A FEATURE ANALYSIS OF SPEECH ERRORS IN SUBGROUPS OF SPEECH DISORDERED CHILDREN

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ABSTRACT - A feature analysis was undertaken of the speech production errors of 99 pre-school children categorised into subgroups of speech disorder. Results indicated that type of errors could not be accounted for by the severity of the speech disorder, indicating the presence of qualitatively different types of speech disordered groups.

INTRODUCTION

The majority of speech disorders in children are currently of unknown aetiology. They are sometimes referred to as "functional" speech disorders to distinguish them from "organic" ones where the physical factors underlying the problem are evident. Are there subgroups amongst these speech disorders of unknown origin which reflect different types of underlying deficit, or do differences between these children only reflect differences in severity? An important consequence that would flow from the clear identification of qualitatively different types of speech disorders would be the development of more appropriate and effective intervention strategies based on the specific loci of deficit associated with each subgroup.

Dodd, Leahy, & Hambly (1989) and Dodd & McCormack (1995) report the identification of 4 subgroups of speech disordered children that is based on different patterns of speech production. Similar subgroups have also been described by Williams and Chiat (1993). The first is the largest group and consists of those children with normal speech patterns but are delayed in their acquisition (henceforth called Delayed). The second group consists of those children with unusual and non developmental speech patterns that are produced consistently (henceforth called Deviant Consistent). The third group have highly variable speech patterns, where the same word is pronounced differently on different occasions (henceforth called Deviant Inconsistent). The fourth group consists of children presenting with articulatory errors involving phonetic distortions. This articulatory group will not be discussed any further in this paper. There are a number of experimental results that indicate that the first three subgroups of children perform differently from each other on a number of non-speech production tasks. For example, Dodd & McCormack (1995) found that the Deviant Inconsistent children have poorer receptive vocabularies than either of the other 2 subgroups. Dodd et al. (1989) found that the Consistent group performed more poorly on tests of phonological knowledge than the other 2 groups (who had essentially normal metalinguistic abilities). Bradford & Dodd (1994) found that the Inconsistent children had poorer fine motor programming skills on non speech motor tasks involving sequential tasks, particularly under time constraints. What has not been closely examined is whether there are differences in the actual patterns of surface speech errors used by the different subgroups of speech disorder, and whether such differences can contribute to our understanding of the deficits underlying them.

As an initial investigation into such speech error patterns, the phonetic feature distance was calculated between the assumed target pronunciation of a speech segment in a word and how it was pronounced by the children in each subgroup. This was done utilising a confusion matrix procedure (Miller & Nicely, 1955). The investigators were interested to see if differences in the extent and type of feature errors provided by this metric would reveal qualitative differences between the 4 groups of children. In previous studies of feature distances between error and target speech sounds it has been found that the majority of errors in both acquired and developmental speech disorders fall between one and two features distance from the target (Stackhouse, 1992: Thoonen, Maassen, Gabreels, & Schreuder, 1994).

METHOD

Ninety nine subjects participated in this study (58 from Brisbane, Australia and 43 from Newcastle Upon Tyne, England). Although there were differences in speech error patterns between the 2 dialects, these inter-dialect differences will not be reported on in this paper. Table 1 displays the number, the age, the severity rating and the word variability score for the children in each group. Children were allocated to the different subgroups on the basis of the types of speech patterns they produced (whether they were developmentally normal, normal but delayed, or not normal), and the degree of pronunciation variability as measured on Dodd's 25 word test (Dodd,). A variability rating of 40% or more was classified as Deviant Inconsistent. Seven children diagnosed as having Developmental Verbal Dyspraxia were also included in this study. They were diagnosed on the basis of the criteria outlined in (Williams, Ingham, & Rosenthal). The data for these 7 children were kindly contributed to this study by Amanda Bradford. All children had normal hearing thresholds.

In order to rate severity of speech disorder for each child the percentage of phonemes in error (PPE) was calculated as this is a common measure of severity (Shriberg, 1994). This is calculated by dividing the number of phonemes produced incorrectly by the number of phonemes in the sample and multiplying by 100. The speech severity rating for each group could then be compared with the feature distance and variability measures.

group	number	age	speech variability	speech severity
control	24	4;3	13.8	8.6
delayed	25	4;2	29.4	26.2
consistent	23	4;6	33.0	37.9
inconsistent	28	4;3	57.8	38.9
dvd	7	6;1	63.9	61.7

Table 1. The number, average age, variability, and severity ratings for each speechdisordered group and a control group.

SPEECH SAMPLING AND SPEECH ERROR ANALYSIS

The Dodd 25 word test of variability involves naming the same word set from pictures on 3 different occasions. For this experiment, each child was audio taped, and their 75 word production (25 X 3) were transcribed phonetically by the 2 authors independently. Inter-transcriber reliability was 83 percent. The authors then agreed on a common transcription for each word where there had been a difference. For each transcribed segment the phonetic feature distance from the expected adult target segment was calculated. There are a number of different feature distance metrics available, reflecting different theories of feature organisation. The feature distance metric used by Blache (1979) was used in this experiment. For example in a word like "fish" /fɪʃ/ a child may have produced [tis]. A feature distance of two would be calculated for the first consonant and for one for the vowel and the second consonant respectively.

RESULTS

Severity and word variability

The initial correlation between the speech disorder severity score (based on percentage of phonemes in error) and the percentage of word variability was strong and significant ($r = 0.88$, $p < 0.05$). However, this result is attributable to including the control and DVD groups in this analysis. Both of these groups are at the extreme of the speech development continuum. The control group, expectably, had both low speech severity and low word variability scores, while the DVD group is defined by both the severity and

variability of its speech output. A measure of the relationship between severity and variability across the 3 less extreme groups of speech disorder provides a more useful picture of this relationship. The correlation between severity and variability when the control and DVD groups are excluded was small and insignificant (r = 0.58), indicating that for at least the delayed, consistent and inconsistent groups differences between them in their speech variability cannot be solely accounted for in terms of severity.

The average feature distance for place and manner errors in each group is displayed in table 2.

group	place	manner
control	1.4	0.9
delayed	2.2	1.2
consistent	2.3	1.8
inconsistent	5.2	4.8
dvd	2.3	2.2

Table 2: The average feature distance for place errors for each group.

Feature Distance: Place
The Inconsistent Deviant group with an average of 5.2 features distance had the largest value compared to the other groups for Place errors. Indeed, in a plane limited to a potential distance of 7, the Inconsistent group showed a marked distance from the target sound. This compares with the other groups where the results of average distances of between one and three features were consistent with those found in the literature.

Feature Distance: Manner
The Inconsistent Deviant group with an average of 4.8 features distance had the largest value compared to the other groups for Manner errors. The results are similar to those for Place errors, with the other groups averaging their Manner errors within one or two features of the target.

The high feature distance values for the Deviant Inconsistent group cannot be accounted for by the speech severity scores. The correlation between the speech severity scores and average feature distance of speech errors across all 5 groups was small and non significant (r = 0.25). This result is attributable to the similarity of feature distance scores across the 4 groups other than the Deviant Inconsistent group. Interestingly, while the Deviant Inconsistent and DVD groups had similar word variability scores, they had very different speech error patterns.

DISCUSSION

Are the differences in speech error type and variability between the groups in this study accounted for by differences in severity? The results of this analysis indicate that this is not so. For this to be so one would assume that both variability of word production and feature distance on errors would increase as the measure of severity increased. Note that while the Deviant Inconsistent group had the second highest percentage of word variability they were not rated as having the most severe speech disorder. The Developmental Verbal Dyspraxia group had the most phonemes in error. Both the Consistent and the Inconsistent groups had similar severity scores. The results for the number of features in error also indicate that they cannot be explained in solely in terms of degree of severity. Again, the Deviant Inconsistent group, although having a lower severity rating than the Developmental Verbal Dyspraxia group, and a similar severity score to the Consistent group, had a markedly higher feature distance than any other group. Previous studies of feature distance between target sounds and speech errors have found that they average between one and two features. The Deviant Inconsistent group display a markedly higher pattern than that, higher even than that reported for DVD in the literature or in this study. This study also indicates that while speech variability may be a characteristic shared by both the Deviant

Inconsistent and Developmental Verbal Dyspraxia groups, the patterns of their actual speech errors are very different. The Deviant Inconsistents make speech errors that are substantially further from the target sounds than the children with DVD.

This is only a preliminary study of the surface pattern errors of speech disordered children. The particular patterns of manner and place errors associated with different subgroups have not been explored in any detail as yet. There are some comments we with to make nevertheless. There are advantages and disadvantages to examining the patterns of surface speech errors using a feature distance method on each speech segment. The advantage is that such a method is quantifiable and can be used when exploring patterns in large numbers of children. The disadvantage is that it has no way of capturing speech changes from target forms that reflect modifications to articulatory gestures that have consequences for the whole word. Certainly for the Deviant Inconsistent group the modifications away from the target form were often reflected in the whole word. For example, one subject from the Deviant Inconsistent group pronounced "shark" the first time as [tjup], the second time as [sjet], and the third time as [ʃak]. This patten indicates an improvement in pronunciation with each repetition (in as much as it is getting closer to the targeted adult form), but it also indicates modifications to the output that reflect overlapping articulatory gestures (for example the raising and rounding of the vowel in the first production).

While some form of nonlinear or prosodic analysis might descriptively capture aspects of these gestural alterations, there appears to be no way of quantifying such representations to allow statistical exploration of large amounts of data. The future direction of this study will necessarily involve a combination of close phonetic descriptions of whole word patterns found in individual subjects, both perceptual and acoustic, and quantifiable analyses of large numbers of subjects that needs must reduce the data in some ways, hopefully not in so clumsy a way as to obscure the reality behind the numbers.

What is evident from this study is that severity as such (as measured by the percentage of phonemes in error) cannot account for either the degree of word variability or the extent of feature distance between actual productions and their target sounds evidenced in these subgroups of speech disordered children. Differences between subgroups most likely reflect differences in the loci of deficit.

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