Phonological Judgement in Children with Phonological Disorders

Le jugement phonologique chez les enfants avec troubles phonologiques

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Abstract

The relationship between speech sound perception and production has implications for both speech sound development and clinical management of phonological disorders in children. The present investigation examined the abilities of 10 children, aged 5 and 6 years, to make judgements of correctness of their speech error sounds when presented in word pairs. The judgements were of three types: immediate speech (self judgements), delayed speech on tape, and speech of an adult. The children were found to have no ability aside from chance to judge their own productions (either spoken or on tape) although the ability to judge the correctness of their error sounds when spoken by an adult neared 100% accuracy. Findings are compared with past research and discussed in relation to speech sound development and clinical implications.

Résumé

La relation entre la perception et la production des sons articulatoires a des répercussions pour le développement des sons articulatoires et le traitement clinique des troubles phonologiques chez les enfants. L'objectif de cette recherche était d'étudier la capacité, chez 10 enfants de 5 et 6 ans, de juger de l'exactitude des erreurs articulatoires présentées en paires de mots. Trois types de jugements ont été étudiés: la parole immédiate (jugements de soi), la parole désordonnée sur ruban sonore, et la parole d'un adulte. Les résultats ont indiqué que les enfants étaient incapables de juger de leur propre production (parlée ou sur ruban), mais qu'ils s'avéraient aptes, dans près de 100% des cas, à reconnaître ces mêmes erreurs lorsque prononcées par un adulte. Les résultats sont comparés à ceux des recherches antérieures et sont interprétés en fonction du développement articulatoire et des répercussions cliniques.

Clinically speech sound perception* has played a large part in remedial practices for children with phonological disorders**. One prominent theory is that errors in speech sound production by the child result from errors in speech sound perception (Locke, 1983, Van Riper, 1939). (For current information on this view relative to otitis media see Paden, Novak, & Beiter, 1987; Roberts, Burchinal, Koch, Footo, & Henderson, 1988; Shriberg & Smith, 1983). The errors in perception are made by the child in listening to another speaker, and these perceptual errors result in an inadequate model for the child's output. As a result, activities related to speech sound perception (such as ear training) frequently are components of therapy for children with phonological disorders and are regarded as an essential step in the traditional approach to articulation therapy (Powers, 1971; Van Riper & Emerick, 1984; Winitz, 1975).

Interestingly, current clinical approaches also rely upon speech sound perception in procedures labelled as "auditory sorting" (Weiner, 1981), "minimal contrast" (Elbert, Rockman, & Saltzman, 1980), or "phonological restructuring" (LaRiviere, Winitz, Reeds, & Harriman, 1974). Indeed, Winitz (1985) advocates "continuing auditory discrimination training during articulation production training" (p. 264). An auditory component is also included in Hodson and Paden's "auditory bombardment" (Hodson & Paden, 1982), and self-monitoring is stressed for generalization (Koegel, Koegel, & Ingram, 1986).

Although speech sound perception is used in both older and more current approaches to therapy, the relationship between speech sound production and perception errors has never been clearly established (Bernthal & Bankson, 1988, p. 157). This relationship has been the central topic of many investigations, but without clear resolution. One finding has been that some (but not all) children have difficulty perceiving differences between phonemes that they misarticulate and the error productions of those sounds which they produce, but not with other phonemes. (For reviews of this topic see: Bountress & Sever, 1990; Hoffman, Stager, & Daniloff, 1983; Locke, 1980a; McNutt, Bryans, & Hamayan, 1981; Weiner, 1967.)

* The term *speech sound perception* is used in this report to indicate an awareness of the contrasting correct and incorrect forms of speech sounds.

** Locke (1983) has proposed that the term phonological disorders "be used as a single, generic term for disorders involving the sounds of a language" (p. 340). In support of this term also see Elbert & Gierut (1986) and Bountress & Sever (1990).

Most investigations of the perceptual skills of children with phonological disorders have focused upon the children's perception of speech sounds presented by external speakers or as external stimuli (or external perception). Fewer investigations have attempted to examine the children's perceptions of their own productions (or self perception) (Aungst & Frick, 1964; Lapko & Bankson, 1975; Woolf & Pilberg, 1971; Shelton, Johnson, & Arndt, 1977), although perception of one's own speech may be most important in developing phonologies and also in remediation of phonological errors (Wolfe & Irwin, 1973; Lapko & Bankson, 1975).

Although findings regarding the relationship between articulatory status, external perception, and self perception are conflicting, there is evidence to indicate that measures of self perception differ from those of external perception. Indeed, Woolf & Pilberg (1971) postulated that self perception and external perception of speech sounds are different abilities. It appears reasonable to suggest that children should be able to monitor their own speech and identify correct and incorrect productions before changes can be made toward a correct model.

The present investigation was designed to examine data from three measures of speech perception and the relationship between these measures and articulatory status. The speech perception tasks were designed to evaluate the ability of children with phonological disorders to judge correct and error phoneme production as spoken by someone else (External Task), to judge correct and error phoneme production of their own productions (Self Monitoring Task), and to judge correct and error phoneme production of their own productions. played back on a tape recorder (Delayed Judgement Task). The Delayed Judgement Task was included to enable comparisons with previous investigations. Articulatory status was assessed from performance on the McDonald *Deep Test of Articulation* (picture form, McDonald, 1964).

Subjects

Subjects were 5 males and 5 females aged 5 and 6 years who misarticulated /s/ and/or /r/. The age range was 5;4 to 6;7 with a mean of 6 years, 1 month. None of the children had participated in speech therapy before the testing sessions. All children had normal hearing (pure tone screening at 15 dB for the frequencies 0.5K, 1K, 2K, and 4K Hz, per ANSI S3.6-1969); average or above scores on the *Peabody Picture Vocabulary Test* (Dunn, 1959); no history of or observable organic or psychological abnormalities; and were homogeneous for socioeconomic status as determined by parental occupation (Blishen Scale, 1967). Eight of the children misarticulated /s/ by interdentalizing it; one of these also misarticulated /r/; and two children misarticulated both /s/ and /r/ with /s/ lateralized in one case. Four of the children misarticulated phonemes other than those being investigated; two substituted /t/ for *th*, one substituted /f/ for *th*, and the last child lateralized *sh*, *ch*, *zh*, and *j* in the same manner that he lateralized /s/. A description of the speech errors under examination for each child is listed in Table 1. Percent correct scores from the McDonald *Deep Test of Articulation* ranged from 76.9 to 0.

For children of this approximate age, 77% produce /s/ correctly in over 80% of the tested contexts, and 81% produce /r/ correctly in over 89% of the tested contexts (McDonald & McDonald, 1974). On this basis the children in this investigation would be considered developmentally delayed in phonological development.

Method

Stimuli

Tasks of speech sound perceptual ability were developed for each individual child to account for the phoneme being examined and the context in which the phoneme was produced correctly and incorrectly. The *Deep Test of Articulation* (McDonald, 1964) was used to maximize the opportunity for both correct and incorrect productions of the required speech tokens. For each child word pairs were selected from their taped production of the test. The first 10 word pairs with correct production (5 word initial and 5 word final) and the first 10 word pairs with incorrect production (5 word initial and 5 word final) were used in the Self Monitoring and Delayed Judgement Tasks. For cases in which children did not produce 10 correct and 10 incorrect productions, the appropriate taped stimuli were repeated until 10 were obtained. The word pairs used had only the test item in error.

The stimuli for the External Task of perception were 10 items selected from the McDonald *Deep Test of Articulation*, 5 of which had been produced in error by the child and 5 of which were correct. Each item was produced both correctly and incorrectly by the examiner for a total of 20 items. [For 3 subjects with no correct productions, the first 5 initial and 5 final contexts from the Deep Test were selected and produced both correctly and incorrectly.] Eight control foils using /k/ produced correctly and incorrectly (as a /t/) were randomly distributed throughout the External Task to evaluate the child's attention to the task (e.g., "cupcow," "cuptow"; "duckpipe," "dutpipe"). All tasks required subjects to look at pictures of the word pair and make judgements of "right" or "wrong" for productions of the target phoneme spoken in word pairs. The phoneme under investigation was tested in an equal proportion of initial (e.g., "cupsun") and final (e.g., "housepipe") syllable positions as well as correct/incorrect

utterances to avoid an expectancy effect (Vellutino, Desetto, & Steger, 1972).

Procedures

The Self Monitoring Task consisted of 20 pictured stimuli (the word pairs described above) that were presented randomly to the child who said each word pair and judged his/her production of the target phoneme as "right" or "wrong" immediately after the production. Simultaneously, the experimenter judged each production of the target phoneme as correct or incorrect. A response was considered correct when the child's evaluation agreed with the evaluation of the examiner and incorrect when the evaluation did not agree. (It should be noted that children with 0% correct production of the test phoneme could not be evaluated for Self Monitoring or Delayed Judgement Tasks.)

The Delayed Judgement Task required right/wrong judgements of a free- field play-back of the taped 20 productions used in the Self Monitoring Task. Taping of the Self Monitoring Task was done using a Realistic Tie Pin Microphone (50-15000 Hz response) with a Yamaha TC800D cassette recorder; playback was done on a Marantz PMD 360 (C) tape player at a most comfortable listening level adjusted for each child with the speaker at a three-foot distance. The test construction, stimuli, required response, and scoring were identical to those of the Self Monitoring Task. The External Task of perception required the child to identify both correct and incorrect productions of the 20 live-voice stimuli as spoken by the examiner with the incorrect productions approximating the child's error. The child looked at the pictured word-pair during the clinician's production and not at the clinician. The child's response was a right/wrong judgement similar to the responses for the other tasks. This task was similar to those used in some remedial procedures (Van Riper & Emerick, 1984).

Pretraining was given before each task using correct and incorrect productions of 20 nontest word pairs (such as "cupcow," "cuptow") to ensure that the child could understand and do the task. All children completed pretraining at the 100% correct level before attempting the experimental tasks.

All children first received the McDonald *Deep Test of Articulation.* Half then performed tasks in the order of Self Monitoring, Delayed Judgement, and External Judgement. The other half performed tasks in the order of External Judgement, Self Monitoring, and Delayed Judgement. It was necessary for the Self Monitoring Task to precede the Delayed Judgement Task for all subjects as the individualized stimuli for the Delayed Judgement Task were recorded during the Self Monitoring Task.

Reliability

All scoring was done by the second author. Intrajudge agreement (item by item) based on test-retest in scoring the McDonald *Deep Test of Articulation* from tape for all subjects was 98%. Interjudge agreement with a second judge for the preceding task for five subjects was 96%. Test items were identical with those on the McDonald *Deep Test of Articulation* and reliability was considered to have been comparable.

Results

Individual subject characteristics and scores for all measures are listed in Table 1. Raw scores for the Self Monitoring and Delayed Judgement Tasks ranged from 8 to 12 correct (40 % to 60%) on the 20 item tasks. Chance performance for a binomial task with 20 trials would be 7.76 to 12.24 (Mean = 10, *SD* = 2.24) (National Bureau of Standards Applied Mathematics Series 6, 1950). Therefore, results indicate that the children performed these tasks at a chance level. Scores for the External Perception Task were either 95 or 100 percent correct. These two distribution factors prevented the use of correlations and statistical analysis using any of the three perception scores. No pattern could be determined indicating differences in accuracy in judging either correct or incorrect productions. All children made judgements of both correct and incorrect.

Discussion

Articulatory status of the children varied from 0% to 76.9% correct production of the test phoneme on the McDonald *Deep Test of Articulation* while scores for Self Monitoring and Delayed Judgement were at a chance level and scores for External Perception were at ceiling or slightly below. Table 1 shows that there were no observable relationships between articulatory status and the three perception measures. This pattern seen for errors with /s/ was also seen for errors of /r/.

Although the children's performance on the Self Monitoring and Delayed Judgement Tasks did not differ from chance, the subjects clearly understood and could complete the two tasks when a non-error phoneme was involve. As the performances on both the Self Monitoring Task and the Delayed Judgement Task were at chance levels it is difficult to determine their relationship. Before this investigation, we would have predicted that the Delayed Judgement Task was a measure of external perception and that scores would have been similar to that of the External Perception Task. This was not so. Scores on the Delayed Judgement Task were not similar to scores on the External Task, but were similar to the Self Monitoring Task. The children produced both correct and

Table 1. Individual subject characteristics and scores expressed in percent correct.

Sex	Age (Yr;Mos)	Speech Error	Deep Score Correct (%)	JUDGEMENTS Self Score (%)	Delay Score (%)	External Score (%)
f	6;0	/s/ interdental	0	—*	—	95
m	5;4	/s/ lateral	0	—	—	95
		/r/	69.2	50	50	100
f	6;7	/s/ interdental	0	—	—	100
		/r/	10.3	55	55	100
m	6;4	/s/ interdental	0	—	—	100
m	6;5	/s/ interdental	5.1	60	40	100
m	6;4	/s/ interdental	5.1	60	50	100
f	5;9	/s/ interdental	15.4	50	50	100
f	5;7	/s/ interdental	48.7	60	45	100
m	6;2	/s/ interdental	76.9	50	50	100
f	6;0	/r/	48.7	50	50	100

* Children with 0% correct production could not be evaluated on Self Monitoring or Delayed Judgement Tasks.

incorrect productions, but they could not distinguish the difference either in the spoken or taped form. The fact that children do equally poorly on these two judgement tasks may suggest a relationship, specific to the child, between (1) the acoustic nature of their productions and (2) their perceptions of those productions.

There is some evidence that children may maintain acoustic distinctions which differ from those of adults (e.g., Macken & Barton, 1980; Maxwell & Weismer, 1982; Weismer & Elbert, 1982). The speech of children has been found to be less consistent than adults on a number of parameters (Weismer & Elbert, 1982) and is perhaps more difficult to categorize. On the other hand, the greater consistency of the adult production may make it easier to determine the boundaries of that production and may also place that production more toward the center on the continuum of accepted adult correct productions. This explanation of similar performances on Self Perception Tasks and Delayed Judgement Tasks focuses on the child's speech and suggests that the speech token produced by children may be fuzzy and consequently more difficult to categorize than the adult token.

A second explanation may relate to the boundaries in the child's model of what constitutes a correct versus an incorrect token. These boundaries may be different, or less well defined, for the child who misproduces the sound than for an adult. Hoffman et al. (1985) and Rvachew & Jamieson (1989) have found that children with /s/ and children with /r/ problems differ from normally speaking children in identifying the boundaries of synthetic speech stimuli. This explanation suggests that the model for perception in the child with phonological disorders may differ from that present in normally speaking children. The two explanations are not exclusive but may coexist and form a focus for treatment. Although some information is available regarding the acoustic nature of the child's production errors (e.g., Baum & McNutt, 1990; Daniloff, Wilcox, & Stephens, 1980; Weismer & Elbert, 1982), further analysis of both the acoustic nature of the child's correct productions and their perceptions of these productions appear warranted.

Results of the present investigation support those of Woolf and Pilberg (1971) and Shelton et al. (1977) in that children's ability to judge the correctness of their own speech sound productions was not found to be related to their articulation proficiency. The results differed from those of Aungst and Frick (1964) and of Lapko and Bankson (1975) who found a significant correlation between a self monitoring measure and articulation proficiency.

There are several variations among these investigations that include age of subjects, type of tasks, type of stimuli, voice for presentation, and number of tasks. Shelton et al. (1977) have commented that these variations may have resulted in different findings. However, when binomial data from past investigations of instantaneous judgement or delayed judgement (Aungst & Frick, 1964; Woolf & Pilberg, 1971; Lapko & Bankson, 1975; and Shelton et al, 1977) were examined, these data appeared similar to ours. (See Table 2.) When using binomial data the likelihood of chance scores must be considered. When there are an equal number of correct and incorrect responses the Mean scores that could be achieved by chance would approximate 50% [n trials x (p=.5)] and variance 25% [n trials x (p=.5) x (q=.5)]. Using the point at which chance responses end and meaningful responses begin (*National Bureau of Standards Applied Mathematics Series 6*, 1950), the mean scores for all tasks of Self Judgement and Delayed Judgement for the investigations listed in Table 2 are close to the chance level. This would indicate that many of the individual scores for the two measures in past investigations were achieved by chance. Indeed, Shelton et al. (1977) noted that in delayed judgement tasks "... they [subjects] did not agree with themselves on particular items of the perception task. As a result their percentages of agreement were low" (p. 713). Our findings of chance performance on tasks of Self Monitoring and Delayed Judgement are similar to the findings reported (if not the conclusions reached) by past investigators.

Table 2. Comparison of results from five investigations that reported measures of self-judgement for phoneme errors on a variety of tasks.

Authors:	Aungst & Frick 1964	Woolf & Pilberg 1971	Lapko & Bankson 1975	Shelton et al 1977		McNutt & Whelan 1990
Misarticulation:	/r/	/r/	/s/	/r/	/s/	/s/
N	27	20	25	44	54	9 [+3 /r/]
Subject age	8;0-10,3	7;5-10	Grades K & 1	8;0-9;6	8;0-9;6	5;4-6;11
TASK						
Comparison with another speaker	30 items *M*=19.56 *SD*=6.89 Range= 2-30	30 items *M*=19.10 *SD*=4.3 Range= 9-29	15 items *M*=53.9%			
Delayed Judgement	30 items *M*=18.96 *SD*=6.76 Range= 1-30	30 items *M*=14.3 *SD*=6 Range= 4-24		40 items *M*=25.3 *SD*=11.8 *M*=24.3 *SD*=13.9	40 items *M*=19.5 *SD*=12.9 *M*=18.9 *SD*=14.7	20 items *M*=9.4 *SD*= 4.47 Range= 8-10
Self or Instantaneous Judgement	30 items *M*=18.15 *SD*=7.56 Range= 0-30		15 items *M*=50.9%			20 items *M*= 11.2 *SD*= 5.4 Range= 10-12
External Judgement	50 items *M*=45.11 *SD*=5.44 Range= 31-50	30 items *M*=28 *SD*=1.97 Range= 24-30	? items *M*=84.4%			20 items *M*= 19.7 *SD*= 2.5 Range= 19-20

Stimuli varied between tasks and between investigations (eg. syllable position, phonetic context, ratio of correct/incorrect phonemes).

Our findings related to judgements of speech sound perception of live speech, produced by an external adult speaker agree with previous investigations. These investigations have found that children with misarticulations had few errors on external judgements of another speaker either on general tests such as Templin's test (Aungst & Frick, 1964) or on specific perception tests of their misarticulations (Woolf & Pilberg, 1971; Lapko & Bankson, 1975). Our data also indicate that six-year-old children with misarticulations of /s/ or /r/ are unlikely to have problems of external perception of misarticulations of their production errors. However, problems may be determined in external perception for some individual children (Bountress & Sever, 1990; McNutt & Hamayan, 1984), some younger children, or for misarticulations of phonemes other than /s/ or /r/ (Locke, 1980b).

The differences in performance between the evaluations of the child's own speech (both Self Monitoring and Delayed Judgement tasks) and the performance on the External Perception Task (at ceiling level) would indicate that these judgements are measuring different levels or abilities. Certainly our data would support that "it is harder for the child who misarticulates the /r/ sound to evaluate his sound deviation while he is in the process of speaking than from an external source" [i.e. an adult speaker] (Wolfe & Irwin, 1973).

Clinical Applications

The application of speech sound perception is an important consideration for clinical work with children having phonological disorders. The results of this investigation show that children may have problems of speech sound production and yet have no difficulties in judging correct and incorrect productions of their error tokens when the token is spoken by an adult. These children agree with adults in judging productions

of an adult speaker. This would indicate that the children's model for perception of the adult speaker is comparable to the adult's model, and would suggest that an exercise commonly used in remedial procedures with such children such as judgements of adult speech may be unwarranted for most children. Tasks of auditory sorting (Weiner, 1981) and those involving minimal contrasts (Elbert et al., 1980) frequently involve a judgement by the child of an adult production. Before tasks of evaluating adult productions are used in therapy, children should be evaluated to determine whether they, indeed, have difficulties in evaluations of adult productions.

Hodge (1990) writes that, "if it is true that the child's sound categories have different boundaries than adults and a goal of treatment is to alter the child's perceptual category boundaries to approximate more closely those of the adult's, this might be accomplished by presenting the child with a continuum of sound stimuli and providing feedback to the child as to each token's acceptability so that he could alter his categorical boundaries to more adult-like standards." This could be done instrumentally by varying the acoustic characteristics of the stimuli using a speech synthesizer. A less systematic method, but more practical for most clinicians, would be to use the speech of children as the sound stimuli to be judged. A number of paradigms appear viable. Comparisons could be evaluated by the child for a number of contrasts before doing self evaluation. A suggested hierarchy might consist of listening to, making judgements of, and receiving feedback regarding the acceptability for contrasts of (1) a child with no speech problem and an adult, (2) two children with no speech problems, (3) a child with a similar speech problem and an adult, (4) the child himself and an adult, and (5) the child himself and another child. The purpose of such procedures would be to alter the child's model of his errors to more adult-like configurations. Although similar procedures have been used in older, established approaches to therapy (VanRiper, 1939; Winitz, 1985), many newer procedures do not include self-monitoring. Further consideration should be given to clinical instruction of self-monitoring skills for other levels of therapy as well as in generalizing to spontaneous speech (Ruscello & Sheldon, 1979). A reassessment and application of self-monitoring tasks would appear appropriate.

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