Journal of American Indian Education

Volume 29 Number 2
January 1990

EFFECTS OF RECURRENT OTITIS MEDIA ON LANGUAGE, SPEECH, AND EDUCATIONAL ACHIEVEMENT IN MENOMINEE INDIAN CHILDREN

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The pathogenesis and medical treatment of otitis media (inflammation of the middle ear), with its associated high probability of fluctuating conductive hearing loss, has been an important topic in Native American health research (Wiet, DeBlanc, Stewart, & Weider, 1980). Despite the high prevalence rates of otitis media in Native Americans (Stewart, 1986), few studies have investigated its consequences for language, speech, and educational achievement (Toubbeh, in press).

Prevalence in Native American Children

Stewart (1986), in a summary of prevalence studies on otitis media in Native American children, reported the following rates: 13-19% of school-age Eskimo children in Baffin Zone, Canada (Baxter & Ling, 1974); 24% of 385 6-16 year old children in an Indian school in South Dakota (Gregg, Steele, Clifford & Werthman, 1970); and, 30% of children in three Navajo boarding schools (Jaffe, 1969). More recently, Goinz (1984) reported that hearing screenings were conducted on 3,865 Indian children representing 29 federally recognized tribes in the states of Michigan, Minnesota, and Wisconsin. Those referred for medical evaluation and treatment following hearing screenings were 37% of the 1-5 year old children and 13% of the 6-17 year old children. Most recently, Scaldwell and Frame's (1985) study of 739 children in six communities in Ontario, Canada yielded a 23% referral rate for suspected middle ear disease.

Consequences of Otitis Media

Non-Native American Children. Research on the consequences of early recurrent otitis media in non-Native American children generally suggests that persistent ear disease is associated with delays in language and speech development and reduced educational achievement. In preschool-age children, ranging from infancy to 6 years of age, studies by Friel-Patti, Finitzo, Conti and Brown (1982); Jerger, Jerger, Alford and Adams (1983); and Teele, Klein, Rosner, and the Greater Boston Otitis Media Study Group (1984), suggest that otitis media is associated with reduced vocabulary and language development. In studies of school-4ge children, researchers have concluded that otitis media is associated with reduced vocabulary acquisition (Holm & Kunze, 1969; Lewis, 1976), reduced language skills (Holm & Kunze, 1969; Zinkus, Gottlieb, & Shapiro, 1978), reduced auditory sequential memory skills (Brandes & Ehinger, 1981; Kessler & Randolph, 1979), speech delays (Eisen, 1962; Hubbard, Paradise, McWilliams, Elster, & Taylor, 1985), and with the need for increased support services in remedial reading, language and speech, learning disabilities, and counseling (Brandes & Ehinger, 1981; Kessler & Randolph, 1979).

Native American Children. Only two studies have addressed associations between otitis media and language, speech, and educational status in Native American children. Kaplan, Fleshman, Bender, Baum, and Clark (1973), in a cohort study of the educational performance of 489 Eskimo children followed from birth to ten years of age, analyzed the scores of children with histories of otitis media compared to non-involved children.

Intelligence and educational achievement scores of the children with histories of otitis media were significantly lower and the differences in school achievement between groups tended to widen with increased age. Fischler, Todd, and Feldman (1985) assessed the language and speech development of 167 6-8 year old Apache children followed audiologically from birth. On standardized measures of picture vocabulary, oral vocabulary, grammatic understanding, grammatic completion, and informal measures of articulation, no statistically significant associations were obtained in relation to age of onset or number of episodes of otitis media.

Thus, the two available research reports on the language, speech, and academic consequences of otitis media in Native American children have yielded conflicting findings. Clinically, Head Start programs continue to report that language and speech impairment is the leading category of disability, with otitis media suspected as a contributing factor (Harris, 1986). Moreover, within school-age children, the Bureau of Indian Affairs estimates that of the children who received special educational services within BIA schools during 1983-84, 24% were classified as language-speech impaired and 53% as learning disabled. Such data underscore the need for an eventual understanding of the possible consequences of early recurrent otitis media on the communication skills and academic development of Native American children.

Background and Purpose

The prevalence of middle ear disease in children of the Menominee Indian Tribe of Wisconsin is consistent with the high prevalence rates for otitis media in Native Americans elsewhere. The 1982 annual hearing screening program conducted through the Bemidji Regional Office of Indian Health Services and the Menominee Tribal Clinic resulted in 38.7% of the 3-5 year old children being referred for medical evaluation and treatment (Goinz, 1983). In addition, a special childhood audiology project conducted from 1983 to 1985 reported prevalence rates as high as 60% for children ages 6 months to 3 years (B. Bricco, personal communication, September, 1985). Annual educational screenings conducted at the Head Start program indicates that language and speech skills are delayed in a high percentage of children (D. Boyd, personal communication, January, 1986). The purpose of the present study, which was initiated in 1986, was to assess the effects of otitis media on language, speech and educational outcomes in Menominee Indian children.

Method

Subject Selection

Subjects were monolingual English-speaking children, aged 3 years, 8 months to 5 years, 8 months, enrolled in the Indian Head Start program. English was the only language used in the program. Ninety percent of the 140 enrollees (126) were from low income families.

Subject selection proceeded in three phases. First, Head Start student health and educational records were reviewed to eliminate subjects with suspected or diagnosed health or developmental disabilities. Second, a variety of additional records were reviewed to identify potential subjects, including routine pediatric screenings, records from the, childhood audiology project, and school health screenings. Third, medical records at the Menominee Tribal Clinic were reviewed in detail to tally the occurrence and types of middle ear disease, as observed in well-baby examinations, early periodic screening and diagnostic treatments, medical treatment for specific ailments, audiological evaluations and referrals for suspected otitis media. A diagnosis of *acute otitis media* (ear infection) was based primarily on pneumatic otoscopy and a diagnosis of *otitis media with effusion* (liquid in the ear) was based on tympanometry. Records indicated that 80% of the diagnoses and treatments were provided by the same physician. The review of medical records yielded a rank-ordering of children based on chronological data establishing absence of or involvement of otitis media. A total of 28 subjects were eventually assigned to two groups of 14 subjects each, designated N-MEI (no history of middle ear involvement) and MEI (history of middle ear involvement).

Procedures

Tests and measures were administered in two sessions to prevent subject fatigue. Middle ear assessments and speech perception testing were conducted by an experienced preschool speech pathologist who was unaware of the individual subjects' middle ear histories. Language and speech assessments were conducted by the first author, known to the children as a former Head Start staff member.

Middle Ear Assessment. Two to 7 days prior to administration of the language and speech measures, all subjects received a middle ear assessment including: a) an otoscopic examination (Welch Allen Model 2400), b) pure tone testing at 15 dB HL and at threshold for 1000 Hz (Beltone Model 112 Audiometer equipped with TDH-50H earphones), and c) immitance testing (GSI 28 Electroacoustic Bridge), including peak compliance and peak pressures. All instrumentation was calibrated to ANSI (1969) standards one week prior to testing.

Language and Speech Assessment. Language comprehension testing included measures of single word vocabulary assessed with the *Peabody Picture Vocabulary Test - Form M* (PPVT-M) (Dunn & Dunn, 1981), and auditory memory sampled from Subtests 5 and 6 of the *Test of Auditory Comprehension* (TAC) (Trammel, 1981). The TAC assesses the ability to recall two JAC 5) and four (TAC 6) critical elements in sentences by selecting the appropriate representative picture. Stimuli were presented via audiocassette tape using a Marantz PMD 201 player equipped with lightweight Aiwa A55 earphones. Language production was estimated by an index of average words per utterance obtained from the language-speech sample described below.

The speech protocol included measures of speech perception and speech production. Speech perception was assessed using an experimental protocol, the *Sound and Syllable Probe (SSP),* which consisted of three lists containing 15 English consonants combined with the vowel /a/ to form consonant-vowel nonsense syllables (Shriberg, Kwiatkowski, Block, Katcher, Kertoy, & Nellis, 1984). A stimulus tape was presented in the subject's better ear at two intensity levels; at 40 dB HL above the 1000 Hz threshold established at the time of pure tone screening (SSPI) and the second and third randomized lists at 20 dB HL above threshold (SSP2, SSP3). After training by the examiner, subjects responded to the taped presentations which required repetitions of the syllables in the carrier phrase, "Say _." Stimuli were presented via the headphones and the audiocassette tape recorder. Subject responses were recorded on high quality TDK tapes by a second Marantz recorder equipped with a matching Sony EC-3 microphone placed approximately 12 inches from the subject's mouth. Language and speech production was assessed from a continuous 15-minute speech sample elicited with a variety of toys, story books, and pictures. Recording procedures were similar to those used for speech perception testing.

Reliability and Group Comparability. Responses to the SSP tasks and the continuous speech sample were transcribed by consensus by two persons using the procedures described in Shriberg (1986) and Shriberg, Kwiatkowski, and Hoffmann (1984). A reliability assessment was obtained for five randomly selected subject tapes from the original 28 (18%) representing both subject groups. Overall point-to-point retest agreement was 90.9% for broad transcription of consonants and 86.7% for vowels.

Inferential statistical analyses were carried out to assess group composition relative to demographics, middle ear history, and middle ear status at the time of testing. As shown in Table I the groups did not differ statistically in gender [$X2$ (1) = .15; $p > .05$], age [$F(1,26) = .16$; $p > .05$], or prior educational histories in one of three available programs: an infant stimulation program [$F(1,26) = .35$; $p > .051$, language and speech services [$F(1,26) = .13$; $p > .05$], or a Head Start program [$F(1,26) = .15$; $p > .05$]. Overall, children's participation in the three programs prior to age 3 was minimal, with children in both groups attending Head Start for approximately 16 months prior to the date of testing. Non-verbal subtests from the *Wechsler Preschool and Primary Scale of Intelligence* (Wechsler, 1967), administered by a licensed school psychologist to an available 17 subjects representing both groups, yielded mean non-verbal IQ scores of I 11. 7 for the N-MEI group and 109 for the MEI group [$F(1,26) = .29$; $p > .05$].

TABLE 1

Demographic and educational histories of children in the two middle ear groups.

Group	N	Gender		Age (mos.)		Educational History (mos)					
						Infant Stimulation		Language/Speech		Head Start	
		Male	Female	*M*	*SD*	*M*	SD	*M*	SD	*M*	SD
N-MEl	14	9	5	57.6	7.0	0.8	7.0	2.6	3.2	15.4	5.6
MEI	14	8	6	56.5	7.2	1.7	3.9	4.4	9.6	16.3	6.0

As planned, the groups' middle ear histories differed significantly. The mean number of treatment visits for symptomatic or asymptompatic otitis media was 0.2 visits (SD 0.4; range 0-1) for the N-MEI group and 10.4 visits (SD 4.9; range 6-23) for the MEI group [$F(1,26) = 60.33$; $p < .05$]. On the day of testing, however, there were no statistically significant differences between the groups on pure tone testing based on a pass/fail criteria for both ears [X^2 (1) = 0.7; $P > .051$. Measures of peak compliance and peak pressure indicated significantly poorer middle ear functioning for the MEI group (peak compliance [X^2 (1) = 4.76; $p < .05$]; peak pressure (X^2 (1) = 4.76; $p < .05$]), based on a pass/fail criteria of .2 to 1.8 ml compliance value and - 200 to + 100 mmH20 pressure values for both ears. Pure tone data for each subject indicated that sensitivity levels were not sufficiently reduced to impact performance on the language and speech measures.

TABLE 2
Language comprehension and language production data.

	N-MEI (n=14)			MEI (n = 14)			
Measure	*M*	SD	Range	*M*	SD	Range	F
PPVT-M**	44.6	21.6	6-77	21.3	14.0	3-42	11.46*
TAC***							
5	14.5	0.7	13-15	13.6	0.9	12-15	9.09*
6	10.9	2.3	7-14	8.6	2.0	4-12	8.26*
AWU****	4.4	1.4	2.6-6.6	3.7	0.8	2.4-5.6	2.26 ns

*p < .05
**PPVT - M: *Peabody Picture Vocabulary Test - Individualized Form M;* values are percentiles.
***TAC: *Test for Auditory Comprehension;* values are raw scores. TAC 5: memory for two critical elements in sentences; TAC 6: memory for four critical elements in sentences.
**** AWU: Average Words Per Utterance; computed from the continuous speech sample.

Results

Language Measures

Table 2 includes descriptive and inferential statistical results for the two language comprehension measures and the language production measure. Using percentile equivalent scores (Anastasi, 1982) from the *Peabody Picture Vocabulary Test-M*, the MEI subjects' single word comprehension vocabulary scores were significantly lower than the N-MEI group scores. Also, differences in scores on both subtests of the auditory memory measure were statistically significant, with children in the MEI group obtaining lower average scores. Finally, comparison of Average Words Per Utterance (AWU) as obtained from the continuous speech samples indicated that groups' scores were not significantly different, although trends toward lower scores in MEI children occurred.

Shriberg's (1986) data indicated that the correlation of AWU with Brown's mean length of utterance (MLU) is approximately .96. For the present purposes the N-MEI's mean AWU score of 4.4 words corresponds to Brown's Late Stage V of sentence development, whereas the lower MEI mean score of 3.7 words corresponds to late Stage IV to Early Stage V (Miller, 1981).

TABLE 3
Speech perception and speech production data. All scores are percentages.

	N-MEI (n=14)			MEI (n=14)			
Measure	*M*	SD	Range	*M*	SD	Range	F
Speech Perception**	88.5	6.5	80-100	88.9	10.4	60-100	.02 ns
SSP1	72.2	15.0	46-100	67.0	21.1	29-100	.56ns
SSP3	69.6	22.1	36-100	69.5	22.1	36-100	.06ns
Speech Production							
Severity***							
PPC-S	81.6	4.2	76.5-88.4	78.3	5.6	69.3-87.0	3.08 ns
PCC-C	80.2	10.9	56.1-92.9	75.5	9.6	58.8-88.7	1.45 ns
PCC-O	81.3	5.4	71.1-89.0	77.5	6.5	67.9-87.2	2.90 ns
Intelligibility Index	98.0	1.1	96.0-100.0	92.7	5.1	81.5-98.9	14.50*

*p < .05
**'Sound-Syllable Probe: SSPI, 40 dB HL; SSP2 and SSP3, 20 dB HL.
*** PCC: Percentage of Consonants Correct; PCC-S: singletons; PCC-C: clusters; PCC-O: overall.

Speech Perception and Speech Production Measures

Table 3 includes descriptive and inferential statistics for the three tasks used to assess speech perception and the two indices of speech production. The speech perception scores for the SSP tasks were computed to reflect only speech perception errors, with errors due to speech production removed from the percentage calculations. As shown in Table 3 both groups achieved higher percentage scores at the 40 dB HL level than at the 20 dB HL levels, with no statistically significant differences between groups at any of the three levels. Additional analyses of the two 20 dB tasks were undertaken, using confusion matrices to inspect speech perception error types. These data suggested that the error response patterns of children in the MEI group were more 'guesslike,' including deletions of consonants in the CV words, substitutions of unlikely consonants, and the addition of syllables.

Speech production scores were provided as output from a software package (Shriberg, 1986). As shown in Table 3, severity of speech production was assessed by indices reflecting percentage of consonants correct in singletons, clusters, and an overall combined score. Although trends again indicated lower average scores for the MEI group on both consonant singletons and consonant clusters the mean differences were not statistically significant at the .05 alpha level.

Finally, the software provided an index of children's speech production intelligibility based on the percentage of words in the continuous speech samples that the transcribers were able to understand. The difference between groups means was statistically significant, with the MEI children again averaging lower scores than children in the N-MEI group.

Educational Follow-up

Two years after the above data were collected, a follow-up assessment was undertaken to determine if educational progress differed in the two groups of children. Of the original 28 subjects, 24 (12 in each group) had standardized achievement scores on the *Comprehensive Test of Basic Skills* (McGraw-Hill, 1982) available from the Menominee Indian School District. Statistically significant differences in mean scores were obtained on Oral Comprehension [$F(1,23) = 5.57$; $p < .05$] and Vocabulary [$F(1,23) = 6.65$; $p < .05$]. On Oral Comprehension the average percentile score of the N-MEI children was 61.7 compared with the MEI mean score of 38. 1. On the Vocabulary subtest, percentile scores for the two groups were 63.5 and 37.9, respectively. No statistically significant differences were obtained between mean scores on subtests of Sound Recognition or Math Computation and Application.

Finally, a detailed review of grade placements and support services indicated that two of the original 14 children in the N-MEI group (14%) had received a total of two services or class adjustments. In contrast, seven of the original 14 MEI subjects (50%) had received a total of 13 grade changes and/or support services, including retention in kindergarten, placement in a special pre-kindergarten language program, language and speech therapy services, Chapter I remedial services, and learning disability program placements.

Discussion

Conceptual models of the causal network relating early otitis media to later language, speech, and academic delays have been proposed in a number of sources (e.g., Hasenstab, 1987; Menyuk, 1980; Shriberg, 1987; Shriberg & Smith, 1983). Most generally, they stress the importance of a reliable auditory input, one that provides consistent information on the salient acoustic cues subserving speech (Kuhl, 1982). Successful early speech perception is viewed as fundamental to all levels of language acquisition, including lexical development and the cognitive-linguistic processes underlying efficient organization and categorization of information. Viewed from this perspective, each of the language, speech, and educational outcomes and trends observed in the present study plausibly can be viewed as a consequence of early otitis media with effusion.

Although the present data add to the evidence that early recurrent otitis media in Native American children is associated with lowered language-speech and educational achievement scores, such findings have prompted relatively few large-scale research studies. The notable lack of attention to the possible sequelae of otitis media in Native American children has been discussed by several researchers. Among the possible reasons offered are: a) an assumption that the language deficits of Native American children can be attributed to bilingualism, cultural differences in language learning and language usage, and the cultural bias in the construction of standardized tests (Harris, 1986); b) a perception by physicians and Indian community members that otitis media is so common a childhood disease that possible consequences go unrecognized (McShane & Plas, 1982); c) an attitude by physicians that health treatment services are adequate and therefore preclude language and educational sequelae (Stewart, 1986); and, d) a focus by Indian Health Services on primary health care, resulting in lack of services for language-speech and educational sequelae and a lack of communication to other agencies responsible for special educational services (Toubbeh, in press).

The findings of the present study suggest the need for increased awareness of the long-term sequelae of recurrent otitis media within the Indian community, within health care agencies, and within associated educational service agencies. Indian community members must be educated to understand the importance of seeking medical care for children who repeatedly experience this disease and physicians must be aware of the possible language-speech and educational sequelae of early recurrent otitis media. Communication must be facilitated between health care providers and service agencies, i.e., Head Start programs, and schools. Most importantly, educators of Indian children need to be made aware that although social-economic and cultural factors may influence educational progress, early recurrent otitis media may place a child at additional risk for normal acquisition of communicative competence.

Acknowledgments

We thank the following people for their assistance with this study: Mrs. Delores Boyd, Head Start Director; Mr. Jerry Waukau, Dr. Cindy Weisflock, and Mrs. Mary Beth Pecore, Menominee Tribal Clinic; Dr. Roger Klumb, Superintendent, Carol Dodge, Director of Instruction, and the Menominee Indian School District Board of Education. This work was supported by grants from the United States Department of Education, Research in

Education of the Handicapped Program, G008400633 and the National Institutes of Neurological and Communicative Disorders and Stroke, NS-26241-01.

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