

A COMPARISON OF THE VERBAL TRANSFORMATION EFFECT
IN NORMAL AND LEARNING DISABLED CHILDREN

BY

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THESIS

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TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
INTRODUCTION AND RATIONALE	1
Cognitive Factors	3
Neurophysiological Implications	5
Phonetic Considerations	5
Perceptual Factors	7
Learning Disorders	9
Neurological Aspects of Learning Disabilities	11
Auditory Processing Disorders	15
STATEMENT OF THE PROBLEM	16
METHODOLOGY	17
Subjects	17
Materials	17
Procedure	18
Statistical Treatment	18
RESULTS	20
DISCUSSION	25
Physiological Aspects	26
Classroom Management	28
Implications for Further Research	28
SUMMARY AND CONCLUSION	29
APPENDIX A. Number of Transformations and Different Words Per Subject	31
APPENDIX B. Directions Given to All Subjects	33
REFERENCES	34

EXTRA BOOK PART

LIST OF TABLES

TABLE		Page
1	Analysis of Variance of Verbal Transformations in Normals and Learning Disabled Groups to Three Test Words	20
2	Incidence of Verbal Transformations According to Test Group and Chronological Age	21
3	An Analysis of the Number of Different Words Verbalized by Normal and Learning Disabled Groups to each of Three Test Words	22

Introduction and Rationale

Locke (1894) set down a principle for perception in which continued stimulation with an unchanging pattern will lead to illusory changes, or under some conditions to perceptual fading and disappearance. This principle applies to auditory stimuli as well as to visual stimuli (Warren and Warren, 1966). If a person repeats a word over and over, he will generally experience a lapse of meaning called semantic or verbal satiation. When a person repeats a word aloud such as "ace" without pausing, the stimulus should be acoustically equivalent to "say" repeated.

Warren and Gregory (1958) concluded in their preliminary studies that passive listening to repeated words produces both phonetic and semantic lability whereas repeating words to one's self produces only semantic effects without illusory change to other phonemes. Warren (1961a) termed his auditory illusion, based on listening to recorded repetition, "the verbal transformation effect". The "verbal transformation effect" is a means of studying factors underlying perceptual organization of speech sounds (Warren, 1971). It is suggested that verbal transformations reflect skilled reorganizational mechanisms employed during connected discourse as an aid to comprehension (Warren, 1968).

Verbal transformations are illusory effects which occur while one

is listening to recorded repetitions of clearly pronounced single words (Warren, 1966a). Warren presented single utterances (words and non-sense syllables) two times per second for a period of three minutes. Subjects were instructed to call out the word they heard initially, and then to call out each change as it occurred. Warren (1966a) concluded from these studies that verbal transformations occur with all syllables and words, that they usually involve considerable distortion of clear auditory stimuli, that they vary greatly with individuals, and that they usually invoke more than four different responses.

Numerous researchers (Locke, 1894; Bryan and Harter, 1897; Lashley, 1951; Brain, 1962; Taylor and Henning, 1963; Feder and Bever, 1965; Fay, 1966; Fenelon and Blyden, 1968; Huey, 1968; Warren, Obusek, Farmer and Warren, 1969; Green, 1971; Obusek, 1971; Warren and Warren, 1971; Harper, 1972; Naiser, 1972; Warren, 1972a; Warren, 1972b; Wilcox, Neisser and Roberts, 1972; Warren and Obusek, 1972; Obusek and Warren, 1973a; Warren and Ackroff, 1974) have investigated the relationships between verbal transformations and cognitive factors, neurophysiological factors (Bryan and Harter, 1899; Brain, 1962; Paul, 1964; Feder and Bever, 1965; Warren and Warren, 1966; Savin and Bever, 1970; Obusek, 1971; Harper, 1972; Naiser, 1972; Warren and Obusek, 1972; Obusek and Warren, 1973a; Warren and Ackroff, 1974), phonetics (Miller and Kicklizer, 1950; Warren, 1961a; Evans and Kitson, 1967; Evans, Longdon, Newan, and Pay, 1967;

Chase, 1971; Clegg, 1971; Lass and Golden, 1971; Warren, 1972b; Warren, 1972c; Lass and Gasperini, 1973; Lass, West, and Taft, 1973; Obusek and Warren, 1973b; Warren, 1973a; Warren 1973b; Goldenstein and Lacher, 1974; Warren, 1974a), and speech perception (Broadbent, 1958; Warren and Gregory, 1958; Hirsh, 1959; Ladefoged, 1959; Ladefoged and Broadbent, 1960; Axelrod and Thompson, 1962; Christovich, 1962; Norman, Taylor, and Henning, 1963; Amster, 1964; Barnett, 1964; Garrett, 1965; Natsoulas, 1965; Garrett, Bever, and Fodor, 1966; Warren and Warren, 1966; Evans and Wilson, 1968; Bever, Lackner, and Kirk, 1969; Warren, Obusek, Farmer, and Warren, 1969; Warren and Warren, 1970; Warren and Obusek, 1971; Ben-Zeev, 1972; Chapin, Smith, and Abrahamson, 1972; Tekiele and Lass, 1972; Warren, Obusek, and Ackroff, 1972; Berlin, Lower-Bell, Cullen, and Thompson, 1973; Lass, Silvis, and Seattle, 1974; Warren, 1974b; Warren and Sherman, 1974).

Cognitive Factors

Miller (1962) maintains that the repeated verbal stimuli used in verbal transformation research is quite different from the presentation of stimuli found in normal speech. Hence, drawing general conclusions regarding verbal transformations and perceptual or cognitive organization under these special conditions is risky. Miller suggested that the verbal transformation effect will at least evidence some of the complex organizational mechanisms which

underlie speech perception and cognition.

Warren (1970) explored the effects of "identification" or "reaction" time in verbal transformations on perceptual or cognitive synthesis of speech. He maintained that the comparison of identification times for targets within speech can be used to elucidate the temporal course of speech perception and the units employed in perceptual processing. It appears that synthesis of speech into syllables must precede analysis into the component items. In this study he concluded that 1) detection of phonemes probably does not involve access to an echo-box short-term for search directed towards the trace of speech sounds corresponding to the target phoneme, 2) it does not correspond to a teasing apart of joined features so that the sensory input corresponding to these components can be identified.

Inversely, Warren and Obusek (1971) studied cognitive and perceptual factors in regard to "phonetic restorations" which is the omission of speech sounds in context. Warren and Obusek proposed that phonemic restorations offer promise as a method for investigation of the effect of verbal context upon perception and for probing the mechanisms used for temporal integration of speech. Their research indicated that phonemic restorations seem to involve skilled storage of auditory information, with final perceptual synthesis dependent upon prior and subsequent context.

Neurophysiological Implications

There have been only a few studies regarding the neuro-physiological implications of verbal transformation. Paul (1964) studied levels of cortical inhibition and illusory changes of distinct speech upon repetition. Perl (1970) studied verbal transformation effects and their application to cerebral dominance studies. It was predicted that right-ear presentation of a word stimulus would produce more reported change than left-ear presentation, and vice-versa for a tone tape. It was found that the two types of stimuli used in this experiment, words and tones, seem to interact differently with the two hemispheres. Presumably, the parameters of the effect are different for words and tones. Perl relates ear effects in dichotic listening to the length of the perceived stimuli. He suggests that verbal material presented to the left ear passes to the right hemisphere before being sent back across the commissures to the left hemisphere, whereas verbal material from the right ear only has to cross once to reach the left temporal cortex.

Phonetic Considerations

In the first detailed phonetic analysis of the verbal transformation effect, Barnett (1964) concluded that the articulation positions of both vowels and consonants were relatively labile and subject to frequent illusory changes.

Clegg (1971), using 18 separate repeating syllables followed by the vowel /i/ concluded that the syllables share the features of voicing, nasality and friction, but not of duration and place of articulation. It was found that the smallest organizational groupings seemed to be meaningful words for the aged, English phoneme sequences for young adults, and individual phonemes for children. This study suggested that verbal transformations reflect skilled reorganizational mechanisms employed during connected conversational speech as an aid to comprehension. More specifically, Warren (1968) noted that from ages six to ten, nonsense words are frequently reported having speech sound sequences not found in English; such as the initial /sr/ blend. Young adults (18 to 25) however, seem to organize in terms of phoneme clusters as perceptual units. These young adults report nonsense words, but cluster phonemes according to the rules of English. Adults over 60 years of age generally imply meaningful English words in their verbal transformations. Warren (1968) found that the number of phonemic changes decreased with increasing age and concluded that perceptual reorganization involved finer and finer distinction with advancing age.

Perceptual Factors

Other research in verbal transformations and age groups indicate that this illusion is based upon mechanisms employed for comprehension of speech. Warren and Warren (1966) showed that virtually no illusory changes were experienced at the age of five. By the age of six, almost half of the subjects heard illusory changes at a rate consistent with older children. At eight, all subjects heard the illusory changes. The average number of verbal transformations for all subjects was 34 during the three minute presentation.

Unlike the phonemic aspects of verbal transformations, individuals aged 18 to 25 reported identical average changes (31) to the 8 to 10 year old group. The 62 to 86 year old group was found to have far fewer, less than six such changes (Warren, 1961). Warren observed that the effects of aging on verbal transformation suggests that: (1) this illusion reflects reorganizational processes normally leading to the correction of errors in speech perception; and (2) the age differences observed for verbal transformations mirror changes in processing strategies over our life span in keeping with changes in functional capacity.

Brain (1962) points out that "meaning of a word which appears earlier in a sentence may depend upon the words which follow it." Chistovich (1962) noted in her studies that it is not only meaning that depends on context but that subjects who attempted to

repeat speech as quickly as possible manifested many errors in phonemes. She maintained that these errors reflect the temporal course of speech identification.

Warren suggested that these illusory changes reflect reorganizations which occur normally when part of a continued message is not confirmed by context. With repeated words there can be no stabilizing grammatical and semantic environment provided by surrounding words (Warren, 1970). Hence, the repeated word is subject to successive reorganizations. Warren (1966b) states that these skilled reorganizational processes could not appear until language skills had attained a certain level in children. The author indicated that the normal child generally achieves this level by the age of six or seven.

When studying the inverse of verbal transformation, phonemic restoration, it is easier to understand why this illusion, verbal transformation, takes place. In phonemic restoration, the context is clear, but a portion of the verbal stimulus is absent. In these studies a portion of a clear statement is replaced by an extraneous sound. It appears in these studies, that the delay in perceptual organization accompanying phonemic restoration causes the earlier portion of the sentence to appear as simultaneous with the extraneous sound. In essence, closure is performed automatically. Warren and Obusek (1971) discovered that if the extraneous sounds replacing the missing phoneme are eliminated, phonemic restorations are

inhibited. Here, the authors maintain that the processes underlying verbal transformations and phonemic restorations are related and supplementary. Verbal transformations seem to represent a mechanism employed normally for correcting errors in initial perceptual organization and for solving ambiguities.

Phonemic restorations, verbal transformations, and much of verbal and non-verbal auditory perception, require the ability to distinguish between different temporal arrangements of the same sounds (Warren, 1968).

Learning Disorders

Tarnopol (1971) maintains that learning disabilities constitute the most pervasive medical problem of children in the United States. Depending upon how learning disabilities are defined, it appears that this difficulty affects between 5 to 20 percent of the nonretarded child population. Usually children with learning disabilities appear normal until they enter school.

Research indicates that learning disabilities appear to be associated with minimal brain dysfunction (Tarnopol, 1971). Compared with the blind, deaf, cerebral palsied, severely emotionally disturbed, and mentally retarded, the nature of these dysfunctions in learning disabilities tends to be subtle. Overall, the term learning disabilities is used to distinguish the problems of those children who are not mentally retarded but who have difficulty

learning due to mild central nervous system dysfunctions.

Terminology and the identification of these children was the concern of the Task Force Dysfunction in children. This committee was composed of nine physicians, two psychologist-educators, and an agency executive. The results were published by the National Institute of Neurological Diseases and Blindness (now the National Institute of Neurological Disease and Stroke). Thirty-seven different terms had been found which designated this condition, including dyslexia, perceptual deficit, hyperkinetic behavior syndrome, organic brain damage, minimal cerebral palsy, and learning disabilities (Clements, 1966). From this array, the Task Force selected the term minimal brain dysfunction and issued the following statement:

"1. Brain dysfunction can manifest itself in varying degrees of severity and can involve any or all of the more specified areas, e.g., motor, sensory, or intellectual. This dysfunction can compromise the affected child in learning and behavior.

2. The term minimal brain dysfunction will be reserved for the child whose symptomology appears in one or more of the specific areas of brain function, but in mild, or sub-clinical form, without reducing overall intellectual functioning to the subnormal ranges. (Note: The evaluation of the intellectual functioning of the "culturally disadvantaged" child, though perhaps related, represents an equally complex, but different problem." (Tarnopol, 1971).

Unfortunately the problem of terminology has not been settled. Physicians tend to prefer a term such as minimal brain dysfunction, which points to the medical nature of the problem. Educators tend

to prefer a term such as learning disability, educational handicap, or perceptual disorder, which indicates that the problem is educational in nature. Parents, on the other hand often decry terms which include such words as brain, neurological, cerebral, or even handicap or dysfunction. They tend to prefer neutral terms such as learning problem (Tarnopol, 1971).

Neurological Aspects of Learning Disabilities

In the past it was assumed that a child would learn adequately if he had adequate hearing and vision and all of his mental capacities. But unlike the gross functional disabilities of brain-injured adults, the neurological learning disabilities in children are not necessarily the result of brain injury; some may be genetic, many are the result of just an "imperfection of nature", some are due, perhaps, to a maturation delay; and some no doubt may be the result of actual brain injury (Calvachini and Trout, 1971).

Dysfunctions in the brain causing learning disabilities are not necessarily due to damage yet may be developmental or hereditary in nature (Myklebust and Johnson, 1962). For educational purposes, designations of these damages seem unweildy as it is easier to interpret them as behavioral manifestations instead of to the degree of involvement in the brain. Johnson and Myklebust (1967) maintain that initially these manifestations are most often behavioral, not neurological and that the more observable symptoms

are psychological in nature.

In assessing the criteria for learning disabilities as different from other handicapped children, it is assumed that those children having a psychoneurological learning disability have, as a group, adequate motor ability, average to high intelligence, adequate hearing and vision, and adequate emotional adjustment together with the deficiency in learning (Johnson and Myklebust, 1967); however, specifics remain to be clarified. For instance, a child with learning disabilities might also have minor motor disabilities coupled with a degree of emotional disturbance.

The deficit in learning must also be qualified and quantified. The most commonly recognized deficits in learning are those that pertain to academic success. The deficiencies in ability to comprehend the spoken word, to read, to write, and to do arithmetic have, therefore, received the most attention. In addition to these forms of verbal learning there are also nonverbal forms of learning such as social perception (Johnson and Myklebust, 1967).

Several indices of the extent of the efficiency have been used with varying degrees of success. Johnson and Myklebust (1967) assert that the common index has been whether the child is one year or more below the level of expectancy. It must be remembered that for the majority of children the mental and chronological ages are essentially equivalent. Those below 90 IQ are usually excluded, however, some children with learning

disabilities are far above average in intelligence any may not fall below the level of expectancy when mental age is used as an indication of the learning level that should be attained. Therefore, Johnson and Myklebust (1967) state that the most satisfactory ratio, the most accurate manifestation of relationships between attainment and level of learning is expected, is obtained when achievement is related to mental age, termed the Learning Quotient, (IQ).

The deficit in learning can either be verbal or nonverbal in nature. Because disabilities predominantly verbal in nature are more commonly observed and because measures of these functions are more firmly established, they are considered first and in greater detail. The three primary areas in which these functions are observed are through the input and output processes involving intergration (Johnson and Myklebust, 1967).

The input system collects and transmits environmental information, both external and internal, to the integrative system. Of the five senses which collect environmental information, three are of prime importance in learning: vision, hearing, and somesthesia, the cutaneous and proprioceptive sensation. The output system is responsible for observable behavior, that is, muscle movement and the functioning of the autonomic nervous system. The output system is responsive to the integrative and input systems. Feedback through the three primary sensory modalities give the integrative system control over its end product. These relationships

are fundamental to learning. The presumption is that learning is systematic and sequential and that the order of events is for output to follow, not to precede input. Johnson and Myklebust (1967) maintain that this principle of learning in terms of input and output is stated primarily in terms of initial learning processes because, after a level of competence has been attained, words may be learned through usage.

Another consequential manner in which learning disabilities can be considered is by the sensory modalities through which a given type of learning occurs and through which the learning processes might be deficient.

The integrative system is the most complex and exists at all levels of the central nervous system, including the spinal cord, brainstem, and the cerebral hemispheres. The cerebral cortex is the most complex level of the integrative system and the site of higher cortical functions such as thought processes. The integrative system deals with recognition, selection, integration, storage, and use of information. It is responsible for perception, cognition, memory, intellect, formulation of motor activity, and awareness (Johnson and Myklebust, 1967).

A number of investigators have reviewed the neurophysiological correlates of learning. Galambos and Morgan (1960) have summarized the data and point out that before conditioning, what is to become the conditioned stimulus causes a variable evoked response in afferent

sensory tracts and also in limbic structures. These responses, like their cortical counterparts, become larger, more complex, and more stable in learning. The new cortical activity is matched by novel events in limbic and reticular structures that are all probably similar in kind. Thus, limbic, reticular and cortical structures are all involved in learning.

Auditory Processing Disorders

In recognizing auditory perceptual disorders, a multitude of factors must be considered; figure-ground segregation, auditory short-term storage, reversible figures such as figure-ground reversal and changes in orientation, perceptual changes such as pitch, intensity, duration, and complex tones, loudness perception considering frequency, duration, and summation, tonal qualities such as timbre, volume and density, auditory patterns perception, auditory space perception such as sound localization (binaural intensity differences and binaural time differences) distance judgements of sounds and inversion of auditory space (Chapin, 1972). Friedlander (1970) states that auditory language disabilities are more widely distributed among children than are visual disabilities.

Statement of the Problem

Much research has been performed dealing with verbal transformation in normal children and adults and normative data has been established for these populations. No research in verbal transformation involving the learning disabled (LD) child has been reported. The LD child has been found to have disorders involving phonetic, cognitive, neuro-physiological, and perceptual problems. It would seem that more information regarding verbal transformations and the LD child may give more understanding of these children's behavioral problems, social relations, language development, and may have implications toward their general educational management.

The purpose of this study was to determine the verbal transformation abilities of LD children who manifested disabilities especially pertaining to auditory processing and language acquisition and ability. An attempt was made to determine differences in verbal transformations of normal and LD individuals and to consider how such differences, if any, may have implications for the overall management of this type of child.

Methodology

Subjects

Two groups of 10 male school children were used as subjects. All subjects had SRTs of no poorer than 25dB for each ear. The first group consisted of 10 children ranging in age from six to twelve who manifested auditory processing disorders but were not on any medication. The second group (control) consisted of normal six to twelve year old students who did not manifest any specific auditory processing problems. The students from the first group were selected from two schools specializing in the education of learning disabled children.

Materials

A female speaker recorded three words of varying length and complexity, one nonsense and two real words: tress, see, and seashore. Each word was then re-recorded approximately twice each second for three minutes. A 15 second leader tape was spliced on to the three recordings so as to allow lead times before presentations. All stimuli were presented while the subject was seated in a sound treated booth (IAC 1200). All stimulus materials were presented binaurally at 40dB sensation level (re. SRT).

Stimuli was played from the recorder through a diagnostic and clinical audiometer (Grayson-Stadler Model 1702-A).

Procedure

Each stimulus tape consisted of a recording of a single word repeated approximately twice a second for a period of three minutes. Each subject was required to call out the first word they heard to substantiate that they were in fact recognizing the one word being repeated on the tape. Then the subject was instructed to call out anything the voice seemed to be saying (Appendix B). Credit for a transformation was given when 1) the subject called out any word which differed from the original word and 2) when the subject called out the original word after having called out a different word immediately before. The subjects' responses were tape-recorded so that different verbal organizations and the exact number of transformations could be tabulated and stored for further analysis. A rest break of five minutes was given after each presentation.

Statistical Treatment

A two by three factorial analysis of variance was used to analyze the effects of group (LD and normal) and word (tress, sea and seashore) on two dependent measures. These were (1) the number of verbal transformations per stimulus and (2) the number of different words called out.

A table of means was used to compare the number of transformations verbalized as a whole between different age groups in both the LD and control groups.

Results

A two by three factorial analysis of variance was used to compute the number of transformations for each stimulus (Appendix A) of each subject in the learning disabled group as opposed to the number of transformations per stimulus of each subject in the control group. The analysis of variance is summarized in Table 1.

Table 1

Analysis of Variance of Verbal Transformations
in Normals and Learning Disabled Groups
to Three Test Words

Source of Variation	SS	df	MS	F
Between Subjects	2908	19	153.1	
A (groups)	1633	1	1633	23.1**
Subjects within groups	1275	18	70.8	
Within subjects	2102			
B (words)	235	2	117.5	1.20
A X B	98	2	49	.50
B X subjects within groups	1768	18	98.2	

**F₉₉ (1,18) = 8.29

The control group verbalized a significantly larger number of transformations than did the learning disabled group ($p < .01$). This supports the hypothesis that there would be a difference in the reported number of transformations between the normal and LD subjects.

The variance between the two groups according to chronological age is indicated in Table 2.

Table 2

Incidence of Verbal Transformations According to
Test Group and Chronological Age

	LD	Normal
6.0 - 8.6 years	.016	39 (for all three stimuli)
8.7 - 12.4 years	10.1	37.4

This table of means indicates that there is a substantial difference in the performance of verbalizing transformations for the two age groups as well as between the two subject groups. These results indicate that LD children do not start transforming, as a whole, until after the eight year-seven month age level. Warren and Warren (1966) indicated in their studies that all normal children transform by the age of eight.

The number of different words verbalized by each subject (Appendix A) was also noted and computed using a two by three factorial analysis as presented in Table 3.

Table 3

An Analysis of the Number of Different Words
Verbalized by Normal and L.D. Groups to
Each of Three Test Words

Source of Variation	SS	df	MS	F
Between subjects	286	19		
A (groups)	118	1	118	12.68**
Subjects within groups	168	18	9.3	
Within subjects	299			
B (words)	147	2	735	9.54**
A X B	12	2	6	.779
B X subjects within groups	140	1.8	7.7	

** $F_{99}(1,18) = 8.29$

The results of this analysis of variance indicated that there was a significant difference between the two groups. The normal subjects verbalized significantly more different words than did the LD group ($p < .01$). This further supports the hypothesis that there would be a difference in transformational performance between the

normal and LD groups.

As noted in Table 3, a significant F ratio was also obtained for the number of different words verbalized ($p < .01$). Evidently, the length and complexity of the stimulus word given does affect the performance of transforming. Whether the stimulus was "real" or "nonsense" appeared to have no significance in the ability to transform. The stimulus seashore produced the greatest number of different words verbalized. The nonsense word tress gave the second greatest number with the real word see giving the least number.

Outward behavior, other than transformations, was noted both through written description of the subject during testing and other verbal behavior was noted on tape recordings of each testing.

One of the most prevalent behaviors noted in five of the six LD children having dysnomia (word retrieval problems) as their major learning or language disability was that they continually repeated the stimulus in echo-like fashion rather than reporting changes they may have heard. When questioned after each stimulus presentation these children stated that the stimulus was difficult to listen to and that they were unable to verbalize any new word if they had heard one. The sixth dysnomic child, dropped from the study due to his lack of verbalization, remained silent throughout all three stimulus presentations, however, he did relate, after the experiment, that he did hear changes in the words.

Each of the above subjects repeated the stimulus in varying degrees of loudness, varying from loud continual repetition to barely audible whispering of the stimulus pattern. Two of these five dysnomic children did manage to call out a transformation for one of the three stimulus presentations (Appendix A). The five who had been echolalic during presentations were given one point credit in the category of number of different words called out. Of considerable interest was the fact that all LD children displayed rigid posture and several displayed body rocking and head-nodding during stimulus presentations.

Discussion

In reviewing the results of this experiment, it is evident that these children with auditory processing disorders displayed abnormal behavior regarding the application of verbal responses to a verbal receptive task. Further research is needed to ascertain whether these children experience a breakdown or retardation of development in the receptive and/or expressive processes in regard to verbal transformations.

Overall, the normal subjects displayed significantly more verbal transformations and more different words per stimulus than did the LD subjects. There was no significant difference noted in the number of verbal transformations or the number of words called out between children in the normal population in the age group of six years to eight years-six months as compared with those children aged eight years-seven months to twelve years. As seen in Table 2, the younger normal group averaged 39 transformations for all three stimuli as compared with 37.4 transformations in the older group. The younger group called out 14 different words throughout the experiment whereas the older group called out 16.8 different words. This indicated that age is not as an important factor in verbal transformation ability as is normal cognitive ability.

In the LD group, the older subjects averaged 10 transformations for all three stimuli compared with .016 transformations for all three stimuli in the younger group. There was also a difference found in the number of words called out throughout the duration of the test between the two LD groups. The older group called out 10.1 words whereas the younger group reported only two different words. Warren and Warren (1966) noted that all normal children verbalize transformations by the age of eight years. In the LD group, however, transformations were not uniformly noted until past the eight year-six month level. This could indicate a delay in processing growth and development or perhaps that the child is outgrowing his deficit or that he is being effectively trained. Any projection should be substantiated by further research.

Physiological Aspects

As a whole, auditory processing disorders refer to a group of diverse problems in which the auditory system is incapable of providing the child with acoustic information in a normal manner to the detriment of his speech, language, and cognitive development. The auditory system is viewed as being composed of the neuro-anatomical pathways extending from the end organ of hearing (cochlea) to the auditory cortex (temporal lobe), and in particular, Wernicke's area at the temporal cortex. Disruptions in this system may result

in a variety of auditory disorders, including reduced hearing acuity, phonemic discrimination difficulties, disruptions of the temporal sequencing of speech messages, and imperfect comprehension of spoken language related to disturbances in the auditory association areas of the language-dominant hemisphere (Clements, 1966). Since all of the LD subjects chosen for this experiment displayed auditory association difficulties resulting in language deficiencies, we might assume that the basis of their problems lay in the language dominant hemisphere. This, however, should be tested further in each child.

In recognizing the child's auditory learning or language problem we must also test to ascertain whether the disorder is one of auditory receptive language ability, including auditory comprehension, auditory memory span, receptive aphasia, sensory aphasia, or auditory verbal agnosia, or one of expressive language ability, including reauditorization difficulties, auditory-motor integration problems or formulation and syntax difficulties. We can justify through extensive testing that each of the LD subjects manifest many of these problems. Dysnomia was just one most often noted.

Verbal transformations may be a key to pinpointing the degree of verbal flexibility in each child and may be of great service as a screening tool in locating auditory processing or language

disordered children in a school or community population.

Classroom Management

Classroom management of the LD child has been studied for years. The results of this study indicate that verbal transformations may be employed as a diagnostic tool for the differential diagnosis between LD and normal children, and may indicate a basis for locating dysnomia or other specific auditory processing disordered children. It may also lend itself to indicating a new approach for teaching verbal flexibility to this type of child.

Implications for Further Research

The development of a neurophysiological model to explain the results obtained in this investigation would be a primary follow-up of this research. Phonemic restoration in learning disabled individuals, as alluded to earlier, would certainly warrant study. Further research should also test the use of verbal transformations as a screening tool to diagnose LD children and as a device to ascertain whether children who manifest specific auditory processing and/or language disorders are ready to return to a normal classroom situation following remediation.

