Developmental Language Disorders: Part I-Definition

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Preface

This article is an excerpt from a longer document entitled "Interagency Committee on Learning Disabilities Report to the U.S. Congress: Developmental Language Disorders" written by Dr. Paula Tallal for the Interagency Committee on Learning Disabilities. This committee was mandated by the U.S. government's Health Research Extension Act of 1985 in order to review and assess the Federal research priorities and findings regarding learning disabilities.

This endeavor was to be preceded by the development of a consensus on the definition of learning disabilities, with inclusionary and exclusionary criteria. The ICLD sought the input of several experts in fulfilling its task. Dr. Tallal was invited to write the report on developmental language disorders, one of the five areas that comprised the ICLD report. A summary of Dr. Tallal's report and all the other reports included in the complete document is entitled, "Learning Disabilities: A Report to the U.S. Congress," is available free of charge to individuals from the National Institute of Child Health and Human Development, Office of Research Reporting, P.O. Box 29111, Washington DC 20040, U.S.A.

Exclusionary Criteria

Language is one of the most complex of all human functions. Normal language development requires the integration of sensory, attention, perceptual, cognitive, motor, and linguistic functions. When one or more of these functions fails to develop normally, language development may be delayed or disordered as a result. Consequently, global mental retardation, hearing impairment, autism, paralysis, or malformation of the vocal apparatus (as in cleft palate), emotional disturbance, frank neurological dysfunction (such as seizure disorder or brain lesions) are conditions which commonly predispose a child to fail to develop normal language at or near the expected age. Language disorders which arise in the presence of one or more of these predisposing peripheral or central impairments are considered to be resulting symptoms of the more pervasive disorder, rather than the primary disorder itself. For example, children with significant hearing loss often have resulting language deficiencies. However, they are not considered to be primarily language impaired. Similarly, language dysfunction can also result from acquired postnatal brain injuries to the areas of the brain which subserve language in the adult. Such language dysfunction is referred to as "acquired aphasia." Although children with language disorders that are secondary to other primary disorders may have many of the same associated characteristics as children with primary or specific developmental language disorders, they will not be the focus of this report.

There are children with seriously compromised language development the cause of which cannot be attributed to any of the above mentioned common causes of language disorders. These children appear to be developing normally in all areas except for language. Early descriptions of these specifically language impaired (LI) children focused on their observed similarity to adult aphasics. They were defined in terms of presumed underlying brain dysfunction or etiology, as opposed to linguistic dysfunction (Myklebust, 1954; McGinnis, 1963; de Ajuriaguerra et al, 1976).

Benton (1964) was the first to suggest that there is a distinct clinical syndrome, which he termed developmental aphasia, that is characterized by a child who shows a relatively specific failure of normal language functions in the absence of those factors which often provide the general setting in which failure of language usually is observed: deafness, mental deficiency, motor disability, or sever personality disorder. The failure can manifest itself either as a disability in expressive language only, with near normal receptive language, or as a disability in both receptive and expressive language. Benton further noted that the interrelationship between language disability and articulation disorder is inconsistent. That is, some developmentally aphasic children also demonstrate impaired development of speech articulation, whereas others do not.

Though developed almost two decades later, the American Psychiatric Association nomenclature (DSM-III, 1981) unfortunately adds very little additional information to the definition of developmental language disorders originally proposed by Benton (1964). Like Benton, the DSM-III divides developmental language disorders into two basic types: The *expressive* type is characterized by a failure to develop vocal expression of language despite relatively intact comprehension of language; the *receptive* type is characterized by a failure to develop both comprehension and vocal expression of language. Developmental *articulation* disorder is listed as a separate diagnostic category, distinct from developmental language disorders. An articulation disorder is characterized by a failure to develop consistent articulations of the sounds of speech. Although listed as a distinct diagnostic category in DSM-III, research has demonstrated that the interrelationship between phonological development (the development of the perception and production of speech sounds) and language development is complex. It is now widely accepted that there are many LI children who have concommitant speech articulation disorders and there also are LI children who exhibit normal articulation. Conversely, there are children with disordered articulation in the absence of developmental language delay (Aram and Kamhi, 1982; Wolfus et al, 1980).

Even a cursory look at these definitions of specific developmental language disorders demonstrates clearly that these are definitions by exclusion. That is, children are defined as developmentally language impaired based on clinical tests that demonstrate those aspects of their development which are *not* responsible for their language problems. The definition, by default, implies that the disorder is specific to language, and is developmental or congenital rather than acquired.

Associated Characteristics (Inclusionary Criteria)

Although clinical definitions have tended to focus on exclusionary criteria, primarily for the purpose of differential diagnosis, research has focused on developing inclusionary criteria based on investigations which demonstrate profiles that *are* characteristic or associated with developmental language delay. Research in the field has focused on two main approaches: (1) investigating in more detail the receptive and expressive linguistic development of language impaired children (the psycholinguistic approach); and (2) investigating in these children perceptual, motor, and cognitive mechanisms that are presumed to be prerequisites for normal language development (the neuropsychological approach).

Linguistic Characteristics

Determining the patterns of language acquisition in LI children has been a major focus of research. The central questions to be answered are: (1) What is the nature of language acquisition in the LI child? and (2) Is language acquisition in the LI child merely delayed or is it deviant as well as delayed? To answer these questions, the grammars of LI children must be characterized with respect to the linguistic representations and grammatical principles embodied in each linguistic component (phonology, morphology, syntax, and semantics) and at different levels of grammar (e.g., D-structure, S-structure, logical form, phonetic form). In addition, to determine patterns of grammar acquisition in the LI child, analyses of the internal changes in their grammar at consecutive stages must be carried out. Only through such analyses can the nature of language acquisition be ascertained. Such analyses require knowledge of linguistic theory, however; for the most part, linguistic theory has not reformed the description of language disorders in children. Rather, what has largely been documented are many linguistic phenomena associated with the language development of LI children. Descriptions converge to build a picture whereby certain phenomena are characteristically associated with language learning in the LI child, and it is these that will be detailed below.

Phonology

In phonology, there are two main questions to be addressed: (1) whether LI children are using normal phonological principles in their acquisition; and (2) whether LI children are acquiring the language-particular facts of the target language (in this case, English). Most phonological studies of LI children have been concerned with the second question, and most of these deal with English-specific rules of allophony, phonemic distinctions, and syllable structure.

Numerous studies have examined the phonetic realization of segments and syllables in the speech of LI children (Compton, 1970; Ingram, 1976; Oller, 1973; Campbell and Shriberg, 1982; Shriberg et al, 1986). The consistent conclusion has been that LI children demonstrate, on the whole, nearly identical phonological processes as those found in the grammars of younger, normal children (syllable and segment simplification and assimilation as reflected by cluster reduction, final consonant deletion, substitution of one stop for another or of stops for spirants, etc.). However, these studies are in general actually concerned with the phonetic specification of segments or segment combinations and, as a result, indicate that the phonetic processes extant in the speech of LI children are normal. Unfortunately, they say little about their phonology, that is, for example, whether or not LI children are acquiring and making use of the actual phonological rules of adult English. Nonetheless, these studies suggest (albeit indirectly) that, in many instances, underlying phonological representations of individual lexical items are normal.

A few studies stand out as exceptions in that they address the first question raised above (Camarata and Gandour, 1984; Leonard, 1985; and to a lesser extent, Leonard and Leonard, 1985). In the Camarata and Gandour study, the authors are able to show how, by utilizing a rather straightforward phonological analysis (in this case, that of examining the distributional facts for the occurrence of certain phonetic segments) what looks like an aberrant and unprincipled system on the surface can be revealed to be the output of a normal phonological rule, one that just does not happen to hold for English. In this case, the important distinction between the acquisition of language-particular facts versus what is a possible phonological rule is made. In the Leonard and Leonard study, the importance of looking at even word-level phonetic context in capturing the rules a child may be using is demonstrated. Although the authors do not appear to appreciate the larger theoretical context into which their findings could be placed (i.e., as evidence in support of the theory of CV or skeletal phonology and evidence to indicate that LI children, like normal children, appear to know and make use of phonological tiers in their language acquisition) once again they are able to make generalizations about data which, without consideration of contextual phonetic information, could not have been observed. In addition, as with the Camarata and Gandour study, Leonard and Leonard are able to suggest a rule in the child's system which can be motivated phonetically (as is the case with almost all known phonological rules) suggesting that normal underlying phonological principles are at play, even when the language-particular facts have not been mastered. Leonard (1985) proposes a specific mechanism to account for how both LI and young, normal children arrive at distorted productions of target words. Although he does not offer an explanation for phonol-

ogical disorders themselves, he argues convincingly for strong similarities between LI and much younger normal children in both their surface and underlying lexical phonologies.

While the above data suggest a delay in the phonological acquisition of LI children, an additional and important finding emerging from studies of their phonological development is that early acquired forms persist, or coexist in free variation, with later acquired forms, over protracted periods of time (e.g., Lorentz, 1972; Edwards and Bernhardt, 1973; Salus and Salus, 1973; and to a lesser extent, Ingram, 1976). As the acquisition of new phonological forms presumably reflects changes in the grammar that should rule out the old forms, the coexistence of distinct and competing phonological representations is a phenomenon which potentially marks the phonological development of LI children as deviant. It suggests that LI children may be constructing grammars which tolerate a variance in representations which would be disallowed in the normal course of acquisition. Such grammars might then be the result of normal acquisition processes. Free variation of competing forms might, however, reflect specific production difficulties rather than differences in grammar per se, and only the analysis of a variety of phonological phenomena over successive stages in phonological development can help to decide between these possibilities. The situation remains an unexplored but potentially critical area to investigate further in addressing the delay versus deviance issue.

Morphology

There are perhaps three primary questions to be addressed in this area: (1) Do LI children know the principles underlying word formation and acquire normal word-formation rules? (2) Do LI children acquire the word-formation rules of English normally? and (3) Does inflectional and other nonlexical morphology bear the same relationship to syntax and phonology in the grammars of LI children as it does in the grammars of normally developing children?

There are few, if any, studies that address the first two questions directly. Most studies in this area have examined the acquisition of specific morphemes and not knowledge of word formation per se. It is striking, however, that no study reports the creation of impossible (in the sense of not allowed by human grammars) word forms by LI children. Moreover, no study reports the use of noun morphology with verbs or vice versa. While English is a less than ideal target language in this regard, given its paucity of bound morphology and the phonetic isomorphism of many of the relevant forms which exist, the data on acquisition of nonlexical morphology in LI children suggest that their grammars embody both normal general principles and correct language-particular rules for word formation. Their use of inflectional morphology also shows consistent and accurate syntactic classification of both roots and inflectional morphemes.

Some work has been done examining the interaction of morphology with phonology in LI children (Smit and Bernthal, 1983; and Camarata and Gandour, 1985). Predictably, there is a clear interplay between the phonetic abilities of LI children and the realization of many morphological inflections. However, there are no data to suggest that morphology and phonology interact in an abnormal way in this population.

Most studies pertaining to acquisition of morphology in LI children have concentrated on the acquisition of specific morphemes, the order in which they are acquired, and the relationship between occurrence of particular morphemes in the speech of LI children and "grammatical stage" as defined by measures of utterance length. Ingram (1972), Kessler (1975), Johnston and Schery (1976), and Steckol (1976), for example, studied the acquisition of a predefined set of inflectional and freestanding grammatical morphemes on which there are considerable normal acquisition data. They examined the order in which these morphemes were acquired and the stage (determined by MLU or mean number of words per sentence) at which they appeared. In each of these studies, LI children appeared to acquire these morphemes in approximately the same order as normal children, but neither their earliest occurrence nor the point of mastery co-occurred with the same developmental stage as was the case for normal children. Typically, LI children produced specific morphemes at earlier stages than normal children, but did not control them until later stages. A somewhat more enlightened study (Johnston and Kamhi, 1984) reveals that LI children differ from normals in that the LI children tend to produce constructions requiring the use of more grammatical morphology, but then omit more of these forms in obligatory environments.

These studies, then, suggest that with respect to order of acquisition of nonlexical forms, LI children evidence normal acquisition patterns, but that with respect to the relationship between morphological acquisition and syntactic "stage," LI children may exhibit deviance. Here, as before, informed linguistic analyses are called for. Length of an utterance tells us little about its internal syntactic structure. Although MLU or MMU have been widely used as indices of grammatical development, acquisition in languages that have considerably richer morphological systems than English demonstrate the inadequacy of such measures rather clearly (e.g., Hyams, 1983; Berman, 1981). Children learning a language with an elaborate morphology such as Hebrew, German, or Italian, for example, use inflectional morphemes even in single-word utterances, that is, utterances with the simplest syntactic structures possible. Johnston and Kamhi also point out the inadequacy of MLU as a measure even when considering only syntactical factors. What is needed, then, are studies of the relationship between the acquisition of actual syntactic structures and acquisition of morphology, on the order of those carried out on normal acquisition (e.g. Hyams, 1983, 1986; Klein, 1985). Such analyses will determine whether particular changes in morphology (e.g., acquisition of the finite/infinite clause dis-

tinction) are linked to acquisition of tense morphology. Only then will we have direct evidence as to whether the acquisition of morphology in LI children is normal or not.

Syntax

The central questions to be addressed here are: (1) Do LI children appear to construct grammars embodying universal syntactic principles? (2) Do LI children show normal acquisition patterns in the instantiation of these principles for English? and (3) Do LI children show normal patterns for acquiring English-specific syntactic phenomena?

Studies in this area rarely address these questions. For the most part, they consist of taxonomic-type investigations of the syntactic forms used by LI children. Menyuk (1964) and Leonard (1972) found that LI children used "normal" NP, AUX, and VP structures, as well as structures involving embedded clauses (complements and relatives). Morehead and Ingram (1973) found that LI children on the whole used particular syntactic categories and structures less frequently than normal age-matched peers, but with the same frequency as normals matched for MLU. Johnston and Kamhi (1984) found LI children typically to have acquisition difficulties with grammatical markers in general.

Very few studies in this area have been guided by syntactic theory. The few early exceptions undertook to perform early-version transformational grammar analyses on the speech of LI children, finding on the whole that LI children produced sentences that involved fewer distinct phrase structure and transformational rules than did normal peers (Morehead and Ingram, 1973; Menyuk, 1964; Lee, 1966). Researchers in this area have failed to utilize more current syntactic theory, however, and syntax perhaps more than any other component of the grammar has been underinvestigated.

Two findings that have emerged nonetheless are worth noting. Both of them are reported in Lee (1966). In this article, among other things, she considers the fact that LI children frequently produce ungrammatical utterances. First, Lee observes that in many cases, LI children produce ill-formed sentences that result from using semantically appropriate lexical items whose syntactic requirements lie outside their syntactic competence. For example, children may use verbs like "guess" or "think," which require a sentential complement (in most cases) before their grammars can generate sentential complements. This may be a phenomenon that occurs in normal acquisition, as well, but the extent to which such potentially problematic asynchronies exist in the grammars of LI children may be abnormal and may provide an important clue regarding the character of grammar building in this population. A second noteworthy observation made by Lee is that LI children produce ungrammatical utterances consisting of word strings that appear to lack any internal syntactic structure. This raises the disturbing possibility that in at least some instances, long past the earliest stages of "beginning to talk," LI children may be constructing utterances outside the framework of a grammar. Since the examples Lee presents do not appear to be social formulas or other typically automatic or "extragrammatical" utterances, this phenomenon could be a marker of clearly deviant language development.

As the distinction between children with preschool language impairments and those evidencing school-age developmental dyslexia may be at least partially artificial, one study of adult developmental dyslexics deserves mention here. Kean (1984) conducted a linguistic investigation into the syntactic abilities (judgement, interpretation, and processing) of adults who were dyslexic as children. She found that the adult dyslexics failed to make correct grammaticality judgements for sentences involving construal of pronouns and anaphors and, in addition, incorrectly interpreted sentences involving certain kinds of referential dependencies. In both cases, the sentences causing problems for the dyslexics involved the Binding principles, syntactic constraints governing the interpretation and dependency relations of the different classes of noun phrases: R-expressions (regular nouns), pronouns and anaphors (reflexives and reciprocals). What Kean found, therefore, was an anomaly or deficit in a specific aspect of syntactic knowledge. Although only a pilot study, her findings raise very specific questions concerning the syntactic abilities of this and other disordered populations. What is especially important about this work with dyslexic adults is that the generalizations concerning their performance could be made only through Binding Theory, part of current syntactic theory. Other generalizations concerning patterns in the performance of LI children also will be observable and characterizable only through a theory about the knowledge base in question.

Clearly, much more research on the syntax of LI children is called for. The essential questions in this area remain completely unanswered. For the most part, syntax in LI children has been taxonomized, not characterized. This is an unfortunate state of affairs, as an examination of the syntax of LI children may shed the clearest light on whether or not they have specifically linguistic deficits. However, there is no question that productive research in this area, work which can uncover important generalizations about the syntax of this population, will have to be informed and guided by linguistic theory. Only then can basic questions concerning the LI child's acquisition of even the most fundamental properties of human syntax be addressed. Some of these questions are currently being studied as part of the NINCDS-funded San Diego Longitudinal Study of the Outcomes of Early Language Disorders (Tallal and Curtiss, 1980-1988).

Semantics

The major questions to be addressed in the area of semantics are: (1) Do LI children acquire a normal lexicon, wherein words are learned, represented, and used in a normal manner? and (2) Do LI children learn to map propositional meanings onto linguistic structures in a normal fashion?

Work on semantics in general suffers from the absence of a coherent theory of semantics or semantic acquisition. There-

fore, the work on semantics in children with language disorders has proceeded in much the same fashion as equivalent work on normal language acquisition. Both of the above questions have been addressed, with a concentration on the acquisition of meaning relations between words and, more recently, acquisition of individual lexical items themselves.

Research into the acquisition of meaning relations in LI children has found that these children express the same range of thematic roles as do normal children. Freedman and Carpenter (1976), for example, found no differences between normal and LI children in the semantic roles they encoded in their utterances at the earliest stages of speech. Leonard et al (1976, 1978) also found no differences between LI children and age-matched normal peers in the range of semantic roles expressed, but did find differences in the frequencies with which specific roles were expressed when age-matched peers were used. LI children tended to use the earliest acquired semantic relations more frequently. These differences disappeared when language-matched peers were used for comparison.

It is difficult to know what to make of these findings. These studies examined only a relatively small set of possible semantic categories which may have left areas of difference unexplored. Moreover, the set considered may represent semantic primitives or primes, an unlearned, basic set of meaning relations. Evidence from Brown (1973), Bowerman (1973), Greenfield and Smith (1976), and many others studying the earliest stages of language production suggests that this may be the case, as even the youngest and least linguistically developed children in these studies express all of the semantic roles used in the above-mentioned studies on LI children. However, using a more extended set of semantic categories, including those of irrealism, intentionality, causative, obligation, and temporality, Curtiss and Tallal (1985) again found no differences between LI and language-matched normals on the range of categories expressed. Differences between groups also failed to show up when considering degree of unsemantic or semantically ill-formed propositions.

The expression of multipropositionality has, however, been shown to differentiate between at least some LI and language-matched children. Johnston and Kamhi (1984) found that LI children expressed fewer logical propositions per utterance, even while producing utterances which were comparable in length to those of MLU-matched normals. This resulted from the increased use by LI children of simple progressive aspect and greater use of motion verbs whose obligatory arguments can be expressed within a single proposition. In the Curtiss and Tallal study, in contrast, there was a significant difference only between a particular subgroup of LI children and both the other LI children and the age-matched normals, on the extent to which they could express multipropositionality.

Recent studies also have examined the nature of lexical acquisition (e.g., Leonard et al, 1982; Chapman et al, 1983; Schwartz and Leonard, 1985; Camarata and Schwartz, 1985). To date, these studies are consistent in their findings. LI children appear to acquire lexical items in a normal manner. What is especially intriguing is the possibility raised by the findings of Leonard et al (1982) and Chapman et al (1983) that LI children also may acquire vocabulary at the same rate as normal children. A mismatch between a normal rate of acquisition on the one hand, and areas of lexical impairment on the other, may give rise to some of the production abnormalities noted in the lexical acquisition patterns of LI children (e.g., the concommitant use of early, semantically overextended words alongside semantically more restricted synonyms). This kind of lexical variation, where more advanced or fully specified lexical entries coexist and are used alongside less fully specified entries to express the same meaning, whether or not they arise as a result of a normal rate of lexical acquisition combined with more delayed lexical development in other areas, once again raises the possibility of deviance in the grammar. This, as well as all other areas of semantic representation and use, clearly needs further investigation.

Pragmatics

Although not technically part of the grammatical system, a major rule system interfacing with grammatical knowledge is the pragmatic system, the rules governing the use of language in context. In examining the nature of pragmatic function in LI children, the question of whether or not these children are more globally communicatively impaired can be addressed. In addition, in language development and mature use, form and function interact in important ways. It is of specific interest, therefore, to determine if children impaired in the acquisition of linguistic form also are impaired in the social and communicative functions of language.

Questions to be asked in this area include: (1) Do LI children exhibit normal patterns of communication? and (2) Are LI children able to use their linguistic knowledge in the service of communication in a normal fashion, that is, do they adequately and appropriately map their linguistic knowledge onto the rules of social discourse?

This area of investigation has seen a considerable growth in research attention. Prior to the last decade, the pragmatic abilities of LI children had yet to be explored. In the last decade, however, a multitude of studies have been conducted on this general topic. The results to date are somewhat inconsistent.

One area that has been examined is conversational participation, that is, the ability to appreciate the reciprocal nature of conversation, and to adequately and appropriately play both speaker-initiator and listener-respondent. Bartak et al (1975) found that unlike autistic children, LI children were quite skilled in their conversational participation, both as initiators and as respondents. Stein (1976), Watson (1977), and Sheppard (1980), on the other hand, found LI children to show somewhat restricted conversational participation, relying more heavily than other children on back channel devices. These findings indicate a lower degree of responsiveness and assertiveness in

conversational interactions. Fey et al (1981), Jacobs (1981), Prelock et al (1981), Van Kleeck and Frankel (1981), Fey (1981), and Fey and Leonard (1984) support the early study by Bartak et al, finding that LI children do not exhibit deficits in conversational participation, especially when compared with children who are somewhat comparable linguistically. These latter studies reveal the importance of not confounding linguistic-pragmatic factors with factors such as age, cognitive maturity, personality, and so on. They also point to the importance of separating the ability to perform certain pragmatic acts from the linguistic means with which those acts are performed. A more restricted range of linguistic devices for performing conversational acts may be expected in children who have linguistic deficits. They do not, in themselves, however, indicate pragmatic deficits. Curtiss and Tallal's (1985) findings from the San Diego Longitudinal Study support this contention. They found that the range of pragmatic acts children display in a conversational dyad can be extensive and comparable across LI and language-matched normals. Complicating matters somewhat, however, they also found that the degree of conversational initiative LI children display may depend on their particular performance strengths and weaknesses. Different expressive-receptive performance profiles were associated with different degrees of conversational initiative, which, it appears, may be more related to linguistic facility in handling particular situational contexts or tasks than to linguistic maturity, per se. What is more, this study suggests that pragmatic performance may change quite dramatically over time.

A second area of pragmatic function which has been investigated is the ability to regulate discourse, that is, the ability to provide feedback regarding your partner's communicative effectiveness. Watson (1977) found that LI children request clarification less than normal children. In contrast, Fey (1981) and Griffin (1979) report that LI children request clarification as often and use the same types of devices to do so. Most studies in this area, however, (e.g., Stein, 1976; Hoar, 1977; Gale et al, 1981) report that LI children are less versatile in the means by which they request clarification, consistently relying on the already given structure of the interlocuter's utterance to do so. These latter findings again point out the difference between linguistic limitations and pragmatic ones.

A third area of pragmatics studied has been speech act range, i.e., the set of functions that utterances are intended to serve. In general, findings in this area mirror those found in other pragmatic areas studied. When linguistic abilities are not considered (e.g., Geller and Wollner, 1976), LI children may appear to be deficient compared to normal children. However, when linguistic and other potentially confounding factors are noted, no such deficits are found (e.g., Fey et al, 1978; Ball and Cross, 1981; Snyder, 1978; Curtiss and Tallal, 1985) although a more restricted set of linguistic means to express intention or function is again often noted.

Another pragmatic ability which, when investigated, has led to inconsistent results, is the ability to code switch, i.e., the ability to produce stylistic variations to suit the social situation. Fey and Leonard (1984) report that LI children failed to simplify their speech when talking to younger children. However, Shatz and Gelman (1973) and Sachs and Davin (1976) found that many young normal children also fail to make stylistic adjustments when talking to adults or babies. In contrast, Fey (1981), Fey et al (1981), and Messick and Newhoff (1979) found that LI children appropriately modify their speech to the age and status of their conversational partners.

The bulk of the evidence on pragmatic function seems to indicate that LI children are not globally, communicatively impaired. Specific task factors may give rise to the appearance of pragmatic deficits, but no pragmatic dysfunctions have consistently been demonstrated. As knowledge of pragmatic ability in the normal population increases, however, new areas to investigate are revealed. Therefore, it may yet be the case that LI children will be shown to have pragmatic deficits in addition to deficits in other areas already known to exist.

The studies of LI children detailed above reveal the important distinction between the mastery of rules of grammar on the one hand and the use or performance of this knowledge on the other. LI children differ from normal children and from each other in their ability to map their linguistic knowledge onto pragmatic acts. This distinction between linguistic knowledge and use is one that may be of major importance in characterizing the impairments that LI children display, as is made clear in considering the issue of linguistic subgroups.

Linguistic Subgroups

One finding that consistently arises in studies of LI children is that not all LI children perform similarly. Three subgroups are widely recognized, including: some LI children who comprehend significantly more than they produce (expressively impaired); some who speak remarkably well, given how poorly they perform on tests of comprehension (receptively impaired); and some who seem significantly impaired across the board, regardless of task or performance domain.

Although the three performance profiles referred to above define hallmark characteristics of LI children, key questions regarding the subgrouping of this population remain unanswered. For example, do LI children also fall into subgroups based upon nonlinguistic performance factors? (See Williams et al, 1980 for a review of this area.) Are the classical subgroupings of LI children meaningful linguistically, that is, are the performance characteristics peculiar to each of these subgroups generalizable along grammatical lines? Are performance strengths and weaknesses, which define subgroup membership, consistent over time, that is, are such subgroupings meaningful clinically?

Attempts to define subgroups along linguistic dimensions have recently been made (e.g., Aram and Nation, 1975; Wolfus et al, 1980). Such studies report a number of distinct patterns of linguistic abilities which distinguish among LI performance

characteristics. Some of the results of these studies, however, are in conflict with each other. For example, in the Wolfus et al study, semantic performance did not correlate significantly with phonological ability, whereas the two areas did correlate significantly in the Aram and Nation study. Other results, though not conflicting, are difficult to interpret. For example, in both studies, syntactic production did not correlate significantly with semantic ability, but semantic and syntactic ability did correlate when receptive syntax was the relevant measure. Furthermore, both studies defined subgroups by performance mode deficits, yet the specific constellation of linguistic abilities correlating with these subgroups differed substantially in the two studies.

As part of the San Diego Longitudinal Study, Tallal and Curtiss (1980-1988), these questions pertaining to subgroupings are being investigated. Data from the first two years of this study yield some surprising answers (Curtiss and Tallal, 1985). In this study, LI children were classified into four subgroups, based on their standardized test performance at the time they were selected into the study: (1) *receptively impaired*, those children whose expressive language age exceeded their receptive language age by a minimum of four months; (2) *expressively impaired*, those children whose receptive language age exceeded their expressive language age by at least six months, but was within one year of their CA; (3) *severely impaired*, those children whose expressive and receptive language ages were both more than one year below the CA; and (4) *mildly impaired*, those children whose expressive and receptive language ages placed the child more than one year below his/her CA only when averaged together. All of the groups were compared each year longitudinally on their ability to comprehend and produce several different clusters of linguistic structures, each of which shared a particular linguistic structure or principle. There were two noteworthy results. First, the pattern of performance across clusters was the same for all of the subgroups. Even more interesting, however, subgroup 2 (the expressively impaired group) outperformed subgroup 1 on every cluster, regardless of the structural linguistic parameters involved. The quantitatively, but not qualitatively, different result obtained suggests that the impairment (or set of impairments) of both groups may be somewhat task-dependent and may lie principally in an area other than linguistic knowledge, per se, since the linguistic signal has the same properties regardless of which performance channels it must pass through. A major difference between these two groups, then, may be that subgroup 2's performance is enhanced or at least unimpeded by certain parameters of structured tasks, whereas subgroup 1's performance is compromised in the same circumstances. Second analyses point to the same conclusion.

In a second set of analyses, Tallal and Curtiss performed detailed linguistic and conversational analyses of free speech data from 30 of the LI children and 30 language-matched normals. The 30 LI children represented 10 children from each of the first three subgroups. First, detailed pragmatic analysis was performed. The only significant difference found between subgroups was that in year 1 of the study, subgroup 1 (receptively impaired) showed significantly more conversational initiative than the other subgroups and the normal children. Aside from this difference, however, in the first two years of the study, the three subgroups did not differ significantly from each other, either in pattern or in level of communicative performance, across the numerous parameters evaluated. Secondly, in evaluating semantic performance, the use and appropriateness of 24 separate semantic roles or structures and semantic ability was examined. Despite the numerous opportunities for differences to be noted, only one significant difference between groups emerged. Subgroup 1 produced significantly more multipropositional utterances than subgroup 2. This was true in the first year (four-year-old) and second year (five-year-old) children in the study. Regarding syntactic performance, once again a rich variety of parameters were examined. At year 1 of the study, significant differences between subgroups were noted. Subgroup 2 used a significantly smaller range of syntactic structures than the other three groups, and subgroups 2 and 3 demonstrated significantly poorer control of syntactically complex structures and produced a significantly higher percentage of ungrammatical morphological and syntactic structures. By year 2 of the study, however, there were no longer significant differences between subgroups. Importantly, these results demonstrate that test performances which showed large expressive language differences between the different subgroups of four-year-old LI children did not translate into significant differences in syntactic, semantic, or communicative performance in spontaneous speech by age five. Moreover, even during the first year of the study, few differences between subgroups emerged, except in the area of syntax. These results again suggest that something other than knowledge of the linguistic system, per se, may be what is differentiating LI children so consistently into subgroups on the basis of standardized test performance. In support of this interpretation is the fact that production of specific linguistic structures was successful (well-formed) on one production task (sentence completion, for example), but unsuccessful (ill-formed or omitted) on another (spontaneous speech). Such differences appear to be related directly to the capacity to handle task-specific features, that is, to couple linguistic knowledge with particular linguistic requirements. Furthermore, although some children succeeded more often with sentence completion than on spontaneous speech, while others performed in the opposite pattern, children within the same subgroup generally appeared to perform similarly. These results are consistent with the hypotheses that the classical subgroupings of LI children relate to psycholinguistic and neuropsychological impairments in this population, rather than to factors pertaining to their acquisition of linguistic knowledge. These unexpected data, implicating neuropsychological rather than linguistic deficits as the potential basis of these classically recognized subgroups of LI children, make it imperative that we take even more seriously hypotheses that characterize LI children as having neuropsychological rather than linguistic deficits.

Neuropsychological (Perceptual/Motor) Characteristics

There is no doubt that LI children have difficulty with various aspects of linguistic processing and/or production. Deviation in the development of linguistic performance may be attributable to difficulty acquiring higher order semantic or syntactic rules. However, it is also possible that linguistic deficits could result from more primary perceptual and/or motor problems, such as difficulty in detecting signal change, in discriminating temporal or spectral features, or in integrating or producing different aspects of complex signals over time. Such processes may be a necessary prerequisite to normal language function. Until we can effectively rule out malfunctions in these more primary perceptual and motor mechanisms, it will be extremely difficult to differentiate between disorders that may arise at different stages of language processing and production.

Clinical descriptions of LI children have consistently reported perceptual motor and memory deficits. These clinical impressions have been supported by numerous research studies (see Tallal, 1981, for review). The studies of Tallal and colleagues over the past 15 years have demonstrated highly significant and consistent nonverbal temporal, perceptual, motor, and memory deficits in LI children (Tallal and Piercy, 1973a, 1973b, 1974; Johnston et al, 1981; Tallal et al, 1981; Stark et al, 1983; Tallal et al, 1985a, 1985b, 1986). These studies demonstrate that LI children are specifically impaired in their ability to discriminate as well as sequence rapidly presented nonverbal stimuli, and hence, remember them. For example, whereas normal children required only 8 msec between two 75 msec tones to respond correctly to their temporal order, LI children required, on average, 300 msec to even discriminate between the tones. This result, replicated in numerous studies using nonverbal auditory, visual, tactile, and cross-modal stimuli, demonstrates that LI children are specifically impaired in their ability to respond correctly to nonverbal sensory information that enters the nervous system quickly in time (simultaneously or in rapid succession), and that the amount of time required by LI children for sensory information processing is orders of magnitude greater than that demonstrated by normal children. Similar temporal deficits in nonverbal temporal motor planning also have been observed in LI children (Johnston et al, 1981; Tallal et al, 1985a, 1985b, 1986). It is important to emphasize that these highly consistent and significant deficits characteristic of LI children are demonstrated both for processing and for producing nonverbal temporal patterns. There are no significant differences between LI and normally developing children on other tasks of information processing/production that do not require rapid temporal integration, or even on the same tasks of temporal integration when stimuli are presented more slowly. Thus, this nonverbal temporal processing deficit is: (1) large in magnitude; (2) specific; and (3) highly replicable across populations of specifically LI children. Importantly, autistic children with articulation disorders (without language disorder) and children with reading disorders (without oral language disorders) have been shown to perform normally on temporal tasks (Stark et al, 1979; Tallal et al, 1980b). However, reading impaired children with concommitant oral language deficits (and decoding difficulties) did show this pattern of temporal perceptual impairment (Tallal, 1980).

The relationship between these nonverbal processing deficits and the verbal disorder of LI children was investigated by Tallal and Piercy (1974, 1975) who published data that provided, for the first time, a direct link between basic nonverbal temporal processing deficits and basic speech perception deficits in LI children. Using computer synthesized speech, which allows for precise control of the acoustic spectra of individual speech sounds, Tallal and Piercy demonstrated that LI children were specifically impaired in their ability to discriminate and sequence precisely those speech sounds that incorporated rapidly changing acoustic spectra (stop consonant-vowel syllables). Importantly, these same children were unimpaired in their ability to respond correctly to speech sounds that were either steady state in nature (isolated vowels) or had been synthesized in such a way as to slow down the rate of acoustic change (stop consonant-vowel syllables with extended format transitions). Thus, these studies demonstrated that LI children are not equally impaired in processing all speech sounds. Rather, they have specific difficulty processing only those speech sounds that are characterized by rapidly changing acoustic spectra which are critical for their discrimination (Tallal and Stark, 1981). Further study demonstrated that these children's errors in speech production were similar to their errors in speech perception. That is, those speech sounds that rely on brief temporal cues for their discrimination were not only most often misperceived by these children, but also were most frequently misproduced or omitted in their speech output (Stark and Tallal, 1979; Tallal et al, 1980a, 1980b). Based on these results linking a specific nonverbal temporal processing deficit directly to the pattern of speech perception and speech production deficits in LI children, Tallal hypothesized that basic neural deficits in temporal analysis and production may preclude or delay the development of normal speech perception and production and thus may impinge on normal language development.

In an NINCDS funded contract (1975-1979), Investigating the Sensory, Perceptual, and Motor Functioning of Children with Language Disorders, Reading Disabilities, or Articulation Disorders, Tallal and colleagues (Stark, Mellits, Kallman) investigated this hypothesis by assessing the degree of receptive language impairment in a large group of LI children. They hypothesized that if the specific temporal perception deficits of LI children were directly related to their receptive language impairment, then the degree of their perceptual impairment should predict the degree of their receptive language impairment. The results of multivariate analyses demonstrated a highly significant relationship ($r = .89$, $p < .001$) between the degree of temporal perceptual impairments and receptive language impairments in LI children. Importantly, this study demonstrated quantitatively that temporal perceptual abilities alone could account for over 80 percent of the variance associated

with the receptive language deficits of LI children (Tallal et al, 1985a).

Although specific developmental language impairment clinically has been defined primarily by exclusion, research has now provided reliable evidence of specific temporal perceptual/motor profiles which appear to be positively associated with LI children. The extent to which these specific temporal variables alone could correctly classify (diagnose) children as language impaired or normal also was addressed by Tallal and colleagues. The results of discriminant function analysis indicated that a combination of six perceptual and motor variables, when taken in combination, could classify correctly 98 percent of the subjects studied as either normally developing or language impaired. These six variables included: (1) rate of multisyllabic word production; (2) discrimination between speech syllables incorporating brief formant transitions; (3) discrimination of simultaneous touches to the fingers; (4) cross-modal (auditory-visual) integration rate; (5) visual integration rate; and (6) double simultaneous tactile stimulation to the hands and/or cheek. These variables had in common the need to perceive or produce basic sensory information quickly in time. Using these six variables alone, Tallal and colleagues were able to correctly classify 31 of the 32 LI children participating in the study as language impaired, and all 36 of the control subjects as normal. Importantly, none of these variables assessed what are commonly considered higher level linguistic functions, or used standardized language assessment procedures used clinically to assess language impairments.

The results of this now large series of studies demonstrate that a specific temporal perceptual/motor mechanism is grossly impaired in LI children. The degree of temporal perceptual/motor impairment is: (1) highly predictive of the degree of receptive language impairment in these children; (2) appears to co-occur in the vast majority of children with specific developmental language disorders; and (3) may well be a "marker variable" for language impairment.

Reading Profiles

Importantly, reading impaired children with concommitant oral language disorders, as well as specific decoding (phonics) deficits, also have been shown to manifest a similar pattern of neuropsychological deficits to those described for LI children (Tallal, 1980a, 1980b). However, reading impaired children who do *not* have concommitant oral language deficits or difficulty learning phonetic rules, do not show these specific temporal perceptual/motor deficits (Tallal and Stark, 1982). Thus, Tallal has hypothesized that a specific neurological mechanism may disrupt phoneme perception and production resulting first in delayed language acquisition in young children and subsequently in delayed reading acquisition in older children. This hypothesis suggests that certain developmental language disorders and developmental reading disorders may result from the same underlying neurological deficit, and may differ only in the age of the child and the learning skills being acquired at different ages.

Recent results from the NINCDS-funded San Diego Longitudinal Study Evaluating the Outcomes of Early Language Impairments in Children (Tallal and Curtiss, 1980-1988) support this hypothesis. These results demonstrate the remarkable predictive outcome of early language impairment (developmental dysphasia) to subsequent reading impairment (developmental dyslexia). Preliminary results of this longitudinal study demonstrate that, based on discriminant function analysis, by age six years, 78 percent of the LI subjects can be correctly classified based on their spelling scores, 86 percent based on their reading vocabulary scores, and 87 percent based on their reading comprehension scores. By age 7 years, 75 percent of the LI subjects are correctly classified based on spelling scores alone, 81 percent on reading vocabulary, and 80 percent on reading comprehension. Similar results have been reported in all previous longitudinal studies reporting a high incidence of dyslexia in children with early language impairments (Strominger and Bashir, 1977; Hall and Tomblin, 1978; Aram and Nation, 1975; Silva, 1980; Silva et al, 1983; Stark et al, 1984).

Longitudinal studies directly demonstrate the co-occurrence of developmental language disorders and developmental reading disorders in the same children at different ages. Nonetheless, these disorders continue to be defined, diagnosed, conceptualized, and treated as distinct clinical and research entities. This is evidenced by the separation between professionals serving language impaired and reading impaired children, both in their clinical and their theoretical training. Whereas speech pathologists and audiologists serve language impaired children, special educators and reading specialists serve reading impaired children. Conferences on developmental dysphasia (developmental language disorders) rarely include papers on developmental dyslexia (reading impairment) and vice versa. Significantly, even the National Institutes of Health have two separate agencies for overseeing research on these populations. Whereas language impairments (aphasia) fall under the auspices and responsibilities of the NINCDS, research on reading impairments (dyslexia) falls within the domain of the NICHD. Similarly, the DSM-III classifies developmental language and reading disorders separately. The results of longitudinal research studies, however, clearly demonstrate that it may be the age of the child rather than the neurological basis that differs between developmental language and developmental reading disorders. Continuing to separate these developmental communication disorders ultimately fails the many children who "progress" from language to reading impaired. Although not all reading impaired children have concommitant oral language deficits, this research suggests that a very high percentage of LI children have some degree of delayed reading acquisition. It is suggested that to continue to separate these disorders potentially impedes progress toward the eventual treatment and prevention of these communication learning disorders.

Cognitive Characteristics

For more than 20 years, LI children have been operationally defined as having normal nonverbal intelligence and normal cognitive capacity. The conclusion that LI children had normal nonlinguistic cognition probably arose because, in order to make differential diagnoses of specific language impairment, as opposed to mental retardation, children had to perform within normal limits on nonverbal portions of standardized intelligence tests. Research on this point remains controversial, however, with some studies suggesting that LI children may exhibit deficits and/or delays in nonlinguistic areas of cognition, and others refuting this interpretation.

LI children have demonstrated difficulties with many different nonverbal aspects of cognition: means/ends knowledge, that is, what children do to obtain objects or to cause actions (Snyder, 1978); interpreting and drawing inferences from visually depicted events (Mackworth et al, 1973; Otto et al, 1973); classification (Johnston and Ramstad, 1978); figurative thought (thought involving visual mental representations), including haptic-problem solving, seriation, and mental rotations (Kamhi, 1981; deAjuriaguerra, 1976; Johnston and Weismer, 1983); rule and hypothesis formulation (Kamhi et al, 1984); and short-term memory processes, especially with respect to parameters relating to memory capacity (e.g., Kirchner and Klatzky, 1985).

On the basis of this and other research, some researchers have hypothesized that LI children do not have a selective language deficit, but have a more general representational deficit which underlies both their linguistic and nonlinguistic difficulties (Morehead, 1972; Morehead and Ingram, 1973; Inhelder, 1966, 1976; deAjuriaguerra, 1976). The finding the LI children exhibit deficits in representational abilities across a range of tasks and at different points in development is consistent with such a view. Such deficits could explain some of the specific impairments noted in the language development of this population. For example, the delay in speech onset, the protracted rate of lexical acquisition, the impoverished range of semantic functions and relations expressed, and the limited propositional complexity of speech could all be the linguistic reflections of representational and conceptual impairments. Moreover, a deficit in rule formulation and hypothesis testing could have equally significant negative consequences for language acquisition.

Such conclusions are premature, however. First, many investigations of nonlinguistic cognition in LI children have failed to find any such deficits in this population. (See Stark et al, 1983, for review.) Studies of the symbolic play of LI children have produced equivocal results (e.g., Lovell et al, 1968; Terrell et al, 1984) as have investigations of operative thought (e.g., Inhelder, 1966; Johnston and Ramstad, 1978). In addition, several of the studies cited above, which purported to find evidence of nonlinguistic cognitive deficits of LI children, presented data from which alternative conclusions could easily be drawn. For example, Johnston and Weismer (1983) concluded that LI children possess an impairment of visual imagery, even though these children did not differ significantly from control children either in the accuracy of their judgements, or in the number of training trials needed to reach criterion on a mental rotation task. The LI children did respond significantly more slowly on the task, implying simply that such children were motorically slow. In another study, Kamhi et al (1984) concluded that LI children evidence deficits in hypothesis testing ability and in nonlinguistic symbolic abilities. The data simply do not support these conclusions. LI children performed normally on a concept acquisition task and on a discrimination learning task (in terms of number of trials needed to reach criterion). However, significantly more LI children than controls were unable to verbalize the correct solution to this latter task, hardly a surprising result given that these are, by definition, language impaired children. The LI children also performed significantly worse on a haptic recognition test, from which the authors concluded that such children possess a general problem with symbolic representation. Clearly, a more parsimonious explanation for these data would be that the LI children have a problem with cross-modal sensory integration (in this case, tactile sensation-visual recognition) as reported by Tallal et al (1981).

Secondly, both theoretical linguistics and psycholinguistics support the contention that linguistic and nonlinguistic rules and representations may differ considerably (e.g., Curtiss, 1982, in press). Therefore, there is no a priori reason to assume that a child with linguistic representational difficulty would necessarily also have nonlinguistic representational difficulty.

Thirdly, not all LI children evidence nonlinguistic deficits; in almost every study cited, at least some of the LI children performed normally on nonlinguistic, cognitive measures. This indicates that LI children do not comprise a single, homogeneous population. Therefore, the fact that many LI children manifest a range of developmental dysfunctions which could impair their language acquisition does not preclude the possibility that a subgroup of these children have a truly selective linguistic deficit.

There is currently no conclusive evidence as to whether the various cognitive deficits that LI children demonstrate stem from a single underlying impairment, or whether they are causally related. However, an investigation into possible relationships between the linguistic and nonlinguistic cognitive deficits in these children would be germane to at least two important issues in the cognitive sciences: First, are language, mental imagery, and other symbolic abilities separate faculties of mind, embodying distinct cognitive principles, or are they different manifestations of a single set of cognitive principles? Secondly, which perceptual and/or cognitive abilities are prerequisites for language acquisition? Because the LI child commonly shows perceptual as well as cognitive deficits, a rigorous examination of linguistic, cognitive, and perceptual function, in the same impaired population, could provide crucial evidence on the fundamental relationships between lan-

guage development and aspects of cognition and perception which are not strictly linguistic. The first such study, wedding linguistic, cognitive, and neuropsychological investigations of the same population is currently underway as part of the San Diego Longitudinal Study (Tallal and Curtiss, 1980-1988).

Social-Emotional Characteristics

Investigating the role that language may play as a mediator in emerging social and emotional development in children has occupied a central position in the field of developmental social cognition. With the development of language, it has been suggested that the child gains a new and powerful means of classifying logical connections and developing reasoning skills that enable him/her to differentiate emotional and conceptual domains and gain mastery within them (Hassibi and Brewer, 1980).

Thus, it might be expected that serious developmental language impairment could have a profound impact on social and emotional development. Indeed, LI children offer a unique opportunity for evaluating the potential relationship between emerging language (or lack thereof) and social and emotional development. However, despite the potential for studying this important developmental issue, until recently, few empirical studies of the social and emotional status of LI children have been reported. This is obviously a fruitful area for continued research.

The studies of Cantwell et al (1980) and Baker et al (1980) provide perhaps the most comprehensive review and new information on the relationship between speech and language disorders and psychiatric disorders in children. These authors report the results of a comprehensive psychiatric evaluation of 100 consecutive cases of children seen in a community speech and hearing clinic. Psychiatric diagnosis of this cohort revealed the presence of a diagnosable psychiatric disorder, according to DSM-III criteria, in approximately 50 percent of the group studied. It is important to note, however, that included as "diagnosable psychiatric disorder," were diagnoses of developmental disorders such as reading and math deficits, and attention deficit disorder. Baker et al (1980) reported a differential degree of these disturbances in children with various linguistic profiles. Children with speech articulation problems, without concommitant language disorders, were found to show the least prevalence for these DSM-III diagnoses. Children with speech and language disorders or language disorders alone were most at risk for these DSM-III diagnoses.

Approaching the association between emotional and speech disorders in children from another direction, Chess and Rosenberg (1974) evaluated the incidence of speech disorders among children referred for psychiatric treatment. They found that over a three-year period, 24 percent of all children referred for psychiatric therapy had some type of language disorder. Psychiatric diagnoses for these children included cerebral dysfunction, developmental lag, thought disorder, and neurotic behavior disorder. However, these authors suggest that without longitudinal studies assessing the relationship between language and social-emotional development in children, it would be difficult to determine whether emotional disorders are primary or whether the resultant stresses of language delays which in themselves create a high probability of secondary compensatory behaviors, such as withdrawal or other kinds of intrusive actions. These authors suggest that these protective and defensive maneuvers may be more easily noted and referred for treatment than the speech or language problem, and, in fact, the speech or language problems may often be wrongly understood as derivative and secondary to an underlying neurotic mechanism, rather than vice versa.

In addition to a longitudinal design, issues pertaining to direction of causality might be addressed by looking specifically at very young children. Stevenson and Richmond (1978) report the only study that has focused on the preschool age child. These authors conducted a comprehensive epidemiological study of three-year-olds living in a London suburb. They found that, of the random sample of 700 children studied, 14 percent displayed behavioral problems. However, 59 percent of the children with language delay displayed behavioral problems. Unfortunately, it is not clear from this study that only children with specific developmental language delay were included in the LI group or whether age was a relevant factor. Children with language delay secondary to other developmental disabilities such as general mental retardation, social deprivation, hearing loss, or infantile autism, also were represented in the population. Thus, the extent to which behavioral problems are associated with these other developmental disabilities cannot be parceled out from those associated specifically with language disabilities. This methodological criticism, unfortunately, must be applied to all of the studies previously reported and reviewed here. Similarly, even the most recently published study on the topic (Beitchman et al, 1986) fails to distinguish specific developmental language impairment from language delay which is secondary to mental retardation, infantile autism, hearing loss, paralysis or malformation of the oral musculature, or frank neurological insult or acquired aphasia.

As part of the NINCDS-funded Longitudinal Study of the Outcomes of Early Language Impairments in Children, Tallal et al (1986) report the prevalence of social and emotional disturbance in preschool age LI children. This study differs methodologically in three important ways from previously reported studies in the literature pertaining to social and emotional sequelae of developmental language disorders: (1) only four-year-old children who had only recently been diagnosed as specifically language impaired were included; (2) subjects were rigorously tested to quantitatively establish that they were both significantly language impaired and that the impairment was specific to expressive and/or receptive language only (children with speech problems only or other neurological, mental, or physical problems were excluded); and (3) a well-matched control group was included. The results of this study also differ from those reported previously. Using a standard-

ized Child Behavior Checklist (Achenbach, 1979, 1980, 1982), it was found that although the mean and standard deviations were significantly different for the Total Scores between the normal and LI groups, further analysis demonstrated that only one of the eight individual Behavior Scales, developed by Achenbach from this checklist, contributed to this significant difference. Similarly, using the Achenbach cutoff of a T-score of 70 or higher to represent clinically abnormal behavior, none of the 49 normal subjects and only five of the 81 LI subjects participating in the study demonstrated abnormality at this level, an insignificant difference. The one scale that did significantly differentiate the LI from the normal children (immaturity for the boys and social withdrawal for the girls) on further inspection, revealed a high number of neurological as opposed to purely emotional items. These included items such as speech problems, confused, clumsy, can't concentrate, won't talk, twitches, and accident-prone. Discriminant function analysis demonstrated that these neurological items from the Achenbach Child Behavior Checklist accounted for the significant majority of variance between groups found for the Total Behavior scores. Ninety-two percent of the boys and 90 percent of the girls could correctly be classified as LI as opposed to normal, based on these neurological items from the Achenbach scale, without resorting to the inclusion of the more specifically social or emotional items from this scale.

The results of this recent study demonstrate that four-year-old LI children are not significantly different than age-match controls in social and emotional development, in areas other than those that reflect neuropsychological integrity. However, when items assessing aspects of neuropsychological functioning are included in standard child behavior checklists, the overall results demonstrate significant differences between Total Behavior scores obtained from groups which, without more detailed analysis, may be misinterpreted as social and emotional disturbance. It is important that interpretations pertaining to social and emotional disorders in LI children, based on parent, teacher, or clinical observation, not be confounded with aspects of behavior which may be associated with the originally diagnosed neurological disorder. It will be important to replicate these findings using other techniques, including clinical observation and other standardized methods. It also will be of particular interest to reassess these same children at the end of the longitudinal study (at age eight) to determine whether or not changes have occurred in the social and emotional profiles of LI children assessed in the preschool and subsequently the mid-elementary school years. Although these results suggest that specific developmental language delay is initially neurological rather than emotional in origin, it is possible that these children develop emotional disturbances with increasing age, perhaps as a result of attempting to cope with the stresses produced by their language and learning disabilities.

Summary and Limitations: Goals for Future Research

Three major points arise form this discussion of definition and associated characteristics of specific developmental language disorders:

(1) Although important similarities may exist between children with specific developmental language disorders and those with language disorders secondary to other developmental disabilities (mental retardation, hearing loss, autism, cerebral palsy, acquired aphasia, articulation disorders) research has been highly confounded by a lack of careful attention to separation between these different developmental disabilities. Until consistent, standardized inclusionary and exclusionary criteria for selecting subjects for studies of specific developmental language impairment are both established and uniformly applied, it will continue to be virtually impossible to generalize research results from one study to the next and to make progress in our understanding of specific developmental language delay. It is suggested that the number one priority for research would be the development of these standardized inclusionary and exclusionary criteria, and the requirement of their uniform usage for subsequent federally or privately funded research in this area.

(2) Somewhat paradoxically, there seems to be a higher tendency to merge children with language disabilities which appear to arise form very different etiologies (mental retardation, hearing loss, autism) into a single category for study and treatment, than to merge children with primary communication-learning disabilities (specific developmental language disorder and specific developmental reading disorder). Research now strongly documents that for many of these children, their language and reading difficulties may result from similar neurological etiology, manifesting itself differently at different stages of development. It is suggested that future research be focused on investigating similarities and differences between children with a variety of developmental disabilities concentrated more directly on etiology and mechanism rather than surface symptomatology. Continued classification based primarily on symptomatology rather than etiology and mechanism may directly impede progress in research and treatment of learning impaired children.

(3) The continued adherence to definition by exclusion, in light of the plethora of new information emerging from research pertaining to inclusionary associated characteristics of LI children impedes progress in this area. It is distressing that the DSM-III (1980) adopted a virtually identical definition of specific developmental language disorders to the published by Benton over two decades ago, suggesting incorrectly that no progress has been made in the ensuing two decades. However, research activity has produced considerable advancements in

our knowledge of the definition and associated inclusionary characteristics of children with specific developmental language impairment, particularly pertaining to neurological, neuropsychological, (particularly temporal perception and production), linguistic, cognitive, and social and emotional profiles. Many of these profiles have been shown to be highly reliable and replicable across many laboratories and groups of subjects. For example, although many different subgroups or profiles of children with language disorders have been identified, temporal/perceptual motor deficits have been shown both to predict level of receptive language impairment accurately and to classify correctly 98 percent of LI children, regardless of their subtype. It is, therefore, unacceptable to continue to adopt a diagnosis based solely on what is not known about LI children, in deference to including in the definition of the disorder what is currently known to characterize these children.

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References

Achenbach, T.M. (1979). The child behavior profile: An empirically based system for assessing children's behavioral profiles and competencies. *International Journal of Mental Health, 7* (3-4), pp. 24-42.

Achenbach, T.M. (1980). DSM-III in light of empirical research on the classification of child psychopathology. *Journal of the American Academy of Child Psychiatry, 19*, pp. 395-412.

Achenbach, T.M. (1982). *Developmental Psychopathology*, New York: John Wiley and Sons.

Ajuriaguerra, J. de, Jaeggi A., Guignard, F., Kocher, F., Maquard M., Roth S., & Schmid, E. (1976). The development and prognosis of dysphasia in children. In E.M. Morehead and A. Morehead (Eds.), *Normal and Deficient Child Language*. Baltimore: University Park Press.

Aram, D.M., & Nation, J.E. (1975). Patterns of language behavior in children with language disorders. *Journal of Speech and Hearing Research, 18*, pp. 229-241.

Aram, D.M., & Kamhi, A.G. (1982). Perspectives on the relationship between phonological and language disorders. In *Seminars of Speech and Hearing Research*.. New York: Thieme-Stratton, pp. 101-114.

Baker, L., Cantwell, D.P., & Mattison, R.E. (1980). Behavior problems in children with pure speech disorders and in children with combined speech and language disorder. *Journal of Abnormal Child Psychology, 8*, pp. 245-256.

Ball, J., & Cross, F. (1981). Formal and pragmatic factors in childhood autism and aphasia. Paper presented at the Symposium on Research in Child Language Disorders, Madison Wisconsin.

Bartak, L., Rutter, M., & Cox, A. (1975). A comparative study of infantile autism and specific developmental language disorder: I. The children. *British Journal of Psychiatry, 126*, pp. 127-145.

Benton, A.L. (1964). Developmental aphasia and brain damage. *Cortex, 1*, pp. 40-52.

Berman, R. (1981). Regularity vs. anomaly: The acquisition of Hebrew inflectional phonology. *Journal of Child Language, 8*, pp. 265-282.

Beitchman, J.H., Nair, R., Clegg, M., Ferguson, B., & Patel, P.G. (1986). Prevalence of psychiatric disorders in children with speech and language disorders. *Journal of the American Academy of Child Psychiatry, 25* (4), pp. 528-535.

Bowerman, M. (1973). *Early Syntactic Development: A Cross-Linguistic Study with Special Reference to Finnish*. London: Cambridge University Press.

Brown, R. (1973). *A First Language*. Cambridge, MA: Harvard University Press.

Camarata, S., & Gandour, J. (1984). On describing idiosyncratic phonologic systems. *Journal of Hearing and Speech Disorders, 49*, pp. 262-266.

Camarata, S., & Gandour, J. (1985). Rule invention in the acquisition of morphology by a language-impaired child. *Journal of Hearing and Speech Disorders, 50*, pp. 40-45.

Camarata, S., & Schwartz, R. (1985). Production of object words and action words: Evidence for a relationship between phonology and semantics. *Journal of Hearing and Speech Research, 28*, pp. 323-330.

Campbell, P., & Shriberg, L. (1982). Associations among pragmatic functions, linguistic stress, and natural phonological processes in speech delayed children. *Journal of Speech and Hearing Disorders, 25*, pp. 547-553.

Cantwell, D.P., Baker, L., & Mattison, R.E. (1980). Factors associated with the development of psychiatric disorder in children with speech and language retardation. *Archives of General Psychiatry, 37*, pp. 423-426.

Chapman, K., Leonard, L., Rowan, L., & Weiss, A. (1983). Inappropriate word extensions in the speech of young language-disordered children. *Journal of Speech and Hearing Disorders, 48*, pp. 55-62.

Chess, S., & Rosenberg, M. (1974). Clinical differentiation among children with initial language complaints. *Journal of Autism and Childhood Schizophrenia, 4*, pp. 99-109.

Compton, A. (1970). Generative studies of children's phonological disorders. *Journal of Speech and Hearing Disorders, 35*, pp. 315-339.

Curtiss, S. (1982). Developmental dissociations of language and cognition. In L. Obler and L. Menn (Eds.), *Exceptional Language and Linguistic Theory*. New York: Academic Press.

Curtiss, S., & Tallal, P. (1985). On the question of subgroups in language impaired children: A first report. Paper presented at the Tenth Annual Boston University Conference of Language Development.

Curtiss, S. (In press). The special talent of grammar acquisition. In L. Obler and D. Fein (Eds.), *The Neuropsychology of Talent and Special Abilities*. New York: The Guilford Press.

Edwards, M., & Bernhardt, B. (1973). Phonological analysis of the speech of four children with language disorders. Unpublished manuscript.

Fey, M., Leonard, L., Fey, S., & O'Connor, K. (1978). The intent to communicate in language-impaired children. Paper presented at the Third Annual Boston University Conference on Language Development.

Fey, M. (1981). Stylistic speech adjustments of language-impaired and normal language children. Unpublished doctoral dissertation, Purdue University.

Fey, M., Leonard, L., & Wilcox, K. (1981). Speech style modifications of language-impaired children. *Journal of Speech and Hearing Disorders, 46*, pp. 91-97.

Fey, M., & Leonard, L. (1984). Partner age as a variable in the conversational performance of specifically language-impaired and normal language children. *Journal of Speech and Hearing Research, 27*, pp. 413-423.

Freedman, P., & Carpenter, R. (1976). Semantic relations used by normal and language impaired children at Stage I. *Journal of Speech and Hearing Research, 19*, pp. 784-795.

Gale, D., Liebergott, J., & Griffin, S. (1981). Getting it: Children's requests for clarification. Paper presented to the American Speech-Language-Hearing Association Annual Convention, Los Angeles.

Geller, E., & Wollner, S. (1976). A preliminary investigation of the communicative competence of three linguistically impaired children. Paper given at the New York State Speech and Hearing Association, Grossingers.

Greenfield, P., & Smith, J. (1976). *Communication and the Beginnings of Language: The Development of Semantic Structures in One Word Speech and Beyond*. New York: Academic Press.

Griffin, S. (1979). Requests for clarification made by normal and language impaired children. Unpublished master's thesis, Emerson College.

Hall, P.K., & Tomblin, J.B. (1978). A follow-up study of children with articulation and language disorders. *Journal of Speech and Hearing Disorders, 43*, pp. 227-241.

Hassibi, M., & Brewer, J. Jr. (1980). *Disordered Thinking and Communication in Children*. New York: Plenum Press.

Hoar, N. (1977). Paraphrase capabilities of language impaired children. Paper presented at the Second Annual Boston University Conference on Language Development.

Hyams, N. (1983). The acquisition of parametrized grammars. Unpublished doctoral dissertation, City University of New York.

Hyams, N. (1986). Core and peripheral grammar and the acquisition of inflection. Paper given at the Eleventh Annual Boston University Conference on Language Development.

Ingram, D. (1972). The acquisition of the English verbal auxiliary in normal and linguistically deviant children. *Papers and Reports in Child Language Development, 4*. Stanford, CA: Department of Linguistics, Stanford University.

Ingram, D. (1976). *Phonological Disability in Children*. London: Edward Arnold.

Inhelder, B. (1966). Cognitive development and diagnosis of mental deficiency. *Merrill-Palmer Quarterly, 12*, pp. 299-319.

Inhelder, B. (1976). Observations on the operational and figurative aspects of thought in dysphasic children. In D. Morehead and A. Morehead (Eds.), *Normal and Deficient Child Language*. Baltimore: University Park Press.

Jacobs, T. (1981). Verbal dominance, complexity, and quantity of speech on pairs of language-disabled and normal children. Unpublished doctoral dissertation, University of Southern California.

Johnston, J., & Schery, T. (1976). The use of grammatical morphemes by children with communication disorders. In D. Morehead and A. Morehead (Eds.), *Normal and Deficient Child Language*. Baltimore: University Park Press.

Johnston, J., & Ramstad, V. (1978). Cognitive development in preadolescent language impaired children. In M. Burns and E.J. Andrews (Eds.), *Selected Papers in Language and Phonology*. Evanston, IL: Institute for Continuing Professional Education.

Johnston, J., & Weismer, S. (1983). Mental rotation abilities in language disordered children. *Journal of Speech and Hearing Research, 26*, pp. 397-403.

Johnston, J., & Kamhi, A. (1984). The same can be less: Syntactic and semantic aspects of the utterances of language impaired children. *Merrill-Palmer Quarterly, 30*, pp. 65-85.

Johnston, R.B., Stark, R.E., Mellits, E.D., & Tallal, P. (1981). Neurological status of language-impaired and normal children. *Annals of Neurology, 10*, pp. 159-163.

Kamhi, A. (1981). Nonlinguistic symbolic and conceptual abilities of language-impaired and normally developing children. *Journal of Speech and Hearing Research, 24*, pp. 446-453.

Kamhi A., Catts, H., Koenig, L., & Lewis, B. (1984). Hypothesis testing and nonlinguistic symbolic activities in language impaired children. *Journal of Speech and Hearing Disorders, 49*, pp. 169-176.

Kean, M.L. (1984). The question of linguistic anomaly in developmental dyslexia. *Annals of Dyslexia, 34*. pp. 137-154.

Kessler, C. (1975). Post-semantic processes in delayed child language related to first and second language learning. In D. Dato (Ed.), *Georgetown University Roundtable on Language and Linguistics*. Washington, DC: Georgetown University Press, pp. 159-178.

Kirchner, D., & Klatzky, R. (1985). Verbal rehearsal and memory in language-disordered children. *Journal of Speech and Hearing Research, 28*, pp. 556-565.

Klein, S. (1985). A note on UN-verbs. In J. Godberg, S. Mackage, and M. Twescoat (Eds.), *Procedings of the West Coast Conference on Formal Linguistics, 4*. Stanford, CA: Stanford Linguistics Association.

Lee, L. (1966). Developmental sentence types: A method for comparing normal and deviant syntactic development. *Journal of Speech and Hearing Disorders, 31*, pp. 311-330.

Leonard, L. (1972). What is deviant language? *Journal of Speech and Hearing Disorders, 37*, pp. 427-446.

Leonard, L., Bolders, J., & Miller J. (1976). An examination of the semantic relations reflected in the language usage of normal and language disordered children. *Journal of Speech and Hearing Research, 19*, pp. 371-392.

Leonard, L., Steckol, K., & Schwartz, R. (1978). Semantic relations and utterance length in child language. In F. Peng and von Raffler-Engel (Eds.), *Language Acquisition and Developmental Kinesics*. Tokyo: University of Tokyo Press.

Leonard, L., Schwartz, R., Chapman, K., Rowan, L., Prelock, P., Terrell, B., Weiss, A., & Merrick, C. (1982). Early lexical acquisition in children with specific language impairment. *Journal of Speech and Hearing Research, 25*, pp. 554-564.

Leonard, L. (1985). Unusual and subtle behavior in the speech of phonologically disordered children. *Journal of Speech and Hearing Disorders, 50*, pp. 4-13.

Leonard, L., & Leonard, J. (1985). The contribution of phonetic context to an unusual phonological pattern: A case study. *Language, Speech, and Hearing Services in the School, 16*, pp. 110-118.

Lorentz, J. (1972). An analysis of some deviant phonological rules of English. Unpublished manuscript.

Lovell, K., Hoyle, H., & Sidall, M. (1968). A study of the play and language of young children with delayed speech. *Journal of Child Psychology, Psychiatry, and Allied Disciplines, 9*, pp. 41-50.

Mackworth, N., Gradstaff, N., & Pribram, K. (1973). Orientation to pictorial novelty by speech disordered children. *Neuropsychologia, 11*, pp. 443-450.

McGinnis, M.A. (1963). *Aphasic Children: Identification and Education by the Association Method*. Washington, DC: Alexander Graham Bell Association for the Deaf.

Menyuk. P. (1964). Comparison of grammar of children with functionally deviant and normal speech. *Journal of Speech and Hearing Research, 7*, pp. 109-121.

Messick, C., & Newhoff, M. (1979). Request form: Does the language-impaired child consider the listener? Paper presented to the American Speech and Hearing Association Annual Convention, Atlanta.

Morehead, D. (1972). Early grammatical and semantic relations: Some implications for a general representational deficit in linguistically deviant children. *Papers and Reports in Child Language Development, 4*. Stanford, CA: Department of Linguistics, Stanford University.

Morehead, D., & Ingram, D. (1973). The development of base syntax in normal and linguistically deviant children. *Journal of Speech and Hearing Research, 16*, pp. 330-352.

Myklebust, H.R. (1954). *Auditory Disorders in Children: A Manual for Differential Diagnosis*. New York: Grune & Stratton.

Oller, D. (1973). Regularities in abnormal child phonology. *Journal of Speech and Hearing Disorders, 38*, pp. 36-47.

Otto, D., Honck, K., Finger, H., & Hart, S. (1973). Event related slow potentials in aphasic, dyslexic, and normal children during pictorial and letter matching. *Proceedings of the Third International Congress of Event Related Potentials of the Brain*. Bristol, England.

Prelock, P., Messick, C., Schwartz, R., & Terrell, B. (1981). Mother-child discourse during the one-word stage. Paper presented at the University of Wisconsin Symposium on Child Language Disorders, Madison, Wisconsin.

Sachs, J., & Devin, J. (1976). Young children's use of age-appropriate speech styles in social interaction and role-playing. *Journal of Child Language, 3*, pp. 81-98.

Salus, P., & Salus, M. (1973). Language delay and minimal brain dysfunction. Paper presented at the winter meeting of the Linguistic Society of America.

Schwartz, R., & Leonard, L. (1985). Lexical imitation and acquisition in language-impaired children. *Journal of Speech and Hearing Disorders, 50*, pp. 141-149.

Shatz, M., & Gelman, R. (1973). The development of communication skills: Modification in the speech of young children to indirect directiveness in varying contexts. *Applied Psycholinguistics, 1*, pp. 295-306.

Sheppard, A. (1980). Monologue and dialogue speech of language-impaired children in clinic and home settings: Semantic, conversational and syntactic characteristics. Unpublished master's thesis, University of Western Ontario.

Shriberg, L., Kwiatkowski J., Best, J., Hengst, J., & Terselic-Weber, B. (1986). Characteristics of children with phonologic disorders of unknown origin. *Journal of Speech and Hearing Disorders, 51*, pp. 140-161.

Silva, P.A. (1980). The prevalence, stability, and significance of developmental language delay in preschool children. *Developmental Medicine and Child Neurology, 22*, pp. 768-777.

Silva, P.A., McGee, R., & Williams, S. (1983). Developmental language delay from three to seven years and its significance for low intelligence and reading difficulties at age seven. *Developmental Medicine and Child Neurology, 24*, pp. 783-793.

Smit, A., & Bernthal, J. (1983). Voicing contrasts and their phonological implications in the speech of articulation-disordered children. *Journal of Speech and Hearing Research, 26*, pp. 486-500.

Snyder, L. (1978). Communicative and cognitive abilities and disabilities in the sensorimotor period. *Merrill-Palmer Quarterly, 24*, pp. 161-180.

Stark, R., & Tallal, P. (1979). Analysis of stop consonant production errors in developmentally dysphasic children. *Journal of the Acoustical Society of America, 66*, pp. 1703-1712.

Stark, R., Tallal, P., Kallman, C., & Mellits, E.D. (1983). Cognitive abilities of language delayed children. *Journal of Psychology, 114*, pp. 9-19.

Stark, R.E., Bernstein, L.E., Condino, R., Bender, M., Tallal, P., & Catts, H. (1984). Four-year follow-up study of language impaired children. *Annals of Dyslexia, 34*, pp. 49-68.

Steckol, K. (1976). The use of grammatical morphemes by normal and language impaired children. Paper presented at the American Speech and Hearing Association Convention.

Stein, A. (1976). A comparison of mothers' and fathers' language to normal and language deficient children. Unpublished doctoral dissertation, Boston University.

Stevenson, J., & Richmond, N. (1978). Behavior, language, and development in three-year-old children. *Journal of Autism and Childhood Schizophrenia, 8* (3), pp. 299-313.

Strominger, A.Z., & Bashir, A.S. (1977). A nine-year follow-up of 50 language delayed children. Paper presented at the annual meeting of the American Speech and Hearing Association, Chicago.

Tallal, P., & Piercy, M. (1973a). Defects of non-verbal auditory perception in children with developmental aphasia. *Nature, 241*, pp. 468-469.

Tallal, P., & Piercy, M. (1973b). Developmental aphasia: Impaired rate of non-verbal processing as a function of sensory modality. *Neuropsychologia, 11*, pp. 389-398.

Tallal, P., & Piercy, M. (1974). Developmental aphasia: Rate of auditory processing and selective impairment of consonant perception. *Neuropsychologia, 12*, pp. 83-93.

Tallal, P., & Piercy, M. (1975). Developmental aphasia: The perception of brief vowels and extended stop consonants. *Neuropsychologia, 13*, pp. 69-74.

Tallal, P. (1980). Auditory temporal perception, phonics, and reading disabilities in children. *Brain and Language, 9*, pp. 182-198.

Tallal, P. (1980b). Language and reading: Some perceptual prerequisites. *Bulletin of the Orton Society, 30*, pp. 170-178.

Tallal, P., Stark, R., Kallman, C., & Mellits, D. (1980a). Developmental dysphasia: The relation between acoustic processing deficits and verbal processing. *Neuropsychologia, 18*, pp. 273-284.

Tallal, P., Stark, R., Kallman, C., & Mellits, D. (1980b). Perceptual constancy for phonemic categories: A developmental study with normal and language impaired children. *Applied Psycholinguistics, 1*, pp. 49-64.

Tallal, P. (1981). Language disabilities in children: Perceptual correlates. *International Journal of Pediatric Otorhinolaryngology, 3*, pp. 1-13.

Tallal, P., & Stark, R. (1981). Speech acoustic-cue discrimination abilities of normally developing and language-impaired children. *Journal of the Acoustical Society of America, 69*, pp. 568-574.

Tallal, P., Stark, R., Kallman, C., & Mellits, D. (1981). A re-examination of some non-verbal perceptual abilities of language-impaired and normal children as a function of age and sensory modality. *Journal of Speech and Hearing Research, 24*, pp. 351-357.

Tallal, P., & Stark, R.E. (1982). Perceptual/motor profiles of reading impaired children with or without concommitant oral language deficits. *Annals of Dyslexia, 32*, pp. 163-176.

Tallal, P., Stark, R., & Mellits, D. (1985a). The relationship between auditory temporal analysis and receptive language development: Evidence from studies of developmental language disorder. *Neuropsychologia, 23*, pp. 314-322.

Tallal, P., Stark, R., & Mellits, D. (1985b). Identification of language-impaired children on the basis of rapid perception and production skills. *Brain and Language, 25*, pp. 314-322.

Tallal, P., Dukette, D., & Curtiss, S. (1986). Emotional profiles of language-impaired children. *Journal of the American Academy of Child Psychiatry*. (Submitted for publication).

Terrell, B., Schwartz, R., Prelock, P., & Messick, C. (1984). Symbolic play in normal and language impaired children. *Journal of Speech and Hearing Research, 27*, pp. 424-429.

VanKleeck, A., & Frankel, T. (1981). Discourse devices used by language disordered children: A preliminary investigation. *Journal of Speech and Hearing Disorders, 46*, 250-257.

Waisbren, S.E., Norman, T.R., Schnell, R.R., & Levy, H.L. (1983). Speech and language deficits in early-treated children with galactosemia. *The Journal of Pediatrics, 102* (1), pp. 75-77.

Watson, L. (1977). Conversational participation by language deficient and normal children. In J. Andrews and M. Burns, (Eds.), *Selected Papers in Language and Phonology, II*. Evanston, IL: Institute for Continuing Education.

Williams, D.M., Darbyshire, J.D., & Vaghy, D.A. (1980). An epidemiological study of speech and hearing disorders. *The Journal of Otolaryngology, Supplement, 7*, pp. 5-24.

Wolfus, B., Moscovitch, M., & Kinsbourne, M. (1980). Subgroups of developmental language impairment. *Brain and Language, 10*, pp. 152-171.