SPEECH-SOUND DISCRIMINATION AND ARTICULATION ERRORS IN CHILDREN AGED 8–12

by

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ABSTRACT

Of the numerous variables which have been theoretically related to functional articulation disorders, speech sound discrimination (SSD) has received the most research and clinical attention. However, the majority of these investigations were done with children below age 7 while articulation therapy is generally considered for school-aged children. The present study investigated the possibility that in older children some misarticulations do not have this corresponding relationship. SSD was examined in 39 normal speaking children and 60 children with multiple misarticulation problems between 8 and 12 years of age. Significant differences were not found on SSD tasks between groups of normal children and those with articulation problems nor between groups of children with articulation problems categorized by type or number of phoneme error.

Of the numerous variables which have been theoretically related to functional articulation disorders, speech sound discrimination (SSD) has received the most research and clinical attention. Nevertheless, the relationship remains controversial. When reviewing accumulated studies, Sommers & Kane (1974) concluded that: "the weight of experimental evidence indicates that children with functional misarticulations are likely to have inferior speech-sound-discrimination" (p. 114). Similarly, Winitz (1975) concluded that "the research literature has demonstrated that children with speech errors evince [sic] considerably more discrimination errors than normal speaking children" (p. 48). In contrast, Powers (1957) had previously found the experimental data to provide no evidence of systematically inferior SSD in children with functional articulation defects and Rees (1973) more recently reported a similar, negative conclusion. McReynolds, Kohn and Williams (1975) obtained equivocal results from a distinctive feature analysis of misarticulating children's discrimination of their own production errors. Shelton, Johnston and Arndt (1977) and Shelton, Johnston, Rucello and Arndt (1978) were not successful in relating listening or discrimination tasks to articulation training and they, as well as Woolf & Pilberg (1971), have questioned the nature and underlying assumption of defective SSD in children with functional articulation disorders.

The continuing controversy and conflicting findings argue against a simple association between SSD and articulatory proficiency. A number of investigators have proposed that

SSD deficits may not be generalized but rather, related to specific phonemes (Prins, 1963; Aungst & Frick, 1964; Monnin & Huntington, 1974; Winitz, 1969; 1975), a possibility not explored in most previous studies. However, this hypothesis is supported by Locke's (1980b) recent finding in younger children that misproduction of the /f-θ/ contrast was highly associated with defective perception, whereas perceptual difficulty did not appear to underly productive failures involving the /w-1/ contrast.

The association between SSD and articulatory proficiency may also interact with age since the development of SSD decelerates markedly after age five, while articulatory development typically continues until the age of 8 (Templin, 1957). Weiner (1967) concluded that a positive relationship between auditory discrimination and articulation is almost invariably found in studies of *younger* [italics added] children. Finally, Locke (1980b) noted that the substitution of /f/ for /θ/ was associated with misperception of this contrast much more frequently in younger than in older children. However, Sommers (1974) suggests that research is necessary to determine if "auditory deficiencies at early ages ... continue into young adulthood" (p. 120).

Deficits in SSD were early suspects as a basis for articulation problems (Travis & Rasmus, 1931). Training in SSD, commonly known as "ear training", was long ago (Van Riper, 1939) advocated as a therapy technique for functional articulation disorders. Despite the conflicting and equivocal research findings reviewed above, ear training has remained a common clinical practice (Fleming, 1971; Weber, 1971; Van Riper, 1972; Mower, 1980; Winitz, 1980). Indeed Winitz (1975) has stated that ear training alone may be sufficient for the correction of some articulation problems.

Although originally associated with traditional approaches to articulation therapy, ear training has also been suggested in the context of more current approaches involving distinctive features (Winitz & Pressler, 1967), phonological rules (Ingram, 1976), and operant procedures (Mower, 1977). It appears that "many clinicians have faith in the common sense objective of ear training ..." (Perkins, 1977, p. 388), perhaps because some younger children are seen clinically to have difficulty discriminating between their misarticulated phonemes and the standard versions produced by the therapist. However, articulation therapy is most frequently carried out with school children aged 8 or older who are presumably past the age of phonological maturation (Templin, 1957; Sander, 1972). Thus, the supposition of SSD deficits and application of ear training exercises appears especially questionable for this group. No published account of articulation therapy differentiates between practices for younger and older children and standard therapeutic procedures appear to be applied without regard to age, phoneme or severity. Certainly if older children do not have difficulty with SSD current articulation therapy directed toward SSD or "ear training" would appear inappropriate.

The present study was designed to examine the association between SSD and misarticulation of specific phonemes in older children with functional articulation disorders. To maximize the study's relevance to clinical practice, experimental procedures included common features of articulation therapy. Thus, articulation was assessed on widely-used, commercially available tests and SSD was examined by requiring judgments of the similarity of paired stimuli, a paradigm familiar to most clinicians and incorporated into commonly used tests (Templin, 1957; Wepman, 1973).

SUBJECTS

Subjects were obtained by screening all children between the ages of 8 and 12 years in seven elementary schools. Subjects were selected from children found to meet the following criteria: 1) hearing thresholds of 20 dB or less (re: ANSI, 1969) in each ear at 500, 1000, 2000 and 4000 Hz; 2) intelligence within the normal range as estimated by the classroom teacher; 3) registration in the appropriate grade for age; 4) English spoken in the home; 5) no observable or reported oral anomalies or neurological problems; and 6) no history of previous speech therapy.

The experimental subjects consisted of 60 children with a mean age of 9 years 11 months. They all met the above criteria and also exhibited misarticulations during a sentence screening test and during administration of the *Screening Deep Test of Articulation* (McDonald, 1968) for at least one phoneme at least 20% in error.

The control group consisted of 39 children with a mean age of 10 years 2 months. All met the initial selection criteria, exhibited no misarticulations during spontaneous speech or during the *Screening Deep Test*, and were in the same classroom as the experimental subjects.

Procedure

Experimental data were obtained in seven schools of the Protestant School Board of Greater Montreal (public schools). All testing was carried out individually with each child in a quiet location within his school, and no child was tested before his parents had provided written consent to his participation in the study. All children selected for the study were first given a pure-tone audiometric screening evaluation and completed *The Quick Test* (Ammons & Ammons, 1977) which assesses single-word vocabulary by use of pictures. Information was also gathered regarding children's age, sex, handedness for writing and parent's occupation (Blishen, 1967), a socio-economic index for occupations in Canada. Articulation was screened by having the child repeat a sentence screening test. *The Screening Deep Test of Articulation* (McDonald, 1968), which examines production of /s/, /l/, /r/, /tʃ/, /θ/, /ʃ/, /k/, /f/, and /t/, was then administered according to the prescribed procedure. Misarticulations observed during the screening procedure were further explored through presentation of appropriate *Deep Tests of Articulation* (McDonald, 1964) which were administered and scored according to instructions in the manual.

The literature suggests that children are more likely to have SSD errors on the phonemes which they misarticulate rather than having an overall SSD deficit. However, commercial tests of SSD include a wide range of phonemes (Templin, 1957; Wepman, 1973) and consequently may not permit the most relevant analysis of SSD in children with articulation problems (see Locke, 1980a). Since no currently available test of SSD contrasts phonemes likely to be produced in error, with a number of probable production substitutions in both pre- and post-vocalic position, the SSD test used in the present study was especially designed to meet these aims. The test included 15 different consonants, all uttered with the vowel /ʌ/. Each consonant was paired with itself and with two likely substitutes to form 30 stimulus pairs. Each pair was presented once in CV-CV order and once in VC-VC order to form a total of 60 stimulus pairs (see Appendix 1). Selection and pairing of the consonants was guided by several considerations including the frequency of misarticulation (Winitz, 1969) and of perceptual confusion (Miller & Nicely, 1955), the magnitude of distinctive feature differences between members of a pair (Goldman, Fristoe and Woodcock, 1970) as well as the need to control for equal presentations of each consonant. Thus, the present SSD test represented an attempt to relate the discrimination task to articulation errors to the maximum degree possible within the context of an apriori test.

The 60 stimulus pairs were recorded by a female speaker using a Sennheiser microphone with a Yamaha TC800D cassette tape deck on SuperTape (Radio Shack). The recorded intensity of each stimuli was adjusted so that the peak intensity of each stimuli was within 2 dB of a 1 KHz calibration tone placed at the beginning of the cassette. These stimuli were presented by Yamaha cassette tape deck (TC800D) at 65 dB sound level through matched dynamic earphones (TDH-39) housed in neoprene cushions (MX-41/AR). Children were instructed to encircle "S" or "D" on their answer sheet depending on whether they thought the two sounds in each pair were the same or different. Two practice trials preceeded the test, which required approximately ten minutes to complete.

RESULTS

Analysis of the data was complex because most of the experimental subjects misarticulated a number of different phonemes. To facilitate statistical analysis, these children were first subdivided into misarticulation groups according to the phoneme most frequently in error on the *McDonald Screening Deep Test of Articulation*. Twenty-nine children were found to have a primary problem with /s/; thirteen with /θ/; seven with /tʃ/; six with /r/ and five with /ʃ/. This distribution is similar to that found in younger children. Comparisons among these groups and the control subjects by ANOVA for unequal N's (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975) indicated no significant differences among groups with respect to age, sex, handedness for writing, parent's occupation or scores on the *Quick Test*.

The means and standard deviations of SSD correct scores are presented in Table 1 for all test items and for items involving only prevocalic or only postvocalic consonants for each of the articulation groups (controls and five misarticulating groups). Scores were normalized by the BLOM procedure (Barr, Goodnight, Sall and Helwig, 1976) and ANOVA procedures were carried out on total SSD scores, prevocalic SSD scores and postvocalic SSD scores, using a program for unequal N's (Nie *et al.*, 1975). No significant differences in SSD were found among any of the six articulation groups (control and five misarticulating groups) in any of the three analyses.

The above analyses examined the children's performance in discriminating all phonemes included in the SSD test. However, it is quite likely that SSD deficits might be restricted to those particular phonemes which are misarticulated. To explore this possibility, a MANOVA procedure (Barr, *et al.*, 1976) was used to examine accuracy only on those items on the SSD test which required discrimination of those consonants most often misarticulated by each of the five misarticulation groups (/s/, /θ/, /tʃ/, /r/ and /ʃ/). There were no significant differences between any of the groups in the discrimination of any of these phonemes. In other words, the children who misarticulated /r/ were not significantly poorer than the controls or other misarticulating groups in discriminating items on the SSD test involving /r/ contrasts and, similarly, the other misarticulation groups were not poorer in discriminating the particular consonant which they most frequently misarticulated.

When children were categorized as "good" or "poor" discriminators, no significant differences in articulatory performance scores were determined between those children who had SSD scores above the mean score and those whose scores were below the mean. Additionally when children were categorized by severity according to the number of different sounds misarticulated, no significant differences in SSD scores were observed between these three severity groups.

The above analyses examined SSD performances relative to the phoneme most frequently misarticulated by different groups of children. However, most of the children misarticulated more than one consonant. Thus the data were further explored by examining discrimination of particular sounds by *all* children who misarticulated those particular sounds. Since this resulted in overlapping subject groups, statistical comparisons were not possible among groups. Nevertheless, the data shown in Table 2 provide no suggestion that the speech sound discrimination in normal articulating children was consistently superior to

TABLE 1

The mean number and standard deviations of correct responses on Speech-Sound Discrimination (SSD) tasks for control children and five groups of misarticulating children. (Scores were rounded from 4 decimal places.)

		Control	Misarticulating children who most frequently misarticulate:				
			/s/	/θ/	/tʃ/	/r/	/ʃ/
		n=39	n=29	n=13	n=7	n=6	n=5
Total SSD scores	x̄	56.6	56.4	55.9	56.6	57.8	55.6
Maximum = 60	SD	(4.7)	(7.3)	(4.5)	(2.2)	(1.5)	(5.7)
SSD scores for Prevocalic consonants	x̄	27.9	27.9	28.1	28.6	28.2	27.6
Maximum = 30	SD	(2.8)	(4.3)	(1.7)	(1.1)	(1.0)	(3.3)
SSD scores for Postvocalic consonants	x̄	28.7	28.5	27.8	28.0	30.0	28.0
Maximum =30	SD	(3.1)	(3.1)	(3.3)	(1.5)	(0.5)	(2.6)

that in misarticulating children. In fact some children who have articulation problems appear to have better SSD for the phoneme which they misarticulate. The children who misarticulated /r/ had considerably fewer errors on discrimination of /r/ contrasts (.08 errors) than the control children (.28 errors) and the children who misarticulated /ʃ/ also had considerably fewer errors on discrimination of /ʃ/ contrasts (.09 errors) than the control children (.23 errors).

DISCUSSION

The present study explored speech sound discrimination in a large number of misarticulating children in an age group which has previously received little research attention. Analysis of the data indicated no significant differences among groups of misarticulating children or between experimental and control subjects in overall performance on a SSD test. Furthermore, no differences were indicated or even suggested by finer analyses which examined SSD only with regard to the specific sounds misarticulated.

Assessment of SSD through paired comparison procedures such as that used in the present study have been shown to produce higher error rates than those obtained when using carrier phrases or sentences (Schwartz and Goldman, 1974). Sentence stimuli and syntactic cues also appear to facilitate the processing of speech (Miller and Isard, 1963; Beasley, Bratt and Rintlemann, 1980) and it seems probable that a semantic component would also facilitate SSD. The use of isolated CV and VC in a paired comparison task would, therefore, appear to be a sensitive procedure especially when, as in the present study, the stimuli included consonants likely to be misarticulated or misperceived. Thus it seems highly unlikely that the lack of significant differences observed in the present study could be attributed to an insufficiently sensitive test of SSD.

This hierarchy of difficulty of SSD (syllable, word, phrase, sentence) appears exactly opposite to that often stated for production (Van Riper, 1972). Production constraints may

TABLE 2

The means and standard deviations of errors in Speech-Sound Discrimination (SSD) of five phonemes by control children and by all children who misarticulate each phoneme.

			SUBJECT GROUPS All children who misarticulate					
		Control n = 39	Any Phoneme n = 60	/s/ n = 44	/θ/ n = 34	/tʃ/ n = 22	/r/ n = 25	/ʃ/ n = 22
Items on SSD test requiring discrimination of:								
/s/	x̄	.56	.63	*.68*	.74	.59	.44	.59
	SD	(.68)	(.97)	(1.03)	(1.16)	(.73)	(.65)	(.67)
/θ/	x̄	.69	.62	.66	*.68*	.55	.48	.68
	SD	(.86)	(.98)	(1.01)	(1.09)	(.80)	(.82)	(.95)
/tʃ/	x̄	.23	.25	.31	.27	*.27*	.08	.22
	SD	(.49)	(.65)	(.74)	(.75)	(.46)	(.28)	(.43)
/r/	x̄	.28	.13	.18	.24	.09	*.08*	.09
	SD	(.76)	(.60)	(.69)	(.78)	(.43)	(.40)	(.43)
/ʃ/	x̄	.23	.20	.25	.29	.14	.16	*.09*
	SD	(.49)	(.63)	(.72)	(.80)	(.35)	(.37)	(.29)

include the organization and manipulation of motor aspects of speech as well as the effects of increased semantic and syntactic load (Panagos, 1979; 1980). Further investigation is needed to determine the relationship between SSD and speech-sound production at varying levels of semantic and syntactic complexity.

Although the present results cannot disprove a relationship between SSD and articulation errors, they certainly do not suggest any such relationship among the older population included in the present study. It remains possible that our subjects may be deficient in discriminating among sounds which they themselves produce (Aungst & Frick, 1964), something which we were unable to explore. It may also be that, at a younger age, they had a SSD deficit directly related to their misarticulations (Locke, 1980a, b). If so, our results clearly show that discrimination may improve in the absence of an equally significant improvement in articulation (since experimental subjects did not differ from controls in SSD but were clearly poorer in articulation).

As mentioned previously, a form of SSD (ear training) is frequently used in articulation therapy in which the child listens to another person and discriminates between the correct production and an incorrect production of the phoneme which he misarticulates. A frequently cited purpose of this training is to teach the child to recognize auditory differences between his error and the correct production of the phoneme and to establish a good model of the correct speech sound. If children, especially younger children, have problems with both articulation and SSD, then SSD training may be one avenue for therapy.

However, there are reservations regarding the usefulness of perceptual training in affecting production (Williams & McReynolds, 1975).

However, if children do not demonstrate deficits in SSD, the use of remedial exercises would appear irrelevant to correction of misarticulations. Our results suggest that such exercises may indeed be irrelevant, at least in the case of older children. At the very least, our results indicate that thereapy methods involving ear training for older children should not be applied without a prior assessment demonstrating that the child does, in fact, have significant difficulty in SSD.

Although further study of SSD may be merited in younger children, our results suggest that it will not prove to be the most fruitful direction for research with older children. This study has identified a large group of older children (N = 60) who persist in misarticulating despite normal proficiency in SSD. In light of this finding, both researchers and clinicians might do well to turn their attention to factors other than SSD.

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APPENDIX 1

Speech-Sound Discrimination Phoneme Pairs

1. kʌ-kʌ
2. ʌs-ʌs
3. ʃʌ-sʌ
4. ʌl-ʌr
5. rʌ-rʌ
6. lʌ-lʌ
7. ʌʃ-ʌʃ
8. ʌdʒ-ʌʒ
9. ʌr-ʌr
10. sʌ-θʌ
11. θʌ-θʌ
12. wʌ-wʌ
13. ʌtʃ-ʌk
14. dʒʌ-dʒʌ
15. zʌ-zʌ
16. ʒʌ-ðʌ
17. ʌu-ʌl
18. ʌt-ʌt
19. pʌ-pʌ
20. tʃʌ-kʌ
21. ʌd-ʌdʒ
22. θʌ-pʌ
23. tʃʌ-tʃʌ
24. ʌr-ʌu
25. dʌ-dʌ
26. ðʌ-zʌ
27. ʌk-ʌt
28. lʌ-rʌ
29. ʌp-ʌtʃ
30. ʒʌ-ʒʌ
31. ʌu-ʌu
32. ʌz-ʌd
33. ʌp-ʌp
34. ʌl-ʌl
35. dʒʌ-ʒʌ
36. ʌt-ʌʃ
37. ʌk-ʌk
38. tʌ-ʃʌ
39. ʌð-ʌð
40. ʌs-ʌθ
41. pʌ-tʃʌ
42. sʌ-sʌ
43. ʌdʒ-ʌdʒ
44. ʌʒ-ʌð
45. ʌʒ-ʌʒ
46. ʌʃ-ʌs
47. wʌ-lʌ
48. tʌ-tʌ
49. dʌ-dʒʌ
50. ʌθ-ʌp
51. ʌtʃ-ʌtʃ
52. ʌð-ʌz
53. ʃʌ-ʃʌ
54. ʌθ-ʌθ
55. kʌ-tʌ
56. ʌd-ʌd
57. ʌz-ʌz
58. zʌ-dʌ
59. ðʌ-ðʌ
60. rʌ-wʌ

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