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**A MODULAR CONCEPTION OF LEARNING DISABILITIES: AN
INVESTIGATION OF COMPOSITIONAL AND PROTOTYPICAL
CLASSIFICATION BEHAVIOR**

City University of New York

Ph.D. 1987

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A Modular Conception of Learning Disabilities:

**An Investigation of
Compositional and Prototypical
Classification Behavior**

by

Antoinette J. Lynn

**A dissertation submitted
to the Graduate Faculty in Psychology in
partial fulfillment of the requirements
for the degree of Doctor of Philosophy,
The City University of New York**

1987

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ABSTRACT

The viability of a modular thesis (e.g., Fodor, 1983) as applied to learning disabilities and their underlying cognitive structures was examined. The language processing and visuospatial processing systems were investigated as paradigmatic modular systems. Two theoretically distinct assumptions regarding representation of classification in semantic memory were utilized, one language-based, tree-like "compositional" organization, the other perceptually-based "prototypical" (e.g., Rosch, 1976) organization.

To observe whether some classification behavior varies as a consequence of dysfunctions within a module, dyslexics 8 to 12 years of age were observed whose disabilities were postulated as manifestations of dysfunctions within particular modules. The dyslexics were divided into two groups based on Boder's methodology: dysphonetics whose disability is theoretically language based; dyseidetics whose disability is theoretically perceptually based.

Analysis of sorting strategies of the hierarchical or compositional task revealed an inferred hierarchical organization, demonstrating the composition of concepts underlying sorting choices. Measurement of item typicality within a category revealed structuring of basic level categories.

The evidence supported the claim that two distinct modular systems coexist, one represented by compositional concepts, the other by prototypes:

(1) Compositional classification questions produced significantly different results for words and pictures, whereas typicality judgments did not, suggesting different modular systems mediate responses differently as a function of classification question asked;

(2) The absence of picture/word differences for the typicality task suggests that it accesses the perceptual system underlying typicality judgments based on prototypes;

(3) Dysphonetics made significantly fewer choices based on compositional criteria than the other two groups, and did not evidence significant differences in response type as a function of stimulus form/compositional question; however, their typicality judgments were not different

from normals. Thus, impairment within the module accessed by a classification task resulted in divergent classification.

The findings did not suggest divergent classification on the typicality task for dyseidetics, suggesting that more sensitive measures of visuoperception should be employed in future studies to more accurately describe this group of dyslexics.

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INTRODUCTION

Overview of the Study

Thinking requires a conceptual system. Without one, the experience of each event and each entity would be a completely unique experience. In order to think, it is necessary to classify events and entities into classes of similar kinds. Classification, categorization and the formation of concepts of natural objects is currently receiving special attention in many disciplines.

Until recently, a significant view in American psychology (within the behaviorist tradition), considered classification, categorization and concept formation primarily as aspects of problem solving within the domain of the psychology of learning (Mervis & Rosch, 1981). Now investigation into these issues has become an area of study in its own right.

Two major avenues of study of classification behavior,

which derive from theoretically distinct assumptions regarding the representation of category classification in semantic memory, can be characterized as language-based "compositional" organization and perceptually-based "prototypical" organization. Representations can be said to be organized by schemata which are characterized in terms of certain abstract features (e.g., transitivity [to be discussed subsequently]) of the various types of representations. Schemata can be thought of as general mediating factors between the abstract features and behavior that make the classification of the phenomena within categories possible.

In this study, compositional classificatory schemata are regarded as reflecting concepts about the world wherein having a concept [x] is a) to know the meaning of the word 'x'; b) to be able to both pick out or recognize a presented object x and have ideas of x when x is not present; c) to know the nature of x, i.e., to have apprehended the properties which characterize x (The Encyclopedia of Philosophy, 1967, entry: CONCEPTS). Prototypical classificatory schemata are regarded as reflecting categories which mark divisions within our conceptual system. Having a prototype [y] is a) to be able to both pick out or recognize a presented object y and

have images of y when y is not present; b) to have apprehended the properties which characterize y such that a resulting prototype is a generalization of some typical characteristics of an object (and perhaps others belonging to the same category) represented by $[y]$.

Compositional concepts form a hierarchical organization of concepts with treelike schemata (e.g. Luria, 1981). These schemata support transitive relationships between concepts where all concepts are composed of more simple ones, organized in increasing complexity or abstraction. The label "compositional" was chosen to emphasize this quality.

Compositional concepts can represent objects which belong to any of three types of sets, namely, sets of kinds, artificial sets, and empty sets. Sets of kinds are sets of objects in the world, i.e., natural-kinds (e.g. trees) and artifactual-kinds (e.g. man-made objects such as chairs). These sets have specifiable membership criteria that determine set membership, criteria which reflect essential features common to the members in the set (e.g., membership criterion for the artifactual set of chairs is "functional for sitting"). Artificial sets are sets whose membership criteria are arbitrary (e.g.,

membership criterion for an artificial set might be "all the things in a particular room that weigh over two pounds"). Empty sets are sets without members (e.g., the set of all unicorns). Together these sets encompass all possible sets of objects.

In this study, compositional representations are considered as representations of compositional concepts which belong to one of the three sets described above. Since compositional representations of concepts are composed of more simple ones, compositional representations can subsume all logically possible combinations of such representations.

The structuring of the compositional concept can be compared with Rosch, Mervis, Gray, Johnson, & Boyes-Braem's (1976) notion of basic level categorization. In their view, the most salient level of abstraction within a category is neither at the superordinate level (e.g. furniture) nor at the subordinate level (e.g. easy chair), but rather at some middle level (e.g. chair). A single mental image or prototype can reflect the entire category.

Mervis and Rosch (1981) argue that people divide the world into prototypical categories determined by the

manner in which the world is naturally divided into objects. That is to say that prototypes are representations of real-world natural and artifactual sets and not representations of either artificial or empty sets. Not only does this view described by Rosch and others (e.g. Miller & Johnson-Laird, 1976) presuppose that prototypes reflect determinate sets as described above, but it also presupposes that such representations reflect only those kinds of objects which can be simply and systematically represented by a prototype. Thus, on Rosch et.al.'s view, prototypical representations of categories are a subset of kind-sets and are not selected out of all logically possible combinations of more simple concepts as in the case of the compositional concepts. Rosch et.al. argue that one would find very few of the logically possible combinations consistent with kinds of actual objects in the world because most such combinations do not in fact reflect kinds of actual objects which are also amenable to simple systematic representations.

Methods of observing semantic processing and classification behavior include delineating differences between different age groups and between typical and atypical classification behavior. For example, age differences in defining concepts have been observed along

the continuum of concrete (e.g., dogs have four legs) to abstract (e.g., dogs are animals) associations (e.g. Luria, 1980). Also, relationships between levels of abstraction within a category (i.e., superordinate [e.g., furniture], subordinate [e.g., armchair], or middle level [e.g., chair]) and age of acquisition have been investigated (e.g., Horton & Markman, 1980). Finally, typical and atypical classification behavior has been investigated by analyzing the stability of implicit hierarchical organizations as manifested by sorting strategies employed by subjects (e.g., Frumkin-Feis, 1982).

Several studies have suggested that learning disabled children are less likely to employ meaningful categories (e.g., taxonomic) when attempting to learn new information. Instead they try to remember the items without imposing any organization strategy (e.g. Torgesen, 1977; Torgesen, Murphy & Ivey, 1979; Frumkin-Feis, 1982). Related studies (Ceci, Lea & Ringstrom, 1980; Ceci, Ringstrom & Lea, 1981) have demonstrated that learning disabled children's recall on memory tasks which stress their impairments (e.g., a memory task presented auditorily to children with impaired auditory memory) is only minimally enhanced by semantic cues (e.g., category

names). But, semantic cues did enhance recall for both the normal group and the learning disabled group whose impairment was not stressed (e.g., a memory task presented auditorily to children with impaired visual memory). Finally, it has been suggested that at least some learning disabled children have semantic problems, e.g. underdeveloped or aberrant internal semantic structures (e.g., Frumkin-Feis, 1982; see also Luria's discussion of normal development of semantic structures, 1980).

In this study, it was argued that both compositional concepts and prototypes can function in a cognitive model of mind. That is, such a model reflects the mind's capacity both to "compose" all logically possible complex concepts from more simple ones and to represent (by prototypes) kinds of objects organized by categories which mirror divisions in the real-world. It was also argued that this capacity can be enabled by distinct, separate cognitive faculties or modular systems which characterize each of the classification schema.

The idea of modular systems was adopted from J. Fodor. In his book, Modularity of Mind (1983), he argues that modular systems are relatively isolated cognitive systems, limited to processing information related to a specific

domain (e.g., language), and encapsulated in that the range of information to which the particular system has access is circumscribed. These systems will be described in detail in the chapter on Fodor's model.

Language processing and visuospatial processing may be considered as paradigmatic modular systems, one handling exclusively verbal material, the other exclusively visuospatial material. In contrast, processes such as thinking and problem solving may be considered as non-modular systems. The latter access or potentially access all information known by the individual in any form it might be preseeded. Fodor views these systems as the ones involved in fixation of belief (i.e., to form a belief).

The model developed here was designed to offer a conceptual framework in terms of which hypotheses can be formulated, explanations can be offered, and psychological experiments can be designed. This model and its conceptual framework was applied specifically to learning disability phenomena and the cognitive structures which may explain them. This study was designed to test the viability of a modular model of mind and the conceptual framework it offers.

The particular modular systems investigated here were the language module and the perceptual module which processes meaningful stimuli. It may be that unnameable, abstract percepts (e.g., abstract designs) which cannot be identified with a prototype are processed by another module (i.e., one specified for such nonverbal mediation). It was postulated that compositional concepts characterize some content of the language module, whereas prototypes characterize some content of the particular perceptual module investigated.

In order to test the postulates relating content of the language and perceptual modules to classification behavior that is mediated by each module, specific kinds of classification behavior as manifested by particular sorting strategies were observed. Also, to observe whether classification behavior characteristic of a module varies as a consequence of dysfunctions within that module, learning disabled subjects whose disabilities were postulated as specifiable to a particular module were observed. That is, the disabled subjects had disabilities that were identifiable as manifestations of dysfunctions within particular modules independent of their classification behavior. Therefore, if the classification behavior of a subject with specified dysfunctions within a

module varied as a consequence of those modular-specified dysfunctions, then such systematic variation can be taken as evidence for classification behavior mediated by specified modules.

The disabled children were divided into two groups based on their disability: dysphonetic dyslexics whose disability is language based and dyseidetic dyslexics whose disability is perceptually based. (These disabilities will be specified in the chapter on learning disabilities.) Such divisions allowed for observance of variation in classification behavior (i.e., typical versus atypical classification behavior) for each module independently. All observations were compared with nondisabled behavior.

The investigation utilized two classification tasks. One task examined compositional classification behavior and the other task examined prototypical classification behavior. The compositional (i.e., language) task was administered by asking a neutral question thereby allowing children to choose which sorting strategies to employ (i.e., compositional or functional). Analysis of the sorting strategies employed by subjects (i.e., compositional or functional or combined sorting

strategies) revealed an inferred hierarchical organization. Compositional strategies were defined as pairing objects belonging to the same taxonomic category (e.g., pairing articles of clothing), whereas functional strategies were defined as pairing objects belonging to different taxonomic categories whose relationship is determined by facts in the world (e.g., pairing a man with a hat). The prototypical (i.e., perceptual) task was administered by asking a directed question that structured which sorting strategy to employ (i.e., prototypical). This procedure allowed measurement of how typical an item was considered within a category thereby revealing the structuring of basic level categories (Rosch's view).

Both tasks were administered in a word condition and a picture condition in order to assess whether classification behavior varied as a function of stimulus form. It was hypothesized that classification behavior based on questions accessing the compositional module would vary as a function of stimulus form because the specificity of pictures make them context-laden and therefore more likely to access functional relationships. That is, a picture functions as a particular example of a general concept. Words are more generic, that is they function as general terms for concepts, and therefore more

likely to access compositional concepts. Conversely, it was hypothesized that questions accessing the perceptual module would not vary as a function of stimulus form because both the picture and the word would pick out the same prototype which would, therefore, motivate the same response. That is, in this case both the word and the object are related to the prototype in the same way.

Two sets of hypotheses were confirmed. The first set claimed that at least two separate and distinct modular systems coexist, a language module represented by compositional concepts and a perceptual module represented by prototypes. The evidence for this finding was threefold. Firstly, the results offered evidence that words and pictures are processed differently as a function of classification question asked. In the compositional task, the word stimuli produced significantly more compositional responses than did the picture stimuli for the normal and dyseidetic dyslexic groups. In the typicality task, there were no such response differences for any group. This asymmetry suggests different modular systems (i.e., different classification schemata) are mediating the responses differently as a function of the classification question asked. Secondly, the findings suggest that stimuli can influence some types of responses

for some kinds of tasks. The fact that words and pictures produced significantly different responses for the compositional task but no differences for the typicality task also suggests that the two tasks are accessing different modular systems (i.e., classification schemata). Thirdly, the results from the sample of dysphonetic dyslexic children indicate that they made significantly fewer sorting choices based on compositional criteria in both the word and the picture condition of the compositional task than did the other two groups. Thus impairment within a module accessed by the classification task resulted in divergent classification behavior predicated on that modular system.

The second set claimed that language disabled (as represented by dysphonetic dyslexics in this study) subjects evidence significantly different compositional classification behavior as compared with normals, but evidence no difference in prototypical classification behavior; whereas perceptually disabled (as represented by dyseidetic dyslexics in this study) subjects evidence significantly different prototypical classification behavior as compared with normals and other disabled groups, but evidence no difference in compositional classification behavior. The evidence confirmed the claim

regarding the language disabled subjects but was equivocal regarding the perceptually disabled subjects (perhaps due to limited sample size). The results suggest that at least some language disabled dyslexics have conceptual problems specific to compositional tasks and may therefore have impairments specifiable to the compositional modular system.

The Background

For the past six years, I have been a learning therapist practicing remedial cognitive therapy with learning disabled children and adults (ages 6 to 40; IQ above average) on a one-on-one basis. These years of experience have provided the opportunity to closely observe the nuances of specific learning disorders in these individuals. Over these years I have adopted a model of mind which broadly seems to explain both intact and deviant behavior (i.e., behavior associated with learning). Moreover, the model has often been the underpinning of effective remedial programs.

The model assumes that each individual capable of improving dysfunctional performance through remediation has an observing ego. In psychoanalytic theory, the process of psychoanalysis requires that the observing, reasonable ego be separated from the automatic, defensive, experiencing element for the person to effectively engage in the psychoanalytic process (Fenichel, 1945). Similarly, in learning therapy this ability of an individual to engage in the therapeutic process is based on the

co-operation of a reasonable ego. This aspect of the self is that which is capable of reflecting on multiple forms of self. That is, this capacity allows one to reflect on one's self and one's experience by casting such reflections into symbolic representations. In addition, this capacity enables the establishment of sufficient distance from experience so that the person is able to reflect on his/her own self and experience. In essence, this capacity of a person is his/her penultimate Iness, the capacity of the self to reflect on itself.

This kind of self awareness offers the individual the capacity to both observe and understand (in age appropriate ways) the specific kinds of errors that he or she is prone to make as a consequence of his or her learning disability. Becoming a "good" observer of one's dysfunctional behavior entails both seeing and predicting when such behavior occurs. For example, the poor speller can learn to identify the kinds of words which are problematic for him (i.e., b/d reversals, phonic problems, specific "exceptions," and so on). The poor reader can learn to predict the kind of material which will be difficult to decode and/or comprehend, and schedule extra time for such reading. The poor writer may learn to use a word processor and to utilize several methods of editing.

As part of becoming a "good" observer of one's dysfunctional behavior, the individual can learn to consciously compensate for the kinds of errors he or she is likely to make. Such conscious compensation can take the form of learning spelling rules, becoming an active reader by asking questions before reading difficult material, or learning explicit structures for various writing requirements (e.g., expository writing). Inherent in this point of view is the notion of automatic and controlled processes. Automatic semantic processing refers to the spontaneous and unconscious extraction of some aspects of a stimulus' meaning (Posner & Snyder, 1976; Posner, 1982). Sternberg and Wagner (1982), among others, consider normal development to involve the progressive automatization of processing such that limited capacity resources (e.g., attention and/or consciousness) initially involved in superficial (e.g., phonetic) analysis become available for higher level (i.e., controlled) analysis, e.g., inferring, problem solving, and so on.

Remedial learning seems to evolve in at least two ways, one pertaining to automatic processes, the other to controlled processes. First, through drill of basic

skills which heretofore have been difficult for the individual to master (e.g., phonetic spelling), some behavior becomes automatic or not dissimilar from the automatic processes in a normally functioning individual. That is, bridges if you will are constructed by consciously focussing on material that is difficult to master (e.g. phonics), bridges that ultimately operate similarly (i.e., quasi-automatically) to those skills which develop in most people automatically as a by-product of learning to read, spell and so on (e.g., phoneme perception). However, such bridges do not seem ever to be "constructed" to function perfectly automatically. That is, the poor speller never becomes an excellent speller.

Beyond the construction of bridges (i.e., drill in basic skills), the individual must learn to observe, predict and compensate for the disability and consequent behavior, as well as unlearn dysfunctional habits, erroneous information, and so on. That is, the aware observer can learn to compensate for dysfunctional behavior by learning strategies which consciously circumvent problem areas while maximizing particular individual strengths. These conscious compensations involve the controlled processes. For example, a poor speller can easily employ a word processor and a spelling program. Nevertheless, if a

sequencing disorder underlies that spelling problem, then the sequencing disorder will probably compromise many activities which require sequencing. A sequencing disorder is characterized by phonemic substitutions and mis-sequencing of phonemes within words & words within sentences. This disorder is often accompanied by subtle comprehension limitations especially for rapid, lengthy, syntactically complex spoken and written language, with intact single word vocabulary and general semantic competence (Denckla, 1979).

For example, an adult client (28 years old) has a significant sequencing disorder. She has mastered spelling and reading, skills which were difficult for her to acquire in childhood, but still has difficulty sequencing factual information when attempting to communicate a complex sequence of events. The underpinnings of this difficulty seems to be problems with complicated syntax as illustrated below. This difficulty affects both telling and writing about complex ideas or events where the order of presentation is critical. For example, as a social worker she must keep daily logs of her activities with clients. In writing these brief records, she often will make one point about a client, move on to another point, and then return to the first.

Although problems with order have been pointed out to her on her job many times, she claims that when initially writing the records she has great difficulty perceiving them.

She now understands her problems in detail, a significant first step, and is attempting to develop compensatory strategies with which to deal with this problem, especially on her job. She has tried to list events as they occur to her (almost always out of sequence), then attempt to number them in some coherent order, and only then to write a report. This compensatory strategy is only partially successful because even after the listing of all the events, she often fails to perceive a coherent order in which to present them. Her disability blocks the effective use of any strategy which relies mainly on some aspect of temporal or logical sequencing because the complicated syntactic structures required for such presentation elude her.

However, what she can learn are various methods of organization, application strategies for each method, and specific ways of making coherent transitions. Indeed, in this case more successful strategies have involved abstracting the inherent structure of typical daily

records and longer reports so that she can fill specific content into a preexisting structure. For example, together we have determined that the structure of a daily record is 1)focus of encounter (with no more than two different points), 2)client's report regarding focus (one or two sentences), 3)social worker's intervention (one sentence) 4)client's response to intervention (one sentence), 5)any follow up activities for social worker. With such a structure, this client is able to enter the appropriate content.

In addition, she can learn to identify and employ her strengths. She is a talented musician and song writer, can easily describe moods and feelings, and fairly accurately describe what she has observed. Another of her strengths is a ready empathy with her clients which frequently allows her to understand their feelings and motivations. Moreover, she is learning to incorporate these impressions in reports by first listing her clients' strengths and weaknesses and then plugging this information into the appropriate structures. A recent example of her report writing, a six month reassessment of a case, illustrates her use of explicit structures as well as her continuing sequencing problem. The first paragraph illustrates her ability to use a structure and enter

content: one statement about the client's compliance, one about what the client has learned, one of evidence supporting this claim, one of whether services are still needed:

Client is continuing to come regularly for counseling. She is learning ways to communicate her feelings more openly with the family and is less flustered in times of stress. Her children have been obeying her authority more often, but this is still not consistent. Further counseling is needed.

But in the second paragraph her sequencing problems emerge:

In the area of parenting and home management, client is delegating more responsibilities to her children who are completing their tasks more willingly. Client is continuing to develop her parenting skills and is becoming more confident.

Note that the topic sentence of the paragraph is the second sentence. Noticing that the second sentence is out of order because it is a more general statement than the first is extremely difficult for this woman, although when it is pointed out to her she can now quickly realize that a mis-sequencing of ideas has occurred. That is not to say that all writing must be so structured. Rather her writing can become so unstructured that such strict adherence to structure is necessary for her.

What is important about this case for this discussion is that, although this woman will probably never be able to

rely completely on an inherent ability to sequence events chronologically or logically, she will nevertheless learn to predict the coming of a problematic sequence and utilize one or several learned effective strategies (e.g., first abstracting the structure, then entering the content), thereby exerting some control over the heretofore disabling situation. That is to say that sequencing will probably never become a completely automatic procedure because of the profundity of her inability to sequence even a list of events. In the example cited above, the syntactic markings that indicated that one statement is more general than the other were not apparent to her. Nor does it appear feasible at this time that she will ever possess strategies which will enable her to utilize complicated syntactic structures completely independently. Nevertheless, instead of being functionally incapacitated by this disability, she is learning to apply control processes to both compensate for and circumvent heretofore disabling situations.

The model being developed here includes both automatic processes and consciously employed, controlled, complex processes. It also allows for self observation and reflection. These constructs can be mapped onto the modularity thesis briefly described in the introduction

where lower-level automatic processes are present in modular systems while higher-level control processes are part of the nonmodular systems with self-awareness as one feature of nonmodularity. It will be recalled that the modular systems are usually, 1)automatic (i.e., unconscious), 2)isolated from other modular and nonmodular systems, are 3)limited to processing information related to a specific domain, and are 4)encapsulated in that the range of information to which the particular system has access is circumscribed. In contrast, the higher level, nonmodular processes can be conscious, amenable to executive control and capable of utilizing some or all of the information garnered from the automatic modular systems. What differentiates the nonmodular from the modular processes is this capacity to potentially utilize all of the information garnered from the automatic modular and nonmodular processes.

The metaphor to building bridges which eventually operate nearly automatically is suggestive of the literature on the novice-expert shift, where overlearning allows an ability (e.g., driving) to appear automatic. However, unlike a truly modular ability (e.g., phoneme perception), a quasi-modularized ability can come under close conscious control whenever one deems it necessary or

important to do so. As Fodor (1985) puts it, "You can, and do, bring driving...under close conscious control when your sense of the task suggests that it would be well to do so, for example,...when there seems to be snow on the road. [But],...you can't voluntarily modulate your phone analysis procedures; the best you can do is try to pay more attention" (p. 39).

The quasi-modularized abilities constructed by the disabled person through overlearning or drill function similarly. For example, it can be said that the extent to which the "bridges" (e.g., sound/symbol relationships) built by the poor speller begin to function automatically, is the extent to which they function as part of a quasi-modularized system. These quasi-modularized systems are also penetrable on two counts. The constructed bridges are vulnerable to high anxiety states--they tend to fall apart at such moments. Also, behavior which results from such bridges can be modulated--predicting that anxiety is going to sabotage some bridges alerts the individual to consciously attend and consciously modify the otherwise quasi-modularized activity.

Specific disabilities can disrupt specific automatic processes (modular) and/or aspects of complex processes

(nonmodular). As has been noted frequently in the literature (e.g., Benton, 1977; Denckla, 1979), the protocol of a learning disabled individual usually reveals a cluster of related difficulties which seem to involve more or less discrete cognitive systems (i.e., discrete automatic, modular processes and/or complex, nonmodular strategies). From the point of view of this study, these same relationships can be mapped onto the modular cognitive model of mind being developed here. For example, the developmental disorder dyslexia with mixed-global language disorder can be compared, albeit roughly, with the acquired disorder alexia with aphasia. Such disorders could also theoretically be mapped onto a modular model where the language module plus perhaps some nonmodular systems were compromised by both disorders. However, in discussing the nosology of learning disabilities Denckla has raised the following caveats:

Nosology itself is controversial in this field; some leading figures in the analysis of symptoms urge us to forswear "syndromes" in favor of less medically based constructs. Our patients outlive us; deprived of anatomy, we reason by analogy. The "mechanisms" of which we are able to speak are inferred from clusters or correlations of functions or dysfunctions, at best longitudinally sequential in time; they have not yet been demonstrably proven chains of causality. Furthermore, intensely aware of the interplay between nature and nurture in the developmental period, we offer up our bits of "neurologizing by analogy" as might an

archaeologist hold aloft a potsherd from beneath the rubble, crying "Look! Brain factors here." Yet I submit that our cheerful (though cautious) plagiarism of assumptions and tests from classic adult-referenced neuropsychology has heuristic value. (Denckla, 1979, p. 535)

In discussions of the model being developed here similar caveats obtain. As discussed in more detail in subsequent chapters, a modular model should roughly account for neuropsychological findings, but at the same time such a model should not be expected to map specifically onto neurological structures. Nevertheless, such a model should be able to account for dysfunctions as well as cognitive functions which is one of the reasons that learning disabled subjects were chosen for this study.

From the point of view of the model propagated here, a specific modular system (or systems) may not develop adequately because of a cognitive disability. Such inadequate development may result not only in underdevelopment of that system (or systems), but also in aberrant development of that and/or related systems. Underdevelopment may result primarily from the fact of the disability. But underdevelopment may also derive from underutilization of the particular system due to unreliable results when accessed. For example, a child who is having difficulty learning letter sounds may not

only passively experience this phenomena (i.e., the underdevelopment of the system), but also may actively avoid accessing the system by defensively refusing to engage in activities related to learning letter sounds. As such a child develops, an investigation of his cognitive functioning might reveal an almost total disuse of the sound/symbol system to decode or spell words, while, at the same time, an over-reliance on pattern perception (e.g., does the word look "right"; does the pattern look like any recognizable word).

Aberrant development may result primarily from the fact of the disability. That is, a disability may abet inconsistent, incoherent, and/or fallacious development within the compromised system. Such aberrant development may also have consequences beyond the compromised system. For any system which receives information from the compromised system, may receive information adversely affected by it. And such inaccurate information over time may result in inadequate or aberrant development of that related system as well.

For example, a twenty-five year old woman graduate student in rabbinical school has a history of poor spelling and difficulty remembering specific facts (e.g.,

dates, names, letter sounds). The etiology of her disability appears to have been several impaired lower level abilities including phoneme perception and effectively organizing or chunking details upon learning new information. Her case can be construed as an example of lower level impairments secondarily effecting higher order functioning. That is, her impaired lower level or modularized abilities may have fed the nonmodular systems inaccurate or incomplete information thereby requiring those systems to devise aberrant compensatory strategies. As will be seen, in this case those aberrant compensatory strategies took the form of attending only to major concepts while ignoring supporting details.

This client is considered in her rabbinical school to be an exceptional orator and sermon writer, but has difficulty writing an academic paper. Her teachers are continuously perplexed by this dichotomy in her performance. Her writing difficulties include poor spelling, poor transitions, and inadequate development of ideas and concepts. Working together we discovered that she has an excellent ability to understand concepts, but she consistently fails to present her conceptual arguments with supporting evidence, relevant details, and illustrative examples. However, she does employ striking

examples to illustrate pictures of what she wants her congregation to comprehend from her sermons. Still her examples are not always consistently or coherently developed or related to her conceptual points. Some excerpts from a recent sermon may illuminate this point.

I know a man who I didn't know. What I mean is, I didn't know him when he lived on this earth. When he was alive physically, I was a different person, in a different place. This sermon is for him, because it is through stories of his laughter, is [sic] playtime, his breath and his death, that I better understand what it means to be alive.

The above paragraph opened the sermon. Subsequent paragraphs developed the following themes: a situation from her own parent's home emphasizing the risk a child takes using forbidden red handled scissors and a related example from the biblical story of Abraham and his son Isaac where in this rabbinical student's version Isaac has used a forbidden knife:

...Isaac has once again taken the red handled knife from the kitchen and has been using it with out [sic] permission. Abraham desperately needs the knife because God, his boss, has asked him to prepare a special presentation to the board...a type of offering. Well Abraham can't find the knife anywhere..."Whose [sic] got the red handled knife..."Sarah, do you have it...I know Isaac get in here...(I'm going to kill that kid) Isaac come in here and bring that knife with you!

...What a risk Isaac took in using that knife. What a risk it is for Abraham to present

the best of his work to God. What an incredible risk on God's part to demand so much. What a risk being a parent...being a child...being God. How good it is to be alive and to hear the demands...to feel disappointment...to risk getting caught...to be rewarded for the unexpected...to live your life never taking any moment for granted. To test yourself so that a risk is worth it because in testing yourself you push yourself harder and force yourself to find your limits and then to go beyond them. To risk letting go of your control so that you might feel for a moment...I'm going to kill that kid...

Notice that she has written an emotionally gripping sequence which lacks sentence structure and logical development of her points, but nevertheless has carried her audience with her in developing her ideas. However, such tactics would not work so well in an academic paper which is one of the reasons why her academic papers are inferior to her sermons. That is, her ideas or concepts are interesting, but her development is inadequate.

The sermon continues developing the story of Abraham and Isaac for several paragraphs (5), then several paragraphs about risks (3), then a short Jewish story, and only then the following paragraph:

Alas what I learned from that man who I didn't know was that life is worth it no matter the cost. That in order to be most like Abraham we must be willing to test ourselves and take all of the risks. This friend could ski even after one leg was amputated. He wanted to fish even though he weighed almost as much as the fish he would catch.

Here she makes an obscure reference to her "friend" without mentioning either that she had referred to him in the opening paragraph or that this "friend" was the dead man to whom she had referred in that paragraph. Her congregation may not have been able to recall the reference. Surely, in an academic paper, such an obscure reference would seem incoherent. But to this woman, such problems with cross-reference are astounding. For her the sermon is organized by the concept of risk. The details illustrate but are superfluous. The example of the dead man is as important as the story of Abraham and Isaac. For her way of comprehending is to focus on the concepts without particular regard for supporting details. And she finds it difficult to appreciate that others might comprehend information in other ways.

Initially she rationalized her behavior on the grounds that the details were unimportant, boring and obvious. However, with further probing we discovered that her abhorance of detail was a defense against recognizing her poor ability to organize, memorize and utilize detail effectively. Being a bright individual, when faced with difficult material to learn or write about, she compensated by immediately delving into the heart of the

matter, i.e., the concepts involved, while ignoring the "superfluous" details. She had developed this strategy to such a degree that she was unaware of her aberrant behavior.

The last two cases will be offered in order to present possible examples of discrepancies between the development of the compositional representational system and the prototypical representational system. That is, one case will illustrate underdevelopment of the compositional system with an intact prototypical system, and the other case will illustrate the opposite phenomenon. In order to do so, the theory must go rather far beyond the data. However, both cases offer interesting possibilities of such development and are presented in that spirit.

The first of these two cases illustrates inadequate development of the prototypical representational system. A recently evaluated six year old girl functions in the superior to very superior ranges on verbal tasks and average to high average ranges on performance tasks of the WISC-R. Thus, the subtest scaled scores of the performance tests were significantly below the scores on the verbal tests. Although none of the performance scores fell below the 50 percentile, they nevertheless reflect a relative

discrepancy between verbal abilities (in the 96 percentile) and performance abilities.

Picture Completion showed adequate ability to notice important details. However, Picture Arrangement (50 percentile) reflected relatively poor use of those important details and other visual cues when sequencing a series of pictures into stories. Object Assembly (63 percentile), assembling puzzles, revealed difficulty with reproducing a familiar object. When constructing the puzzle of the girl, she got all of the pieces in place except the skirt by matching edges. She then had to rearrange the pieces to include the skirt. What she did not seem to have done is to use the information that a typical girl might wear a skirt and integrate that information into her initial construction. She did not seem to have a working image of such a typical girl. This example is even more striking because she attends a school where the girls must wear skirts everyday. Even more revealing was her construction of the puzzle of the horse. She knew it was a horse, but she could not place the pieces together correctly. "I wish I could see a horse someplace. I need to see what one looks like to put it together," she declared. When asked after completion of the task if she could find the "picture of the horse"

in her head, she said she could not. In contrast, she scored in the 95 percentile on the Vocabulary subtest and in the 99 percentile on the Similarities subtest. In the spirit of drawing contrasts to illustrate the model being developed here, the data from this case can be extrapolated to postulate that there is a significant discrepancy between the development of her two classification systems which reflects a specific learning disability (other data corroborates a visual-motor integration immaturity and possible visuoperceptual impairments which are interfering with learning). That is, this child can be viewed as having a relatively underdeveloped prototypical classification system while at the same time possessing a highly developed compositional conceptual system.

The other case illustrates the opposite development. This ten year old boy is dysnomic (as measured by the Jansky Screening Index Picture Naming Test). He made 10 errors on the Wepman Auditory Discrimination Test (3 errors is the cut off for poor performance) and performed in the dysphonetic range on the Boder Test of Reading-Spelling Patterns. Some of his WISC-R scaled scores for individual subtests were as follows: Vocabulary 9, Arithmetic 14, Picture Arrangement 17, Object Assembly

14. The scores reveal a significant split between verbal and performance abilities. The following Educational Records Achievement Battery Scores corroborate his language problems (Independent School Percentiles): Vocabulary 34 percentile, Reading Comprehension 17 percentile, English Expression 30 percentile. Examples from the WISC-R Vocabulary subtest also reveal his difficulties. He defined join as to combine, diamond as see-through jewelry, prevent as to avoid something.

Yet his remarkable imagination peopled with a panoply of images of characters with subtle variations and deviations from one another (such representations will be considered to be prototypes subsequently), all of which he understands impeccably, stands in sharp contrast to his verbal skills. For example, at 9 years 2 months his answers to the Stanford-Binet Absurdities (9 year old level) were as follows: When explaining what is absurd about the statement that a man had the flu twice (the first time it killed him and the second time he got well quickly), he said, "The first time he was dead--he couldn't get alive again...Only Jesus proved he had the power to make a dead person alive again." When working through the Christopher Columbus absurdity (In an old graveyard in Spain they have discovered a small skull

which is believed to have been that of Christopher Columbus when he was about ten years old), he said, "Christopher Columbus -- when you die, Christopher Columbus didn't die in Spain...Christopher Columbus'...his bones wouldn't be there, oh, and when he was 10 years old he wasn't dead." In both examples it might be said that his "prototypes" (i.e., what it means to be alive, dead, or Jesus and who Christopher Columbus was) aided his reasoning through these absurdities. He seems to express the problems in terms of the typical images he has.

He also can write an effective story, although his language problems are apparent:

Firday [sic] the 13 I went to my country house. When I got there I started to play ball. But when I was playing ball, I saw a egg under a three [sic]. I walked up to the three quietly. But when I touch [sic] the egg I found out that it was a ball I got annoyed I through [sic] the ball behind me I ran back and started to play ball.

One possible explanation for his relatively creative ability to explain the absurdities and write such a vivid vignette is that he indeed has a remarkable imagination full of prototypes.

However, lexical definitions and verbal abstractions are difficult for him. He is a poor reader and speller, and

therefore, writes poorly as exemplified above. Again in the spirit of extrapolating possible examples of the model from the data presented here, the following description of his functioning is offered. His impoverished lexicon (and impoverished compositional system) may be secondary to his reading and spelling disability. The lexical system may not have adequately developed because he has had to spend so much time and effort, as well as concentrate so diligently, decoding words, that development of his compositional system was compromised. The process of decoding has not as yet become a completely automated process. Because of this lack of automation, processes with limited capacity such as attention or concentration are relegated to the role of decoding. Consequently, the controlled, limited capacity resources are not free to engage in higher order processing, including perhaps enriching the compositional network.

These two cases are significant because they illustrate how particular modular systems might develop inadequately in otherwise intact individuals. Two such systems, one based on prototypical organization and the other on compositional organization, are the ones which have been investigated here in children with specific learning disabilities. The model propagated in this study suggests

that the two systems can both participate in a model of mind and that their schemata are represented in distinct and separate faculties or modules. Such modules operate qua automatic processes with the added restrictions of information processing limited to a specific domain (e.g., language) and isolation from other such systems. This model will be described in detail in the chapter on Fodor's Modular Model of Mind. Broadly, the model developed in this study not only allows for modular systems, but also provides for the existence of nonmodular processes: higher level control processes amenable to executive control and capable of utilizing some or all of the information garnered from the automatic modular systems and other nonmodular systems. As pointed out previously, what differentiates the nonmodular from the modular processes is this capacity to potentially utilize all of the information garnered from other systems. Finally, the model allows for self observation and reflection to be one of the nonmodular processes.

The study investigated proposed to provide evidence that children with particular learning disabilities, as diagnosed by individual evaluation administered by school psychologists, can evidence problems in one of these classification systems as a consequence of their

particular disability. To argue this case and develop both the model and the specific tasks utilized in this study, the following points will be explored: 1)presentation of some relevant current studies investigating learning disabilities, 2)examination of unitary versus dual processing models, 3)development of the notions of prototypicality and compositional concepts 4)presentation of a modular model of mind, and 5)reflections and adaptations of the model and the experimental evidence, followed by the plan of the specific study investigated.

SPECIFIC LEARNING DISABILITIES

The Present Study

This study examined semantic processing and classification behavior as manifested in sorting strategies in two specific groups of dyslexic children, dysphonetic and dyseidetic readers and spellers (as specified below). Dyslexic children were chosen as experimental subjects because it was reasoned that 1)reading behavior can be considered as closely related to classification behavior, and 2)that dyslexic or reading disabled children with specific deficits which interfere with reading in specific ways would also evidence particular aberrant semantic processing and classification behavior as a consequence of their deficits.

The argument that reading and classification behavior are related can be substantiated in several ways. First of all, when investigating classification, Luria (1981) has demonstrated that classification behavior as evidenced

by sorting strategies differentiates levels of education: illiterate adults tend to sort along more 'concrete' dimensions (e.g., dogs have tails) although they are capable of sorting along more 'abstract' (e.g., dogs are animals) dimensions when asked to do so. Luria concludes that spontaneously sorting by more abstract categories reflects a logical hierarchy of concepts learned at least in part by reading.

Reading can also be considered as interrelated with classification behavior. Both skills involve lexical access. Gagne (1985) defines lexical access as follows:

During lexical access, the meanings of words are identified. The term comes from the notion that humans have mental dictionaries (lexicons) that are accessed during language comprehension...Lexical access is the end result of decoding. That is, when patterns of print or sound are recognized, the meanings associated with these patterns are activated in long-term memory. (p. 168)

When the lexicon is accessed and meanings are associated with patterns, comprehension involves understanding. Understanding involves classification. Therefore, it can be said that a classification schema is often accessed. Thus, classification behavior can be said to involve lexical access. Moreover, when engaged in the act of reading, comprehension demands many levels of

understanding. One such level is frequently classification, i.e. identifying the category to which a particular object is a member.

Other researchers have made similar assumptions. When Hunt, Davidson and Lansman (1981) investigated the relationship between reading comprehension and speed of lexical access in college students, they used category membership tasks. They measured reading comprehension with the comprehension subtest of the Nelson-Denny reading test and speed of lexical access with reaction time classification tasks requiring retrieval from memory. For example, in one task subjects were presented with two words: one was always a superordinate category (e.g., furniture); the other one varied randomly such that half the time it was an instance of the superordinate category (e.g., chair) and half the time it was not a member of the category specified (e.g., peach). Results indicated that speed of identifying category membership (i.e., speed of lexical access) correlated with reading comprehension about .30.

Hunt et.al.'s use of category membership tasks as a measure of speed of lexical access has merit. However, although they reported the correlation of .30 as a

substantial finding, it accounts for only nine percent of the variance. It may be that the correlation between speed of categorization and reading comprehension is only .30. Or it may be that a more robust correlation was masked by the study design. For, studies with designs like this one, which do not differentiate among the kinds of reading problems the less skilled readers are exhibiting, often mask findings by treating all subjects with reading problems as part of a single, uniform group. The subjects in the group of poor readers might have possessed significantly distinct rather than uniform deficits. Therefore, the low correlation may be a function of this lack of differentiating among reading problems.

In the present study, the dyslexic experimental subjects were divided into subgroups of dyslexics for two theoretical reasons. Firstly, specific subgroups of dyslexics were studied because the processes which underlie reading are so complex and so numerous, that these abilities must be vulnerable to many different deficits (Rapin & Allen, 1983); therefore, dyslexia should be assumed to result from any or several of these many deficits. Indeed, the confluence of research suggests that a nosology of learning disabilities must include at

least several different syndromes among children with dyslexia (e.g. Denckla, 1974; Ingram, 1975; Mattis, French & Rapin, 1975; Benton, 1977; Rapin & Wilson, 1978). And, as noted above, researchers who fail to delineate such subgroups may obtain ambiguous results. Secondly, it was postulated that dyslexic or reading disabled children with specific deficits which interfere with reading would also evidence specific aberrant semantic processing and classification behavior as a consequence of such deficits. This idea is elaborated below.

Boder's method (1982) of delineating dyslexic syndromes was utilized in the present study because it was reasoned that members of two of her groups, dysphonetic and dyseidetic readers and spellers, could exhibit problems with specific, but distinct, kinds of classification tasks as a consequence of their particular deficits. In addition, it was postulated that the specific, but distinct, deficient classification behavior that would be exhibited by these two groups would result from dysfunctions in different cognitive systems or modules. Specifically, it was postulated that members of the dysphonetic group would exhibit problems with tasks requiring compositional kinds of classification behavior resulting from deficits in the language module (as

described earlier and as elaborated upon subsequently), whereas members of the dyseidetic group would exhibit problems with prototypical classification behavior resulting from deficits in a perceptual module. A description of the deficits associated with each subgroup will help to clarify these postulated relationships.

Dysphonetic readers and spellers have auditory processing deficits manifested as auditory perception and discrimination deficiencies, and sequencing, sound-symbol integration and word analysis-synthesis difficulties. This syndrome has been described by several investigators including Boder who identified this group based on an analysis of reading and spelling errors (1971), as well as, Pirozzolo (1977), Denckla (1979) and Mattis (1978). Among language disordered children this disability is considered the most prevalent (Ingram, 1975; Morley, 1972; Rapin, 1983). Typically word attack skills are phonetically inaccurate in reading and spelling such that the ability to sound out unknown words is extremely poor or nonexistent (Boder, 1982) and the learning of phonetic analysis is difficult and often incomplete. Misarticulations are also exhibited. The disabilities described as characteristic of this syndrome impinge upon basic functions which operate qua the perceptual apparatus

of language.

Hence, in this study, the dysphonetic dyslexics were considered to possess impaired language modules. It was reasoned that dysphonetic dyslexics would exhibit difficulties with tasks which are mediated by the language module. Tasks mediated by the language module which involve word meanings can be considered as accessing a lexicon also within the language module. Such a lexicon probably includes a compositional classification system. As stated in the introduction, compositional and prototypical classification behavior are postulated as reflecting two distinct systems of category representation mediated by two distinct faculties or modules. In this study compositional classification behavior was measured by a hierarchical sorting task described in detail in the next section. It was hypothesized that dysphonetics would exhibit difficulties with compositional classification tasks. Because their primary disability, decoding, would compromise their ability to access their lexicon, tasks accessing the compositional system (which is postulated as included in the lexicon) should reflect those deficits. That is, tasks accessing the compositional system should reveal the implicit hierarchical organizations as manifested by sorting strategies employed by subjects.

The dyseidetic group has been associated with visual spatial disorders (Boder, 1982), sometimes referred to as Gestalt-blind readers and spellers or visuoperceptual dyslexia (Mattis, French, & Rapin, 1975). This group represents a small minority of all language impaired children (Mattis, et.al., 1975). In this group, the primary problem is not with the language, but with visuoperception. That is to say that the primary deficit can be viewed as a consequence of a dysfunctional faculty or module whose primary characteristic is visuoperceptual and that such a faculty can be distinguished from a linguistic faculty. Further, this faculty can be said to possess it's own unique classification system, here postulated as internally represented by prototypes. (Such a faculty may also be distinguished from a visuoperceptual faculty which mediates abstract nonverbal information which is not represented by prototypes [e.g., facial recognition].) If this is the case, then tasks requiring prototypical classificatory behavior should be deficient in this group.

This study will not address either the question of whether a learning disability necessarily implies brain pathology or what that brain pathology might be. Rather a

cognitive model of mind will be offered which should be distinguished from one based on brain behavior relationships, and, therefore, should not necessarily be regarded as mapping onto specific brain areas. Nevertheless, both Denckla's and Rapin and Allen's speculations regarding the linguistic behavior of learning disabled children who resemble dyphonetic dyslexics and the possible neurological underpinnings of their disorder will be briefly presented. It is the contention of this study that the specific semantic category problems (i.e., compositional & prototypical) postulated as found in children with the disabilities specified will help delineate what Denckla refers to as problems intermediary between panconceptual (G) and specific (S) deficits.

In addition, it is unclear precisely what Rapin and Allen consider "semantic categories" and what they mean when they report that they have observed this disabled group of children as having "relatively intact" semantic categories (p. 167). However, it is not expected that specifying particular semantic category problems will contradict their observations.

Finally, the fact that specific types of dyslexias may be related to specific brain pathology (i.e., localizable

in brain) while not confirming a modularity thesis, can nevertheless be considered as supporting evidence for such a thesis. For evidence which confirms that localized brain pathology results in the disruption of some kinds of tasks, while at the same time not disrupting other kinds of tasks, suggests encapsulation and isolation of those corresponding cognitive functions. And evidence of cognitive encapsulation and isolation offers sufficient warranty for the provisional acceptance of the modularity thesis as a working hypothesis for the thesis suggests a model which allows for such encapsulation and isolation.

Denckla (1979) has described a specific dyslexic syndrome associated with a sequencing disability similar to the dysphonetic syndrome described above. However, she has also (1983), as have others (Rudel, 1980; Rapin, 1983), characterized these problems somewhat differently. Focussing on the limited capacity for generalization that many language impaired youngsters exhibit, Denckla might argue as she has elsewhere (1983) "...my bold suggestion is that a pure dyslexic, with no deficit in spoken language, appears to have some subset of general verbal learning deficits associated with left convexity frontal lobe (p. 41)." Such subjects are characterized by "...deficiencies of rehearsal, coding, selective

organizing, or learning-to-learn strategies that are confined to the verbal, analytical, and sequential aspects of learning. These weaknesses are somewhere in the middle between G [i.e., the general intelligence factor of IQ theory] and S [specific] factor deficits and do not express themselves either in general (G) panconceptual failure or specific (S) aphasia-like language failure (p. 37)." Similarly, Rapin and Allen (1983) have described a phonologic-syntactic syndrome as including the findings described by Boder, as well as, having syntactic problems (e.g., "the baby is cry"), but with semantic categories relatively intact. And like Denckla they postulate some frontal lobe involvement in this syndrome. Indeed, they point out the co-occurrence of phonologic and syntactic deficits in both this dyslexic syndrome and that of adults with an acquired expressive aphasia.

These syndromes are discussed to suggest that a model based on adult neuropsychology (i.e., brain-behavior relationships) can offer different, but not necessarily unrelated, explanations for deviant behavior. For example, if, as suggested above, the cognitive model being presented here is able to offer possible refinements in understanding of concepts, categories, and classification behavior, then such refinements may offer more precision

to neuropsychological considerations.

The model developed in this study also suggests that a cognitive model of mind may have explanatory value regarding cognitive dysfunction which the discipline of neuropsychology has largely ignored thus far. The fact that at present neuropsychologists postulate brain involvement, e.g., frontal lobe involvement, whereas the cognitive models offer other constructs, e.g., specific modules, should not at this time be taken as contradictory. If findings from both models consistently obtain, then the models in both disciplines accounting for both sets of findings need to be constructed. But, at present, to insist that particular models in one discipline need necessarily account for all of the findings and/or postulates in the other discipline is to prematurely dismiss certain kinds of investigations. For example, several psychologists and neuropsychologists (e.g., Grossman, 1985 & Morton, 1985) criticize Fodor's short book on Modularity of Mind for not accounting for all of the evidence accrued in the last 15 years in related disciplines. But that would constrain such an idea before it has had a chance to be explicated. Or as Forster put it, Modularity is "a programmatic sketch of the kinds of things it would be worth having a theory

about." Similarly, the model offered here is one approach to considering classification behavior. The fact that it does not, in its present form, account for frontal lobe involvement in this behavior is not to discount such involvement, but rather to focus on other cognitive considerations.

Classification Behavior in Learning Disabled Children

How have other researchers investigated classification behavior in learning disabled (LD) children? A.R. Luria (1981) discussed the investigation of conceptualization in the book Language and Cognition. Luria's description of abstract, verbal-logical generalizations compliment the theory being propagated here. They are just the sort of traits that characterize the compositional representation schema. Luria noted that when school aged children are asked to define concepts (dog), measurement of the development of their verbal logical system of hierarchically structured abstract categories is possible. Normally, at school age, they begin to define concepts more abstractly, switching from definitions that are concrete situations or features associated with an object (e.g., dogs have four legs) to ones which reflect development of hierarchically structured abstract categories (e.g., dogs are animals).

Another method of investigation that he employed is comparison and differentiation, i.e., asking what two items have in common. Here Luria noted that due to an

undeveloped verbal logical system of hierarchically structured abstract categories, pre-school and young school children usually point out what is different between the two items presented (e.g., dogs bark but cats say meow). For according to Luria, the identification of common features involves including an object in an abstract category (e.g., dog and cat are animals).

A third method of classification, often referred to as the superfluous fourth, involves presenting three objects that belong to the same category plus one item which is functionally related to them but a member of a different category (e.g., a saw, an axe, a spade, and a log). Again sorting strategies differentiate between younger and older school children. Further, as noted above, Luria and others have demonstrated that sorting behavior differentiates levels of education: illiterate adults tend to sort along more concrete dimensions although they are capable of sorting along more 'abstract' dimensions when asked to do so.

In sum, Luria suggests that in normal development there is a measurable change from concrete definitions of categories of objects characterized by identifying objects with concrete situations and features, identifying

differences rather than similarities, and combining items which are functionally related rather than categorically related. The developmental change is characterized by the ability to employ what Luria refers to as abstract, verbal-logical generalizations. These verbal-logical generalizations include the ability to formulate abstract categories (e.g., dog and cat are animals), here referred to as compositional concepts.

Thus, Luria is arguing for a fundamental change during development which differentiates adults and older children from younger children. This differentiation is not only a quantitative difference in the degree of internal detail and richness of essentially the same conceptual system, but a genuine qualitative change in that system. This position is theoretically problematic as it lacks an explanation of learning which allows a child to acquire (learn) a concept that s/he does not already have the capacity to acquire.

Nevertheless, Luria's observations regarding developmental change are important: normal maturation should involve the development of the ability to make verbal-logical generalizations. Education and literacy probably play a crucial role in this maturation. And

finally, children with verbal learning problems are at risk for aberrant development of this conceptual ability, for exhibiting difficulties with abstract, verbal-logical generalizations or compositional concepts.

A series of studies of classification behavior in LD children will now be discussed in relation to the proposed study. The discussion will focus on 1)examination of the propensity of LD's not to spontaneously employ conceptual categories (e.g., e.g. Torgesen, 1977; Torgesen, Murphy & Ivey, 1979; Frumkin-Feis, 1982; Bauer, 1982; Suiter and Potter, 1978); 2)consideration of the fact that category information when used to cue recall does not seem to facilitate recall when the task accesses an impaired modality (Ceci, Lea & Ringstrom, 1980; Ceci, Ringstrom & Lea, 1981); 3)dual processing or verbal versus visuoperceptual processing in LD's (Fletcher, 1985; Swanson (1986); 4)LD's metacognitive understanding of the workings of their memory systems (e.g., Torgesen, 1979; Ceci, 1982); 5)differentiation between automatic and purposeful semantic processing (Sternberg & Wagner, 1982; Ceci, 1982; Goldstein, Hasher & Stein, 1983; Ceci, 1984); 6)the specific task to be used in this study to investigate compositional networks (Frumkin-Feis, 1982).

Several studies have suggested that LD children are less likely to employ conceptual categories when attempting to learn new information (e.g. Torgesen, 1977; Torgesen et.al., 1979; Frumkin-Feis, 1982). Torgesen (1977) found that LD children were less likely than normal children to organize stimulus material to be learned into conceptual categories. However, he found that if LDs were instructed to cluster stimuli when studying, recall scores improved significantly. In fact, when Torgesen, Murphy and Ivey (1979) instructed LD and normal children to sort several items into taxonomic categories, an unexpected recall test revealed no differences either in recall or clustering scores. Nor did the groups differ in their ability to sort according to semantic category. Yet if the LD children were not specifically told to use organizational strategies, both recall and clustering scores were significantly inferior to normals. Therefore, it would appear that the issue is not that LD's are unable to organize material into categories, but that they do not spontaneously utilize this strategy when instructed to learn new material. Indeed, as discussed in more detail below, Frumkin-Feis (1982) found that both of her LD groups chose categorical groupings significantly less frequently in a sorting task. In the language of this

study, when LD's were learning new material, compositional concepts (mediated by the language module) were not automatically accessed; however, when directed to categorize, the LD's could access the categories needed. That access may have been augmented by the nonmodular central processing systems.

Other researchers suggest that LD children underutilize category clustering strategies. Bauer (1982) reports that he found in his 1979 study that for aurally administered words derived from four categories, not only was the LD subjects' total recall significantly inferior, but LDs were also less likely than normals to recall items in category clusters. Dallago and Moely (1980) also found that nondisabled readers recalled more and clustered more than LD readers when they were presented pictures from ten categories.

Similarly, Suiter and Potter (1978) presented forty pictures of concrete nouns from four categories (food, animals, household items, toys) to language disabled children with no visual memory impairments as measured by the Visual Sequential Memory Subtest of the Illinois Test of Psycholinguistic Abilities. Suiter and Potter presented half of the subjects with the pictures clustered by

category. The other half were presented with the same pictures, but they were not clustered by category. Subjects' recall of the clustered pictures was significantly greater than subjects' recall of the unclustered pictures, suggesting that clustering by category enhances recall of pictured nouns for language disabled subjects without visual memory impairment. However, since normal controls were not tested in this study, it is unclear whether clustering by category would enhance their recall as well.

Other researchers (Ceci, Lea & Ringstrom, 1980; Ceci, Ringstrom & Lea, 1981) have demonstrated that LD children were only minimally helped by semantic cues (i.e., category labels) on memory tasks which stress their impaired modality. This group of researchers used the Detroit Test of Learning Aptitude to divide the disabled subjects into four groups: 1)LD's with visual memory impairment; 2)LD's with auditory memory impairment; 3)LD's with both visual and auditory impairments; 4)nonLD's with no visual or auditory memory impairments. Such subdivisions allowed them to identify an underlying cognitive impairment (or impairments), predict behavior as a consequence of the impairment and compare the results among groups with differing impairments.

Ceci, Lea and Ringstrom administered two experimental memory tasks, a visual task and an auditory task. In the visual task, line drawings of an object in one of several colors were presented individually. In the auditory task, names of objects which rhymed with one of four target words were presented by either male or female voices. For both conditions, each object belonged to one of several semantic categories. Findings confirmed the initial groupings: the visually impaired LD recalled less on the visual task than the auditorily impaired or normals while the auditorily impaired evidenced the opposite profile. Those subjects with impairments in both modalities recalled less on both tasks than all other groups.

Ceci, Lea and Ringstrom also looked at semantic and nonsemantic cued recall in the following manner. The semantic cues were category names; the nonsemantic cues were color and location for the visual task and rhyme (e.g., all the words that rhymed with 'air') and voice gender for the auditory task. For the normal group, the semantic cues yielded superior results as compared with the nonsemantic cues for both tasks. For the impaired groups the semantic cues aided recall only for the task administered in the unimpaired modality. That is,

semantic cues were significantly less effective in enhancing recall on the visual task only for the visual memory impaired group, and on the auditory task only for the auditory memory impaired group. Thus, the LD's did not respond effectively to semantic cueing on memory tasks which stressed their impaired modality, suggesting to Ceci, Ringstrom and Lea (1981) diminished semantic processing in the impaired modality.

However, nonsemantic cueing revealed no such differences in performance between LD's with an impairment in one modality and normals. Thus, LD's with visual memory impairments could be as effectively cued as normals by color and/or location and LD's with auditory memory impairments could be as effectively cued as normals by rhyme (phonemic cue) or voice gender. Decrements were associated only with semantic, i.e. category name cues.

In contrast to Ceci et.al., the study researched here is predicated on the assumption that it is not the modality that is crucial to performance on a particular task, but the cognitive module or system accessed. That is, it is not the fact that it was the visual and/or the auditory modality that processed the information, but the fact that it was a language and/or a perceptual system which was

accessed during a particular kind of task. Although this distinction will be dealt with in greater detail in subsequent chapters, it is important here because it may help to clarify Ceci and his colleagues findings as discussed below.

It is the contention of the study researched here that there are at least two cognitive modules or systems, each possessing a different category representation schema. Based on this model, the alternative explanation, i.e., cognitive module accessed not only modality (i.e., auditory & visual) processing, may suggest a more precise characterization of the LD's performance. Such an explanation would 1) characterize the auditory memory impaired group as having verbal-sequential memory problems associated with the language module, thereby possessing a diminished and/or aberrant compositional category representation schema as well as auditory processing problems, and 2) characterize the visual memory impaired group as having perceptual problems associated with a perceptual module, thereby possessing a diminished and/or aberrant prototypical category representation schema as well as visual processing problems. Such an explanation would characterize semantic processing problems specific to category and module (i.e., compositional or

prototypical). It would also account for the relative lack of such a decrement for the so-called nonsemantic, modality but not module, specific cues (e.g., rhyme for the auditory modality & color for the visual modality). That phonemic or rhyming cues and location cues, module specific phenomena, were not impaired relative to normals probably suggests that normals tend to encode information on the semantic level when possible.

When Ceci, Lea and Ringstrom (1980) had subjects sort items according to semantic category, they then found that semantic cueing enhanced recall more than nonsemantic recall for both normals and LD's with deficits in only one modality. Moreover, following the sorting task which required focussed concentration on semantic categorization, recall in the impaired modality improved significantly. Thus, as noted above (Torgesen et.al., 1979), it is not that LD's cannot utilize semantic categorization in their so-called impaired modality, but rather that they do not spontaneously do so. In the language of the study researched here, when the memory tasks were initially performed the module accessed automatically processed the information. However, when the LD was required to focus on a categorization task, it may be that his central nonmodular systems mediated the

task and recall was enhanced. The aberrant category representational schema may have been ameliorated by other systems.

Swanson (1986) also looked at verbal versus visual-perceptual processing and found that recall of skilled readers was enhanced by semantic associations as compared with LD's. He had LD's and skilled readers view nonsense pictures (selected from Vanderplas & Garvin's [1959] shapes) without names, or with names that either emphasized the semantic aspects of the picture or names that were not so associated. A test of simple main effects indicated that a significant difference occurred between groups for the name associated condition ($F=4.69$, $p<.05$), but not for the unnamed or name nonassociated conditions (F 's <1). However, since he did not divide his LD's into subgroups, it is unclear whether all of his LD subjects possessed the same deficits and consequently exhibited the same disinclination to utilize semantic information to enhance recall. It may have been that his LD group mirrored the general population, i.e., that most of the LD's had some kind of a language impairment and only a small minority had a perceptually based deficit. If this were the case, then the behavior of the perceptually impaired would be masked by the behavior of

the majority.

Fletcher (1985) used both verbal and nonverbal stimuli to study memory ability in subgroups of LDs. He divided his disabled population as Rourke (e.g., 1978) and his colleagues do, based on patterns of academic achievement as measured by the Wide Range Achievement Test (Jastak & Jastak, 1978). He criticized most research on memory in LDs for two reasons. Firstly, as this researcher has argued above, most studies treat LDs as a homogeneous group with similar memory deficiencies. In fact, Rourke (1978; Rourke & Finlayson, 1978; Rourke & Strang, 1978) among others has found consistent differences in verbal and visual-spatial processing as a function of primary academic deficiency: LDs primarily deficient in a) arithmetic, b) reading and spelling, and c) reading, spelling and arithmetic evidenced differences in verbal and visual-spatial processing. Secondly, most investigations of memory use verbal material only.

Therefore, Fletcher employed both verbal and nonverbal stimuli. The verbal task consisted of a list of 12 animals. The nonverbal task consisted of eight squares each containing five dots. The child was instructed to remember one dot in each square. Administration was based

on selective reminding techniques. Findings indicated that the subgroup of children with reading problems only exhibited retrieval problems on the verbal task, whereas children with reading and arithmetic problems showed retrieval problems on the verbal task and both storage and retrieval problems on the nonverbal tasks (for all ANOVA's, $p < .05$). These findings suggest that the LD's with reading problems only have a language processing deficit, while those with reading and arithmetic problems also have a nonverbal processing deficit.

However, the findings do not allow for a more specific characterization of the cognitive deficits. This is because, although Fletcher (and others who utilize Rourke's method) employ subgroups, their groupings are based on the performance of complex tasks. Even though different academic tasks may access different cognitive processes, Rourke's grouping of dyslexics is not based on differentiating these cognitive processes. As pointed out in the beginning of this section, the processes which underlie reading (or other academic abilities) are so complex and so numerous, that these abilities must be vulnerable to many different deficits (Rapin & Allen, 1983); therefore, learning disabilities should be assumed to result from any or several of these many deficits.

Thus, Rourke's method of grouping is at risk for assuming uniformity while including subjects with dissimilar cognitive deficits.

A more effective and informative method of investigating the cognitive deficits of LD's is to demonstrate that specific cognitive deficits results in specified academic deficiencies (e.g., dyscalculia or deficient decoding of words). Demonstrating that subjects who manifest poor academic performance in specific subject areas may possess similar cognitive deficiencies, as Fletcher did, is using the result to determine the cause. Similar results may have different causes.

In the main, the studies presented above have based their findings on experimental paradigms utilizing list learning verbal and/or visual memory tasks. Such paradigms may allow the researcher or clinician to observe the child's ability "...to create an order, that is, to 'ask the right question' (Denckla, 1983, p.38)." Indeed, Denckla believes that the learning of word lists may require the subject to "...provide sequential-organization, verbal-analytic, and encoding-rehearsing strategies (p. 37)" and is therefore more demanding than a reasoning task like the similarities

subtest (of the Wechsler Intelligence Scale for Children).

Other researchers have claimed that LD's tend to display less insight into the workings of their own memory systems. Torgesen (1979) suggests that LD's have not developed "the cognitive and emotional characteristics necessary to adapt to the requirements of a task and to use active and efficient task strategies." Ceci (1982) suggested that LD's spontaneously engage in less semantic processing (i.e., do not spontaneously sort items to be recalled into semantic categories) as described above. Chi & Gallagher (1982) compared normally functioning children and adults for speed of processing. They suggested that LD's may use their attentional abilities inefficiently. However, despite the amount of research investigating memory deficits, few studies have described the kinds of conceptual difficulties the disabled children might be exhibiting. The present study is an endeavor to delineate classification difficulties in LD's by isolating classification behavior associated with accessing the compositional network from classification behavior associated with accessing the prototypical network.

Some authors have attempted to differentiate between automatic and purposeful semantic processing. Automatic

semantic processing refers to the spontaneous and unconscious extraction of some aspects of a stimulus' meaning (Posner & Snyder, 1976; Posner, 1982). Sternberg and Wagner (1982), among others, consider normal development to involve the progressive automatization of processing such that limited capacity resources initially involved in superficial (e.g., phonetic) analysis become available for higher level analysis, e.g., inferring, problem solving, and so on. Thus, with practice, the skilled reader devotes less and less attentional capacity to the decoding process itself and has more capacity available for comprehending the meaning (Ellis & Hunt, 1983). This conception is relevant to the model being developed in this study. In essence, modular systems are automatic processes while nonmodular systems are controlled processes.

Several researchers argue that the failure of automatic semantic processing in some LD's results in their having to rely on more effortful, conscious forms of processing that require the limited-capacity reserves of their attentional system (e.g., Ackerman & Dykman, 1982; Laberge & Samuels, 1974). After extensively reviewing the literature, Sternberg and Wagner (1982) have suggested LD's appear to have less automated reading skills, as

compared with skilled readers, and therefore must devote more attentional resources to the decoding of words leaving less available for processing their meaning.

Other researchers argue that memory deficits observed in LD's result from a failure of conscious (controlled) forms of analyses that require limited-capacity attentional reserves (Bauer, 1982; Ceci, 1982; Goldstein, Hasher, & Stein, 1983; Simpson & Lorschach, 1983). Ceci (1984) suggests that a likely basis for these differing views is that those who argue for an automatization failure have examined tasks requiring skill (e.g. reading, typing, walking, driving a car), while those who argue the contrary have examined specific processes underlying skilled performance. To substantiate his view Ceci cites Goldstein et.al's (1983) finding that LD's coding of frequency information (i.e., how often a stimulus appeared in a list) could be considered "automatic" in that it did not require limited-capacity resources, was not a conscious or controlled behavior, was not amenable to practice, and did not show a developmental trend. In contrast, effortful, purposive forms of processing did show a developmental trend and seemed to be responsible for the LD's memory deficit as detailed below.

Ceci (1983) found developmental differences in LDs and nonLDs purposive processing. He presented 4 and 10 year old nondisabled and 10 year old LD children with pairs of primes and pictures in two conditions, measuring picture-naming speeds. One condition was designed so that there was a high probability that the prime for a given picture was semantically related to it (e.g., animal-DOG), while the other condition was designed so that a low probability (80% were unrelated) that the prime for a given picture was related to it (e.g., animal-CARROT).

He found similarities between the 4 year old nondisabled and the 10 year old LDs: picture naming speeds in both conditions were not significantly different. In contrast, the 10 year old nondisabled were much faster naming related pictures in the high probability condition. In addition, in the high probability condition, the 10 year old nondisabled naming speeds were slower when an unrelated prime was presented.

However, this was not the case for the LDs and the four year olds. Their picture-naming speeds were no slower than if no prime at all was used which Ceci argued as evidence that the 4 year olds and LDs were not purposively processing the meaning of the primes. Nevertheless,

related primes were associated with 35 to 42 millisecond benefits: "Evidently, at some basic level the meaning of all primes were being processed...and this form of basic semantic processing was capable of conveying benefits for the processing of related pictures...but was not an impediment to naming speeds when the subsequent pictures were unrelated" (Ceci, 1983, p. 431). In contrast, in the high probability condition, the 10 year old nondisabled subjects who were purposely processing the meanings of the primes as well as utilizing the expectation of relatedness, exhibited slower naming speeds when the items were unrelated.

In another study designed to assess the developmental course of automatic and purposive semantic processing, Ceci (1984) presented 7, 10, and 13 year old LD and nondisabled subjects with lists of words to be recalled. All words were unrelated except four items occupying serial positions 9, 10, 20, 30. These four items were semantically related (e.g., animals). He reasoned that automatic processing would be evidenced by the superior recall of either item 9 or item 10 because "...this type of semantic facilitation takes place only between successively presented items that are separated by brief interstimulus intervals" (p. 356) in semantically related

items. In contrast, he reasoned that purposive semantic reasoning would be evidenced by the superior recall of two or more of the related items.

Ceci argued that automatic processing of a word as conceptualized by Posner and his colleagues (e.g. Posner & Snyder, 1976) involves accessing and activating the word's semantic representation. Further, "when an adjacent word is semantically related to it (i.e., shares some of the previous word's activated semantic representation), its processing becomes more efficient...Thus it was reasoned that the processing of item 9 would make available part of its representation for the processing of item 10, and possibly... effective in the reverse" (p.356). That is, recall of one of the related items through "automatic activation" would allow measurement of automatic semantic processing.

Purposive semantic processing as conceptualized by Ceci (1982, 1983), Ceci and Howe (1982), Simpson and Lorschach (1983) "...consists of a deliberate attempt to link semantically related items together. This form of semantic analysis '...is a purposeful, strategic, form of processing, requiring a conscious and deliberate plan to process a stimulus' meaning. It takes place within the

limited capacity of the child's working memory system whereas automatic semantic processing occurs in the virtually unlimited capacity of the long-term system'" (Ceci, 1983, p. 428; Ceci, 1984, p. 356). That is, recall of two or more of the related items would be evidence of purposive semantic processing.

The probability of recalling each adjacent related item [9 & 10] was greater than the probability of recalling all other items, including the two related items which were spaced apart [20 & 30] (see Ceci, 1984 for a detailed description of this and the following statistical relationships). A log-linear procedure was used for evaluating recall of the four related items. For the LDs automatic semantic processing was more prominent in the recall of the 7 and 10 year olds, but less in the 13 year olds ($p's < .05$). In contrast, the reverse was evident for purposive semantic processing. The nondisabled evidenced a similar pattern except that purposive processing was evident at a younger age.

Ceci's elaborate hypotheses are interesting and relevant to the model being developed in this study. As noted, many of the clinical observations described in the introduction can be seen as mapping onto the notions of

purposive (controlled) and automatic processing. Furthermore, within the framework of the model being developed here, automatic processing is subsumed by modules while purposive processing may be executed by the central systems. Ceci also made an impressive effort to develop a statistical model by utilizing a log-linear procedure because it "provides a means of assessing the interrelationships among polychotomous factors where no necessary distinction is made between dependent and explanatory variables" (Ceci, 1984, p. 356). In addition, he tested for "goodness of fit" to his model and found it adequate.

However, it is unclear that Ceci's simple task actually provides adequate evidence for his theory. His findings only suggest in a general way that nondisabled subjects are more likely at an earlier age to purposively relate items together using their semantic relationship (i.e., their being members of the same category). Further, Ceci did not employ subgroups of dyslexia in this group of studies. Rather he used one group of poor readers, characterized by poor reading performance. However, he did attempt to make the LD group uniform, i.e., they possessed normal IQ's, with verbal scores lower than performance scores on the WISC, and were significantly

below grade level in reading. Nevertheless, as the underlying cognitive deficits associated with poor reading were not delineated, the members of the LD group could have possessed significantly distinct rather than uniform deficits. Without identifying the underlying cognitive deficits, the researcher is unable to specify which deficits lead to which kinds of deviant behavior. All they can do is suggest that groups of children with certain characteristics (e.g., low verbal IQ scores) also exhibit problems with certain kinds of tasks.

Frumkin-Feis (1982) also investigated the verbal encoding ability of LD children with memory impairment. Her study will be the last one presented because several of the tasks she employed were also utilized in the present study.

She used a cognitive ability, memory, to differentiate her disabled groups. She also screened academically normal children for memory deficits. Thus, she looked at three groups: LD children with verbal memory impairments, LD children without verbal memory impairments, and nondisabled children without memory impairments. To examine encoding ability, she administered a task which employed Wicken's technique for release from proactive

interference. To measure this release, the stimuli shifted or changed along phonemic or semantic dimensions. In the shift condition, the shift occurred in the last trial. The phonetic encoding shift occurred in the initial consonant blends of the stimulus words; the semantic encoding shift occurred in the taxonomic category membership of the stimulus words.

Findings did not differentiate performance between the disabled group without memory impairments and the nondisabled group. However, the disabled group with memory deficits did not exhibit the release phenomenon following phonemic shifts as observed in the other two groups. In addition, the memory impaired disabled group exhibited significantly less of a release pattern than the other two groups on the semantic release task. Because Frumkin-Feis utilized a cognitive ability to differentiate her LD's, she was able to demonstrate a difference in their performance predicated on the presence or absence of a specific cognitive deficit. And because her findings were so robust, the Wicken's task was also used in the present study as a further measure of differential cognitive abilities of dysphonetic and dyseidetic dyslexics. It was hypothesized that dysphonetic dyslexics would not evidence the release phenomenon for the phonemic

stimuli due to their phonetic deficits. It was also hypothesized that dyseidetic dyslexics might evidence relatively less release on the semantic task as this task could access the prototypical classification system.

Frumkin-Feis also administered a hierarchical clustering task in an attempt to assess the structure of a semantic network. This task was used to measure hierarchical or compositional category representations in the present study as well. Briefly, this task is a sorting procedure adapted from one used by Zurif et.al. (1974) with aphasic adults (a complete description of this task appears in the method section). The stimulus nouns were chosen by Frumkin-Feis using several criteria. All words were concrete nouns of relatively high frequency (Thorndike & Lorge, 1944) and judged to be visualized easily. The eight nouns were: husband, wife, lady, king, hat, crown, dress and tie. The set of nouns was related along several dimensions. Relationships within the subset of human beings (e.g., husband-wife) and within the subset of wearing apparel (e.g., hat-tie) were considered to be categorical (i.e., compositional) relationships. Conversely, relationships between human beings and wearing apparel were considered functional relationships. Frumkin-Feis' findings suggested that both learning

disabled groups exhibited more inconsistent sorting choices, and thus more variability in their choices, than the nondisabled group. Both groups chose categorical groupings significantly less frequently. However, both the normals and disabled group without memory impairment did evidence sorting based on an implicit, stable hierarchical organization, whereas the memory impaired disabled group did not demonstrate clear differences between categories.

This hierarchical sorting task was employed in the present study to measure category behavior mediated by the compositional schema of the language module. It was postulated that this sorting task would measure compositional concepts because compositional relationships obtain among the subset of human beings and among the subset of wearing apparel. That is, all members of each subset belong to a more inclusive category and all of those members have common components. The task was administered such that the subject was presented with all possible triads of the set of eight nouns. Thus, frequently, the subject had to choose between a compositional relationship (within the more inclusive category) and a functional relationship (between human beings and wearing apparel). Functional relationships

were defined as those based on facts of the world (e.g., men wear hats). It may be that "men wear hats" is represented by a prototype. This study did not investigate that issue. Such relationships were labeled functional so as to distinguish them from the ones whose typicality was being investigated (in the prototypicality task).

The task was administered by asking the question, "Which two are more alike, more the same?" This question did not direct the subject as to which sorting strategy to employ. Thus, both the neutral question and the tension between choosing the compositional relationship and the functional relationship provided an opportunity to measure the frequency with which a subject chose (or the frequency with which the task was mediated by) the compositional relationship.

It was hypothesized that dysphonetic dyslexics would exhibit compositional classification difficulties because their primary disability, decoding, would compromise their ability to access their lexicon. That is, as noted previously, the dysphonetic dyslexics are considered to possess impaired language modules. It was reasoned that dysphonetic dyslexics would exhibit difficulties with

tasks which are mediated by the language module. Tasks mediated by the language module which involve word meanings can be considered as accessing a lexicon also within the language module. Such a lexicon probably includes a compositional classification system. Compositional classification behavior is postulated as reflecting a distinct system of category representation mediated by the language module. Thus, it was hypothesized that dysphonetics would exhibit difficulties with the hierarchical sorting task described above. Specifically, because their primary deficits, decoding, would compromise their ability to access their lexicon, the hierarchical sorting task accessing the compositional schema (which is postulated as included in the lexicon) should reflect those deficits. That is, if the task accesses the compositional schema, it should reveal the implicit hierarchical organizations as manifested by sorting strategies employed by subjects. The dysphonetics implicit hierarchical organizations should be compromised as a consequence of their disability.

As asserted above, this research is concerned with postulating two distinct category representations schemata, each of which is specific to and mediated by a unique faculty or module. Thus far anecdotal clinical

observations described in the introduction and research regarding LD children have been presented as related to these postulations. A completely different line of inquiry also addresses some aspects of these issues, namely, the research regarding unitary versus dual processing. This research will be reviewed in the next chapter.

COGNITIVE MODELS AND CLASSIFICATION BEHAVIOR

Models of Unitary Versus Dual Processing

What are some other means of empirically determining the existence of modular systems? One set of research questions deals with the controversy between unitary and dual processing models, addressing the issue of single or unitary processing versus dual processing of verbal and nonverbal stimuli. If modular systems exist, then dual or multi-processing must likewise exist.

The characteristic feature of the dual processing model is that the different types of input are coded and represented in memory separately (Pavio, 1971, 1978; Posner, 1973). Briefly, Pavio's version of the model features representations of verbal and nonverbal information as functionally independent and distinct, and consequently as stored in functionally distinct systems: verbal information is coded and stored in a verbal system which is specialized for linguistic intercourse whereas

perceptual information is coded and stored in a nonverbal or perceptual system specialized for that kind of information. The two systems may be independently activated and accessed by the appropriate kind of knowledge. Each system is characterized by a uniquely organized semantic association network which connect and define the various representations such that the systems are not necessarily isomorphic. This allows for associations to occur in one system but not in the other; some linguistic associations can be based solely on linguistic knowledge whereas some perceptual associations in the nonverbal system can be based solely on nonverbal knowledge. Theoretically, the systems can and do interact by interconnections at a "referential level", but this interaction takes time because it requires translation from one system to the other. Thus, one of the reasons why the reaction time research paradigm is so popular in dealing with questions concerning these models is the postulated time it takes for the separate systems to interact with one another. If it takes time for the two systems to interact, then this time delay should be measurable.

The characteristic feature of unitary or single processing models is that both verbal and nonverbal

information concerning a particular concept or object is represented in a single or common code in memory. That is, knowledge whether gained from verbal or nonverbal experience is not distinguished in memory: although both a word and a picture may symbolize an object, the representation of that object in memory is not specialized for the form of the symbol, i.e., type of stimuli. Hence, both the word and the picture will activate the same codes for conceptual meaning. The representations are usually described in terms of abstract and/or logical features (e.g., syntactic features) (Schank, 1972; Chase & Clark, 1973; Anderson & Bower, 1974; Norman & Rumelhart, 1975; Nelson, Reed, & McEvoy, 1977; te Linde 1982).

Several researchers have investigated the controversy between unitary and dual processing models by using pictures and written words of the same or similar objects. Recently, they have utilized reaction time paradigms to study accessing and processing time differences between the two types of stimuli (e.g. te Linde, 1982; Durso & O'Sullivan, 1983; Babbitt, 1982). Both the unitary processing and the dual processing models make predictions regarding such reaction time paradigms. Pavio (1975) was the first to use such paradigms to test consequences of the dual processing view. (His studies

will be reviewed later in this chapter.) Subsequently other investigators have followed his direction because the predictions regarding processing time of words versus pictures vary according to the model postulated as discussed below. However, although several investigators propose and consider models of memory and memorial codes, most of the research has actually focussed on processing similarities and differences of the two models (te Linde, 1982).

The data from reaction time studies, where subjects are asked to read words or name objects or make judgments regarding them, generally shows a consistent 'picture advantage' in terms of faster processing time for pictures. To account for these data, the common code adherents assume that pictures access the common semantic codes faster than words do. This assumption is usually based on claims that pictures are visually more distinct thereby facilitating faster access and interpretation (e.g., Banks & Flora, 1977) or that phonological processing must occur prior to semantic interpretation and thus words require more time than the processing of their pictured counterparts (e.g., Pellegrino, J.W., Rosinski, R.R., Chiesi, H.L., & Siegel, A., 1977; Rosinski, R.R., Pellegrino, J.W., & Siegel, A.W., 1977).

The claim that the distinctiveness of pictures facilitates faster access and interpretation is supported by demonstrations of a consistent 'picture advantage' or faster processing of pictures regardless of the question posed, i.e., the task demand. In particular, these claims rely on experimentally demonstrating that a picture advantage obtains even when subjects are asked to make judgments which according to dual processing theories should be mediated by information that is verbally represented. On the dual processing view, judgments which directly access verbally represented information should not show the same degree of 'picture advantage' for processing speed as do judgments which access coded representations specialized for perceptual information.

Banks and Flora (1977), common code adherents, claim that there is a consistent picture advantage because pictures are processed faster and therefore allow for faster semantic interpretation than do words regardless of the kind of judgment subjects are asked to make. They asked subjects to make judgments regarding the intelligence of animals. They argued that this was a query that should, on the dual processing view, involve the verbal systems because it would be difficult to

represent intelligence in images. Their results confirmed a consistent picture advantage.

The argument that a dual processing model is committed to the view that information regarding intelligence is necessarily stored in the verbal system is not clearly supportable. In fact, on Rosch's view of prototypes such information could be represented as a prototype. As is being argued here, prototypes may indeed be the content of a perceptual system. Thus, Banks and Flora may have only demonstrated that pictures are processed faster than words for questions which are mediated by a perceptual system. Or another explanation is that beliefs regarding the intelligence of animals may be centrally processed because such beliefs might be part of the central systems which process belief fixations (see the section on modularity for a complete discussion). In that case, Banks and Flora may have only demonstrated that pictures are processed faster than words for questions which require interaction with central processing systems.

Pellegrino and his associates (1977; Rosinski, R.R., et.al., 1977) claim that the consistent picture advantage results from the fact that words require more processing time than pictures do because words consistently require

phonological processing prior to semantic interpretation. But, they postulate that semantic processing is mediated by common representations which will activate common codes for verbal or visual stimuli. They investigated this claim by looking at reaction time differences in processing judgments regarding size and category.

The choice of size and category as the judgments to investigate was based on the following reasoning. Common code models predict a consistent picture advantage, and therefore equivalent latencies for pictures or words respectively, regardless of the content of the judgment; i.e., irrespective of whether the task is category or size judgments. Dual code models do not predict such equivalent latencies because information about size is considered to be represented in the visual system while information about categories is represented in the verbal system. Thus, on the dual code view, latencies should vary according to the kind of judgment called for, and not only according to the form of the stimuli.

Subjects in the Pellegrino study were presented with either single words or pictures of large and small animals and objects and asked to make judgments either regarding size or category. For the category judgment task, the

subjects were required to decide whether the stimulus was an animal or an object; for the size judgment task, the subjects were required to decide whether the stimulus was large or small as compared with a predefined referent. The results showed consistently faster response times for pictures than words regardless of the kind of judgment required. Pellegrino et.al. concluded from these data that semantic decisions are mediated by common representations which activate common codes for verbal or visual stimuli, but phonological processing prior to semantic interpretation results in a consistent picture advantage in processing time measures.

However, although Pellegrino et.al. assume that judging category membership is a linguistic task, current research regarding prototypes (and exemplars) make this assumption questionable. Briefly, on Rosch's (1976) view, prototypes are the most characteristic members of a category which Rosch refers to as basic objects. Basic objects have in common the following: 1)attributes, 2)motor movements, 3)similarity of shape, and 4)identifiability of an averaged shape (Rosch, 1976). Further, many experiments have shown that categories are coded in memory neither by means of a list of individual members of the category nor by means of a list of formal criteria necessary and

sufficient for category membership, but, rather, in terms of a prototype of a basic object (i.e., typical category member) (e.g. Rosch, 1975; Rosch et.al., 1976).

Rosch's research suggests that prototypes might be coded in a perceptual system. Judgments regarding category membership may not be primarily lexical; to wit, the easiest way to denote a particular kind of animal or common object is by way of an image, not by a lexical definition. Further, basic objects are ostensibly definable: they are directly demonstrable in the world as represented by a particular object. Now, for the research that was reviewed regarding category judgments, the researchers purposely chose objects and animals which could be easily pictured. Thus, on Rosch's view, they chose basic level objects as the items about which to make judgments. If these category judgments rely on prototypical considerations, and especially when the stimulus is a picture, then it is only reasonable to suppose that a perceptual system is the one that is accessed. For, as will be recalled, a prototype includes similarity of shape. And surely in this experimental design the appropriate stimuli to prime shape similarity judgments are pictures.

In summary, the assumption that category judgments are always linguistic, irrespective of the type of objects and the form of the stimuli involved, is questionable. Perhaps Pellegrino et.al.'s subjects never did engage in a linguistic task, but took longer to process the words phonetically. Whatever the case for words, the query regarding category judgments for pictures indeed may not have been a linguistic task. Certainly assuming category judgments are unquestionably a linguistic task is unwarranted.

Pavio's initial reaction time experiments (1975) were intended to support a dual processing model. He demonstrated that judgments of actual size differences are faster for pictures than for words when subjects are presented with pictured stimuli controlled for size, while judgments of word pronounceability are faster when subjects are given words as compared with pictures. Pavio regards this data as support for his dual processing model which predicts that judgments concerning perceptual inferences will be made more quickly when the stimuli are images, because the pictured stimuli will directly access and quickly activate the associative system expressly related to perceptual information. Conversely, the processing of verbal information will be faster when the

task demands explicitly require the subject to directly access the semantic network related to linguistic input and data, as did the word pronounceability judgments.

te Linde (1982) also designed experimental tasks which required subjects to render judgments along two distinct dimensions, size comparisons between two objects (e.g., same sized pairs: thimble-acorn; different sized pairs: rooster-dime) and associative relatedness (e.g., associated pairs: table-chair; nonassociated pairs: bed-gun) regarding pairs of objects. He chose these tasks to ensure that activation of the presumed perceptual systems would be manifest for size judgments and activation of the presumed verbal systems would be manifest in associative relatedness judgments. He designed the study to investigate which model, unitary or dual processing, would best account for the findings when questions regarding size, a visuoperceptual function, were compared with questions regarding associativeness, a non-visuoperceptual function. He made specific predictions regarding speed of processing for each model.

In te Linde's first experiment subjects were required to make size (e.g., are rooster and dime the same size) and association (e.g., are mouse-cheese associates of each

other) judgments for pairs of words and pairs of pictures. Findings revealed that speed of decision was significantly faster for pictures as compared with words in judgments of size ($p < .001$), but less so for associative decisions ($p < .05$). As te Linde points out, common code models do not predict the difference in processing time observed here, but dual code models can account for these results. For the dual models would predict a significant difference in size judgments between imaged stimuli and written stimuli, as the verbal input would have to be converted into a nonverbal code compatible with the nonverbal associative network, because size information is perceptual information that presumably would only be stored in the nonverbal systems. On the other hand, it can be argued that the speed of association decisions did not show the same magnitude of difference between words and pictures because associative information may be coded and therefore available in both systems. That is, for imaged items the nonverbal systems may have mediated the associative decision while for the linguistic stimuli the verbal systems may have been activated.

te Linde's next investigation mixed the presentation of the stimuli such that some pairs were matched word-word, some picture-word and some picture-picture presentations

for both size judgments and associative decisions. The stimuli were the same as used in the first experiment. He suggested that dual code theories would predict that regarding size judgments reaction times for mixed pairs would be faster than for word-word pairs because only the word stimulus would have to be translated into the relevant code. On the other hand, reaction times for associative decisions should be slowest for mixed pairs because the stimuli must be converted into a common code (either verbal or nonverbal) before a decision can be reached. However, common code theories would simply predict that the mixed condition should evidence intermediate speeds regardless of type of judgment. The results indicated that size judgments continued to show an advantage for pictures and was intermediate with respect to the mixed condition, but latencies for all three conditions under the associative decisions were not significantly different. The predictions of the common code models did not account for the findings regarding associative judgments: no picture advantage for processing time was observed nor did mixed pairs obtain an intermediate reaction time. The predictions of the dual code theories as delineated by te Linde were not satisfied with regards to the associative decision task: association

reaction times were not slower for mixed pairs.

In a third investigation te Linde (1982) again demonstrated that the picture advantage disappeared in associative decision tasks. Here he employed a speeded inference task adapted from Friedman and Bourne (1976). Four stimuli were utilized: cow, tree, leaf, butter. These were presented in pairs of pictures or pairs of words. Subjects were instructed to verbally respond as follows: large, small, strong, or weak--depending upon the stimuli presented. Thus, cow-butter should elicit a response of 'weak' as the items are weak associates of each other, but are neither both large nor both small. Results confirmed that the picture advantage disappeared in associative decision tasks. Moreover, te Linde compared his findings to those of Friedman and Bourne (1976). The four stimuli they utilized were hippo, mouse, bus, car, pairs of which varied on the dimensions of size and category. All possible pairs in both a word and a picture condition were presented such that the pair had a common value on one dimension. Subjects were instructed to respond with the common value of the pair. Results indicated a significant picture advantage for processing for both types of judgments. Thus questions regarding category yield the picture advantage, but questions

regarding association do not. Here again Friedman and Bourne have made the same confusion as discussed above regarding category judgments: i.e., they may not be linguistic tasks.

te Linde offers two possible solutions for the dual code models. One possibility is to postulate that connections between symbolic systems occur at the associative level of meaning as well as the referential level. Given this solution, reaction time for association decisions (e.g., mouse-cheese) for mixed picture-word stimulus pairs would not differ from word-word and picture-picture pairs as the findings show. te Linde's other suggestion is to postulate a common, abstract level of representation equally accessible to words and pictures, in addition to the two modality specific representational systems.

There is another possible solution, a model of modular systems specialized for language and visual perception (among others), with central systems that respond to demands not mediated only by one of the modular systems. In this case, associative decisions would be based on factual knowledge about the world (e.g. mice eat cheese). In discussion of Fodor's (1983) model, it will be proposed that information based on experience, i.e., all the

information based on experience that established the associative pathways in a module, is deferred to the central processing systems. Hence, these associative decisions would necessarily be made by the central systems and operate for this kind of information similarly to te Linde's referential level where both pictures and words are represented. On Fodor's view, central system processing may not require that reaction times for central processing are significantly slower than for module processing: some responses which are relatively superficial, but nonetheless necessarily mediated by the central systems because the judgment regards factual knowledge, may be relatively quickly processed.

Other researchers have also shown that different kinds of information are differentially available given different kinds of stimuli at least in terms of speed of access. Durso and O'Sullivan (1983) investigated common nouns (animals and food), proper nouns (famous persons & states of United States), and their pictorial counterparts. They revealed that reading latencies for proper nouns were reduced by prior experience (i.e. either reading the proper name or seeing a picture of it) with either their verbal or pictorial representations, whereas latencies for common nouns were reduced only if the

subject had previously seen the word. The results were consistent with the suggestion made by Durso and Johnson (1979) that words generally activate a more generic set of information than do pictures. They argue that words and pictures typically differ semantically as well as physically. An unfamiliar picture is a novel stimulus and as such communicates unique and specific information. Common nouns, on the other hand, are familiar and thereby elicit more generic aspects of the semantic representation of the concept. However, when the words utilized were proper names, they operated more like pictures: unique and specific stimuli each of which was able to facilitate the naming and recognition of the other regardless of condition.

Although Durso and Johnson and Durso and O'Sullivan consider their findings as evidence for differences in type and specificity of information within a commonly coded semantic system, the difference can also be related to differences between prototypical categories and verbally mediated (compositional) concepts. Pictures may be considered to trigger similarity judgments, i.e. how similar is the pictured example to the prototype. Proper nouns and their pictured counterparts may well be specifically related as Durso and Johnson argue and

therefore reciprocally prime one another for recognition. On the other hand, common nouns when read may be more generic than their pictured counterparts, for the reading of common nouns, unlike making similarity judgments, may be purely or predominately a linguistic task. Perhaps reading the generic noun does not necessarily conjure a basic level category, but accesses a lexical representation only, since the system is directed to read the word, primarily a linguistic task.

To sum up, the so called 'picture advantage' for processing time is dependent on the kind of judgment subjects are required to make. Questions regarding associative relationships consistently showed no difference in processing time for pictures and words. Further, differences in processing time for pictures and words of familiar common and proper nouns showed that familiarity with proper nouns shortened reaction times, but that the same familiarity with common nouns only facilitated the reading of the word when the word had been read previously. Thus, in both cases what accounted for differences in processing time was not merely the type of stimuli (pictures or words) being processed, but especially the kind of information being accessed (i.e., linguistic, perceptual or functional information). This

distinction was alluded to in the previous section regarding research in learning disabilities. It will be expanded in subsequent chapters. Suffice it for now to point out, that it was not the processing modality (visual vs. linguistic) nor the form of the material being processed which mattered, but the content of the information needed to mediate a response. That is, dual processing can be substantiated when it is the character (e.g., visuospatial, linguistic, factually associated) or the kind of information needed to mediate a response which distinguishes the stimuli (object + question) being processed in each condition.

The studies presented in this chapter offer evidence of dual processing, i.e., separate mediation of linguistic and nonlinguistic information. Further, the evidence against dual processing models can be reconciled with dual models if certain distinctions regarding the kind of information accessed are maintained. In the subsequent chapters, this issue, the kind of information accessed or the content of linguistic and nonlinguistic information, will be explored.

The present study employed both a word and a picture condition. Furthermore, the questions were designed in

such a way as to specifically differentiate between responses mediated by the different modules (linguistic and visuoperceptual).

In the next section, Rosch's notion of prototypes will be explored in detail, particularly with regards to the postulate of this study that prototypes are a feature of the visual-perceptual module or faculty. Then, in the following section, Fodor's model of dual processing will be presented.

Prototypes and Classification Behavior

The notion of prototypes has been alluded to several times in this discussion. What, in fact, are prototypes? Thus far, they have been treated as perceptual representations coded in a visuoperceptual module: functional units or gestalten which include the most characteristic or typical features of certain concrete objects.

Before exploring this notion further, the relevance of a discussion of prototypes to this study will be examined. The cognitive model of mind upon which this study is based represents the apprehension of information as a process whereby several distinct modules initially access that information. These modules are each specified for a particular and different domain of information. (More precise qualifications for module specificity and nonmodular systems will be addressed in the next chapter.) One such module is postulated to be specified for nonverbal perception of items belonging to sets of natural-kinds (e.g., trees) and artifactual-kinds (e.g., chairs) henceforth referred to as determinate sets.

In this section it will be argued that nonverbal perception of items belonging to determinate sets is organized to enable a system of perceptual prototypes. To complete the argument, the section will conclude with a justification of the claim that the system of perceptual prototypes is included within a module.

The first argument turns on the idea that prototypes represent an image or percept which is a generalization of some typical characteristics of concrete objects. This percept can be described as a result of "...an exaggeration of the attributes, motor movements, and shapes characteristic of only some members of a category...as though they were characteristic of all" (Rosch, E., Mervis, C., Gray, W., Johnson, D., & Boyes-Braem, P., 1976. p. 433). Thus, the content of the percept or prototype is an image (Rosch, et.al., 1976). If the prototype is an image, then its formation may be predicated upon the nonverbal perception of objects. That is, it may be predicated upon innate, basic perceptual properties such as color, shape, size and so on. Such properties can be considered as the essential perceptual components of the schema of prototypes. Further, it is likely that prototypes are coded as a consequence of the

perception of concrete objects together with prototypical schemata (i.e., subsequent to a young child's first experience with such objects). Therefore, the process of nonverbal perception is uniquely disposed to educating prototypes, to allowing a system of perceptual prototypes to evolve based on certain members of a category hierarchy.

Which kinds of members of a category hierarchy qualify for this position? Consider a common, concrete object such as a chair. It can be designated as belonging to the following hierarchy: rocking chair, chair, furniture, man-made object, physical object, thing. The kind of member that "chair" belongs to the so-called basic level of abstraction (Rosch, et.al., 1976) which enables a generalization of both optimal unity of an image and general applicability. In the present example, the common object "chair" can be abstracted to formulate a vivid image which can then be applied to almost any chair which a person might encounter. That is, this basic level category allows for the abstraction of a vivid image from a relatively small sample and simultaneously facilitates a reliable application of the image to a wider class than the original sample. Moreover, this level of abstraction possesses a "peculiar psychological salience" (Fodor,

1983, p. 94) that clusters at some middle level (e.g., chair) and falls between the superordinate level (e.g., furniture) and the subordinate level (e.g., rocking chair) (Mervis & Rosch, 1981). Roger Brown (1958) interprets this level as "The name of a thing, the one that tells what it 'really' is, is the name that constitutes the referent as it needs to be constituted for most purposes" (Brown, 1958, p. 17). Fodor calls it the "basic perceptual category."

This notion of basic level, located somewhere in the middle of a typical hierarchy, possesses a psychological salience such that it is intuitively apprehensible. However, precise definitions of this middleness have not as yet been developed. It may be that the intuitive apprehensibility of which objects in a category hierarchy cluster at this level of abstraction merely reflects intuitions of relative salience (see Fodor, 1983, pp. 94-97). Or it may be that the identification of "basic level" objects is dependent upon empirical determination of the criteria for selecting those objects that provide both sufficient perceptual vividness and generality of application. Whatever the case may turn out to be, objects which intuitively seem to possess this middleness or basic feature also tend to relate in the same way to

the following psychological properties.

One important psychological property of these basic objects is that they provide more information than superordinate or subordinate category members. Rosch, et.al. (1976) investigated this hypothesis by presenting nine categories of concrete English nouns which were divided into three levels of abstraction: superordinate, basic level and subordinate. Judges were given one and one-half minutes per object to "...list all of the attributes that were true of the items included in the class of things designated by each object name" (Rosch, 1977, p.214). Results showed that very few attributes were listed for the superordinate categories, a significantly greater number of attributes were listed for the hypothesized basic level objects and an equivalent number of attributes to the basic level objects were listed for the subordinate level objects.

That is, basic level objects like chair yielded a significantly longer list of attributes than superordinate level objects like furniture. Moreover, the basic level object lists included only a few less attributes than the lists for subordinate level objects like rocking chair. The subordinate level objects lists included all of the

basic level attributes plus a few particular attributes specific to the subordinate category member. Thus the basic level category can be considered to provide maximal information because it is at the most inclusive level of the hierarchy which also yields an "informationally packed" list of attributes.

Another psychological property evoked by basic level objects is that consistent motor programs are employed when interacting with them. To measure this property Rosch et.al. (1976) employed the same nine word sets described above. They were presented to twenty subjects who were instructed to "...describe, in as much finely analysed detail as possible, the sequences of muscle movements he made when using or interacting with the object" (p.216) in three minutes per object. Results showed that virtually no motor movements occurred in common for the supposed superordinates (e.g., tool), a large number of movements were made in common to basic level objects (e.g., hammer), and no more movements were made in common to subordinate (e.g., claw hammer) than to basic level objects. Thus, as predicted, the results of this aspect of the investigation also confirmed that basic level objects represent the most inclusive level which is also replete with information.

A third property evoked by the basic level objects is the similarity of shape and appearance. This kind of similarity might be characterized as follows: "Roughly, you can draw something that is just a dog, but you can't draw something that is just an animal; you can draw something that is just a chair, but you can't draw something that is just furniture" (Fodor, 1983, p. 96). The Rosch group (1976) measured this phenomena by superimposing traced outlines of pictures of objects. For example, the superordinate category animals consisted of traced outlines of pictures of the following basic level members: cats, dogs, fish, butterflies. Subordinate members were particular kinds of cats, dogs, and so on.

Findings supported the hypothesis that basic objects were the most inclusive category which had similar shapes. That is, the mean overlap ratios of items within the same superordinate category yielded significantly different ($p < .001$) results in the direction of similarity of shape for basic category members. A significant ($p < .05$) but significantly smaller increase in similarity was obtained for subordinate over basic members. Thus, basic members were found to be the most inclusive level at which similarity of shape was confirmed.

Yet another psychological property evoked by basic level categories is that they are ostensively definable. That is, they are clearly identifiable when their instances are encountered. Corroborating evidence of the ostensiveness of basic level categories has been adduced by several investigators. Measures of reaction time have demonstrated that objects are recognized as members of basic level categories more rapidly than as members of categories at other levels (Rosch, 1975; Intraub, 1981). Labels of basic categories have been found to occur frequently in everyday language (Cruse, 1977). Finally, basic level category labels are generally denoted by single signs in American Sign Language whereas other category levels are almost exclusively denoted by multiple sign sequences (Newport & Bellugi, 1978).

The above entry completes the listing of psychological properties evoked by basic level categories which make them perceptually salient and therefore viable affiliates of a system of perceptual prototypes. Before elaborating the above claim, two criticisms of the notion of prototypes will be considered.

First of all, as Rosch (Mervis & Rosch, 1981) in her discussion of prototypes admits, it can be argued that the

findings concerning basic level biases are a result of linguistic factors including, for example, shorter, more frequently used names. For example, basic level categories are often coincidental with high-frequency items in vocabulary counts, whereas subordinate or superordinate categories are infrequently coincidental with such items. However, a plausible response to this objection is that basic objects have shorter high frequency names precisely because they are the most inclusive category level for which we have vivid images.

Some investigators have attempted to circumvent this issue by devising novel stimuli. For example, Horton and Markman (1980) utilized artificial categories in order to present novel stimuli to subjects. To construct an artificial category the overall body shapes of a natural animal was used with additional novel features as the necessary and sufficient characteristics of the category. Each category was given a nonsense name. Each superordinate level category member was defined by three novel features (e.g., horns, feathered tail and type of feet for the superordinate level category Ungulate). Members of the Ungulate category included shapes recognizable as camels, buffalo, pigs, giraffes, zebras, goats, cows, and so on. For example, the 'ungulate'

category member "horse" possessed ungulate characteristics of horns, a feathered tail, and a special type of feet, and yet its overall shape was still recognizable as a horse since it retained the basic head and body shape of a horse. Basic level category members (e.g., the one based on horse) varied in size, body orientation, and skin markings, but as noted retained the shape of a horse. Other categories were similarly constructed. Distractor items were also modeled after natural animals. Children correctly identified more exemplars and distractors from basic than from superordinate categories ($p < .001$). Such findings argue against the claim that the identifiability and salience of basic level objects is merely a function of the fact that the names of those objects tend to be higher frequency words than their superordinate and subordinate counterparts.

Secondly, Fodor finds many problems with prototypes as concepts, although he is willing to countenance their existence as some mental event which is essentially nonconceptual. For Fodor prototypes (or exemplars) are not concepts because as he construes concepts, they function as the meanings of terms. Further, meanings, he contends, must be composable, that is, they must be constructable from simpler concepts or else we would not

be able to understand a complex linguistic expression when we heard it for the first time. However, Samet (1985b) offers an interesting concrete example which shows how two prototypes can conjoin to construct a complex of prototype representations and even be combined with a Fodor-type concept:

say we have the phrase 'bankrupt dwarf bachelor', and for the sake of argument let's say that the hearer (H) has 'bankrupt' represented in terms of prototypical properties, 'dwarf' represented in terms of an exemplar, and 'bachelor' represented in terms of necessary and sufficient conditions. So for H,...BANKRUPT = ps(bankrupt) = the condition whose typical instances around here involve being put in receivership by the court, having to negotiate a payment plan with creditors, and so on....DWARF = ex(dwarf) = being a member of the same (relevant) physiological kind as the little person on Fantasy Island....BACHELOR = df(bachelor) = being an unmarried adult male...When H hears the phrase 'bankrupt dwarf bachelor', she (perhaps) thinks of an unmarried adult male who is a member of the same physiological kind as the little person on Fantasy Island and who is in a condition whose typical instances involve courts and creditors in the ways specified above (Samet, 1985b, p. 21).

But Samet's counterexample is not without problems. Samet chose for his example of prototypes 'bankrupt', the condition whose typical instances around here involve being put in receivership by the court, and so on. However, it is not clear how this state of bankruptcy can satisfy the properties of a prototype, i.e., an image

representing the exaggeration of attributes, motor movements and shapes characteristic of the most typical members of a category.

Nevertheless, the prototype model as elaborated by Rosch and others in the recent literature on cognitive theory contains an intuitive core and is sufficiently operative to be useful, however incomplete and underdeveloped it may currently be. Furthermore, what is particularly pertinent to this study is the resource offered by the prototype model to characterize the difference between a perceptual and language module.

Thus, it was argued here that nonverbal perception is organized to enable a system of perceptual prototypes. It was postulated that prototypes are the perceptual representations of basic level categories coded within a perceptual module specified for determinate sets. It was hypothesized that classification behavior varies according to the domain (i.e., linguistic versus perceptual) of the information being processed.

One hypothesis investigated in this study was that classification behavior based on questions accessing a perceptual module would differ from classification behavior based on questions accessing the language

module. In order to test this hypothesis, children's typicality ratings of basic level category members were collected based on a method similar to the one used by Bjorklund, Thompson and Ornstein (1983). (Methodological details appear in the method section of this study.) They gathered typicality rating data from children in kindergarten, third and sixth grade in order to develop norms for children of those ages. Subjects first selected examples of familiar word-concepts and then rated them on a 3-point scale in terms of category typicality. The present study employed this procedure to assess typicality ratings and reveal the structuring of prototypes. A picture condition as well as a word condition was included in order to assess whether classification behavior varied as a function of stimulus form. It was hypothesized 1) that classification behavior based on questions accessing a perceptual module would not vary as a function of stimulus form because both the picture and the word would access the same prototype which would, therefore, motivate the same response; 2) that dysphonetic dyslexics classification behavior would not be significantly different from normals on this task; 3) that dyeidetics would evidence deviant classification behavior on this task consequent of their impaired perceptual module.

The discussion presented thus far has examined 1) some intuitions garnered by the investigator through clinical observation; 2) studies and theories regarding the conceptual ability and classification behavior of LD children; 3) research regarding unitary versus dual processing models; and 4) postulations and research regarding basic level objects and their prototypes particularly as characterizing the organization of the module specified for visual perception. The next section will present an overview of Fodor's model of cognition with particular emphasis on characterizing the linguistic module.

Fodor's Model: The Modularity of Mind

Model construction based on information processing metaphors has developed in several directions. Contemporary cognitive theory has adopted as a working hypothesis that the paradigmatic psychological process is a sequence of transformations of mental representations and that the paradigmatic cognitive structure is a system of such transformations (e.g., Posner, 1978; Posner, Pea, & Volpe, 1982; Fodor, 1983). Cognitive psychology views the mind as consisting of specific faculties adapted for such transformation and analysis. In neuropsychology there is increasing evidence of brain specificity for certain psychological mechanisms. A current, influential trend in philosophy of mind, closely related to the field of artificial intelligence, views the mind as essentially a symbol manipulating device modeled after computers. Modern logic offers new methods for reducing complex computational processes to concatenations of basic elements and combinatorial operations on them. Thus a prevalent view is that mental functioning, or at least a large part of mental functioning, can be thought of as

cognitive systems characterizable on the model of computational devices.

This study is proposing a cognitive model which should not be regarded as necessarily mapping onto neuroanatomical structures. Nevertheless, it should not be overlooked that much neuropsychological evidence suggests that a brain lesion can selectively disturb "the performance of any task that makes heavy use of the subsystem which would be impaired" (Shallice, 1981) which Shallice refers to as an "extended principle of modularity." Moreover, Shallice suggests that "computational independence is made easier by separability of physical processes in the brain." Fodor considers this sort of neuropsychological data as evidence for, but not necessarily as confirmation of, a modular model of mind. Marshall (1984) holds that neuropsychology has "unambiguously adopted the principle of modularity." And Shallice (1981) offers that the "extended principle of modularity" has been supported by "the discovery of a wide variety of such highly selective deficits...one of the main characteristics of the history of human neuropsychology."

In this chapter Fodor's model of modularity (1983) will

be presented concurrently with a discussion of some of the characteristics of the language module proposed in this study. The chapter will conclude with a discussion of some of the substantive criticisms of the modularity thesis.

Fodor attempts to account for some of the notions described in the beginning of this chapter by appealing to faculty psychology with some new features. Employing Gall's view that the various faculties or cognitive structures each subserve one capacity, are specific to that domain, and differ from those which serve another, he likens these structures to computational modules.

Essentially he suggests that some psychological mechanisms are what he calls modular systems and some are not. According to Fodor, the modular systems are isolated, domain specific, computational, and encapsulated. They are isolated because their interaction with other systems of knowledge available to the individual is not regular or routine, but limited. They are domain specific because the system provides answers only to a particular range of questions. They are encapsulated because the range of information that the system consults in deciding what answers to provide is

circumscribed. This lack of unlimited access does not mean that no information is shared between the various cognitive systems; i.e., between modular and non-modular systems, but rather that access is controlled and available only in certain specified ways. This point will be discussed in more detail subsequently.

Language processing and visuospatial processing may be considered as paradigmatic modular systems (though there are probably others), one handling exclusively verbal material, the other exclusively visuospatial material. In contrast, processes such as thinking and problem solving may be considered as non-modular systems. The latter access or potentially access all information known by the individual in any form it might be preserved. Fodor views these processes as the ones involved in fixation of belief (i.e. to form a belief). Fodor does not offer empirical evidence for this claim; rather he argues by analogy to hypothesis formation in science.

Hypothesis formation in science has two characteristic properties. One is that no part of the total corpus of scientific knowledge can be excluded, in principle, as irrelevant to the formation and truth of a scientific hypothesis. Any such exclusion in practise merely

reflects our degree of ignorance concerning the relevant relationships. The second property of hypothesis formation in science is that no hypothesis has its own degree of confirmation or empirical content so that it can be tested in isolation from the rest of the theory. Note that both of these properties are holistic in character, namely, neither the empirical content (referring to confirming and disconfirming evidence) nor the truth content (conditions under which a hypothesis is true or false) can be specified in isolation from the rest of scientific knowledge. Fodor claims that such systems as thinking and problem solving are essentially involved in fixation of belief. By analogy to hypothesis formation these mechanisms will be holistic in character and therefore non-modular. Fodor admits that he does not have empirical evidence for this analogy:

...I have been assuming that the typical function of central systems is the fixation of belief (perceptual or otherwise) by nondemonstrative inference. Central systems look at what the input systems deliver, and they look at what is in memory, and they use this information to constrain the computation of 'best hypotheses' about what the world is like. These processes are, of course, largely unconscious, and very little is known about their operation (p. 104).

Before a detailed discussion of the modular systems can occur, it is essential to make two orthogonal distinctions

in Fodor's view. First, there is the distinction between sensory modality and the content processed (the medium versus the information). Second, there is the distinction between types of content, e.g., verbal information and visual information. The fact that some types of content are characterized in terms that are related to the medium should not obscure the distinction in question. Hence, looking at a series of pictures (i.e., imaging) is a perceptual task, whereas reading a sentence belongs to the domain of linguistic functioning despite the fact that in both cases the medium is visual. For example, looking at a Chinese character is only a perceptual task for one who is illiterate in Chinese, but can be a linguistic task for a literate Chinese person, although the visual modality involved is the same for both acts.

To characterize the domains further, Fodor suggests that the modular systems directly receive the input stimuli (from things in the world) and construct structural content (i.e., they codify information) from the stimuli. They make quick, automatic, comparatively superficial computations on the inputs. These computations are automatic processes. They are merely triggered by the input without there being context-driven considerations, i.e., there are no interruptions of the computation

process for the purpose of relating this particular item to other items throughout the corpus of knowledge.

According to Fodor, during the brief processing, the information therein is virtually encapsulated (i.e., the range of information that the system consults in deciding what answers to provide is limited to within the domain). He proposes encapsulation because it allows for extremely fast, bottom-up processing without interference from, or interaction or integration with, information available in the central systems or that information concurrently being processed in other modules. This brief encapsulation period provides an opportunity for an accurate codification of the stimulus before interpretation occurs.

Fodor holds that the output of these input systems are extrapolations from the stimulus, namely, the coded results of the computations performed upon the stimulus. The nuance of subtler, contextual, analytical or historical information available to the central systems does not interfere with or enhance such computations. Rather, the codes are processed according to schemata or particular propositions whose content may be analogous to Chomsky's innate grammar or representations of Rosch's

basic objects, and other such structures. They are delivered to the central processes for more complete and general mentation: preservation in memory, more elaborate understanding, more detailed analysis, and so on.

Fodor emphasizes frequently in his presentation that encapsulation need not be absolute to be an interesting working hypothesis, even if it cannot be demonstrated in its extreme. These kind of idealizations are standard practise in science and their fruitfulness in each case should be measured in terms of the testable consequences they entail.

Fodorian input systems are not only encapsulated, fast acting analyzers, they are also mandatory in that they are automatically triggered by impinging stimuli. In contrast, the central processing systems are control processes amenable to executive control: one can choose or at least attempt not to acknowledge 'seeing' someone or something one does not wish to see, but one cannot prevent the registration of the image of the object by the visual system unless one closes one's eyes or turns away.

Under most circumstances the central systems do not have routine access to the lowest levels or initial interpretations of stimuli. In fact, one of the arguments

for the postulation of two kinds of information analyzing systems is to explain quick, mandatory initial translations which conjure a code such that the central systems are able to make more complicated, higher level interpretations and elaborations over time. This is not to say that the central systems cannot have access to the specified systems; in fact, they may have access to almost any aspect of these computations, but only by a deliberate selection procedure which directs specific attention to the particular aspect chosen for concentration. This can be seen as analogous to the difference between automatic processing and conscious awareness of and attention to such processing. However, were this kind of conscious attention required for all input analysis, the system quickly would become a slow, plodding, sluggish interpreter.

The sort of access that the central systems have to specific modules raises two separate issues. First of all, there is the issue of the conditions under which the central systems have access to the modules. Secondly, given that the central systems have some provisional access to the modular systems, there is the issue of the scope of such access within the module.

These issues have been addressed regarding many current models by several theorists and investigators. Generally, they have adopted the notion of lexical access as a means of accounting for and describing the process of comprehension of the initial code (e.g. Perfetti, 1985; Rumelhart & McClelland, 1982). Lexical access constitutes recognition of a given word by accessing some permanent semantic memory. Information is registered from the stimulus as it impinges upon the sense organs. It then passes through several levels of processing.

Theories concerned with such access can be divided into two groups: bottom-up approaches and interactive approaches (Perfetti, 1985). Bottom-up approaches regard the passage of elementary features to word recognition as a pathway in which information flows in only one direction, namely, from the impinging stimuli to some semantic memory or central processor. Interactive approaches concur that information flows in this bottom-up pattern, but contend that the flow of information occurs in the opposite direction as well. Both positions assume that information is processed at several levels of complexity and meaningfulness. The pathway usually includes at least levels of basic feature detectors, letter identification and word recognition; the number and

kinds of levels differ among approaches, but the basic notion of levels of processing does not.

Some investigators of these issues have attempted to delineate and differentiate the roles of the automatic processes and context-driven post-perceptual processes. Certain experimental procedures including Cloze methods, phonemic restoration paradigms, and context effects have been used to address these issues. Some recent evidence from each of these procedures will be reviewed in order to assess the sort of access central systems might have to modular systems.

Cloze procedures have been accepted as demonstrating the effect of expectations (and therefore in Fodor's system background information from the central systems) upon language perception. In Cloze procedures, the subject is presented with the first several words of a sentence and then asked to complete the fragment. For example, Fischler & Bloom (1980) studied the influence of presentation rate on context effects of sentences for a lexical decision task for words that are highly likely, highly unlikely and semantically anomalous (phonologically correct nonwords, e.g. choes) sentence completions. Subjects were presented with 96 sentences in which the

last word varied such that it was 1)a word which was highly likely to end the sentence, 2)a semantically acceptable but unlikely word to end the sentence, or 3)a pronounceable syntactically acceptable but semantically anomalous word. The length, number of syllables and frequency of the words were matched across the three conditions. The words of the context (sentence) were shown singly in succession at rates of 4, 12, 20, or 28 words per second. The lexical decision stimulus (the word) remained visible until the subject responded. The results revealed a small but significant facilitation for the highly likely words at 4 ($p < .10$) and 12 ($p < .05$) words per second, but no facilitation was obtained for the two faster rates. In contrast, a significant inhibition for the anomalous word condition was obtained at all presentation rates.

Fischler and Bloom claim "...that sentence contexts have systematic effects on the ability to recognize a word as a word, [and] that these effects can be interpreted as [inhibiting] semantically inappropriate words..."(p. 224). They support this claim by arguing that at least 4 and 12 wps mirror normal reading rates which "...suggests that the general meaning of a sentence can be obtained and used to direct attention with little apparent effort or

conscious comprehension" (p. 224).

Their arguments are not conclusive. They point out that the average reading rate is 300 words per minute (5 words per second). Then they claim that their procedure mirrors reading. However, this claim is compromised by the fact that their results for facilitation of highly likely words were significant at 12 words per second ($p < .05$), but failed to be significant at 4 words per second ($p < .10$). Thus, although Fischler and Bloom argue that sentence context systematically effects word recognition, their claims are too strong for such a weak result.

Fodor argues that the task demands of the Cloze procedures set the subject up to use background information from the central systems because in attempting to try to correctly respond, the subject attempts to guess by using the context whenever he can. And, if the subject tries to guess or make some judgment regarding the correct response, then the central systems are probably deliberately accessed to attend to the task. Further, Fodor argues that the inhibition obtained for the 'semantically anomalous' words suggests that at least some of the effects of sentence context must be 'postperceptual' or after an initial analysis of the

lexical content has been made by the input systems. In a word, it took the subjects time to identify a syntactically correct nonword.

Samuel (1981) studied phonemic restoration in a signal detection paradigm. Two types of stimuli were presented: items in which segments of words were replaced by extraneous sound and items in which the extraneous sound was superimposed on the critical phoneme. The stimuli systematically varied as follows: high frequency and low frequency words; two syllable, three syllable, and four syllable words; real words and matched pseudo words (phonologically legal nonwords); phone class (fricative, stops, etc.); position of replaced/added phoneme also varied. Stimuli were presented singly. On each trial subjects were asked to report whether they thought a stimulus utterance was intact (noise superimposed) or not (noise replacing). This procedure allowed for the calculation of the signal detection parameters of discriminability and bias: miss rate (d') = $P(\text{intact}|\text{replaced})$ and false alarm rate (β) = $P(\text{replaced}|\text{intact})$. The discriminability parameter (d') measured how perceptually similar the two types of stimuli sound; perceptual restoration of the replaced items should make them sound intact (noise superimposed), producing low

discriminability scores. The bias parameter (β) measured the tendency of subjects to report stimuli as intact (noise superimposed) when they are not, reflecting post-perceptual decision processes because the sound is first replaced by perceptual illusion and then judged intact post that perceptual phenomenon.

Findings suggested that phone class of replacement sound (acoustic similarity to white noise), position of replacement sound, and forward and backward masking contributed to sound replacement. These variables are all perceptual phenomena and therefore, for Samuel, indicative of bottom-up processing. Further, the findings showed more restoration in words than in phonologically possible nonwords. Samuel regards this finding as confirming top-down context-driven (in the form of lexical knowledge) influence on perceptual processing. However, Fodor argues that this finding is evidence of top-down processing within the module: Phonemic restoration occurs when the signal (e.g. white noise) is sufficient to confirm the presence of a schema that is expected on the basis of a context (i.e., the rest of the word). On Fodor's view, to claim that the central processes have been accessed would require showing that the information needed is beyond knowledge regarding the lexicon, because according to

Fodor's model such lexical knowledge is located within the language module. This point will be explored subsequently.

In a third experiment, stimuli were presented in a sentence context which included both the phonemic restoration paradigm and ambiguous and disambiguating sentences with forced choices between two real words. In this version of the phonemic restoration paradigm, restoration could produce at least two different real words (e.g. batter/battle). The same sets of words were used for the forced choice paradigm. d' and beta were calculated for the phonemic restoration paradigm as above. For the forced-choice word judgments, a signal detection measure was also calculated. Here beta measured the likelihood that the predicted word was reported, regardless of what word was originally presented. These results showed that discrimination (i.e., the perceptual measure) of the replaced/added phoneme was better when a word is predictable in the context of a sentence than when the context of the sentence is neutral. As Samuel suggests, apparently high-level information of the type available in this testing situation was unable to influence low-level perceptual processing. Thus, not only was the amount of phonemic restoration inversely

proportional to the subject's ability to discriminate the stimulus word with a phone missing from an undistorted token of the same type, but such discrimination was actually better when items were highly predictable from the context. Both of these findings argue for the biasing of post-perceptual decision processing rather than context-driven expectations.

Swinney (1979) investigated the effects of semantic context on lexical meanings by presenting sentences which included 1) either an ambiguous word or an unambiguous control word which was roughly synonymous with one reading of the ambiguity and, 2) either a sentence with no disambiguating context or a strongly disambiguating context. This produced four variations: for example, priming the subject by informing in the first sentence that a government building was plagued with problems and then following with a sentence like a) the man found several bugs, b) the man found several roaches, spiders, and other bugs, c) the man found several insects, or d) the man found several roaches, spiders, and other insects (the actual sentences were longer, but the meanings conveyed were the same). These sentences were orally presented while the words 'ant', 'spy', or 'sew' were visually presented after the word 'bugs' or 'insects'. Subjects

were instructed to signal whether or not the visually flashed word was a real word. Reaction times were measured.

Findings showed that lexical decisions for visual words related to each of the meanings of the ambiguity were facilitated even when a strong biasing content was presented. Thus, although only one of the ambiguous meanings was contextually relevant, both were facilitated by the context. Swinney concludes that these data appear to provide some evidence for autonomy of the lexical access process (bottom up) during sentence comprehension. Further, as Fodor points out, this looks less like focussed, deliberate attention of contextual background information from the central systems. Rather it looks more like

...some sort of associative relation among lexical forms (between, say, 'spy' and 'bug'); a relation pitched at a level of representation sufficiently superficial to be insensitive to the semantic content of the items involved. This possibility is important for the following reason: If facilitation is mediated by merely interlexical relations (and not by the interaction of background information with the semantic content of the item and its context), then the information that is exploited to produce the facilitation can be represented in the lexicon; hence internal to the language recognition module. And if that is right, then contextual facilitation of lexical access is not an argument for the cognitive penetration of the module. It makes a difference...where the

penetrating information comes from (Fodor, 1983, p.79-80).

Given the above evidence the following proposal may account for such data: within the language module a lexical association network, much like the one described in the heyday of associationism, develops through information based on experience. Terms for things frequently connected through information based on experience become themselves connected in the lexical association network. Briefly, it would operate such that a particular lexical unit would automatically excite neighboring, contiguous lexical associations, and this information along with phonemic translation and grammatical parsing, would become part of the final linguistic code. These lexical 'meanings' would be quick, probabilistic associations to the particular morphemes, whose full meaning according to the context and other pertinent knowledge would be comprehended when centrally processed.

However, this proposal does not completely resolve the problem. Lingering issues remain: have the differences between the modules and the central systems been blurred beyond recognition? For if the association between lexical items is grounded on information based on

experience, then the essential difference between the modules and the central systems is compromised.

This problem can be addressed by making the following distinction. The distinction is between what is associated, i.e., the elements that the association includes, and the basis for that association. The former includes the lexical items themselves (in the case of the language module) together with the associative pathways that connect them and nothing else. The latter material, i.e., all the information based on experience that established the associative pathways in the module, is deferred to the central processing systems.

Six other theoretical objections of the modularity thesis will now be examined: 1)that the notion of modularity is simply a description of so many subroutines; 2)that the role of attention in modular system is underdeveloped; 3)that penetrability of the module, i.e., "leaking" or divulging information at various levels along the "bottom-up" route terminating with the "output" code (which is delivered to the central systems), defies encapsulation; 4)likewise, as discussed earlier, the alleged top-down penetration of the module from the central systems is in fact a top-down penetration; 5)is

there a suitable and substantive characterization of the output from the modules to the central system which will issue and warrant a sufficiently rich modularity thesis?; and, relatedly 6) can any characterization of an output that is adequate as a response to (5) be attributed to a sub-personal system as opposed to one which reflects the whole person, i.e., the central, nonmodular systems?

Putnam (1984) argues that Fodor's characterization of modules in computational terms renders these modules as being very close to, if not just, constructs known in computer terminology as subroutines. A subroutine is a sequence of computational steps such that the first step in the sequence is an operation on a given input; the last step in the sequence produces an output; and the intermediary elements are isolated from other computational operations. Now, if the modularity thesis is interpreted in this manner, then it escapes the other objections noted above, but it also fails to carry the explanatory weight Fodor attributes to it. For instance, Fodor wishes to distinguish between central processing systems and the variety of postulated modular systems. But if modularity is nothing but the existence of computational subroutines, then no such distinction can be made, since different subroutines may exist even within a

central processing system (e.g., for problem solving).

In response to Putnam's objection, one can argue that the representation of the mind as a set of subroutines can be viewed in two ways. The mind can be viewed as a set of different subroutines (e.g., memory, reasoning, etc.) each of which is topic neutral but functionally identified, such that any of these subroutines can receive input of any character (i.e., the content of the input is not relevant). In contrast, the mind can be viewed as a set of subroutines which are content-specific faculties such that each system is specialized to receive input only of a certain character. Putnam's objection has force against the former characterization only. That is, the former characterization is just a characterization of a subroutine. But since Fodor quite explicitly views a modular system in accordance with the latter model, this sort of objection is not adequate in itself.

Putnam in anticipation of precisely the kind of response articulates his deeper objection, namely, that, "...it is clear that Fodor's view that an informationally encapsulated subroutine can have 'concepts' presupposes a number of doctrines which are not explicitly spelled out in The Modularity of Mind, doctrines which many readers

who might be sympathetic with aspects of the model would find bizarre" (p. 260). The details of this deeper point will be elaborated upon further when discussing the final critical point (6) in this discussion.

The second criticism involves the characterization of attention. That is, how to specify the class of those attention diverting situations which penetrate the routine operation of a module? For example, when one reads, the language module is activated. However, if the telephone rings, attention may be diverted. Hence, the operation of the linguistic module may be penetrated. But, if one antecedently knows that a telephone answering machine device is activated, then normally one's attention will not be diverted from the reading activity and thus no modular penetration occurs. This is not to say that the ringing of the telephone is not noted, but rather that the noting of it does not interrupt the routine operation of the module. Marshall (1984) has pointed out that Fodor's discussion of attention is underdeveloped. As Marshall puts it:

Further discussion of attention within the Fodorian framework would be valuable. Classical faculty psychology recognized a separate power of attention, often likened to a searchlight, illuminating first this, then that, either under the exercise of the will or moved against our will by the attractive forces of the

environment. The phrenologists argued, per contra, that attention is no more than "the active state" of any particular perceptive, intellectual or affective faculty and that there are consequently "as many species of attention as fundamental faculties of the mind" (Spurzheim, 1824). Fodor's response to the attentional counterexample to mandatory processing is to suggest that it is not the case that the input analyser is itself switched off but rather that its output is no longer available to central processes. Fodor quotes results that show high-level processing of the unattended channel in dichotic listening tasks as being compatible with this interpretation (Lackner & Garrett, 1973). These experiments, however, deliver language to both ears, and it is therefore unclear what relevance they have to the modularity story, even if one grants that their design suffices to prevent attentional switching (see Newstead & Dennis, 1979). Nonetheless, it would certainly make biological sense to have a mechanism that restricted the access of input systems to central processes (in order to concentrate on the task in hand, as Ben Luca pointed out) provided, of course, that loud noises and sudden movements could automatically overcome that inhibition.

Marshall's point regarding attention highlights a requirement that Fodor's model should satisfy. But, this criticism does not entail that the theory is unable to account for it. In the present study, this issue does not directly arise as the subjects are not required to divert their attention at any point during the classification tasks.

Marshall (1984) also discusses two problems regarding the penetrability of the module. One is the problem of

modular leakage and the other is the problem of contextual influence. The problem of modular leakage arises from the fact that the central processing systems seem to be capable of accessing information processed within the module. As discussed earlier in this chapter, Fodor must allow for some top-down access from the central systems (e.g., Fodor's response to Fischler & Bloom's data; i.e., levels between phonological and logical form are available).

Marshall describes this difficulty as follows: "This is a pity, because it [that information is available between 'levels'] suggests that modules can 'leak' the results of their computations at (almost) any structural level, and that what is, in point of fact, leaked is determined by the relevance of that level to the task in hand." Fodor handles this point by arguing that information is available at intermediate levels of representation "at a price" of imposing "special demands on memory or attention." Yet, as Marshall has noticed, not all tasks to which Fodor refers (e.g., Posner's font versus alphabetical identification paradigm where font identical characters are responded to faster than alphabetically identical characters) impose special demands on attention or memory.

Marshall proposes a possible solution, namely, that central processing access occurs not at any point along the processing pathway within the module, but only at well-defined interlevels: "The answer, I suspect, is that all complex modules have well-defined interlevels; and any genuine interlevel is, in principle, equally available to central processes. Overall task demands will determine when it is necessary to access an interlevel. But this is to propose a far richer interaction between complex modules and central processes than the reflex or 'tunnel' image (you can only see what goes in and what comes out) of a module suggests."

The second issue regarding penetrability is the problem of contextual influence. This issue is relevant to the present study and has direct consequences for the task designed to access the compositional (linguistic) module. As described in the section discussing learning disabilities, the compositional task presents the subject with stimulus triads of human beings and wearing apparel in picture and word form. Associations between human beings or between wearing apparel items are regarded as manifestations of compositional concepts whereas associations between human beings and wearing apparel

items are regarded as manifestations of functional relationships. In terms of the above discussion, it now becomes clear that the functional relationships alluded to above are, in effect, context driven. This interpretation is available because the task demands are neutral with respect to choice of classification strategy (see section on research hypotheses for complete discussion of task).

As Marshall points out, there is a well-entrenched tradition in both experimental psychology and artificial intelligence that "...all kinds of semantic and pragmatic information can be brought directly to bear upon early stages of linguistic processing" (p. 222). The idea is that contextual information influences perception of the physical stimulus. If this is the case, then information from the central systems can penetrate the modules to influence processing within them.

The issue of contextual influence was already addressed in connection with the problem that the differences between the modules and the central systems have been blurred beyond recognition. At that point in the discussion, the proposed solution was to distinguish between what is associated, i.e., the elements that the association includes, and the basis for that association.

Fodor's response to the problem of contextual influence is essentially the same: The shallowness of the output of the modules is the result of the removal of all the information based on experience that established the associative pathways in the module.

But to what does this claim of shallowness commit Fodor? In other words, what possible levels of description can the output of modules feature? Candidates include syntactic descriptions, logical forms and semantic descriptions. Shallowness seems to suggest that the level of description is sufficiently minimal so as not to attract context interference. Marshall thinks that, "syntactic and logical form might be where the module ends" (p. 224), thereby guarding against contextual influence. Marshall's restriction excludes a rich semantic description because it is vulnerable to contextual information: understanding the meaning of an utterance may include understanding of the particular context (i.e., situational circumstances).

A parallel situation obtains in the case of a perceptual module. Here shallow outputs would be certain geometric properties of the stimulus. But Fodor is very unhappy with this solution for it renders modules to be incapable

of handling any object and event recognition. As Fodor puts it,

...surely, from the point of view of phenomenological accessibility, perception is above all the recognition of objects and events. Shallower systems of representation can therefore constitute only interlevels of input analysis. What, then, is its output? (Fodor, 1983)

Fodor's solution is to identify the modular output as prototypes (in the sense of Brown (1958) and Rosch et.al. (1976) basic level categories). However, Marshall rebuts this proposal, "But I totally fail to see how any of this helps. If input analysers only deliver dog, then what on earth does recognize poodles?" (p. 224) Marshall supports his counterexample by referring to a study by Warren and Morton (1982). They demonstrated that prior presentation of pictures of objects facilitated subsequent tachistoscopic recognition of a different picture of the same basic level object (e.g., "clown" for pictures representing a pierrot and a red-nosed circus clown in markedly distinct postures) up to 45 minutes later.

This particular problem while relevant theoretically to the explication of the modularity thesis, is not a constraint on the present study for the following reasons. All pictured stimuli utilized in the typicality

experiment (see the section on prototypes and the method section for details) were line drawings of typical basic level objects exhibiting as few particularizing details as possible. Thus, the picture of a hammer was a line drawing of a typical claw hammer, the picture of a chair was a line drawing of a typical wooden chair without arms and so on. That is, the line drawings represented those kinds of basic level objects from whence, according to Rosch et.al. (1976), the prototypes are abstracted.

The final criticism of the modularity thesis to be addressed is related to the discussion above regarding the output of modules. That is, can any characterization of an output that is adequate as a response to the shallowness issue, be attributed to a sub-personal system as opposed to one which reflects the whole person? Here is the dilemma. The more data for which the model has to account (e.g., the case of the poodle), the richer the description of the output has to be. And the richer the description of the output, the more vulnerable the module is to penetration. This problem is the first horn of the dilemma. The second horn of the dilemma is the recognition that vulnerability to penetration can be reduced by shallow description of output. However, shallow description of the output excessively restricts

the scope of the module.

Putnam thinks that Fodor's solution is to invoke a causal theory of denotation which allows escape from the first horn of the dilemma. The causal theory postulates causal chains which establish denotation without increasing the information available to the person. Therefore, one can have shallow output descriptions which also are sufficient to account for the necessary data (e.g., the theory allows for the identification of the poodle). Thus, the threat of penetrability is avoided. But if the original problem was how we recognize poodles according to the modular thesis, then the mere attachment to poodles through a causal chain without an echo (i.e., information) in the modular structures of the person is unhelpful. As Putnam remarks, "...the denotation of our terms depends on the whole structure of our language and belief system, and not just on the 'causal attachments'." (Putnam, 1984, p. 263) In other words, whatever resources are required to explain understanding of language and recognition of objects must be intrinsic to the whole belief system.

The six theoretical objections presented are substantive. These objections must be addressed, but at

this time, there is no particular evidence to suggest that the modularity thesis cannot resolve these issues. Moreover, the general idea of modularity is supported by evidence from many areas of discourse: for example, cognitive theory, neuropsychology and some artificial intelligence models. As Marshall has written, "Modularity is clearly a term whose time has come."

This discussion concludes the presentation of the various relevant topics germane to the development of the present study: relevant literature on learning disabilities, models of unitary versus dual processing, prototypes and their role in a modularity thesis and an examination of the modularity thesis. What follows in the next chapter is a summary of the modularity model proposed in this study, its theoretical relationship to learning disabilities and detailed explication of the specific hypotheses of the study.

COMPOSITIONAL AND PROTOTYPICAL PROCESSING

The Proposed Model

Common Code models represent the coding of information as a single code regardless of input modality while Dual Code models represent the coding of information as functionally distinct depending upon input modality. A general way of characterizing this controversy between dual and unitary coding models is as follows. The dual coding model belongs to a family of conceptions which can be located on a spectrum ranging from stronger to weaker. The common feature among all the models along the spectrum is that they delineate more than one cognitive faculty. The difference among them can be construed as the degree to which they differentiate between the postulated faculties. That is, one dualist model can be viewed as stronger than another if it specifies more relevant distinguishing properties among the faculties. Thus the strongest dualist view is the Fodorian style modularity

model. Such a model of course entails a dual processing model; however, the converse does not in general hold. That is, there can be dual processing models which are not modular models (e.g., Pavio, 1975; Posner, 1982).

This study opted for the strongest dualist model, namely the Fodorian style modularity model. Specifically, the study focussed on two modules, the linguistic module and perceptual module for determinate sets. It was postulated that each module possesses a limited, shallow association network employing different organizational methods: a linguistic module with a network based on compositional analysis and a perceptual module with a network based on prototypes.

The proposed model also allows for the organizational methods characteristic of each association network within each unique module to occur under differing conditions. The association network based on the compositional analysis (i.e., linguistic) can be considered as classically hierarchical. The hierarchy in effect represents the decompositional architecture of linguistic concepts with the usual constraints on such hierarchies. Specifically, this hierarchy would be characterized by levels conceptualized as trees with the specific

relationship between nodes or connections being transitive. Transitivity refers to a relationship so relating items that if the first is related to the second and the second is related to the third then the first is so related to the third (e.g., a poodle belongs to the more inclusive category of dog which belongs to the more inclusive category of animal).

In contrast, the association network analyzing perceptual data is postulated to be organized by prototypes. The prototypical network is based on associations of similarity, contrast and contiguity (and perhaps other relationships) and is not hierarchically organized. Since the features that make up the associations are themselves not transitive and not hierarchically organized, the resulting network is not, in general, transitive either (e.g., poodle and dog belong to the prototype dog, but animal does not).

The model also suggests that under normal circumstances the linguistic module consistently pairs phonemic units (i.e., audio and orthographic representations) with lexical features (words) organizing an association network based upon these features. Likewise the perceptual module organizes its network based upon prototypes. In both

modules, as incoming information is analyzed, it is transformed into codes constructed from these networks which are then appropriated to the central processing systems as needed.

Now if a particular individual has a learning disability which interferes with automatic and accurate phonemic processing (e.g., dysphonetic dyslexia), then this model predicts aberrant and under development of category representation within the deficient domain consequent of the inconsistent and inaccurate pairings of phonemic units with their appropriate lexical features. Such inconsistencies and inaccuracies may also lead to under utilization and reliance upon this manner of processing incoming information.

The model further suggests that input from other modules should not be affected unless they too are dysfunctional in some specified way. Thus under most circumstances both input from other modules and the functioning of the central systems should not be affected except insofar as the code delivered from the dysfunctional module to the central systems is compromised by the disability. This is not to say that some disabilities may not arise from dysfunctions of the central systems, but rather to offer a

way of classifying and understanding various learning disorders and disability syndromes.

This model further predicts some specific consequences when category representations are accessed by particular kinds of tasks. Normal children should display a developmentally appropriate ability to utilize both the compositional and perceptual networks as the task demands. However, children suffering from a disability in phonemic processing (e.g., dysphonetic dyslexia) should make more aberrant (i.e. inaccurate and inconsistent) and developmentally immature category choices when the task demands access the compositional association network. Similarly, children suffering from impairments of perceptual processing should exhibit deviant responses when the prototypical network is accessed.

The Research Hypotheses

To examine these hypotheses two experimental tasks were employed in both pictorial and written word conditions. All stimuli were presented in both conditions.

Specifically, the two tasks investigated classification behavior in both conditions. Results for each task were compared among the groups: the dysphonetic learning disabled subjects, the dyseidetic learning disabled subjects, and the nondisabled subjects.

As described in the section on learning disabilities, a word clustering task was administered to investigate differences in compositional clusterings among the experimental groups. The stimuli consisted of people and wearing apparel. Decisions based on compositional analyses were defined as those which match people with people. Decisions based on functional relations were defined as those choices pairing people with wearing apparel. It will be recalled that, as discussed in the section on modularity, functional relationships were postulated not to be part of the language module (the compositional network), but rather such information accessed the central processors. It will also be recalled that this task was neutral with respect to demanding which strategy (compositional or functional) the subject should employ. As noted previously, functional relationships may be represented by prototypes (e.g., women wear dresses), but the possibility of prototypicality of these relationships was not investigated. Strategy employed was

a dependent variable.

Stimulus triads (i.e., 3 stimuli per trial) were presented to the subjects whereupon the subject was queried as to which two of the three stimuli were more alike. It was hypothesized that 1) normal children would make different hierarchical decisions depending upon condition (i.e. word versus pictorial condition). It was reasoned that the word condition should produce relatively more decisions based upon compositional considerations. That is, the response bias should be in the direction of people-people decisions. On the other hand, the pictorial condition should produce relatively more decisions based upon functional decisions. That was predicted because (given that the task demand was neutral with respect to choice of mediating strategy) according to current literature pictures tend to activate more specific versus generic responses (Durso & Johnson, 1979; Durso & O'Sullivan, 1983). The specificity of pictures make them context-laden or specific, unique instances, and therefore they tend to access functional relationships. Words, on the other hand, act as general terms and thus access concepts.

2) It was further hypothesized that dysphonetic dyslexic

children would exhibit significantly more aberrant or atypical responses in the word condition than their normal counterparts, because the task was likely to access the compositional network. However, their pictorial condition should be more similar to the normal children as perception of functional relationships should be less impaired.

3) Finally, it was hypothesized that the performance of dyseidetic dyslexic children would not reflect aberrant choices because the task theoretically accessed the compositional system.

As described in the section on prototypes, a measure of category typicality was utilized to determine variability along this dimension. It was hypothesized that 1) normals would exhibit no significant differences in choices across conditions (word & picture) as the task demands are the same for both tasks. That is, the task demands under both conditions require typicality judgments and thus specifically and explicitly ask for judgments based on prototypical formulations of category membership. Both pictures and words should pick out the same prototype because that is what the task explicitly demanded. Therefore, no differences in choices across conditions

would be observed. 2)Dysphonetic dyslexic children should not exhibit significant differences between the two conditions because their disability does not compromise the underlying processing faculty (i.e., the perceptual module). 3)The dyseidetic dyslexic group should exhibit significantly aberrant decisions in this perceptual task as manifested by a)response differences between pictures and words indicative of a deficient prototypical network, and b)significant differences in decisions as compared with the two other groups.

To further investigate the dysphonetic disability two tasks adopted from Frumkin-Feis (1982) were used. As discussed in the section on learning disabilities, in her study verbal encoding tasks using the Wicken's release from proactive interference technique indicated that learning disabled children with verbal encoding problems were particularly impaired on phonetic as compared with semantic encoding tasks. In the present study, these tasks were employed to 1)investigate whether this same pattern of phonetic versus semantic encoding impairment obtains for the phonetically impaired subjects in this study, and 2)determine whether performance on these tasks is predictive of performance on the other experimental tasks administered.

METHOD

Subjects: All subjects (Ss) were between 8-12 years of age and had no peripheral auditory perception problems as assessed by the school. Learning disabled subjects who were included in the study were assigned to either the dysphonetic dyslexic group or the dyseidetic dyslexic group. All subjects who were referred for participation in the study were first required to have their parents or guardians sign a letter of informed consent (see appendix for copy of this letter). Of the forty-three subjects originally referred, four were disqualified because they did not meet the study criteria as determined by the screening battery (see details in screening battery section in this chapter). One was too young, one had severe emotional problems, one was a nonreader, and one did not fit into either dyslexic group. Thus thirty-nine subjects were seen: twenty-three normals, twelve dysphonetic dyslexics, four dyseidetic dyslexics. The small number of dyseidetic dyslexic children reflects the small number of children with this particular disability in the general population (e.g., 5% in Mattis, et.al,

1975; 4% in Denkla, 1975).

All subjects in the dyslexic groups were were so certified by the Committee of the Handicapped of the Board of Education of the City of New York. These subjects were enrolled in special education classes. No child had a history of significant emotional disturbance as determined by school personnel. The normal subjects were chosen from mainstreamed students attending the same elementary school (see Table 4 in Results Section for other subject variables).

The Screening Battery

Intellectual Functioning: Intellectual functioning was assessed by the school with the Wechsler Intelligence Scale for Children-Revised. No child whose Intelligence Quotient was below 85 was included in the study.

Academic Ability: Reading level was determined by the reading section of the Wide Range Achievement Test (WRAT) (Jastak & Jastak, 1965) for both dyslexic groups. The WRAT reading subtest measures word recognition of single words of increasing difficulty. This test is considered an adequate indicator of a subject's word attack skills.

Furthermore, WRAT scores have been standardized on a large normative population and therefore allow an individual score to be accurately compared with the general population. School administered California Achievement Test reading scores were utilized for the normal group. No student whose reading score was below grade level was admitted to the study.

Boder Test of Reading - Spelling Patterns: A total of thirty-nine subjects were divided into three groups according to the results of this measure and the reading measures: 1) twelve dyslexic children who exhibited dysphonetic reading and spelling errors as measured by the Boder Test of Reading - Spelling Patterns (Boder & Jerico, 1982) and had a reading level at least 1.5 years below grade level; 2) four dyslexic children who exhibited dyseidetic reading and spelling errors as measured by the Boder Test of Reading - Spelling Patterns and were reading at least 1.5 years below grade level; and, 3) twenty-three adequately achieving children who exhibited age appropriate academic achievement according to their teachers and grade level or better scores on the California Achievement Test--reading comprehension section. They were not tested on the Boder Test. As these children were not specifically screened for reading

problems, it may be that some of them did, in fact, have reading problems that were neither impeding their classroom performance significantly as assessed by their teachers nor impinging on their reading comprehension ability as assessed by the California Achievement Test to the degree that the comprehension measure was below grade level.

The dysphonetic dyslexic group ($n=12$), 5 girls and 7 boys, ranged in age from 9.33 years to 12.0 years old, with a mean age of 11.0 years (132.1 months). The dyseidetic dyslexic group ($n=4$), 3 girls and 1 boy, ranged in age from 10.3 to 12.6 with a mean age of 11.1 (133.0 months). The normal group ($n=23$), 11 girls and 12 boys, ranged in age from 8.0 years to 12.75 years, with a mean age of 10.16 (122.3 months). The dysphonetic dyslexic group and the normal group were significantly different in age ($t=2.13$, $p<.04$), with the normal group being younger.

Auditory Discrimination Ability: Auditory discrimination of speech sounds was assessed by the Wepman Auditory Speech Sound Discrimination Test (Wepman, 1958) for dyslexic groups. In this task subjects are required to determine whether two words presented are the same or different. The test consists of forty pairs of single syllable words, thirty of which differ by one phoneme

either at the beginning or end of the word, and ten of which are identical. Subjects must rely solely upon auditory cues as he or she is not allowed to see the experimenter pronounce the words, i.e. the subject has his or her back to the experimenter during administration.

This test was administered so that subjects who committed errors above the cut off score (more than 3 errors) could be compared with subjects who did not to assess whether the two groups performed significantly differently on the experimental tasks.

The Experimental Battery

All subjects were tested individually over two sessions in a quiet room. Each subject was assigned randomly to one of four possible administration sequences. Each session lasted about one hour.

All subjects were individually tested on three experimental tasks. The dyslexic groups were also administered the screening battery individually. All responses were recorded by hand.

Several considerations determined the organization of the sessions: 1) only one condition of the noun sorting tasks (i.e., one condition of the Hierarchical Task and one condition of the Typicality Task) was administered per session; 2) in all sessions order of task administration was one verbal encoding condition, the hierarchical clustering task, the typicality task and lastly the second condition of the verbal encoding task. This order of administration was designed to allow hierarchical clustering to occur without being influenced by the typicality task. Because the typicality task was divided into categories prior to administration while the hierarchical one was not, it was important to administer the hierarchical task first so as not to influence sorting strategies in that task (subjects might have been more likely to sort according to category after participating in the typicality task). In addition, this order of administration allowed for maximum interval between administration of the first and second verbal encoding tasks, so that performance on one would not confound performance on the second encoding task.

The pictorial and word conditions of the classification tasks were administered on separate days, with a minimum of one week intervening between administrations. The

instructions were repeated prior to each administration and all responses were recorded by hand. If the word condition of the Hierarchical Clustering Task was administered in a session, then the picture condition of the Typicality Task was administered in that session, and vice versa.

One condition of the phonetic and one condition of the semantic encoding tasks was administered during each individual testing. For each presentation, one condition was presented in the release condition and one condition was presented in the nonrelease condition. Order of presentation was randomized. The instructions and practice trial were given before each administration.

The Hierarchical Clustering Task

This task was administered identically in both the written word condition and the pictorial condition, except that in the pictorial condition the subjects did not name the nouns while performing the task so as not to prime linguistic processing (e.g., Durso & Johnson, 1979). The same nouns were used in both conditions to make the tasks as similar as possible in order to compare performance in

the two modalities.

Stimuli: A set of eight nouns was presented in all possible triads yielding 56 triads per word and pictorial condition. Each triad was presented on separate pages of a loose leaf note book in a triangle format. The stimuli were presented in a fixed random order such that the same stimulus did not appear in two consecutive triads and each stimulus appeared the same number of times in each position of the triangular presentation format. Each condition was presented in a different fixed order. Half of the subjects were administered the fixed order from 1 to 56 and half of the subjects were administered the fixed order from 56 to 1 for each condition. In addition, half of the subjects received the word condition in the first session and half received the pictorial condition in the first session.

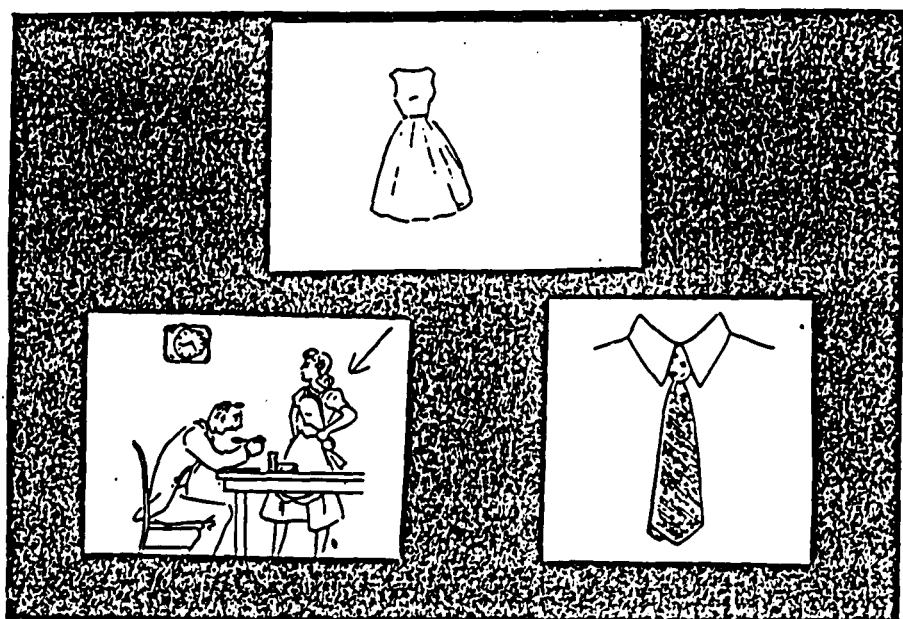
The stimulus nouns were chosen by Frumkin-Feis using several criteria. All words were concrete nouns of relatively high frequency (Thorndike & Lorge, 1944) and judged to be visualized easily. The eight nouns were: husband, wife, lady, king, hat, crown, dress and tie. The set of nouns was related along several dimensions. Relationships within the subset of human beings (e.g., husband-wife) and within the subset of wearing apparel

(e.g., hat-tie) were considered to be compositional relationships. Conversely, relationships between human beings and wearing apparel were considered perceptual/semantic relationships. All pictures were line drawings chosen from children's books and magazines for realistic depiction of the noun (see Figure 1).

Administration: Each subject was required to read and define each word in the written word condition and name and define each stimulus in the pictorial condition prior to task administration. If an error was made, it was corrected and the subject was asked to read or name the entire set again. If a subject was hesitant in responding, a prompt such as "What is a.....?" or "What does the word mean?" After demonstrating sufficient familiarity with each stimulus, task administration began. The subject was presented with one triad at a time. For each triad trial the subject was asked to choose which two of the three items were more similar. The precise instructions were: "Choose which two are more the same, more alike." Then the experimenter pointed to each of the three possible pairs saying: "These two, or these two, or these two. Which two are more similar?" These instructions were given for the first few trials and subsequently only if the subject became confused as to the

Figure 1

Example of Hierarchical Stimulus Triad



task requirements. The subjects were reminded to read the stimuli aloud in the word condition and not to name the stimuli in the picture condition as needed.

Responses to the SC task were computed as follows in order to formalize the expectation criteria that people-people choices and apparel-apparel choices would be more likely to occur. The sum of people-people choices plus apparel-apparel choices minus the sum of people-object choices ($[P \backslash P + A \backslash A] - [P \backslash A]$) provided each subject with one SC score for words and one for pictures. That score could range from +56 to -56, where the +56 stands for all possible P\A choices plus all possible A\A choices minus no P\A choices and -56 stands for no P\A choices plus no A\A choices minus all possible P\A choices. Positive numbers indicate choices in the direction of compositional or P\A and A\A choices and negative numbers indicate choices in the direction of functional or P\A choices.

Category Typicality Judgment Task

This task was adapted from Bjorklund, Thompson and Ornstein (1983) and utilized their method of investigating

typicality judgments in children. Subjects were asked to rate how typical of its category each stimulus presented was on a 3 point scale. The task was administered in a written word and pictorial condition.

Stimuli: Nouns from three natural language categories employed in the Bjorklund et.al. study were utilized. They are presented in Table 1. Eight nouns were chosen to represent each category from the Bjorklund list, two highly rated items in their study (i.e. near 3.0.), two medium rated items (i.e. near 2.0) and two low rated items (i.e. near 1.0). Examples of the stimuli used in the picture condition are presented in Figure 2.

Administration: Subjects were presented with a deck of cards (pictures or words depending on condition) for each category separately. Subjects' ratings were obtained by having them point to one of three black and white schematic faces drawn on 4 x 6 inch index cards. The faces displayed each had a different expression: a smiling one labeled 'very good' representing very good category examples (3.0), a straight-mouth one labeled 'okay' representing okay category examples (2.0), and a downturned mouth one labeled 'poor' representing poor category examples (1.0).

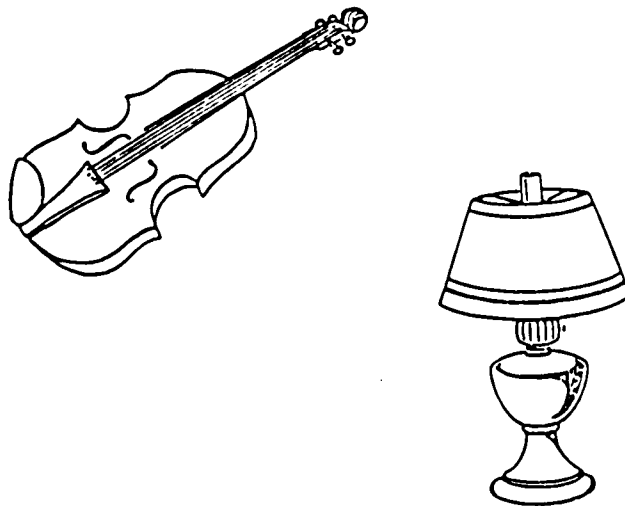
Table 1

Category Sorting Stimuli: Typicality Rating

Category	Rating
Tools	
hammer	2.88
saw	2.75
screwdriver	2.67
wrench	2.63
pliers	2.50
axe	2.08
nails	1.79
ladder	.88
Instruments	
guitar	2.63
piano	2.58
drum	2.50
trumpet	2.46
violin	2.29
flute	2.17
tambourine	2.04
accordion	1.50
Furniture	
couch	2.79
bed	2.67
table	2.54
chair	2.50
desk	2.21
lamp	1.79
television	1.50
clock	.83

Figure 2

Examples of Typicality Stimuli



Following the procedure of the Bjorklund et.al. team, each subject was instructed as follows:

Let's play a game. Pretend that you have met someone from outer space who has just landed on earth. Now this creature wants some help in understanding how things are here because he doesn't understand anything. Here is how you can help. I am going to give you these cards with words (pictures) on them. I want you to read the words (name the pictures) and put them under the very good face (E. points to the smiling face) if you think the one you are looking at is a very good example, under the okay face (E. points to the straight-mouthed face) if you think it is an okay example, or under the poor face (E. points to the downturned face) if you think it is a poor example. Let's try. I will help you at first.

The experimenter then began with a practice example from the category of food and said, "We are going to teach our outer space creature about food. Shall we tell him that steak is a very good example of food (pointing to the smiling face), an okay example (pointing to the straight-mouthed face), or a poor example of food (pointing to the downturned face)."

If the subject pointed to the smiling face, the experimenter said, "Yes, steak would give the outer space creature a very good idea of what we think of when we say food." If not, the experimenter explained that steak is a good example of food. Next the experimenter said, "Shall we tell him that peanut butter is a very good (etc. as

above)..." Peanut butter was used to demonstrate an okay example of food. The same set of directions were used to demonstrate that popsicle is a poor example of food.

After the subject demonstrated sufficient understanding of the faces, the experimenter stressed that choices should not be made according to likes and dislikes as for example with popsicle. It was pointed out to the subject that although he or she might love to eat popsicles, they were still poor examples of food.

The question, "How would you rate candy?" was used to test understanding of this concept. When the subject demonstrated adequate understanding of the task, the test items were administered. For the test items, the subject was first asked to read (or name) each item within the category being investigated and define or show the experimenter how to use the item. Then the subject was asked whether each item did or did not belong to the category being investigated. Finally the subject was asked to rate each item as a very good example, an okay example or a poor example of the category. During administration, the subject was reminded to name the stimuli aloud for the word condition if he or she failed to do so and not to name the stimuli during the pictorial condition.

A sum of all ratings for each category (tools, musical instruments, furniture) was calculated for each condition (word and picture) and these sums were compared.

The Phonetic Encoding Task

The remaining task was a replication of Frumkin-Feis' (1982) modifications of the Wickens' technique for release from proactive inhibition (PI), which was used to measure verbal encoding along phonetic and semantic dimensions. In the release condition, condition 1, words with the same initial consonant blends were used for the first three trials and ones with a different initial sound were presented on the final trial. In the nonrelease condition, condition 2, all words presented on all trials had the same initial consonant blend.

Stimuli: The stimulus words used in each condition are listed in order of presentation in Table 2. All items used in this task were mono-syllabic, with A and AA word frequency counts (Thorndike & Lorge, 1944). The average word frequency was equal for all trials.

Administration: Stimulus words were tape recorded and

Table 2

Phonetic Encoding Task Stimuli

Trial 1	Trial 2	Trial 3	Trial 4
Release Condition			
Street Strong String	Strange Strike Stretch	Strength Stream Strain	Face Fall Fame
Nonrelease Condition			
Stood Store Stair	Stone Start Stove	Star Storm Staff	Stand Stock Stamp

presented to the subject on headphones at a rate of one word per second. Immediately following the presentation of the words on trial 1, the subject began a distractor task of color naming. The colors were named from randomly presented blue, green, purple, black, red and orange colored circles on an 8 1/2 x 13 white cardboard sheet which was placed directly in front of the subject. To ensure prompt attention to the distractor task and to avoid rehearsal attempts, the experimenter pointed to the first colored circle immediately following the last word of each trial. Color naming lasted for 15 seconds at which time the tape requested stimulus retrieval with the command signal 'recall'. The subjects then had 12 seconds to recall the three words in any order at which time the tape began the next trial with the orienting command 'ready', followed immediately by the words of the new trial. This procedure was repeated for each trial. The instructions used to introduce the task were as follows:

Can you name these colors aloud for me?
(Subject demonstrates ability to name colors)
Now on this tape recorder you will hear three words. Listen carefully to those words. After you hear the three words I want you to name these colors again as quickly as you can, and continue naming them until you hear the recorder say 'recall'. Then stop naming the colors and tell me the three words of the new trial. We will continue like this until the tape says 'stop'. Now let's try a practice trial.

The words book, table and chair were presented followed by 5 seconds of color naming before recall was requested in the practice trial. Administration of the experimental task followed successful recall of the practice words.

The Semantic Encoding Task

The Wickens' technique adapted from Frumkin-Feis was also used to measure semantic encoding. The procedure for this task was identical to that used in the phonetic encoding task, except that the stimuli were semantically related rather than phonetically similar.

Stimuli: In the release condition, condition 3, the stimulus words were names of common animals for the first three trials, and names of articles of clothing for the last trial. In the nonrelease condition, condition 4, names of articles of clothing were presented on all four trials. The words used in this task are listed in order of presentation in Table 3. All words are monosyllabic, high frequency words and average word frequency was equal for all trials.

Administration: The stimuli were presented with headphones at the rate of one word per second. The same

Table 3

Semantic Encoding Task Stimuli

Trial 1	Trial 2	Trial 3	Trial 4
Release Condition			
Goat	Lion	Bear	Shirt
Dog	Horse	Sheep	Belt
Pig	Deer	Fox	Dress
Nonrelease Condition			
Hat	Scarf	Vest	Coat
Shirt	Tie	Cap	Slip
Cape	Glove	Shoe	Boot

instructions, practice trial and distractor task as used in the phonetic condition were utilized in this condition.

Data Analysis

The Ss were divided into three groups according to specific reading performance criteria (see Screening Battery in Measures section). The data was analyzed as follows: First, means and standard deviations were calculated for the screening battery and these means were compared among the groups. Second, results of the classification tasks were analyzed using t tests to compare mean scores of the three groups. Pearson correlations were calculated to determine correlations of screening battery variables with results from the classification tasks. In addition, the dysphonetic experimental group was divided into three groups based on Wepman performance (screening battery task). Performance on the experimental tasks of the three subgroups was compared to determine if Wepman performance predicted performance on either experimental task. Scatter plots of these data were also constructed. Third, results of the phonetic and semantic encoding tasks were analyzed by

comparing performance on trial 4 minus trial 3 for the release versus the nonrelease conditions. Group means were compared with t tests.

The hierarchical clustering task was analyzed by computing an SC score for each subject (see Measures section for details on SC computation). This score was formulated in order to formalize the expectation criteria that people-people choices and apparel-apparel choices (i.e., compositional choices) would be more likely to occur. This score was also formulated to formalize data which in other studies (Zurif, et.al., 1974; Frumkin-Feis, 1982) has been presented in tree graphs. Then group means were compared by t tests.

The typicality rating task was analyzed by calculating sums for all ratings for each category (tools, musical instruments, furniture) and then comparing group sums by t tests.

The t test was employed for the above comparisons because they are specific, orthogonal, a priori comparisons of related samples.

The encoding tasks were analyzed by comparing mean scores among the three groups. t tests were employed for these data also as specific, a priori predictions were

made based on a previous study (Frumkin-Feis, 1982).

Mann-Whitney U tests were computed post-hoc for all comparisons.

RESULTS

The results will be presented in the following manner. First, the results of the screening battery will be given. Second, the results of the experimental battery will be given in two sections, with a brief discussion following each section. The first section will present the findings of the two noun sorting tasks, the Hierarchical Clustering Task and the Typicality Task. The second section will present the findings of the Phonetic and Semantic Encoding Tasks.

The Screening Battery

Group characteristics are presented on Table 4. The dysphonetic group (mean age=132.1; mean Sim=3.9) and the normal group (mean age=122.3; mean Sim=10.7) were significantly different on age ($t=2.13$, $p<.04$) and WISC-R Similarities scaled scores ($t=8.08$, $p<.001$). There were no significant gender differences between the groups. The mean IQ was above 85 by school report, but the New York

Table 4

Mean Performance on Screening Battery by Group

	Normals ^a (<u>n</u> =23)		Dysphonetics ^b (<u>n</u> =12)		Dyseidetics ^c (<u>n</u> =4)	
	Mean	SD	Mean	SD	Mean	SD
Age in months	122.3	14.4	132.1	9.5	133.0	11.9
Boder reading standard score	-	-	69.8	9.1	63.2	6.0
Wide Range Achievement Test reading standard score	-	-	75.5	6.2	75.3	13.3
WISC-R Similarities scaled score	10.7	2.3	3.9	2.6	5.8	2.5
Wepman error score	-	-	6.3	5.1	4.0	0.8
California Achievement Test reading grade level	6.1	1.7	-	-	-	-

^aboys n=12
girls n=11

^bboys n=11
girls n=5

^cboys n=1
girls n=3

City public school would not release actual scores. However, it should be noted that if the IQ scores of the dysphonetics were estimated based on the mean Similarities subtest scaled score, the mean IQ for that group would be 64. Therefore, the Similarities score underestimates that group's verbal functioning. As dyslexic children are known to have both lower Verbal IQs than Performance IQs, as well as, to have significant inter-subtest scatter, the low Similarities scores are not unexpected in this group (e.g., Denkla, 1979). On the other hand, if the IQ scores of the normal group were estimated based on the mean Similarities subtest scaled score, the mean IQ for that group would be 105, a likely estimate. In a normal group neither significant differences between Verbal and Performance IQs nor significant inter-subtest scatter are expected.

The Wide Range Achievement Test mean standard score for the reading subtest for the dysphonetic group was 75.7 (range=64.0-86.0) and for the dyseidetic group was 75.3 (range=67-95). The Boder Test of Reading-Spelling Patterns mean standard score for reading for the dysphonetic group was 69.8 (range=56.4-84.7) and for the dyseidetic group was 63.2 (range=56.1-69.9). See Table 4 for mean performance on Screening Battery by group.

The variability in Wepman scores was greater for the dyphonetic group, but no patterns related to that variability were observed. For purposes of exploration, the dysphonetic group was split into three subgroups based on Wepman performance (number of errors): subgroup 1, the poor performers (n=4) mean error score=11.5, range=7-20; subgroup 2, the borderline performers (n=5) mean error score=4.8, range=4-5; subgroup 3, the within normal limits performers (n=3) mean error score=1.67, range=1-2. Comparisons of subgroups on all experimental tasks (SC scores for words and pictures, and mean scores for each of the three typicality categories for words and pictures, i.e., 8 comparisons among three subgroups or 24 comparisons in total) yielded these significant findings: Poor subgroup 1 versus normal limits subgroup 3 performed significantly differently on the word condition of furniture and the picture condition of tools of the typicality task ($p < .02$ & $p < .002$, respectively); poor subgroup 1 versus borderline subgroup 2 performed significantly differently on the word condition of furniture and the picture condition of furniture ($p < .05$ and $p < .03$, respectively). Scatter plots constructed to further analyze these data revealed that the single subject of subgroup 1 who earned an error score of 20 was responsible for the significant difference in performance

for subgroup 1 in all cases.

The Categorization Tasks

Findings for normals, dysphonetic dyslexics, and dyseidetic dyslexics on both categorization tasks are presented on Tables 5 and 6. A Pearson correlation showed that over the whole sample, the Similarities scores correlated with the hierarchical clustering task (.39 for words; .30 for pictures). The theoretical model upon which this study is based predicts that performance on the Similarities subtest and the Hierarchical Clustering Task would be correlated (i.e., mediated by the linguistic module). Therefore, this level of correlation is predictable. In addition, age differences did not correlate with the hierarchical clustering task (-.10 for words; -.16 for pictures).

Hierarchical Clustering Task (SC): For normals, a t-test comparing SC scores for words and pictures revealed that there was a significant difference between choices in the word condition and the picture condition, with more choices based on compositional criteria in the word condition. For the dysphonetic dyslexic group, there were

Table 5

Comparison of Mean Performance on Categorization Tasks

	Normals (<u>n</u> =23 ^a)			Dysphonetics (<u>n</u> =12 ^a)			Dyseidetics (<u>n</u> =4)	
	Words	Pictures	t	Words	Pictures	t	Words	Pictures
Hierachal Clustering Task (SC)	25.0	8.2	4.89**	-0.3	-9.5	2.08*	18.5	4.5
Category Typicality Task (PD) ^a								
tools	16.6	17.0	n.s.	15.9	15.8	n.s.	16.0	15.5
instruments	18.9	18.8	n.s.	19.4	18.6	n.s.	20.5	20.0
furniture	16.1	16.8	n.s.	15.8	16.2	n.s.	16.5	13.5

^afor PD task, normals n=22, dysphonetics n=11

*p < .06, trend

**p < .001

Table 6

Normals Compared with Dysphonetics

	Words vs. Words p	Pictures vs. Pictures p
Hierarchal Clustering Task (SC)	<.001	<.01
Category Typicality Task (PD)		
tools	n.s.	n.s.
instruments	n.s.	n.s.
furniture	n.s.	n.s.

no significant differences between these choices, though there was a trend indicating that choices in the word condition were based on compositional criteria slightly more frequently. For the dyseidetic dyslexic group, means are reported but statistical tests were not performed because of the small number of cases. The means appear to follow the same trend as the other two groups, that choices in the word condition were based on compositional criteria more frequently.

A t-test comparing SC scores of the dysphonetic group and the normal group showed they were significantly different for both words and pictures, with the normal showing significantly more choices based on compositional criteria (i.e., people-people & apparel-apparel choices) for both conditions. The Mann-Whitney U test also revealed a significant difference when comparing the means of the normals and dysphonetics ($p < .002$ for words & $p < .008$ for pictures). Mann-Whitney U test comparisons between the two dyslexic groups did not reveal significant differences between them. However, Mann-Whitney U test comparisons between the normals and the dyeidetics also did not reveal significant differences in performance. Nevertheless, informal comparison of the means suggested that the dyseidetic group's scores were more like the

normal group than like the dysphonetic group (SC scores for words: +54, +4, +18, -2; SC scores for pictures: +34, 0, -3, -16).

Category Typicality Judgment Task (PD): A sum of all ratings for each category (tools, musical instruments, furniture) was calculated for each condition (word and picture) and these sums were compared. Pairwise t-tests and Mann-Whitney U tests showed no significant differences between the word and picture conditions for any of the categories for any of the groups, nor were any differences found among the groups. However, if consistency was defined as every time a subject made the same typicality rating in both conditions (e.g. gave a 3 rating to piano in both the word and picture condition), then the normals as compared with the dysphonetics showed greater constancy ($t = 2.24$, $p < .03$).

Summary and Brief Discussion

The results of this study offer evidence that words and pictures are processed differently as a function of classification questions asked. In the hierarchical task, the word stimuli produced significantly more compositional

responses than did the picture stimuli. In the typicality task, there were no differences between responses to the word stimuli and responses to the picture stimuli.

The findings also suggest that the two tasks utilized are accessing different aspects of conceptual categories or classification schemas, and that both aspects can coexist in a conceptual system. Thus they support the claims of te Linde and others that a model of dual processing/coding is required to account for empirical findings. For the findings of this study suggest that responses to classification questions are processed by different modules or other systems specialized for kind of question (compositional vs. perceptual), because the kind of question stimulates different systems.

In addition, the findings suggest that stimulus form (word or picture) can influence some types of responses. In this study, words and pictures produced significantly different responses in the hierarchical task but no differences in the typicality task. The picture/word differences found in this study for the hierarchical task are similar to findings of Durso and Johnson (1979) and Durso and O'Sullivan (1983) that words generally activate a more generic set of information than do pictures because a picture is always an unfamiliar stimulus and thus

communicates unique and specific information. Here the findings suggest that words activate a more compositional set of information than do pictures for similar reasons. The pictures appear to have activated more functional (e.g., man and hat) responses perhaps because of the unique and specific nature of pictures. That is, perhaps because pictures suggest specific instances rather than generic sets of information, pictures also elicit more functional sorting responses. On the other hand, the absence of picture/word differences for the typicality task can be explained by considering the task as accessing the perceptual system which underlies typicality judgments based on prototypes. That is, here the picture is an instance of a prototype.

The results from the sample of dysphonetic dyslexic children suggest that 1) dysphonetic dyslexic children do have some type of conceptualization difficulties and, 2) these difficulties seem to be of a compositional nature. Thus, the dysphonetic dyslexic children's responses to the hierarchical task did not show a significant difference in response type as a function of stimulus type (word or picture), though there was evidence of a trend in that direction. Further, if the SC scores are compared (see Table 5), it is clear that the

dysphonetic dyslexic children tended to make more functional choices and fewer choices based on compositional criteria in both the word and the picture condition of the hierarchical task. However, the means of the dyseidetic group do not suggest such divergent classification behavior. On the other hand, typicality judgments were not different from normals. Thus, problems for the dysphonetic group of dyslexics appear to be specifically compositional which is what was predicted based on the linguistic (phonetic + semantic [i.e., the WISC-R Similarities scores]) nature of their disability.

The findings suggest that the dyseidetic dyslexic group of dyslexics whose problems may be perceptually based may not exhibit divergent classification behavior, or at least not to the same degree. The findings may also be indicative of either 1) that the prototypical task utilized in this study is not a sufficiently sensitive measure of prototypicality to reflect actual differences in ability to formulate typicality judgments among the groups, or 2) that the group of dyslexics with perceptual problems should be more effectively distinguished. That is, both more measures and more sensitive measures of visuoperceptual and visual/spatial functioning should be employed in future studies to more accurately describe the

group of dyslexics which displays significant difficulty with typicality judgments, if such a group actually exists.

The Encoding Tasks

The results of the encoding tasks are inconsistent. Repeated measures analyses of covariance found no significant main effects. In addition, an analysis of variance of three way interaction, group X condition X trial was not significant for any interaction.

In depth exploration of the data revealed that many individual results were in the opposite direction from the predicted one (see Table 7). In the phonetic release condition, nine out of twenty-three normal participants scored less on trial 4 than on trial 3, although trial 4 was supposed to be the release condition. Six out of sixteen subjects of both dyslexic groups also scored less on trial 4 than on trial 3. In the phonetic nonrelease condition, twenty of the twenty-three subjects performed the task as expected. In the semantic release condition, twenty-one subjects performed as expected, but in the

nonrelease condition only sixteen performed as expected, with six subjects showing release or more responses on trial 4 than on trial 3. Six out of the sixteen subjects of both dyslexic groups also scored less on trial 4 than on trial 3.

The subjects who scored in the unpredicted direction for one condition were not necessarily the same subjects who scored in the unpredicted direction for another condition. Ten subjects--2 dyeidetics, 3 dysphonetics, 5 normals--scored in the unpredicted direction in more than one condition. Fifteen subjects--1 dyseidetic, 4 dysphonetics, 10 normals--scored in the unpredicted direction in one condition only. Thus, in the phonetic release condition and in the semantic nonrelease condition at least one-fourth of the subjects did not perform as expected on the encoding tasks.

Summary and Brief Discussion

It is difficult to determine exactly why this task was not replicated. Subjects in this study and subjects in the Frumkin-Feis study were New York inner city school children. Although Frumkin-Feis' study used a male voice

Table 8

Number of Subjects Scoring in the Correct (+)^a
or Incorrect (-)^b Direction by Condition

	Normals (n=23)		Dysphonetics (n=12)		Dyseidetics (n=4)	
	+	-	+	-	+	-
Release						
Phonetic	1.65	1.11	0.92	1.08	1.25	0.50
Semantic	2.09	0.95	2.17	0.58	2.50	1.00
Nonrelease						
Phonetic	0.65	0.71	0.75	0.62	1.50	1.00
Semantic	1.39	1.16	1.42	0.90	2.00	1.41

^a correct direction = same or higher score on trial 4 than on trial 3 for release condition and same or lower score on trial 4 than trial 3 for nonrelease condition

^b incorrect direction = lower score on trial 4 than trial 3 for release condition and higher score on trial 4 than trial 3 for nonrelease condition

and this study used a female voice to tape the stimuli, the task should not be vulnerable to such a difference. In this study, subjects were told and were encouraged to recall the maximum number of words on each trial. However, such an experimenter demand should not have interfered with the task if the task itself produced robust findings (see Rosenthal, 1966).

The encoding task was utilized in this study in part to determine its efficacy as a clinical tool. A clinical tool or task is one that allows for inferences to be made based on an individual's performance on a given task. For such a task to be efficacious, the statistical results of any group study must be so robust that performance of any particular member of that group closely correlates with the groups' performance. That is, such results must be both reliable and valid. Reliability refers to whether the same test given on different occasions yields the same results. Validity refers to the predictive value of test scores, i.e., the correlation of the test results with some other valid and reliable measure of the same or similar behavior. Then inferences can be made regarding an individual's performance based on that individual's performance on the particular task.

The encoding tasks do not meet these requirements

because the results were not replicated by a normal or control group similar to the initial control group to which the task was administered. Thus, the task is not reliable because it was not replicated when a virtually identical task was administered, and fails to be valid because performance cannot be predicated based on performance on these tasks. Therefore, the encoding task does not meet the requirements necessary for becoming an efficacious clinical tool.

DISCUSSION

This study investigated the structure of a semantic network and the formulation of prototypes within a semantic classification network in two modalities (verbal and nonverbal) by using words and pictures of the same stimuli. Three questions were asked. 1) Can classification behavior be differentiated based on stimulus form? Here it was hypothesized that for compositional clustering tasks classifying would be different for words and pictures with words showing significantly more organization based on compositional criteria, but for prototypicality decisions no difference would be found between words and pictures because decisions of prototypicality are based on the same nonverbal (e.g., perceptual) criteria regardless of the form in which the stimulus is presented. 2) Can classification behavior be differentiated based on the classification question asked? Here it was hypothesized that classification behavior would be determined by the classification question asked. 3) Since it has been proposed that learning disabled children have aberrant

semantic (e.g., compositional & prototypical) structures and are less likely to employ conceptual categories when attempting to learn new information, do these children exhibit different patterns than normals on either task? Here it was hypothesized that the dysphonetic dyslexic group would exhibit aberrant and variable compositional classifications due to deficient compositional analysis of words, but would show no differences from normals in making prototypicality judgments because classification which does not rely on compositional analysis should not be so compromised.

The findings support the hypothesis that words and pictures are processed differently as a function of classification questions asked, for some types of classification tasks. Questions based on compositional criteria produced significantly different results for different stimulus forms (words or pictures), whereas questions based on typicality judgments did not. The findings also suggest that the two tasks utilized access different aspects of conceptual categories or classification schemata, and that both aspects can coexist in a conceptual system. Several models of conceptual systems can account for these findings. The theoretical question thus is which cognitive model best accounts for

the findings.

Classification experiments are often used to test the fit of the Common versus Dual Coding models. Common Code models represent the coding of information as a single code regardless of input modality while Dual Code models represent the coding of information as functionally distinct depending upon input modality. The classification experiments frequently investigate how verbal and nonverbal information is related by looking at processing time differences using words and pictures of the same or similar stimuli. Common Code theories hold that pictures are consistently processed faster regardless of type of response elicited from the subjects, while Dual Code theories hold that processing time is a function of response type. Recent empirical studies have demonstrated that reaction times change if certain semantic questions are asked (e.g., are mouse and cheese related vs. which is larger belt or giraffe).

However, many Common versus Dual Coding studies have shown that pictures are consistently processed faster regardless of whether the question concerns category membership or size differences (i.e., so-called linguistic or perceptual differences). Pellegrino et.al. (1979), unitary code theorists, argue that the data from their and

other studies dictate that both size and category information must be represented in the same symbolic system. They offer three possible solutions: (i) both size and category information are represented in the verbal symbolic system of a dual memory system; (ii) both size and category information are represented in the nonverbal symbolic system; (iii) both size and category information are represented in a single symbolic system. The existence of prototypes suggests that category information may be stored in the perceptual system at least for common, concrete nouns.

Classical approaches (within the American Behaviorist tradition) to the psychology of classification focussed on hierarchical organization of concepts. More recently Rosch et.al. (1976) have offered the alternative notion of basic level categorization, where the most salient level of abstraction within a category is neither at the superordinate level (e.g. furniture) nor at the subordinate level (e.g. easy chair), but rather at some middle level (e.g. chair), and that often a single, mental image or prototype can reflect the entire category. Some researchers including Rosch further theorize that in addition to the prototype some listing of features, lexical meaning or some other semantic description is

necessary to completely account for conceptualization. This in turn may organize classification into both prototype and compositional components which can be construed as reflecting both verbal and nonverbal inputs.

The modular style model proposed in this study accounts for the data by postulating at least two faculties or modules, one specialized for compositional input and the other specialized for perceptual input. This distinction is tantamount to claiming that the content of the two postulated modules is different in character. Moreover, information content and sometimes stimulus form determines the module accessed.

The claim that the content of the two postulated faculties is different in character is made as one way to distinguish the two faculties. The content of a prototype can be defined by Rosch's criteria for basic level objects, namely, similarity of mental image, attributes, motor movements, shape. The content can be distinguished from the tectonic feature of a prototype. The tectonic feature can be considered as determined by the nontransitive character of the hierarchy in which it is embedded. As is obvious from the above characterization the content of a prototype is heavily dependent upon perceptual information, hence, on some factual information

about the world.

The content of a linguistic or compositional concept is a composition of other linguistic concepts. Precisely this composability is what allows for a transitive hierarchy to characterize the tectonic feature of linguistic concepts.

One question that arises from these descriptions is how the hierarchies are constructed. Fodor's innateness hypothesis suggests an answer to this question. Each classification system consists of innate schemata (e.g., red & square). Experience in the world provides the content that, together with the schemata, allows for the classification systems.

The modular model also allows for an account of learning disabilities. For example, in the case of the dysphonetic dyslexic children the model predicts the disability to be localized in the linguistic module. In fact, in the present study these children scored significantly differently from the normal controls on the compositional task, but exhibited no difference in classification behavior on the prototypical task. Other disabilities localized in other specialized modules such as the perceptual module can also be accounted for by the model.

In such cases where the disability is localized in a specific module, the model suggests that the central systems would be compromised only insofar as the information from the disabled module compromises these systems. It also suggest a possible basis for the fact that the sequelae of many kinds of dyslexia are conceptual problems.

The model suggests remedial programs for learning disabilities that would (i)consciously build some of the connections that have not automatically developed by using the ability of the central systems to focus on particular aspects of a module's functioning; (ii)use the central systems to monitor information from the disabled module to specifically screen for compromised information and develop strategies to identify and compensate for such information; (iii)overlearn these strategies so that they operate quasi-automatically; (iv)use and develop information processing in other modules which are not disabled. All of these remedial programs are specifically derivable from a dualist model.

The present study confirmed that response differences are a consequence of the type of question asked. One important contribution of this study to the corpus of classification research is an alternative method to

reaction time for investigating processing/coding models. In fact, the present method of investigation may address the issue of whether the underlying faculties processing compositional or perceptual information differ more directly. For the present method's efficacy does not rest on an argument regarding whether and/or what kind and/or why there are processing time differences between pictures and words. Rather, the method bypasses that issue and directly addresses classifying behavior similarities and differences (i.e., response differences). Thus, this method allows for investigation of response to stimulus form as a consequence of question posed directly rather than derivatively by inference from reaction time differences. Results from research on reaction time differences can then be posed as an additional problem to be solved for the more direct method of classification experiments.

Another important contribution of the present study is to propose using cognitive disabilities as part of a research strategy for investigating the controversy between unitary and dualist coding models. This strategy is similar to the one employed in neuropsychology when investigating brain/behavior relationships where behavior of brain damaged patients is used to confirm/disconfirm

models of localization of function in the brain. The finding that dysphonetic dyslexics performed significantly differently from normals only on the compositional task is the type of finding that can be used to confirm predictions based on cognitive processing models.

The findings from this study reveal an asymmetry whereby stimulus form made a difference for the compositional task, but for the typicality task stimulus form did not make a difference. That is, for the former task responses to the word format of the stimuli elicited significantly more responses which conformed to the compositional underlying structure of the task than did the picture format. On the other hand, for the typicality task both word format and picture format elicited responses that conformed to the prototypical underlying structure. So the question arises why is there such an asymmetry?

The best answer presently available to this question is that accessing the linguistic module requires that both the question asked and the stimulus form, at least insofar as pictures and words are concerned, be linguistic in kind. This answer is not only inadequate but counterintuitive in that it would seem that we use language so frequently that these sorts of restrictions would not account for actual behavior. This question

needs to be further investigated by using other kinds of compositional questions with words and pictures.

At least three possible explanations should be explored. First of all, the suggestion by Durso and Johnson (1979) that words are generic whereas pictures are specific may be important. They argue that common nouns are familiar and thereby elicit more generic aspects of semantic information, whereas pictures always communicate some specific and therefore unique information. Thus, the pictures in the compositional task in the present study may have been more likely to be processed as specific instances while the words were consistently processed as linguistic information. Secondly, the finding by Luria (1982) and others that nonliterate people tend to be more concrete and spontaneously offer functional/practical rather than conceptual associations, although they can be taught to answer more abstractly, may be related to the asymmetry problem. If this finding suggests relatively less development of the linguistic module in nonliterate people, then perhaps many associations of this sort are processed by the perceptual module in this group. Perhaps this same kind of processing occurs when pictures are used to denote common nouns. Lastly, this study is limited to the investigation of common, concrete nouns. Perhaps the

asymmetry obtains in the case of common, concrete nouns but not in the case of more abstract nouns.

This discussion suggests several investigations. One would be to ask questions like, "Is a hammer a tool?" with pictures and words, instead of the kind of question used in the present study, "Is a hammer a good, okay or poor example of a tool?" to see if the results remain the same. Another would be to use less common (in terms of frequency count) concrete nouns to see if the asymmetry between pictures and words for the compositional task still obtains. Finally, similar methodology employing more abstract nouns could be used to see if the relationships found in the present study hold.

This study suggests other avenues of further research as well. Firstly, utilizing the methodology of this study to investigate postulated structural differences between the faculties is one interesting avenue. That is, if the compositional module is hierarchically structured through transitive relationships while the perceptual module is structured by nontransitive relationships, consequences of these differences can be empirically investigated. Another avenue for further research is to look at the results to the same questions for populations of younger children, older children and adults to map developmental

changes along compositional and perceptual dimensions. Finally, a more sensitive measure of prototypicality and/or more sensitive measures of visuoperceptual functioning might help to determine whether some dyslexics with visuoperceptual difficulties have problems with typicality judgments.

APPENDIX A:

LETTER OF CONSENT

THE CITY COLLEGE

of

The City University of New York

Dear Parents,

I am conducting a pilot education project under the supervision of the psychology department of the City University of New York. I am contacting you to request permission for your child to participate in it.

The children in the project will be between the ages of 8-12, including some with reading problems. The focus is reading and understanding.

The children who participate will meet with me individually. All results will be strictly confidential, but I will be happy to discuss them with you and your child's teacher in order to share with you the strengths and weaknesses of your child in school.

All children join this project will have individual educational testing. This kind of testing will help us know and better understand each child individually. The results will help their teacher appreciate their unique learning style and guide them in their school work. In addition, the results of this study may have general implications for some types of learners.

Thank you in advance for your consideration.

Sincerely,

Antoinette J. Lynn

Please allow _____ (name
of child) to participate in this project. Please do/do not
(circle one) contact me before sharing the results with his/her
teacher.

(signature of parent or guardian)

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