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COMMUNICATIVE DEVELOPMENT IN TWINS WITH DISCORDANT HISTORIES OF RECURRENT OTITIS MEDIA

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The communicative abilities of six sets of same-sex, dizygotic twins (CAs 2;1–4;1) were examined. In each dyad, one sibling had a strong positive history of recurrent otitis media (ROM), while the other twin had a negative or minimal history of ROM. Standardized test performance and spontaneous speech and language abilities were examined. Results suggest that although a history of ROM is associated with lowered receptive vocabulary scores in these dyads, no consistent effects of ROM could be detected in expressive speech and language tasks. In two dyads, the ROM-positive twin did score lower on articulation and language measures; however, in two dyads, children with equivalent histories of ROM outscored their ROM-negative siblings. In the remaining dyads, little difference was observed between the siblings on the measures we used. We suggest that the effects of ROM on communicative development are complex and subtle, and that control of home and day care environment may minimize some of the previously documented associations between ROM and speech-language development.

INTRODUCTION

The study of the effects of otitis media, or middle ear infections, on children's communicative development, is interesting for a number of reasons. First, the ability to document communicatively significant sequalae to what is normally viewed as a common medical condition of childhood can lead to changes in the degree to which otitis media is aggressively identified and treated by pediatric medical personnel. The second reason is perhaps of

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greater interest to professionals in the fields of communication development and disorder. Given the number of children who present with disorders of speech and language development in the absence of frank perceptual, motor or cognitive impairment, it is crucial to ask what leads such children to demonstrate atypical patterns of speech and language acquisition and use. In this regard, otitis media (OM) has increasingly been discussed as a potential culprit, although the results of large-scale surveys of the communicative sequalae of OM have been far from clear, and little effort has been made to link deficits seen in communicatively-impaired children having positive histories of OM with the theoretical impacts which transient hearing loss should have on the developing child.

Otitis media is an extremely common illness in children between birth and two years of age. Teele, Klein, and Rosner (1980) found that almost half of the more than 2500 infants they surveyed had experienced at least one episode of otitis media by one year of age; by age 3, more than 70% had experienced three episodes.

Although OM is thus a pervasive condition of childhood, concern arises when a child experiences recurrent or chronic OM, defined as multiple episodes (>3/yr) over multiple years, with onset prior to 12 months of age (Merchant et al., 1984). OM, particularly when it is bilateral, can depress hearing thresholds by as much as 20–40dB (Fria, Cantekin and Eichler, 1985; Casselbrant et al., 1985), and it is thus not surprising that a growing body of literature suggests that recurrent otitis media (ROM) in early childhood is associated with delayed or disordered speech and language development (Friel-Patti and Finitzo, 1990; Holm and Kunze, 1969; Lewis, 1976; Rapin, 1979; Roberts et al., 1988; Silva, Chalmers and Stewart, 1986; Silva et al., 1982; Teele, Klein, and Rosner, 1984; Wallace, et al., 1988).

However, studies do not uniformly find communicative sequalae following ROM. While Needleman and Menyuk (1977), Paden, Novak and Beiter (1987), Silva et al., (1982), Silva, Chalmers and Stewart (1986) found that children with positive histories of ROM made more articulation errors than children with minimal histories of effusion, Roberts et al., (1988) and Teele et al., Klein, and Rosner (1984) did not find statistical evidence of a relationship between history of early OM and articulation ability.

Estimating the effects of ROM on children's language development has been complicated. Some studies have found that ROM children score somewhat lower on various measures of receptive language when compared to children without significant ROM history (Friel-Patti and Finitzo, 1990; Silva et al., 1982; Teele, Klein and Rosner, 1984). More limited evidence of the possible of the possible effects of ROM on expressive language development has been found using the Sequenced Inventory of Communicative Development (SICD). Wallace et al. (1988) found that proportion of time with bilateral OM was associated with lower scores on the expressive portion

of the SICD. However, appraisal of the expressive language abilities of ROM children has been less common than appraisal of their receptive skills. A number of factors complicate evaluation of the effects of ROM on children's communicative development. Many studies have utilized subject populations which could not be balanced by sex, socioeconomic status, educational, or daycare placement. Control of a number of variables thought to affect speech and language development has not been possible. These include factors such as environmental setting, and parental language stimulation (Camaioni and Laicardi, 1985; Jones, 1972; Sameroff, 1986; Scherer and Olswang, 1984; Yoder and Kaiser, 1989), birth order (Bendersky and Lewis, 1986; Falbo and Polit, 1986), parental education and socio-economic status (Mayer and Jencks, 1989; Parisi and Gianelli, 1979), and school or daycare placement (Factor and Schulmoeller, 1984). Further, some research suggests that young children's day care settings are independently associated with propensity to diagnosis of ROM as well as differential performance on communication development inventories (Friel-Patti, Finitzo and Chinn, 1991). Thus, it is possible that frequency of ROM and changes in language performance are both affected by a child's day care placement at a young age, but that the OM does not, in and of itself, cause significant changes in communicative performance.

The current study investigates the effects of ROM within same-sex twin dyads discordant for a history of middle-ear effusion early in life. A twin design obviates concerns such as parental stimulation and education, child care placement, birth order, and other variables which potentially exert an influence on communicative development. Moreover, we assume that the health environment (e.g., exposure to contagions) for each child is constant, and that parents provide each sib with equivalent care and treatment for symptomatic OM.

Further, to more closely examine communicative impacts of ROM, we have chosen to perform intensive analyses of the children's spontaneous expressive speech and language behaviors. Because each ROM-negative twin serves as his or her sibling's normal control, it is possible to compare performance on a range of expressive communicative scales.

METHOD

Subjects

Twelve subjects, six dizygotic same-sex twin pairs (2 female, 4 male) participated in this study. Subjects were recruited by contacting ten Mothers of Multiples and Parents of Multiples organizations in the greater Baltimore and Washington DC areas, having a combined membership of over 1,000 families. Parents were informed that study criteria sought dyads in which

Table 1. Characteristics of Twin Dyads[a]

Name	Sex	Age	Onset of OM	Total instances of OM
ES	M	2;1	0;5	8 (treated w. drugs only)
KS	M	2;1	NA	1
MH	F	2;8	0;11	9 (drug treatment only)
KH	F	2;8	NA	0
SC	F	3;10	0;5	14 (drug treatment only)
MC	F	3;10	0;5	4
GR	M	3;11	0;2	15 (1 set PE tubes)
DR	M	3;11	NA	0
AP	M	4;1	0;10	7 (2 sets PE tubes)
JP	M	4;1	NA	0
DEK	M	4;1	0;6	10 (2 sets PE tubes)
DK	M	4;1	1;11	2

[a]Bold type indicates ROM-positive twin.

both twins were of the same sex, (to control for known gender differences in speech and language development), and were one through four years of age, in which one twin had a significant history of ROM and the other did not. Positive history was defined as six or more instances in one year with first ROM diagnosis prior to 12 months of age; negative history was defined as fewer than two instances of ROM per year. Confirmatory medical records from families' pediatricians and ENTs were obtained to augment and verify parental records of ROM in all cases. Cases in which medical records could not be obtained were excluded from the study.

No monozygotic pairs were identified, probably due to anatomical predispositions to otitis. In monozygotic twins answering the study call, either both or neither twin had a significant history of OM. Finally, twin pairs in which one sibling demonstrated atypical or discrepant development from either his/her twin, or presented with frank developmental disability were excluded from analysis.

The final six dyads were same-sex, dizygotic pairs. In three dyads, the OM-negative twin had a completely negative documented history for otitis media. In the remaining three dyads, the differences between the OM-positive and OM-negative siblings were 14 vs. 4, 10 vs. 2 and 8 vs. 1 incident of OM, respectively. The mean number of diagnosed OM incidents for the OM-positive group was 10.5 instances over a roughly two year span; the mean number of diagnosed incidents for the OM-negative group was 1.2 incidents over the same time period. The average difference between affected and non-affected twins was 9.3 instances of otitis media (Table 1). All twins and their families were of middle class SES and spoke a standard dialect of American English. None had remarkable medical histories with the

exception of a diagnosis of ROM, and all passed an oral-peripheral screening test, as well as a hearing screening conducted at 20dB.

Procedure

All children were seen individually in their homes on two occasions one month apart. Each subject completed the following tasks: completion of two standard articulation inventories (The Goldman-Fristoe Test of Articulation (Goldman and Fristoe, 1986) and The Photo-Articulation Test (Pendergast et al., 1984); the Peabody Picture Vocabulary Test-Revised (Dunn and Dunn, 1981), and elicitation of a spontaneous conversational speech sample during play with the first author. All responses were taped, using a Marantz PMD 201 cassette recorder equipped with an external lavalier microphone (Shure Dynamic SM11).

Phonological Analysis of the Conversational Samples

For each child, a corpus of 70 spontaneous utterances, excluding fillers and repetitions, was transcribed and analyzed using Programs to Examine Phonetic and Phonological Evaluation Records (PEPPER) (Schriberg, 1986). This package is a computer software system which can be applied to conversational speech samples to yield measures of intelligibility, percent consonants used correctly, and a feature analysis. A total of 5323 consonants used in spontaneous conversation with the first author were analyzed.

Linguistic Analysis of the Conversational Samples

The same corpus of spontaneous speech was also transcribed for analysis using Computerized Language Analysis (CLAN) (MacWhinney, 1991). CLAN programs were used to derive MLU and Type-Token Ratios (TTRs). Finally, Developmental Sentence Scoring (DSS) (Lee, 1974) was applied to ten of the twelve samples; the relatively young age and language immaturity of the sixth twin dyad made their samples inappropriate for DSS scoring. Developmental Sentence Types (DST) was used for this dyad. DSS scores were computed by hand, and checked using the CLAN DSS option.

All transcripts were retranscribed by a second listener, a graduate student in speech-language pathology, who was naive to the medical history of the subject children. Differences in coding of data were juried among the transcribers and the second author to reach agreement.

Table 2. Summary Speech and Language Findings[a]

	Articulation variables			Language variables			
Dyad	G-F%ile	PAT%ile	PEPPER PCC	PPVT%ile	TTR	MLU	DSS
ES	**57**	**95**	**65.74**	**6**[b]	**.602**	**1.981**	**11/71 sentences**[c]
KS	35	97	71.58	16[b]	.614	1.868	4/71 sentences[c]
MH	**70**	**89**	**66.10**	**71**	**.352**	**3.236**	**7.88**
KH	92	98	83.72	93	.395	4.194	8.65
SC	**74**	**97**	**92.02**	**53**	**.352**	**6.0**	**10.31**
MC	71	57	80	30	.395	4.94	8.379
GR	**24**	**20**	**74.82**	**50**	**.391**	**3.871**	**7.716**
DR	53	63	87.84	55	.381	4.365	10.477
AP	**26**	**44**	**82.42**	**40**	**.490**	**3.062**	**4.76**
JP	29	38	67.55	48	.431	3.387	6.12
DEK	**59**	**63**	**86.14**	**63**	**.361**	**7.581**	**13.56**
DK	23	35	76.41	74	.481	5.609	10.42

[a] Bold type indicates ROM-positive twin.
[b] Raw scores. Test is not normed for children of this age.
[c] Proportion of utterances qualifying as sentences on Developmental Sentence Type analysis.

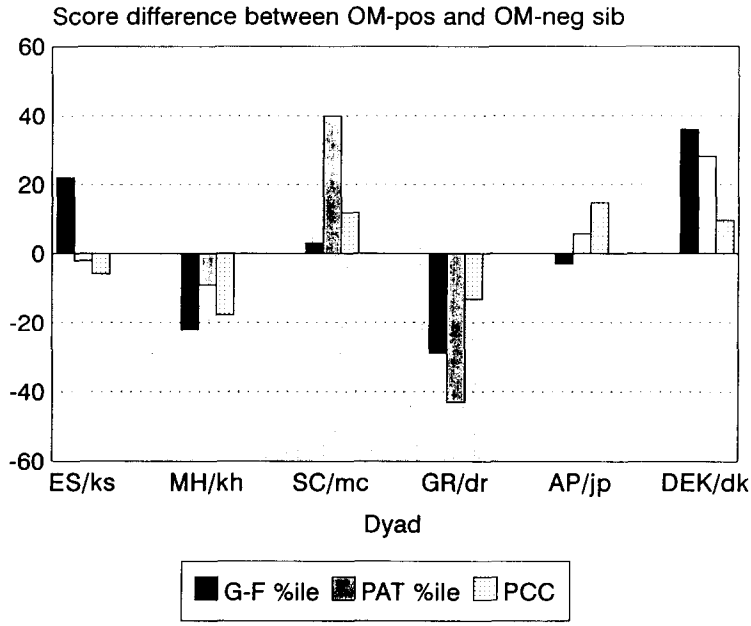

Figure 1. Differences between twins on Goldman-Fristoe Test of Articulation, Photo-Articulation Test and PEPPER Percent Consonants Correct (PCC). In each dyad, the OM-Positive sibling is listed first, in capitalized initials.

RESULTS

Table 2 displays summary data for all of the speech and language variables examined. In each dyad, the OM-positive twin is listed first, in bold face.

Articulation

Figure 1 plots the articulation score differences obtained by comparing each OM-positive twin to his/her OM-negative twin's performance on the PAT, Goldman-Fristoe, and PEPPER Percent Consonants Correct (PCC). One entire twin dyad (AP/JP), and one individual twin (GR) scored slightly below age expectancy on the PAT; all other children scored above chronological age. Average scores on the PAT were almost identical for OM-positive and OM-negative twins, with percentile rank varying only minimally (68th percentile vs. 65th percentile, respectively). However, when viewed on a dyad-by-dyad basis, two OM-positive twins (ES and AP) scored at virtually the same level on the PAT as their OM-negative siblings, two OM-positive children showed relatively marked decrements in performance (MH and GR), and two OM-positive children actually performed better on the PAT

than their siblings with negative histories of OM (SC and DEK). Performance on the Goldman-Fristoe revealed a similar pattern, with the OM-positive group scoring at the 53rd percentile, with an average error score of 19.8, and the OM-negative group scoring at the 52nd percentile, with an average error score of 19.2. In general, percentile scores on the GFTA were somewhat lower than those obtained on the PAT. Only two GFTA scores showed a performance disadvantage for the OM-positive twin within a dyad (MH and GR). Only one OM-positive child (GR) demonstrated marginally clinically depressed articulation development.

Confrontation naming tasks, characteristic of standardized articulation inventories, do not necessarily reflect articulation performance in connected discourse where unstressed functors and morphological inflections may be compromised (Paul and Shriberg, 1982). PEPPER conversational speech analysis (more sensitive to articulation deficits in unstressed grammatical functors) indicated that OM-positive twins produced an average of 80.64 Percent Consonants Correct (PCC), while OM-negative twins produced an almost identical score of 79.03 PCC. Again, there were no clear associations between OM history and accuracy of articulation in spontaneous speech samples. Three OM-positive twins produced consonants more accurately than their OM-negative siblings, while three dyads showed an inverse pattern of articulatory accuracy. Results of a PEPPER feature analysis are displayed in Figure 2, which shows a little difference between OM-negative and -positive twin siblings in terms of percentage of consonantal features appropriately produced. Surprisingly, the two sound classes showing the greatest difference in production accuracy, affricates and liquids, tended to be produced more accurately by children *with* a positive history of ROM, a finding not predicted given prior research.

Language Analyses

PPVT (receptive vocabulary) scores tended to be more uniformly lower for twins with a positive history of ROM. In five out of six dyads, the ROM-negative twin achieved a higher score than the sibling with a history of otitis media, as shown in Table 1 and Figure 3. One OM-positive and two OM-negative children (the sib and an additional twin sib from a separate dyad) scored below the 50th percentile on the PPVT. TTR scores for the two groups of children, when considered as a group, did not differ markedly, and fell within expected values. The average TTR for OM-positive twins was .425, while the average TTR for OM-negative twins was .449. However, in 4/6 dyads, TTR was lower for the OM-positive sibling, in relative agreement with receptive vocabulary scores. Taken together, the scores suggest an effect of recurrent OM on lexical development, consistent with some prior research.

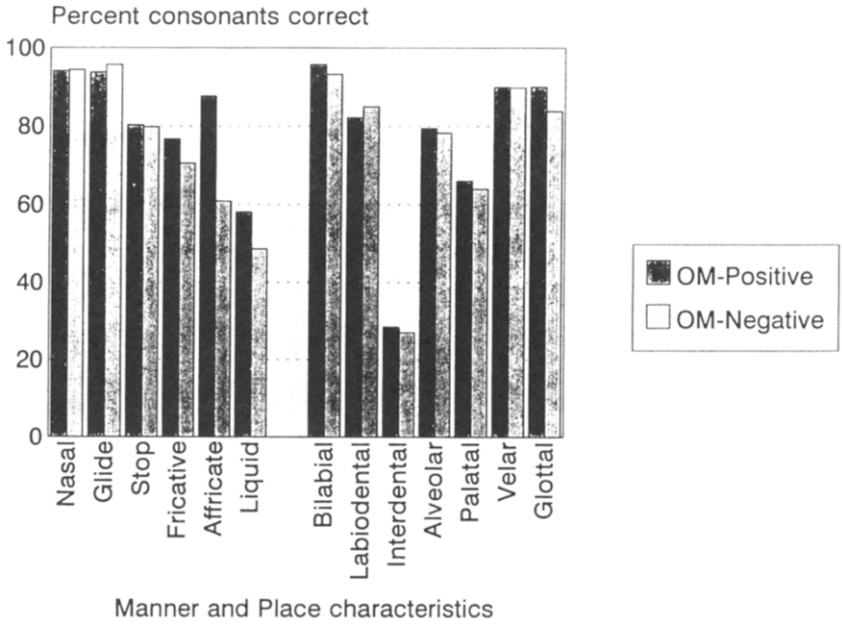

Figure 2. PEPPER Feature analysis of the twins' spontaneous conversational speech.

Results of the expressive language measures were less uniform, and did not clearly suggest an impact of ROM on expressive language performance. Figure 4 displays MLU values for each dyad when compared to chronological age (Miller and Chapman, 1981). All subjects fall within or above the normal predicted age range for MLU. As a group, the OM-positive group produced slightly longer utterances than did the OM-negative group (MLU 5.07 vs. MLU 4.61). Dyads which showed considerable differences between one another were SC/MC and DEK/DK. In both of these dyads, the OM-positive twin demonstrated the markedly higher MLU value.

Both MLU and DSS scores are plotted in Figure 5. One dyad (**ES**/KS) demonstrates indistinguishable performance on these expressive measures. In three dyads, both MLU and DSS scores are depressed in the ROM-positive twin relative to his/her unaffected sib. **GR** and **MH,** while scoring lower on DSS scaling than their OM-negative siblings, still score above the mean score expected for their ages. One twin (**AP**) demonstrates DSS scores below the 10th percentile expected for his chronological age; this score can be considered clinically significant. It should be noted, however, that his OM-negative sibling also demonstrated depressed scores on DSS scaling, though of a lesser extent (<25th percentile). The estimated degree of language delay for the twins in the dyad is 12 months and 8 months, respectively (Lee, 1974). These children were the only in the sample to score below the average expected score for their age. In the remaining two dyads, the child with a

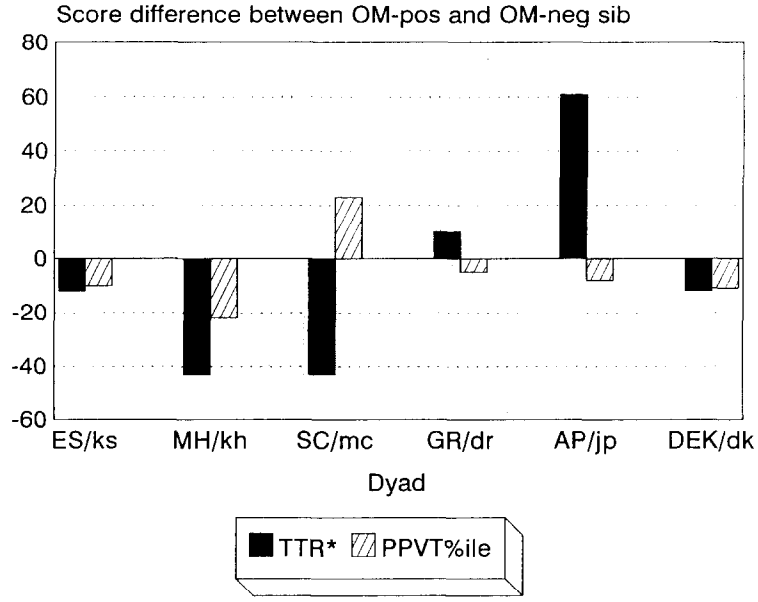

Figure 3. Score differences between the twin dyads on PPVT and TTR analysis.

strong positive history of ROM achieved higher expressive language scores, as measured by MLU and DSS.

Finally, on a qualitative basis, OM positive twins' expressive language was not distinguished by particular error patterns. For example, in a twin dyad such as **AP/JP**, omission of low stress functors, such as *to* in infinitivals, articles or omission of copular verb forms, was as likely to be seen in OM-negative as positive sibs.

Overall Communicative Functioning

When articulation and language performance are considered jointly, only two OM-positive twins (MH and GR) show globally depressed functioning when compared to their OM-negative siblings. GR has the most severe history of ROM in the current sample, while his brother has never had a documented case of otitis media. MH has had nine instances of OM in less than two years, while her sister has had none. However, SC, who has had the second highest number of instances of OM (14 in three and one-half years), consistently outscores her relatively OM-free sibling on all language and articulation measures (including the PPVT). OM-positive twin DEK shows a similar advantage over his non-affected twin brother. One twin dyad shows

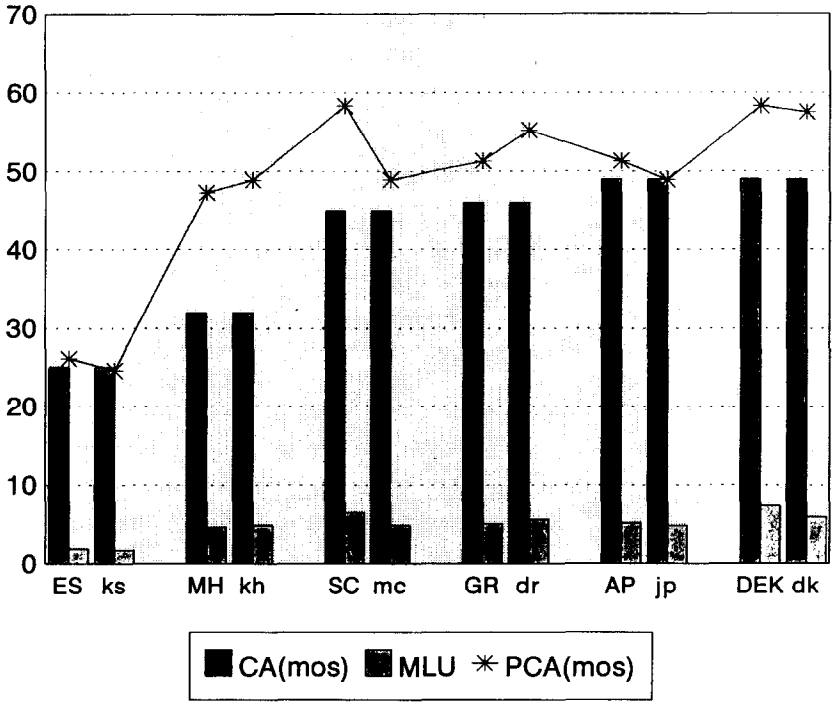

Figure 4. Twins' MLUs plotted against predicted chronological age (PCA). All twins scored at or above expected MLU values.

some dissociation of articulation and language abilities, with the OM-positive twin (AP) scoring more poorly than his brother on language measures, but somewhat better than him on articulation measures. Finally, the youngest twins, ES/KS, do not show any strong differences on the communicative measures employed in this study.

DISCUSSION

This study sought to compare the communicative development of children from similar home and day-care environments who differ in their historical exposure to OM. As a retrospective analysis of a relatively rare population (same-sex twins discordant for ROM), the sample size is quite small, and interpretations of the findings must therefore be viewed with extreme caution.

This study found, as have some previous investigations, that a history of ROM tends to predict depressed receptive and expressive vocabulary scores

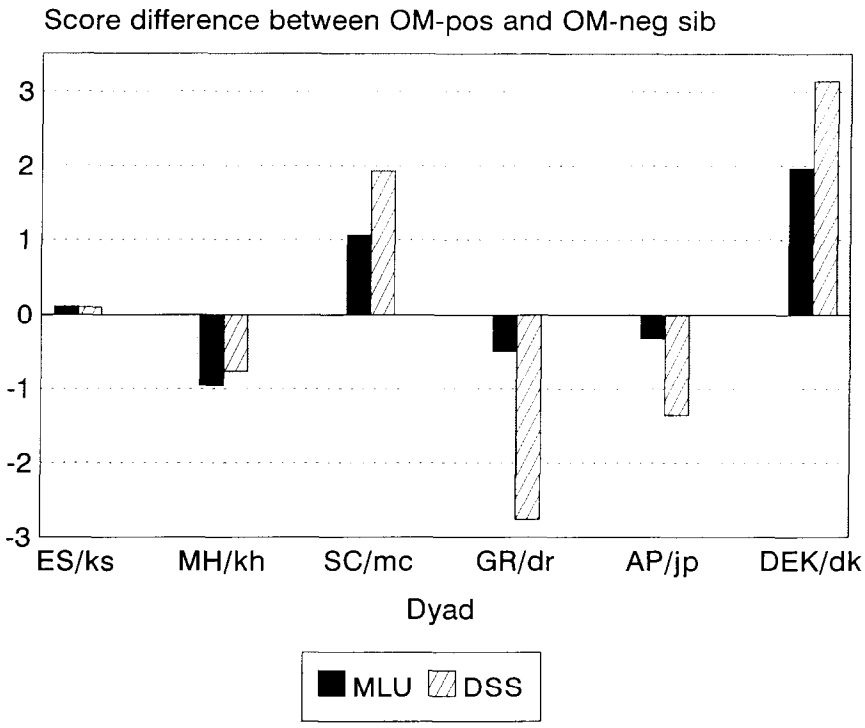

Figure 5. Score differences between twins on MLU and DSS analyses. (DSS values for **ES**/ks represent proportion of sample qualifying as sentences on DST analysis).

when ROM children are compared to peers without a history of otitis media (Wallace et al., 1988). However, while two twins with marked histories of recurrent otitis media demonstrated lowered communicative performance on the full set of articulation and language measures used in this study, a medical record of otitis media did not necessarily predict relative communicative disadvantage for a proportion of our subject population. Despite strong histories of ROM, two twins consistently outscored their OM-negative siblings on all measures employed. One OM twin did not perform measurably differently than his OM-negative twin. Finally, one OM-positive twin scored relatively lower on language measures than did his OM-negative brother, while the brother appeared to have weaker articulation development.

In such a small sample of children, the degree to which lexical abilities were compromised in OM children relative to phonological or syntactic performance is notable. There are reasons to suspect that the most substantial impacts of transient hearing impairment should be on phonological or

morphological ability. Indeed, stopping of fricatives has been cited as an example of OM-induced phonological performance (i.e., Paden, Novak and Beiter, 1987), while depressed hearing thresholds should adversely affect the child's ability to perceive and master English morphology, which is primarily conveyed by low salience final consonant clusters, and unstressed free morphemes, such as articles and auxiliaries.

The more consistent effects of OM on lexical functioning suggest that transient distortion of the input signal is more disruptive of the "incidental learning" component of language (vocabulary) than its rule-governed phonological or syntactic properties, and that these aspects of language are relatively more impervious to transient perterbations in the input, while lexical development suffers under such conditions. In these respects, the current findings are in accord with those of Hoff-Ginsberg (1993), who finds that stylistic variations in maternal input style to children are more likely to affect lexical than syntactic development.

Treatment of the ROM with PE tubes did not appear to affect communicative outcome; of the three twins who received a combination of medical and surgical intervention, one twin demonstrated speech and language delays, one twin outscored his sibling on the measures used in the study, and one twin displayed a mixed profile when viewed against his brother's communicative performance. Age of onset also did not appear to predict communicative outcome.

This research was of a retrospective nature, and there is need for prospective longitudinal study of carefully-controlled dyads to determine whether our results can be duplicated in a larger sample, or whether particular intermediate strategies of word approximation or syntactic formulation can be associated temporally and logically with periods of OM. Until then, it seems relatively unlikely that the most interesting cases of atypical communicative development which are used to formulate models of specific speech or language impairment are the result of temporary auditory attenuation of the input to the child, since such clinical cases primarily present with syntactic rather than lexical deficiencies (Leonard, 1989; Gopnik, 1990a,b; Oetting and Rice, 1993; Crago, Allen and Ningiuruvik, 1993).

Our results seem to support the notion that a number of factors may mediate the relationships between history of OM and communicative development. First, controlling for family and day care setting may minimize the statistical association between OM and speech and language development, as Friel-Patti, Finitzo and Chinn (1991) have suggested. Moreover, when viewed on an individual, rather than group basis, it is clear that children can survive a relatively strong history of ROM with good speech and language development. Given the pervasiveness of OM during child development, more research is needed to gauge its impact on communicative development.

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