precision twice. The /z/ in the anesthetized condition was articulated correctly with normal precision ten times, with less than normal precision five times. However, under normal conditions the /ʒ/ was substituted for the /z/ three times. The /z/ was distorted once, articulated correctly seven times, and with less than average precision four times in the normal arresting condition.

Rate of utterance

The subject's time for reading the 300 word passage was one minute, 54.9 seconds in the normal condition. In the anesthetized condition the reading time was two minutes, 3.6 seconds. The subject was judged to have correctly articulated 287 words in the normal condition and 294 words in the anesthetized condition. The subject's reading rate in the normal condition was 149.8 correct words per minute as compared to 142.8 correct words per minute reading rate in the anesthetized condition.

Isolated Words

Articulatory characteristics

In isolated words (as may be seen in Table 4) the subject was judged more frequently, 161 times, to have articulated consonants correctly in the anesthetized condition than in the normal condition, 135 times. More judged misarticulations occurred in the normal condition, 35, than in the anesthetized condition, 23. More judged number 2's also occurred in the normal condition, 40, than in the anesthetized condition, 25.

Condition and function

The greatest number of correctly articulated consonants was judged to have occurred in the case of syllable arresting consonants produced in the anesthetized condition as seen in Figure 3. The second most frequent instance of correctly articulated consonants occurred in the case of releasing consonants produced in the anesthetized condition. The arresting consonants in the normal condition were next in frequency of correct articulations, and the least frequently correct articulations occurred in the case of the consonants in the normal releasing condition.

In other words, the judges assigned a number 1, from most to least frequently, in the following order: 1) anesthetized condition arresting consonants, 81; 2) anesthetized

Table 4. SUMMARY OF 105 JUDGMENTS OF ARTICULATORY ACCURACY FOR SEVEN RELEASING AND ARRESTING CONSONANTS PRODUCED IN WORDS IN THE NORMAL AND ANESTHETIZED CONDITIONS.

	RELEASING		ARRESTING		TOTAL	
Judgment*	Normal	Anesthetized	Normal	Anesthetized	Normal	Anesthetized
1	67	80	68	81	135	161
2	21	12	19	13	40	25
X	9	8	4	3	13	11
—	0	0	2	0	2	0
Sub.	8	5	12	7	20	12

*Judgments of accuracy are represented by 1, 2, X, —, Sub.
1 = consonants articulated correctly, representing an average degree of precision in articulation
2 = articulated correctly but with less than average precision
X = distorted
— = omitted
Sub. = substitution of an incorrect consonant

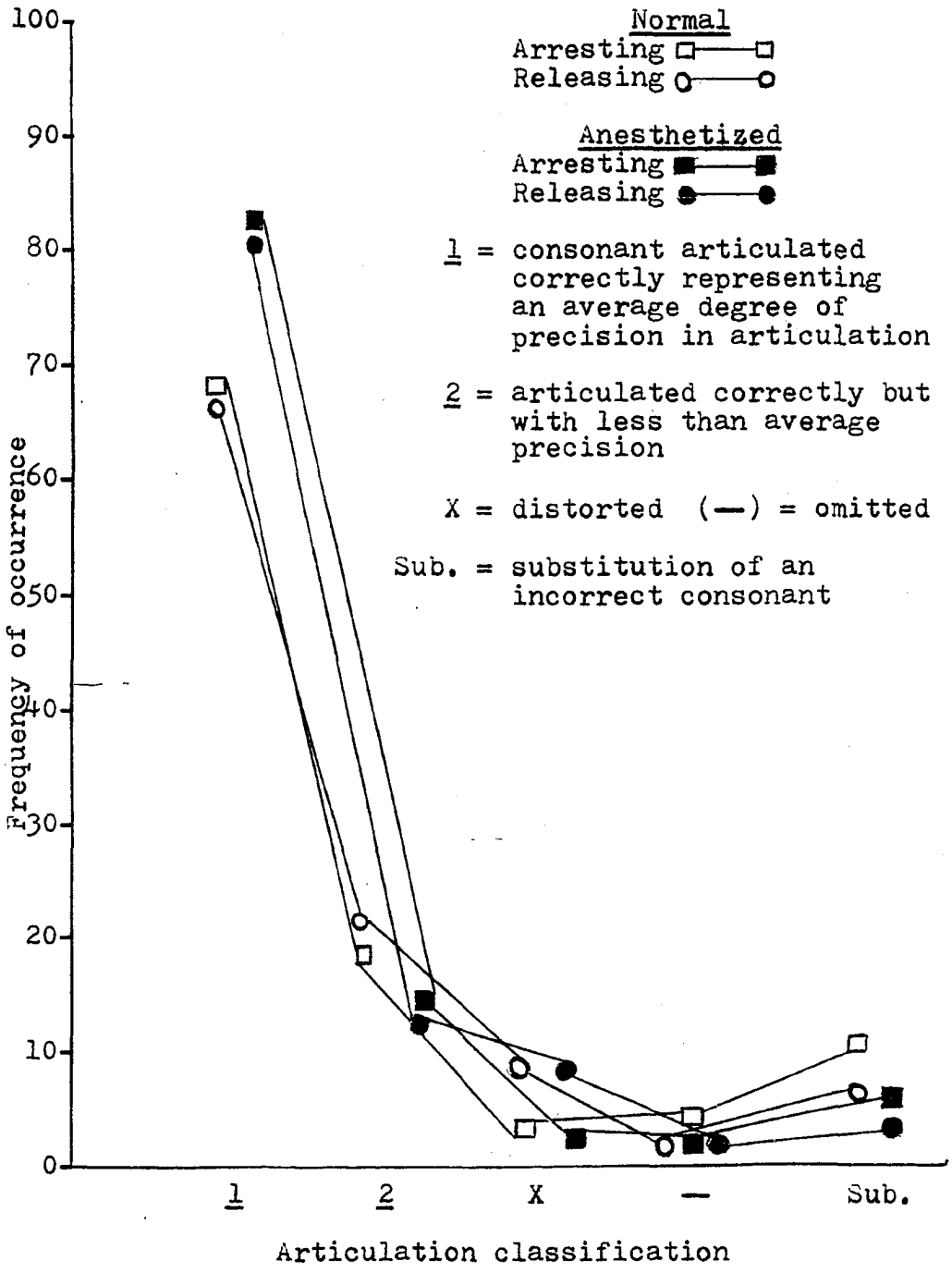

Figure 3. Summary of 105 judgments regarding the articulatory classifications of seven phonemes which functioned as releasing and arresting consonants in words in the normal and anesthetized conditions.

condition releasing consonants, 80; 3) normal condition arresting consonants, 68; 4) normal condition releasing consonants, 67. The judges assigned a number 2, from most to least frequently, in the following order: 1) normal condition releasing consonant, 21; 2) normal condition arresting consonant, 19; 3) anesthetized condition arresting consonant, 13; 4) anesthetized condition releasing consonant, 12.

Distortion type errors occurred, from most to least frequently, in the following order: 1) normal condition releasing consonant, nine; 2) anesthetized condition releasing consonant, eight; 3) normal condition arresting consonant, four; 4) anesthetized condition arresting consonant, three. Omission type errors occurred, from most to least frequently, in the following order: 1) normal condition arresting consonants, two; 2) consonants in the anesthetized and normal releasing conditions and consonants in the anesthetized arresting condition were never judged to have been omitted. Substitution type errors occurred, from most to least frequently, in the following order: 1) normal condition arresting consonants, 12; 2) normal condition releasing consonants, eight; 3) anesthetized condition arresting consonants, seven; 4) anesthetized condition releasing consonants, five.

More consonants were judged to have been articulated correctly in the anesthetized releasing and arresting conditions than in the normal releasing and arresting conditions.

More number 2's were reported for the normal releasing and arresting consonants than for the anesthetized releasing and arresting consonants. There was one more distortion reported in the normal condition than in the anesthetized condition. Two omissions were reported for the normal arresting consonants. More substitution type errors occurred in the normal releasing and arresting consonants than in the anesthetized releasing and arresting consonants. More releasing and arresting consonants were judged with a number 1 in the paragraph than in the words in the normal condition. More releasing consonants in the anesthetized condition were judged with a number 1 in the paragraph than in the words. More arresting consonants in the anesthetized condition were judged with a number 1 in the words than in the paragraph. More releasing consonants in the normal condition were judged with a number 2 in the words than in the paragraph, but more arresting consonants in the normal condition in the paragraph than in the words were judged with a number 2. More releasing consonants in the anesthetized condition in the words than in the paragraph were judged with a number 2. More arresting consonants in the anesthetized condition in the paragraph than in the words were judged with a number 2. More misarticulations were judged to have occurred in the words than in the paragraph. More distortion type errors were judged to have occurred in the releasing consonants in the normal condition in the

words, than in the releasing consonants in the normal condition in the paragraph. An equal number of distortion type errors were reported for the arresting consonants in the normal condition in both the words and the paragraph. More distortions were reported in the words than in the paragraph for both the releasing and arresting consonants produced in the anesthetized condition.

More omission type errors were reported in the paragraph than in the words for the consonants in the normal and anesthetized condition. More substitution type errors were reported in the words than in the paragraph for both the releasing and arresting consonants in the normal and anesthetized conditions.

Some of the words recorded in both the normal and anesthetized conditions were repeated in such rapid succession on the tapes that it was virtually impossible to clearly separate the words when they were randomly recorded on a third tape for judging. The final phonemes of words, in several cases were elided with the initial phonemes of the following words on the judging tape. This may have influenced the judges' assessment of articulatory accuracy of certain consonants. It is recommended that further research be conducted to verify the reported results.

Condition and function of consonant

The results of the reading of the words for the re-

leasing consonants (Table 5) under normal and anesthetized conditions revealed that the /θ/ was judged to have been articulated correctly with average precision (number 1) 15 times. The /z/, under the normal condition was judged with a number 1 four times, the least frequently of the seven consonants. The /z/ was rated with a number 2 five times, five times distorted and the /ts/ was substituted for the /z/ once. Under the anesthetized releasing condition the /z/ also was rated low on articulatory accuracy with eight number 1's, four number 2's, one distortion and two substitutions, /dz/ and /s/. The /s/ also, in both conditions was rated low. Under the normal condition, /s/ had five number 1's, eight number 2's, one distortion and one substitution of /ts/. Under the anesthetized condition, /s/ rated six number 1's, five number 2's, three distortions and the /ts/ was substituted for the /s/.

Table 5 revealed the /s, z, ʃ/ received fewer number 1's than the other consonants in both anesthetized and normal releasing consonants. The /s, z, ʃ/ were the only three consonants found in the substitution column for the releasing consonants (Figure 4).

In the arresting position, the /z/ maintained its low articulatory accuracy in both the anesthetized and normal conditions, receiving a number 1 five times in the normal condition, with two distortion, two omissions and six

Table 5. SUMMARY OF THE RESPONSES OF FIVE JUDGES TO THE ARTICULATORY ACCURACY OF SEVEN PHONEMES APPEARING AS THREE RELEASING AND AS THREE ARRESTING CONSONANTS IN WORDS IN THE NORMAL AND ANESTHETIZED CONDITIONS.

Judgment*	NORMAL RELEASING						
	θ	ð	s	z	n	l	ʃ
1	15	14	5	4	12	12	5
2	0	0	8	5	2	3	3
X	0	1	1	5	1	0	1
—	0	0	0	0	0	0	0
Sub.	0	0	1	1	0	0	6

	ANESTHETIZED RELEASING						
	θ	ð	s	z	n	l	ʃ
1	15	14	6	8	13	14	10
2	0	1	5	4	1	1	0
X	0	0	3	1	1	0	3
—	0	0	0	0	0	0	0
Sub.	1	0	1	2	0	0	2

	NORMAL ARRESTING						
	θ	ð	s	z	n	l	ʃ
1	9	8	13	5	13	11	9
2	5	1	2	0	2	4	5
X	1	0	0	2	0	0	1
—	0	0	0	2	0	0	0
Sub.	0	6	0	6	0	0	0

	ANESTHETIZED ARRESTING						
	θ	ð	s	z	n	l	ʃ
1	11	13	12	8	12	15	10
2	3	1	0	4	2	0	4
X	0	0	0	1	1	0	1
—	0	0	0	0	0	0	0
Sub.	1	1	3	2	0	0	0

*Judgments of accuracy are measured by : 1, 2, X, —, Sub. 1 = consonant articulated correctly representing an average degree of precision in articulation; 2 = articulated correctly but with less than average precision; X = distorted; — = omitted; Sub. = substitution of an incorrect consonant.

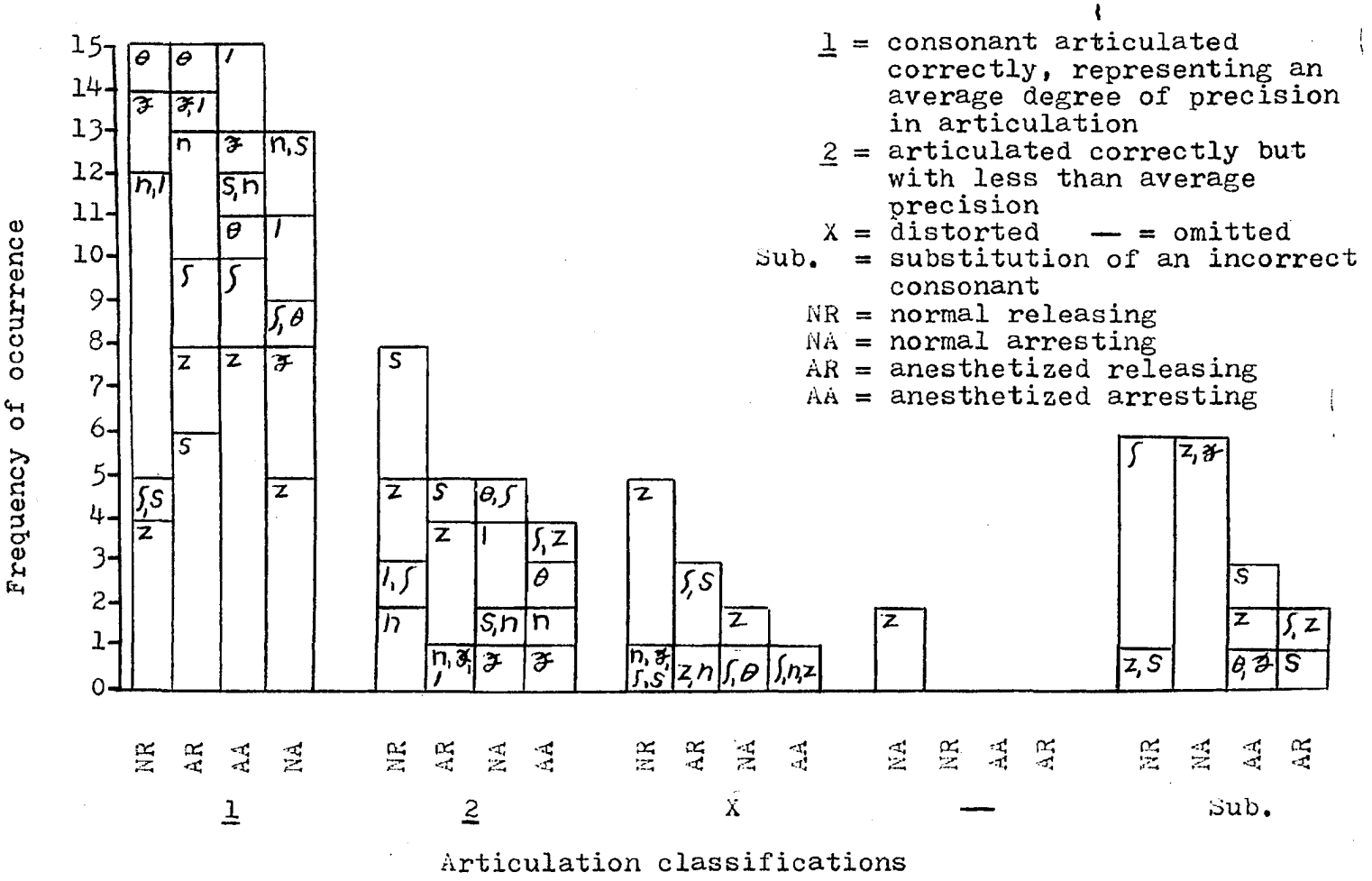

Figure 4. Summary of the frequency of occurrence for the five classifications of articulation for the releasing and arresting consonants produced in words under the normal and anesthetized conditions.

substitutions. In the anesthetized condition the /z/ received eight number 1's, four number 2's, one distortion and two omissions. As an arresting consonant, the /s/ moved up in accuracy, receiving 13, number 1's, and two number 2's under normal conditions and 12, number 1's and three substitutions under anesthetized conditions. The /ʃ/ received nine number 1's, five number 2's and was distorted once in the normal condition. In the anesthetized condition the /ʃ/ received ten number 1's and four number 2's and was distorted once. In the normal condition the /ʒ/ was judged number 1 eight times, number 2 once and the /z/ was substituted for the /ʒ/ five times and the /θ/ was substituted for the /ʒ/ once. Whereas, under anesthetized conditions the /ʒ/ received 13 number 1's, one number 2 and the /θ/ was substituted for the /ʒ/ once.

The arresting consonants most frequently rated number 1 in the normal condition were /s/ and /n/. Under the normal condition the /n/ had 13 number 1's and two number 2's. Under the anesthetized condition, /n/ received 12 number 1's, two number 2's and one distortion. The /s/ was discussed above. The arresting consonant most frequently rated number 1 under the anesthetized condition was the /l/ with 15 number 1's, whereas in the normal condition, it had achieved 11 number 1's and four number 2's.

In summary, the /θ/ and /ʒ/ were judged to have been articulated correctly with average precision and accuracy

most frequently as releasing consonants in the words under normal and anesthetized conditions. The /s, z, ʃ/ were least frequently judged as being correct.

For the arresting consonants, no strong pattern exists between the normal and anesthetized conditions as with the releasing consonants except the retention of the /z/ and /ʃ/ as the least frequently judged number 1 and the addition of /θ/ to this group. All consonants received more number 1 ratings in the anesthetized condition than in the normal condition except for the /s/ and /n/ as arresting consonants. They lost one number 1 rating each, having 13 number 1's in the normal condition and 12 number 1's in the anesthetized condition.

To contrast the articulatory accuracy in the paragraph with the articulatory accuracy in the words, compare Table 3 with Table 5 and Figure 2 with Figure 4.

Examining the normal releasing consonants in the paragraph and in the word list, the most apparent difference was the increase in the articulatory accuracy of the /s, z, ʃ/ in the paragraph. The /ʒ/ decreased in its number 1 ratings in the paragraph and was the only normal releasing consonant which did not remain high or gain in accuracy, in going from the words to the paragraph. The previously described elisions of the consonants that were assessed on the judging tape may have influenced the apparent gain in articulatory accuracy.

The anesthetized releasing consonants in the words and in the paragraph revealed a difference similar to that of the normal releasing consonants with all of the consonants except the /ʒ/ and /θ/ increasing in accuracy of articulation from the words to the paragraph. The /ʒ/ and /θ/ lost one number 1 each, the /ʒ/ going from 14 number 1's to 13 number 1's and the /θ/ going from 15 number 1's to 14 number 1's.

In the normal releasing consonants in the words the /z, n, s, ʃ, ʒ/ were distorted. There were no omissions. There were substitutions for the /z, s, ʃ/. In the normal releasing consonants in the paragraph, there were no substitutions, no omissions and two distortions, the /ʒ/ and /z/.

The contrast between the normal arresting consonants in the words and in the paragraph was less definitive. From the words to the paragraph three of the arresting consonants, /n, s, l/, declined in accuracy of articulation. Three consonants /ʃ, ʒ, z/ increased in accuracy and one consonant, the /θ/ retained the same number of 1's in both the paragraph and the words. In the word list, three consonants were distorted, /θ, ʃ, z/. In the paragraph, the /θ, z, l/, were distorted. In the words, the /z/ was omitted and the /z/ and /ʒ/ were substituted for by an incorrect consonant. In both the paragraph and in the words, the /z, θ/ were sources of inaccurate articulation for the normal arresting consonants.

In the anesthetized condition four arresting consonants, /l, s, ʒ, θ/ decreased in accuracy of articulation, three increased in accuracy of articulation, /z, n, ʃ/ from the words to the paragraph.

The /s, z, θ, ʒ/ were substituted for by other consonants in the words. In the paragraph, the only substitution was the /ŋ/ for the /n/. There were no omissions in the word list for arresting consonants in the anesthetized condition. In the paragraph the /θ, l/ were omitted. Distortions occurred in the word list for /z, n, ʃ/ and in the paragraph for /θ/ alone. The /z/ as a normal arresting consonant maintained a poor accuracy of articulation rating in both the paragraph and the words, but in the anesthetized condition it was low in articulatory accuracy in the words only. The /z/ received ten number 1's and five number 2's in the paragraph.

In summary, an overview of the paragraph and the word list readings under the normal and anesthetized conditions for releasing and arresting consonants revealed these salient observations.

1. In the releasing consonants, there was generally an increase of accuracy in articulation for both normal and anesthetized conditions when the change was made from words to the paragraph.

2. In the arresting consonants, there was no general increase in accuracy in articulation for either the normal

or anesthetized conditions when the change was made from words to the paragraph. The number of consonants that increased in accuracy and decreased in accuracy were approximately equal.

3. In the releasing consonants, the only consonant distorted and/or substituted for in both the paragraph and the words, under both the anesthetized and normal conditions was the /z/.

4. In the arresting consonants, the only consonant distorted, and/or substituted for and/or omitted in both the paragraph and the words, under both the anesthetized and normal conditions was the /θ/.

5. There were three times as many distortions, omissions and substitutions in the reading of the words as there were in the reading of the paragraph.

Judged intelligibility

Twenty-five judges reported on the intelligibility of 42 words and provided 1050 judgments for words recorded in both the normal and anesthetized condition. The judges accurately reported 771 single word utterances as spoken by the subject in the normal condition. The judges accurately reported 845 single word utterances as spoken by the subject in the anesthetized condition. The mean number of correct judgments in the normal condition was 18.4 and the mean number of judgments in the anesthetized condition

was 21.2. Statistical analysis of this difference yielded a t which is significant beyond the .02 level with 41 degrees of freedom.

The extent to which differences in the judged intelligibility of single word utterances between the normal and anesthetized conditions may be related to the quality of the judging tape is indeterminate.

The frequency with which misarticulations occurred on syllable releasing consonants was greater in the normal condition than in the anesthetized condition for both the single word utterances and connected speech. The frequency with which misarticulations occurred on syllable arresting consonants was greater in the normal condition than in the anesthetized condition for both the single word utterances and connected speech.

The frequency with which substitution type errors occurred in both syllable releasing and syllable arresting consonants was greater in the normal condition than in the anesthetized condition in single word utterances. The frequency with which substitution type errors occurred on syllable releasing consonants was greater in the anesthetized condition than in the normal condition in connected speech. The frequency with which substitution type errors occurred on syllable arresting consonants was greater in the normal condition than in the anesthetized condition in connected speech.

The frequency with which omission type errors occurred on syllable arresting consonants was greater in the anesthetized condition than in the normal condition in conected speech. No omission type errors were reported for syllable releasing consonants in connected speech. The frequency with which omission type errors occurred on syllable arresting consonants was greater in the normal condition than in the anesthetized condition in single word utterances. No omission type errors were reported for syllable releasing consonants in single word utterances.

The frequency with which distortion type errors occurred on syllable arresting and releasing consonants was greater in the normal condition than in the anesthetized condition for connected speech and for single word utterances.

The mean number of correct judgments of intelligibility for single word utterances was greater in the anesthetized condition than in the normal condition.

The oral reading rate in correct words per minute was greater in the normal condition than in the anesthetized condition.

CHAPTER IV

SUMMARY AND CONCLUSIONS

This study was designed to explore the role played by tactual feedback in monitoring the speech output of an adventitiously deafened individual. Various dimensions of speech were assessed as the subject spoke normally and as the subject spoke under the condition of topically anesthetized articulators. Seven consonants, /θ, s, z, n, l, ʒ, ʃ/, were examined in terms of articulatory accuracy in connected speech both as syllable releasing and as syllable arresting consonants. Oral reading rate in correct words per minute was also assessed.

In addition, the identical seven syllable releasing and syllable arresting consonants that were assessed in connected speech were judged for articulatory accuracy in single word utterances in the normal and anesthetized conditions. The intelligibility of these single word utterances was also judged in the normal and anesthetized conditions.

The results of this investigation show that in connected speech more syllable releasing and syllable arresting consonants were judged to have been articulated correctly in the anesthetized condition than in the normal condition.

The oral reading rate in correct words per minute was greater, however, in the normal condition than in the anesthetized condition.

In single word utterances more syllable releasing and syllable arresting consonants were judged to have been articulated correctly in the anesthetized condition than in the normal condition. More single words were judged to have been uttered intelligibly in the anesthetized condition than in the normal condition.

Incidental to the present study, the subject was asked to repeat six CV syllables as rapidly as possible for two trials of ten seconds each with a five second pause between each timed period. From a subjective observation made by the investigator it was felt that the subject sacrificed accuracy of production for speed in production. The subject misarticulated many of the CV syllables in the anesthetized condition. The misarticulations were so numerous that it was virtually impossible to differentiate between productions of the CV syllables in order to obtain an accurate count in a specific timed period. Another subjective observation made by the investigator, but not included formally in the study, was that of an increase in latency for the identification of oral stereognostic testing forms from the normal to the anesthetized condition.

The limitations in the design of the present study,

both in the speaking task and judging procedures, may have influenced the judgment of the articulatory accuracy of the single word utterances and the assessment of intelligibility. A forced pause between the readings of the single word utterances could have alleviated the problem of elisions on the tape prepared for judging.

In an attempt to further answer the kinds of questions asked in this study and in similar future investigations, the speaking task might be performed several times by the subject so that intra subject variability could be considered in the final analysis of the judges' responses. The latency in identifying oral stereognostic test forms in the normal and anesthetized conditions could be timed. Other indices of speech performance which might be assessed are phonation time and reading rate in correct syllables per second. It is possible, too, that distinctive feature analysis of the syllable releasing and syllable arresting consonants might provide useful information. It might be of additional interest to have subjects perform the speaking task after application of a placebo.

The results reported in this study are in general agreement with the findings of Ringel and Steer (1963) and Weiss (1968) involving normal hearing subjects. No direct adverse effects on articulatory accuracy were observed when a topical anesthetic was applied to the articulators. Ringel and Steer (1963) did report, however, that when

noise and a topical anesthetic were combined to disrupt auditory and tactual feedback, articulatory proficiency was adversely affected. The present study, insofar as it is comparable with the Ringel and Steer study, does not support this finding. The compensatory modalities used for maintaining adequate speech by an adventitiously deafened subject, of course, may differ from those employed by normal hearing subjects when their auditory feedback has been altered.

Guttman (1954) reported that his subjects' mean number of correct words increased while reading a passage from 40.8 under the anesthetized condition to 41.7 under the combined conditions of auditory masking and an anesthetic. The present study, insofar as it is comparable with Guttman's study, supports this finding. The increased reading time observed in the anesthetized condition in the present study may have been related to articulatory features.

Two of the sensory feedback modalities, auditory and tactual, thought necessary for maintaining adequate speech were substantially reduced, if not essentially eliminated, in the subject involved in the present study. When these sensory modalities were altered, articulatory accuracy and intelligibility were not judged to have deteriorated. Tactual feedback, however, did appear to assume some role in the oral reading rate of the subject studied. It is of interest to note that in this regard the subject's oral

reading rate in correct words per minute, 150.0, in the normal condition was slightly slower than the oral reading rate in words per minute typically reported for college male students. (Johnson, Darley and Spriestersbach, 1963, p. 220.) This relatively slow oral reading rate may be normal for an adventitiously deafened individual. When taction was disrupted the subject's correct word rate decreased from that in the normal condition. It may be that this rate reduction reflects in some degree the extent to which reduced taction necessitated increased dependence on kinesthetic feedback.

In view of the findings it appears that tactual feedback assumes a less critical role than do other feedback channels in maintaining adequate speech in an adventitiously deafened individual.

APPENDIX A

WORD LIST

releasing		arresting	
/θ/		/θ/	
1.	thoughts	22.	mouth
2.	thin	23.	both
3.	think	24.	breath
/ð/		/ð/	
4.	they	25.	soothe
5.	this	26.	breathe
6.	then	27.	smooth
/s/		/s/	
7.	so	28.	pass
8.	sailed	29.	loss
9.	sun	30.	Cassius
/z/		/z/	
10.	zoo	31.	rise
11.	zero	32.	lose
12.	zebra	33.	nose
/n/		/n/	
13.	net	34.	soon
14.	noon	35.	son
15.	never	36.	ten
/l/		/l/	
16.	lean	37.	pull
17.	let	38.	tell
18.	light	39.	ball
/ʃ/		/ʃ/	
19.	shot	40.	fish
20.	ship	41.	wish
21.	she	42.	hush

APPENDIX B

PARAGRAPH

So often we think of the people whom we pass on our way through life, whose friendships we lose or never gain and we feel sad because of this. Many years ago in a small town in Illinois, I met a young man who was to rise above the rest of us and become a powerful figure in government. He had a thin look about him, not the "lean and hungry look" of a Cassius, but the look of a steel rod -- small in diameter but of great strength, mouth set in determination. His eyes, dark and clear, let in light, but only enough to reflect their icy blueness. His eyes would pull others toward him; his voice would soothe. He possessed a kind of invisible net which brought people to him and they never wanted to be free. We would sit for hours with him then, when we were young. As we sat quietly, we would tell each other the thoughts, the hopes and the dreams of the future. That was many years ago. Yesterday when I was returning home at noon to pick up my young son and attend a ball game and visit the zebra, lion and other zoo friends, the smooth voice of a newsman interrupted to announce the death of this friend of my youth. The ten years in which we were close friends had passed too soon. The ship of death had sailed. She had her wish -- another passenger. Times we used to

fish together are gone. Our walks in the chilling blasts of zero weather, when our breath would steam, are no more. He will breathe no more. The loss for us both is great. Hush falls like a shot. Tomorrow, the sun.

APPENDIX C

INSTRUCTIONS AND RESPONSE SHEET FOR JUDGING ARTICULATORY ACCURACY IN THE WORD LIST

I have just given you a response sheet which contains 84 words with a blank space beside each word. Each word contains a consonant which is underlined. I will now play a tape which has 84 single words recorded on it. Your job will be to listen for the consonant underlined in each word and report on the articulatory accuracy of that consonant on the response sheet.

If a consonant was articulated correctly and represented an average degree of precision in articulation report it with a 1. If the consonant was articulated correctly, but not with the precision of average articulation report it with a 2. Report a distorted consonant with an X symbol and an omitted consonant with a dash (—) symbol. If there has been a substitution of an incorrect consonant, report the substitution phonetically. The word order on the tape will correspond to the word order on your response sheet. We are after accuracy and there is no time limit. I will play any word as many times as anyone wishes to hear it. Are there any questions?

KEY: 1 = articulated correctly, and representing an average degree of precision in articulation.

2 = articulated correctly, but not with the precision of average articulation.

X = distorted.

— = omitted.

Substitution of an incorrect consonant, report the substitution phonetically.

1. their	22. son	43. then	64. zoo
2. breath	23. ten	44. fish	65. zero
3. loss	24. she	45. both	66. hush
4. soothe	25. breathe	46. soon	67. hush
5. net	26. pass	47. son	68. light
6. lose	27. shot	48. wish	69. rise
7. so	28. think	49. lose	70. then
8. zero	29. Cassius	50. wish	71. soon
9. ball	30. pass	51. shot	72. lean
10. net	31. sun	52. ball	73. soothe
11. they	32. thoughts	53. sailed	74. not
12. sailed	33. they	54. light	75. mouth
13. let	34. thoughts	55. not	76. smooth
14. nose	35. Cassius	56. breath	77. so
15. zebra	36. zebra	57. zoo	78. rise
16. pull	37. ten	58. ship	79. loss
17. smooth	38. she	59. lean	80. think
18. their	39. fish	60. ship	81. sun
19. noon	40 both	61. let	82. breathe
20. noon	41. thin	62. mouth	83. tell
21. thin	42. nose	63. tell	84. pull

APPENDIX D

INSTRUCTIONS AND RESPONSE SHEETS FOR JUDGING ARTICULATORY ACCURACY IN THE PARAGRAPH

I have just given you a response sheet which consists of a paragraph. In this paragraph certain consonants are underlined in certain words. Under each underlined consonant is a blank space in which you will record the articulatory accuracy of that consonant. From a tape that I will play which contains the paragraph, a consonant articulated correctly and representing an average degree of precision in articulation will be reported with a 1. If the consonant was articulated correctly, but not with the precision of average articulation report it with a 2. Report a distorted consonant with an X symbol and an omitted consonant with a dash (—) symbol. If there has been a substitution of an incorrect consonant, report the substitution phonetically. We are after accuracy and there is no time limit. I will play any sentence or word as many times as anyone wishes to hear it. Are there any questions?

NORMAL CONDITION

KEY: 1 = articulated correctly, and representing an average degree of precision in articulation.

2 = articulated correctly, but not with the precision of average articulation.

X = distorted.

— = omitted.

Substitution of an incorrect consonant, report the substitution phonetically.

So often we think of the people whom we pass on our way through life, whose friendships we lose or never gain and we feel sad because of this. Many years ago in a small town in Illinois, I met a young man who was to rise above the rest of us and become a powerful figure in government. He had a thin look about him, not the "lean and hungry look" of a Cassius, but the look of a steel rod--small in diameter but of great strength, mouth set in determination. Among his features, his nose, undeniably Greek, was most prominent. His eyes, dark and clear, let in light, but only enough to

reflect their icy blueness. His eyes would pull others toward him; his voice would soothe. He possessed a kind of invisible net which brought people to him and they never wanted to be free. We would sit for hours with them then, when we were young. As we sat quietly, we would tell each other the thoughts, the hopes and the dreams of the future. That was many years ago. Yesterday when I was returning home at noon to pick up my son and attend a ball game and visit the zebra, lion and other zoo friends, the small voice the smooth voice of a newsman interrupted to announce the death of his friend of this friend of my youth. The ten years in which we were close friends had passed too soon. The ship of death had sailed. She had her wish--another passenger. Times we used to fish together are gone. Our walks in the chilling blasts of zero weather, when our breath would steam, are no more. We will breathe no more. The loss for us both is great. Hush falls like a shot. Tomorrow, the sun.

ANESTHETIZED CONDITION

KEY: 1 = articulated correctly and representing an average degree of precision in articulation.

2 = articulated correctly, but not with the precision of average articulation.

X = distorted.

— = omitted.

Substitution of an incorrect consonant, report the substitution phonetically.

So often we think of the people whom we pass on our way through life, whose friendships we lose or never gain and we feel sad because of this. Many years ago in a small town in Illinois, I met a young man who was to rise above the rest of us and become a powerful figure in government. He had a thin look about him, not the "lean and hungry look" of a Cassius, but the look of a steel rod--small in diameter but of great strength, mouth set in determination. Among his features, his nose, undeniably Greek, was most prominent. His eyes, dark and clear, let in light, but only enough to

ref, to reflect their icy blueness. His eyes would pull others toward him; his voice would soothe. He possessed a kind of invisible net which brought people to him and they never wanted to be free. He would sit for hours with, we would sit for hours with him then, when he, when we were very young. As we sat quietly we would tell each others, tell each other the thoughts, the hopes and the dreams of the future. That was many years ago. Yesterday when I was returning home at noon to pick up my son and attend a ball game and visit the zebra, lion and other zoo friends, the smooth voice of a newsman interrupted to announce the death of his of this friend of my youth. The ten years in which we were close friends had passed too soon. The ship of death had sailed. She had her wish--another passenger. Times we used to fish together are gone. Our walks in the chilling blasts of zero weather, when our breath would steam, are no more. We will breathe no more. He will breathe no more. The loss of us

both is great. The loss for us both is great. Hush falls

like a shot. Tomorrow, the sun.

APPENDIX E

INSTRUCTIONS AND RESPONSE SHEET FOR JUDGING INTELLIGIBILITY OF SINGLE WORDS

You have just received a response sheet with two sets of blank spaces on it. The first set is titled examples and is numbered one to ten. The second set is numbered one to 84. (Investigator pointed to columns.) I will now play a tape which has ten single words recorded on it. Your job will be to listen for word number one on the tape and to write it in the corresponding blank on the response sheet, blank number one under examples. Write word number two from the tape, in space number two on the response sheet under example two and continue this system for the entire ten words. You will have at least six seconds between words in which to write the word you hear. The ten example words are simply to familiarize you with the task and the timing pattern between words.

You must listen carefully and write a word or mark in each space on the response sheet in order to keep the numbering system correct. If you do not understand a word, guess. If you cannot even guess what the word is draw a line through the blank and prepare to listen for the next word. Are there any questions? (The following example words were then presented: normal, cruel, wound, neck, house, left, milk, blue, and soft.)

Now you will do the same task for the second set of numbers, one to 84. Word number one on the tape corresponds to blank number one in the second set of numbers on the response sheet. Word number two on the tape corresponds to blank number two on the response sheet, etc. This time you will hear the entire 84 words and you will have at least six seconds between words. Words number one, 21, 42, and 63 are the only words numbered on the tape, so you must listen carefully, and write a word or mark in each space on the response sheet in order to keep the numbering system correct. If you do not understand a word, guess. If you cannot even guess what the word is draw a line through the blank and prepare to listen for the next word. Are there any questions? (Words one to 84 were then presented.)

EXAMPLES

1._____ 6._____
2._____ 7._____
3._____ 8._____
4._____ 9._____
5._____ 10._____

1._____	22._____	43._____	64._____
2._____	23._____	44._____	65._____
3._____	24._____	45._____	66._____
4._____	25._____	46._____	67._____
5._____	26._____	47._____	68._____
6._____	27._____	48._____	69._____
7._____	28._____	49._____	70._____
8._____	29._____	50._____	71._____
9._____	30._____	51._____	72._____
10._____	31._____	52._____	73._____
11._____	32._____	53._____	74._____
12._____	33._____	54._____	75._____
13._____	34._____	55._____	76._____
14._____	35._____	56._____	77._____
15._____	36._____	57._____	78._____
16._____	37._____	58._____	79._____
17._____	38._____	59._____	80._____
18._____	39._____	60._____	81._____
19._____	40._____	61._____	82._____
20._____	41._____	62._____	83._____
21._____	42._____	63._____	84._____

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