SECOND LANGUAGE COMPREHENSION : INFORMATION - PROCESSING APPROACH

A Dissertation

Presented to

the Faculty of the Department of Psychology

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

Avishai Raphaeli

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ABSTRACT

Kintsch (1974) presented a theory of representation in semantic memory. The theory hypothesized that language information is represented by a set of propositions and their case relationship , the "text base." In order to evaluate the comprehension of sentences, what is needed is to specify the transformation of information needed to be performed on the information in order to meet the task demand (Alston, 1975,note 1). This paper advanced the thesis that different levels, or degrees, of processing (i.e., transformation) will be required for first language (L_1) and second language (L_2) text bases. It was posited that L_2 elements are mapped onto the cognitive structures of L_1, which then undergo further processing. Within this system, two types of processes were identified : passive processes which do not require attention, and active processes requiring attention (Cf. Norman, 1969). Automatic processing facilitates performance on complex tasks by eliminating the need for sequential processing, thus reducing the task demand. These features were incorporated in a model of second language processing presented in this paper. The model proposed two additional basic assumptions. First, it assumed that L_1 is processed automatically, while L_2 elements require attention.

Second, if an L_2 code could be translated into a corresponding L_1 code, the code would utilize automatic information-flow route activated by L_1 . The model thus enabled the definition of the difficulty of an L_2 item as the combined effect of the number of transformations required for a translation into L_1 , the "between-language" component, and the number of transformations required for the processing of the L_1 code, the "within-language component" . This formulation enabled the generation of testable hypotheses. Two sets of experiments were carried out : One assessing syntactic transformations, and the second assessing phonological processing. The first of the two syntactic experiments compared recognition memory for six L_2 categories differing in difficulty on both the within language component, and the between language component. The second attempted to evaluate hypothesized syntactic difficulties in terms of their effect on recall of lexical information. The results obtained on both syntactic experiments were in the direction predicted,and supported the suggested model. Results of the second set of experiments, testing phonological processing were only partially successful. An analysis is offered suggesting that some of the discrepencies between the hypotheses and the results may be overcome by a more careful examination of the model and its implications.

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Chapter I

Introduction

For years psychologists displayed little interest in the question of second language learning. This state of affairs is changing as a result of the increasing interest in the area of language and language behavior, and educational-political developments emphasizing bilingual education (Pacheco, 1973., Titone, 1974).

The emerging interest in the area is still in its first stages, but the contribution of the psychologist to date has been minimal. The few attempts to develop a theory of second language learning were based on static models which did not reflect advances in psychological theory. This situation is reflected in Lachman's comment that "...the psychological study of language remained for all intents and purposes in the dark ages, and no process model of language existed..."(Lachman & Lachman, 1976). Lachman mentions the attempts by Macnamara and Kushnir (1971) to describe bilingual language switching in information processing terms, but concludes that "...so far the research has not been related to more general models of either language or cognition ..." (Lachman & Lachman, 1976).

The effect of this state of affairs was not limited to academic psychology. Applied research into language instruction

showed a lack of direction prompting Carroll to suggest that what is needed is "...profound rethinking of current theories of foreign language teaching in the light of contemporary advances in psychological and psycholinguistic theory..." (Carroll. 1965).

The present paper attempts to make a small contribution toward the development of a theory of second language acquisition and functioning in adults. An information processing model depicting the relationship between two language code systems is proposed, and several hypotheses derived from it are empirically tested.

In the context of this paper a first language (L_1) is defined as fulfilling two conditions : It is the language learned first as a child, and it has been the language most commonly used in the environment of the child. Conversely, a second language (L_2) is defined as a language learned only after mastery has been attained in the use of L_1 . The model is predicated on the thesis that a second language is processed organized and anchored in the 'old' L_1 language structures. In view of this thesis the model does not apply to young children or coordinate bilinguals.

The empirical part of the present study limits itself to the acquisition of Hebrew by English speaking students. Hebrew was chosen as the target language because phonetically and syntactically the development of Hebrew has been independent of English, due to a minimal amount of physical contact and cul-

tural interaction between speakers of the two languages during their evolution. This necessary restriction by no means implies that the phenomena studied is language specific; the underlying theory and its implications could be generalized to the acquisition of other language systems.

Chapter II

Historical Perspective

The relationships between the researcher and the practitioner are usually complex and difficult to analyze. When applied to the acquisition of a second language the problem is rendered even more difficult due to the very limited contribution of the psychologist and the linguist to the task of the teacher,(Jakobovitz, 1971). The major reason for this state of affairs is the lack of established, empirically supported theory. While Carroll states that there are three theories of foreign language learning, he himself admits that their existence is revealed only through the examination of the practices of foreign language teachers,(Carroll, 1965). The situation resulted in the identification of methodologies with theories, a fact which further hindered attempts to develop new theories. These attempts were resisted by practitioners who could not distinguish between theory and their daily practice. Due to these limitations, traditional theories of second language acquisition are of very limited value. In fact, there exists no true theory of foreign language teaching. The long and arduous search for the ideal method has been conducted by practitioners, with the researcher following close behind, offering scientific legitimacy to existing practices. In this

section an attempt will therefore, be made to distinguish between methodologies and their underlying theorries.

The inability to distinguish between theory and methodology is clearly manifested in the first theory described by Carroll, the "Naive", or "Common-sense" theory of language learning (Carroll, 1976). The "Naive" theory is not a formal theory, but an approach which for centuries has been assumed to underlie the practices and procedures of people involved in foreign language instruction. The nature and principles of this theory can be inferred from such practices.

One should not be surprised that this "Naive" theory description fitted widely diverse practices, and the past 50 years have produced in progression a long list of methods: The natural method, the psychological, the direct, the eclectic, the internsive ASTP, and the conversational method(Hamilton,1965). Many of their elements are now considerd obsolete and the Audio-Lingual habit methodology has become, more or less, "...the 'official' theory of the reform movement in foreign language teaching in the U.S..." (Carroll, 1965). The A-L theory has three basic assumptions : (1) Speech is primary and writing is secondary, hence information must be learned first as auditory disctimination responses and speech responses. (2) Habits must be automatized as much as possible. (3) Habits become automatized through rote repetition.

The underlying assertion of the Audio-Lingual approach was that "...the student can be expected to understand what

is said to him in the new language and reply with appropriate rejoinders without internal or overt reference to English and without seeing printed words..."(Bazan, 1964), This position in an extreme form is summarized by Brooks : "...As we have seen, the acquisition of 'non-thoughtful' responses is the very core of successful language learning..." (1964).

In making these assumptions the new methodology departed from the tenets of the traditional approach, and was "searching" for a new conceptual-theoretical umbrella. The development of behavioral psychology, and especially Skinner's operant conditioning came at a most fortuitous time:

> If Skinner had not been "professing" around 1955, foreign-language theorists would have invented him. In retrospect, it is difficult to imagine how the profession, while seeming to ignore deliberately other "schools" of psychology, chose to ground its practices solely in Skinnerian precepts.
>
> (Pillet,1964, p.34)

The new methodology therefore adopted the concepts and terminology of operant behaviorism, "...the stimulus-response reinforcement theory appeared to be the basic factor..."(Bazan, 1964).

The behavioral approach received a great deal of publicity and generated much experimentation, but the passage of time helped to dim the wild hopes of the late 50's. Research failed to find support to the dramatic superiority predicted for the behavioral method (Jakobovitz, 1971). Studies reviewed by

Carroll (1966) show:

> Exactly what one would expect: students who have been trained in the audiolingual method are better on listening-speaking tests of their new language ability than students who have been trained in the old method; students who have been trained in reading and writing are better on grammar translation tests than students trained in the new audiolingual methods.
>
> (Farnham-Diggory,1972,p.403)

Even the appearant superiority of the A-L approach in the oral-aural domain came under attacks stemming from classroom observations which indicate that it is not unreasonable to assume the possibility of distortion, in that "...series of foreign syllables is perceived audially without separation into syntactical elements; e.g. 'como-estashay?' rather than 'como estas hay?'..."(Bazan, 1964). If the distinct elements are obscured, "...then the syntactical principles already possessed by the learner...will be useless and he will be unable to acquire any new set by which he may group the syllables in a meaningful way..." (Bazan, 1964).

Dissatisfaction with empirical results was accompanied by growing discomfort among both theorists and practitioners concerning the simplistic reductionism of the behaviorally oriented Audio-Lingual approach :

> Indeed, during the last ten years, while a number of language theorists have maintained the position that a Skinnerian approach did produce the expected results, a growing volume of literature aimed either at refuting the narrow view implied in

> pure audio-lingualism or motivated by concerns independent of second-language teaching and learning problems has tended to highlight the complexities inherent in the teaching-learning combination as it applied to education in general and to second language learning in particular.
>
> (Pillet,1974,p.35)

As early as 1963 Lambert elaborated on the complexity of foreign-language learning as an academic activity, particularly in view of the external-motivational factors that Skinner minimized in his approach (Lambert, 1963). In 1964 Ausubel raised the question of a single approach as appropriate to all age levels, maintaining that "...certain features of the Audio-Lingual approach are psychologically incompatible with effective learning processes in adults..."(Ausubel, 1964). These arguments coincided with the general shift of focus in psychology from overt behavior to hypothesized internal states, from behavioral psychology to cognitive psychology. The result of this growing trend has been the formation of "cognitive learning theory."

According to cognitive learning theory, learning a language is "...a process of acquiring conscious control of the phonological, grammatical, and lexical patterns as a body of knowledge..."(Jakobovitz, 1971). Gone is the emphasis on non-thougtful responses and rote repetition; Attention is recognized as an important factor in learning : Practice is treated in reference to stipulated memory systems; Previous knowledge is considered important as it will affect the perception and

processing of new information (Carroll, 1976).

The development of cognitive learning theory as the dominant approach in language learning followed a different route from the one followed by the behavioral theories and the practitioners who accepted them. The emergence of behavioral learning theories was accompanied by a total rejection of all other approaches. Practitioners who accepted the cognitive ideas, however, adopted a more eclectic approach. There appeared to be a growing tendency not to reject behaviorism completely but combine its methods with non-behavioral ones inasmuch as language learning is indeed a mixture of 'conditioned' and 'conceptual learning' (Politzer,1965).

While the two approaches differed in many respects, there was one feature which they shared, the notion of the 'developmental sequence.' According to this position FL teaching has to follow the same sequence as that of native language acquisition. This assumption is one of the foundations of the entire system in the Audio-Lingual school. Thus, Diller states:

> One of the inportant contributions that linguistics has made to foreign language teaching has been the emphasis on the 'natural' sequence to learning, listening, speaking, reading and writing. The implications of this sequence for teaching are that the speaker must first be trained via the ear; a period of aural familiarity with the sounds of a language is an initial step in language learning.
>
> (Diller, 1962)

The same developmental principles are advocated by supporters of the 'cognitive' approach. Carroll, for example,

states:

> The one area of psychological research in grammar that I believe may be promising for foreign language teaching is the study of the development of grammar in the child's native language learning, because it carries the implication that a profitable method of foreign language teaching might be based on a developmental concept in which the several stages of second language learning would correspond to different degrees of completeness in grammatical development. That is, instead of requiring the student at a given stage to make sentences that are well-formed acording to the complete adult grammar, he would be required only to make sentences conforming to the grammar prescribed for that stage. The grammar would then evolve through a number of stages until an adult form is reached.
>
> (Carroll, 1966,p.36)

Farnham Diggory even suggests that "...if we were to apply natural language learning principles to foreign language-teaching we would come up with something like individualized pivot grammars...the pivot grammars would gradually be differentiated into more complicated sentence forms..."(Farnham-Diggory, 1972), (see also Siegel, 1975).

It is the direct utilization of these developmental principles for foreign language teaching with which we strongly disagree, and which leads to the mediation approach in this paper. A short analysis of the suggested error in such indiscriminate application of developmental principles is therefore in order. Developmental principles have been utilized in educational setting in two ways, the first is what Hunt (1961) calls "the problem of the match" or the "principle of iso-

morphism" according to Farnham-Diggory (1972). This principle calls for "...providing a human being with an educational milieu appropriate to his stage of development..."(p.40). The second, which we find hard to accept, places emphasis upon "...matching academic processes to students natural learning processes..." (Farnham-Diggory, 1973,p.402).

As an example, studies of the development of human mathematical ability indicate that topological concepts develop before Euclidean concepts. Therefore, it is argued, the 'natural' order is topological to Euclidean, and the "new" pedagogy will follow this order.

This argument appears to be quite convincing until one realizes that it does not stipulate temporal isomorphism - the sequence of development of the small child is considered as the best sequence for the grown-up.

But, this contradicts the very tenet of almost all theories of cognitive development, that of a <u>qualitative</u> change in thinking. At each stage what one learns corresponds to the <u>existing</u> stage of cognitive development, but might <u>not</u> correspond to later stages. This was clearly demonstrated in experiments by Weir and Stevenson (1959) and Zeiler (1964) in which younger children did better on certain tasks than older children because the older children "...developed complex hypotheses concerning the solution of the problem and that these hypotheses hindered their development of the more simple, correct solution..." (Weir & Stevenson, 1959).

The conclusion drawn from these experiments is that

"...the increasingly complex mind may project its own complexities onto a simpler minded world..." (Farnham-Diggory, 1972,p.32). The difficulty and complexity of a task are not constants but depend upon the way in which they are processed. Furthermore, the very meaning of the concept may be perceived differently by the same person at different stages of his development.

'Natural-sequences' must include an additional assumption, not only do concepts have some unexplained permanence, but their relative position in relation to other concepts is fixed. For example, if the topological concept of 'openness' develops before the Euclideon concept of triangle, natural sequence advocates maintain that when one teaches geometry, years after both concepts were attained, openness should be taught first.

It is suggested that such a position is untenable, it is unsound to disregard possible changes in the relative position of concepts. A study performed by Piaget is in direct support of this contention and illustrtes the need for past and present epistemological analysis of a given knowledge unit:

> In classical mechanics, time is taken as a fundamental notion and velocity as something derived from it (thus, velocity = $\frac{\text{space traversed}}{\text{time}}$). In relativity theory, on the other hand, velocity is taken as a first given, and temporal duration is seen as relative to it. In 1928, Einstein suggested that Piaget undertake developmental studies to find out whether an intuition of velocity depends upon a prior comprehension of temporal duration or whether it is constituted independently of the latter. Piaget accepted the "commission" and, characteristically,

> did two books' worth of research on this and related problems. What he found, very briefly, was this: Velocity does in fact appear to be a more primitive acquisition, and in the early stages, estimations of time seem to be, in part, a function of velocity. But velocity, as adults conceive it, is not a primary datum either. Initially, estimations of velocity depend upon relations of spatial order; for the young child the word faster appears to mean simply "being ahead," "passing," and so on (thus, an object placed near the center of a wheel is judged to be moving at the same speed as one on the outside, because neither gets "ahead of" or "passes" the other).."
>
> (Flavell, 1960, p.258-9)

This case clearly illustrates the theoretical weakness of the second developmental argument. Conceptually, advocating the application of the natural acquisition sequence of one's native language during childhood to the acquisition of a second language at a much later stage of development is highly unjustified. (To carry the argument ad-absurdum, why mot start teaching holophrastic speech?).

Hamilton (1965) followes a similar line of argument, but he addresses it to the A-L devotees, who...

> Obsessed by the notion that unless one become like a little child, he shall not learn a foreign language, have resurrected this (the natural) dead method, ignoring, appearantly, the irrevocable changes which take place in the human mind...the university adult...has already acquired some mastery of a language, and in learning a foreign language he insists upon interpreting the unknown in terms of known..."
>
> (Hamilton, 1965)

It can, therefore, be concluded that second language learning, rather than avoiding recognition of existing structures and knowledge, should emphasize their existence and utilize them in basic methodological decisions:

> Although supportive evidence is scant, it may be hypothesized that in the situation of one firmly established system (established at not only the verbal but at the written level) which continues to be reinforced (outside classroom) and one new born system which receives less frequent reinforcement (the class period) the older system will remain domainant but may be employed as a mediator to facilitate learning of the second system.
>
> (Bazan. 1964)

The purpose of the present study is to try and describe the relationship between an established and a newly acquied language system. A model depicting these relationships is proposed and empirically tested.

Chapter III

A Model of Second Language Acquisition

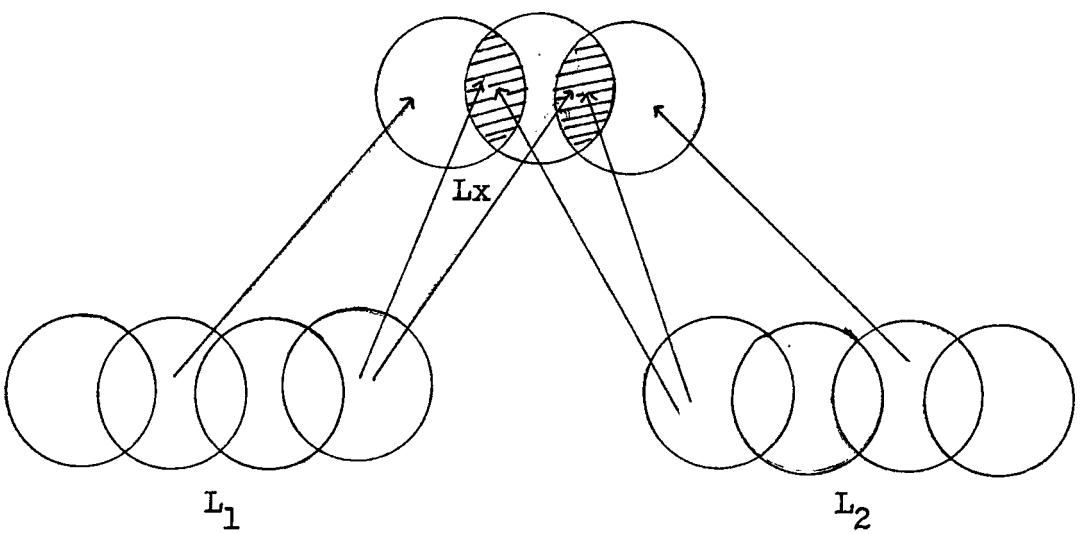
A. Basic Considerations.

To the present day little is known about the psychological aspects of second language acquisition and functioning. Until the present decade psychologists discussed the nature of the interrelationships between two languages spoken by the same individual only in the context of bilingualism. The major question being its effects on IQ scores (Lambert & Peal,1962).

The few attempts to develop models which try to describe L_1 and L_2 functioning resulted in "black box" type models (Cf. George, 1971), which served mainly as post-hoc descriptions to established phenomena. This state of affairscan be attributed to two factors: The general lag in the psychological study of language, and the influence of Skinnerian notions among educators in general and language teachers in particular.

The past few years have witnessed a change in the focus of psychological studies of bilingualism. No longer are we merely interested in observing the bilingual person's performance in school or work. Considerable attention is being paid to the interdependancies of the bilinguals' language with the question of shared or seperated conceptual systems (Cf.

Kolers 1963,1966; Lambert 1969; Glucksberg & Danks 1969). Attempts have been made to develop models of code switching. These attempts, however, suffer from the major shortcomings of earlier attempts - usage of static terms and inability to suggest the underlying processes. The following model by Oksaar (1975) is a typical example:



with its variants with its variants

Oksaar : Code Switching in Bilinguals

Initial attempts to employ information processing terms to describe language switching have been made (e.g., Macnamara and Kushnir, 1971). So far, however, these efforts enjoyed limited success, especially since they bore little relationship to more general process models : "...the research has not been related to more general models of either language and cognition..."(Lachman & Lachman, 1976).

What is needed is a process model which will explain the interdependencies between a first language and second language in memory, and which will do so within the context of a more general information processing model, relating it to other cognitive processes. The model presented here and its accompanying empirical studies, are a small step in that direction.

The proposed approach is anchored in the basic tenet that information will be learned more easily, and retained longer, when the information is organized and anchored in existing cognitive structures, i.e., related to what the learner already knows. Conversely, there is the implication that new information which cannot be assimilated into existing cognitive structures would be harder to learn and retain, (Ausubel, 1968). In the context of second language acquisition, assimilation into an existing structure implies an acquisition model in which comprehension of second language is attained by translation into corresponding elements in an already acquired language, which serves as a mediator between the recognition of the code of the second language and its comprehension. Similarly, conceptualizations are mapped onto the native language and then are translated to the new language (Lachman & Lachman, 1976).

In the development of this model, extensive use was made of the literature on reading and reading comprehension especially the models developed by Smith(1971), and Laberge and Samuels (1974). This strategy was prompted by conceptual and

formal considerations. The underlying reason is the conception that both the reading process and the processing of second language information, are "secondary" systems, which are processed via a "primary" system.

Smith (1971) suggested a theory of reading. In this theory he made three important distinctions: First, Smith distinguishes between the fluent reader and the individual who is learning to read : the beginning reader performs slowly and must consciously attend to each process, while the fluent reader performs many processes quickly and automatically.

> The journey taken by words from their written form on the page to the eventual activation of their meaning involves several stages of information processing. For the fluent reader, this processing takes a very short time, only a fraction of a second.
>
> (Laberge & Samuels.1974)

It is proposed that this distinction applies to second language performance, and indeed enables to distinguish between the person who is bi-lingual, who is assumed to have the capacity for automatic processing in two languages, and the new language student who might have mastered a certain number of words and systactic rules but has to attend sequentially to each one. Attention is a limiting factor, and a passive, automatic and efficient mechanism is necessary to deal with the quantity and complexity of language information. Attention, or utilization of the 'active' system when using L_1, is required only when one encounters ambiguous, incorrect or

missing information (Norman, 1969). Automaticity is acquired through practice (Cf. Mowbray and Rhodes 1952; Laberge and Samuels 1974).

Second, Smith distinguishes between immediate and mediated letter and word identification. Immediate recognition is attained by processing their distinctive features, while mediated processing is indirect and necessitates attentional activation. Such activation of a code can arouse other codes to which it has been associated.

In the context of second language, it is proposed that L_1 features are processed automatically while L_2 features require attention. It is further proposed that the existence of shared features between an L_1 element and an L_2 element will enable the recoding of the L_2 element into the code of the corresponding L_1 element, which can be processed automatically. The processing of L_2 would therefore be facilitated when L_2 and L_1 share features or rules. This is due to the fact that the processing of these features utilizes processing strategies and operations which do not require attention, thus reducing the task demands. It is important that we talk about 'translation' within an information processing framework. In this context it describes the interrelations between two codes within the memory system. This point will be further clarified in the actual model.

Third, and last, Smith theorized that comprehension may be immediate or mediated. Mediated comprehension necessitates

identification of individual words and, necessarily, their syntactic relationship. Immediate comprehension on the other hand, is the direct comprehension of the written material from the distinctive features without the mediation of word identification as Smith (1971) said, "...the information that passes from the brain to the eye is more important in reading than the information that passes from the eye to the brain..."

In the context of second language acquisition it is assumed that it is L_2 which requires mediation, both of individual words and their syntactic relationships.

A language system includes phonological syntactic and semantic components. Each component is at least partially independent and should be studied separately. In the next section two models of second language processing will be offered : One model will attempt to describe the phonological function, and the second, the syntactic. Both models employ strategies, symbols and conceptualizations borrowed from the reading comprehension models proposed by Laberge and Samuels (1974). The models are based on the general assumptions outlined in the above discussion.

A model for the perception of second language phonemes is presented in figure I. The model is based on a four stage theory of memory (Visual Memory - VM, Phonological Memory - PM, Episodic Memory - EM, and Semantic Memory - SM).

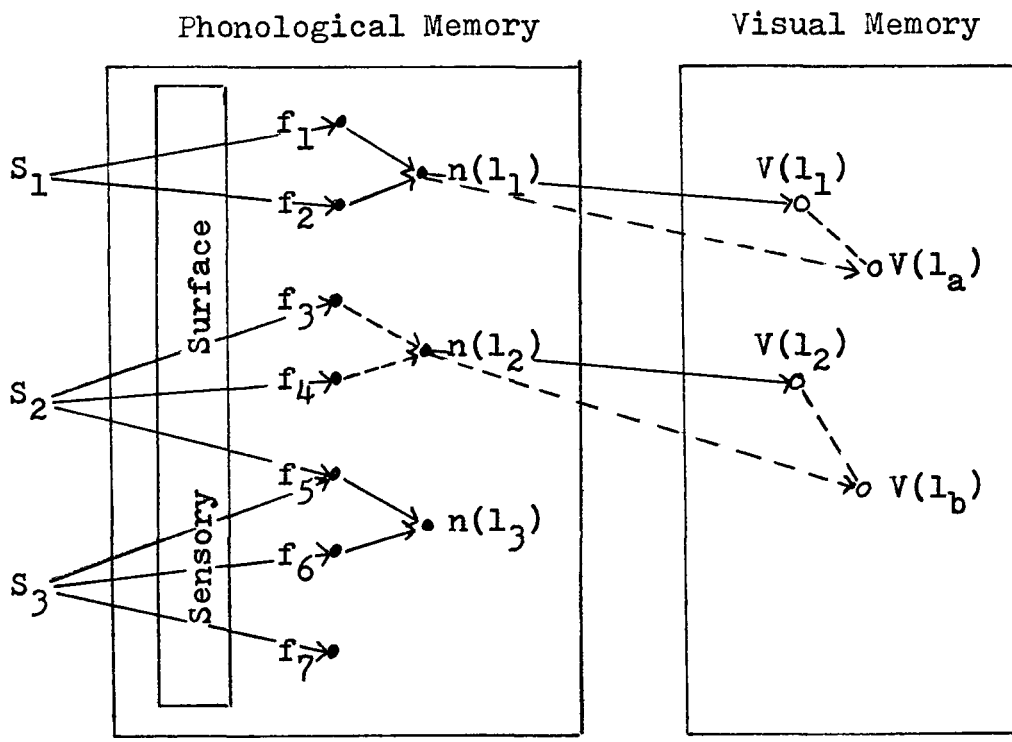


Figure 1 : A Model of the Perception of L_2 Phonemes

S - Auditory stimulus.
F - Sensory features.
n - Letter-name code.
V - Visual letter code.
l_1, l_2 - First language codes
l_a, l_b - Second language codes

• Code activated without attention.
o Code activated with attention.
⟶ Information flow not requiring attention.
⇢ Information flow requiring attention.

According to the model, sounds will be processed in PM according to their features into letter codes of the dominant language. If a match with a written character is required, a reversal of the process will take place in VM. In the example presented in the model, S_1 , an L_2 phoneme, has the same features (f_1 ; f_2) as l_1 and will be processed into $n(l_1)$ with little difficulty. S_2 , another L_2 phoneme, shares feature with both l_1 and l_2 . This ambiguity might necessitate the application of attention. The decision between l_2 and l_3 is explained by relative amount of shared features. S_3 , the third L_2 phoneme, activates f_5 , f_6 , and f_7 . f_5 and f_6 activate $n(l_3)$. The information in f_7 is not utilized for the phonemic perception.

The model is reductionistic and does not incorporate the other memory systems. It is recognized however that the two other memory system do participate in phonemic perception. Thus, for example, information in episodic memory might provide a direct link between features in PM, and a letter code in VM. Another example is an allophone processed into a generic phoneme, which might be tagged in SM. However at the present time, and until some of the basic properties are verified, the proposed simple system is considered an appropriate starting-place.

The model for processing sentences containing syntactic information is presented in figure 2. It follows Laberge and Samuels (1974) suggestion that both word meaning codes and word grouping codes are stored in semantic memory.

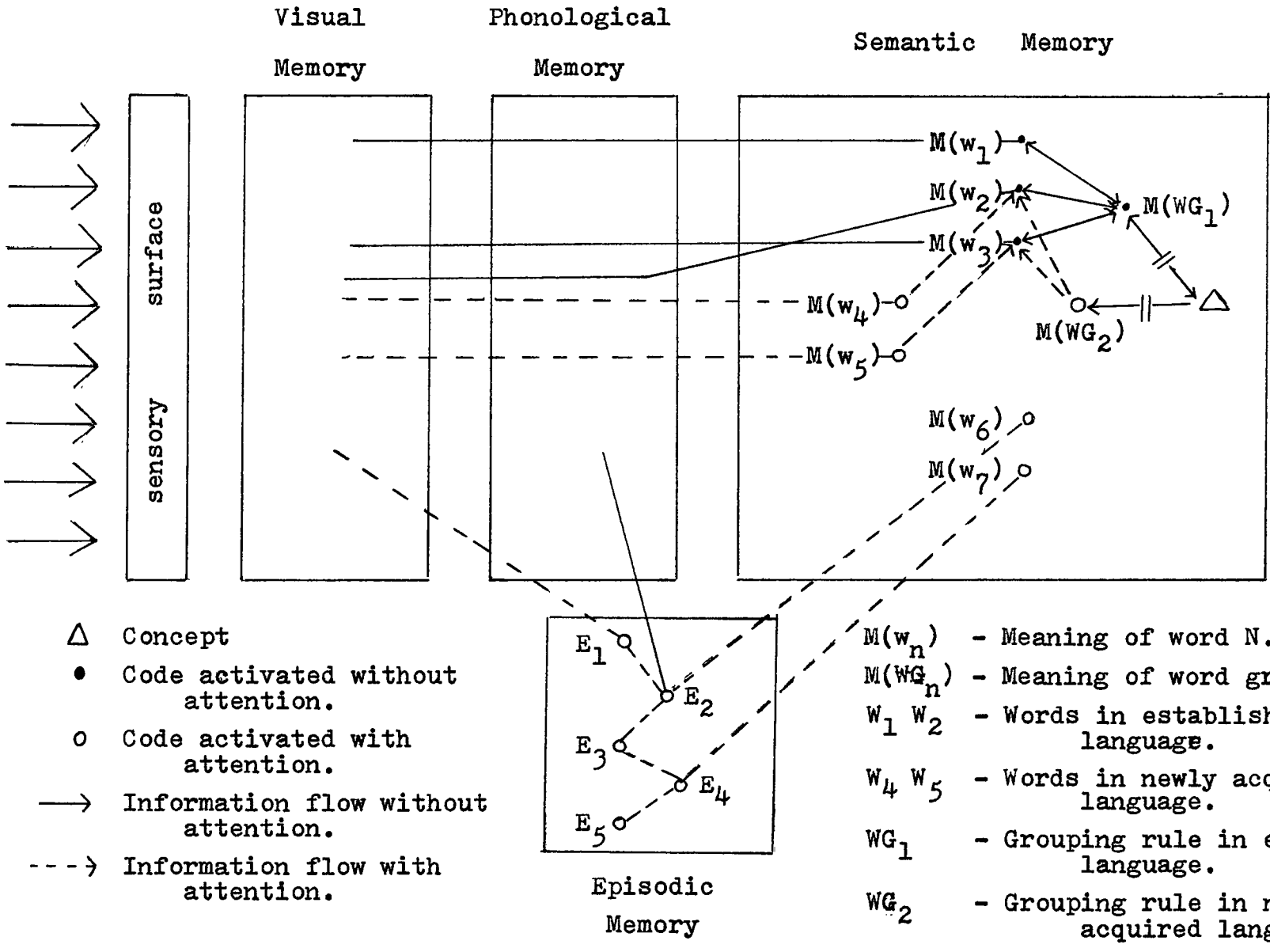


Figure 2 : Processing in Semantic Memory

According to the model, words in L_2 will be processed into word-codes which are then matched with their L_1 lexical equivalents. The activation of the L_1 word codes results in the activation of an L_1 grouping rule or production rule. If the product of their interaction fits criteria already in memory, no forther operations are necessary. If, on the other hand, the task demands are not met, an L_2 grouping rule would be projected producing a new set of propositions and their relationships.

In the example presented in the model, a sentence containing W_4 and W_5 is processed into SM as the codes $M(w_4)$ and $M(w_5)$. These codes have a lexical match in $M(w_2)$ and $M(w_3)$, both L_1 codes. The activation of $M(w_2)$ and $M(w_3)$ automatically activates $M(WG_1)$ and the product of their interaction is evaluated according to semantic criteria already in memory. If $M(WG_1)$ was applicable to L_2 the process is terminated. If not, $M(WG_2)$ is activated. Both the activation of $M(WG_2)$ and the following reactivation of $M(w_2)$ and $M(w_3)$ require attention.

The model emphasizes that comprehension of sentences is a constructive process, influenced by context, previous information in semantic memory, and the ability to perform mental operations upon representation in memory. This view is advocated by Kintsch (1974), and Simmons (1973). The emphasis is on the dynamic properties of the memory system. The structure of memory is presented in terms of potential organization which may be produced upon demand, i.e., a semantic network may be

produced on the basis of inferential information and production rules to meet the task demands. According to Kintsch (1974), this ability of semantic memory to perform mental operations on the information represented to produce different sets of propositions and relationships among propositions is the basis of language comprehension. This view is similar to that of Frederiksen (1972). and corresponds to the assimilation theory in semantic memory (Barclay, 1973).

The model, like its phonological counterpart, is limited and discusses only processing in semantic memory. It is recognized however that other systems participate in the processing of linguistic information, and for that reason the other memory components are listed in the model, but are not discussed.

B. Testing the Model

Phonological Level

Lane (1964,1965) found a clear discrimination transfer between Spanish and English. Other studies (Politzer 1961; Tione 1961; Suppes 1962) confirm his notion that learners attempt to employ native language habits in learning foreign sounds. These studies emphasize auditory discriminations because the languages studied had identical orthography and required the ability to discriminate between different phonemes.

In Hebrew, the problem is more complex due to a different orthography. The desired behavior is therefore labeling-matching (Lane,1964), i.e., associating the proper visual representation to an auditory stimulus. Our task was therefore to identify matched phonemes in English and Hebrew and map them on a common phonetic matrix. On this matrix we selected six phonemes (represented by letters) representing three sets: (1) Hebrew phonemes having very close phonetic counterparts in the English language (e.g., /מ/- M). (2) The second set consists of phonemes not having similar phonetic sound in English (e.g., /ת/ - ∅). (3) Last, Hebrew elements with partial matching to English phonemes (e.g., /א/ - /A/). The subjects' task is to perform auditory-visual "matching", i.e., match the sound of the phoneme in each set with the appropriate character.

Theories of phonemic perception suggest several alternative

predictionsas to the relative difficulty of tasks involving L_2 phonemes. Language teaching practitioners are likely to point to the inherent properties of the phonemes and will pay little attention to the relationship between L_1 and L_2 . This approach cannot be used to generate hypotheses in the present experiment, due to the fact that the groupings in the three sets do not represent inherent systematic arrangement.

A second approach emphasizes ease of articulation as the determining factor. This view is represented by Liberman (1957), who emphasized the motor component in speech perception, and also by Sperling's idea of subvocalization (1969). This theory would cause us to hypothesize that the three guttural letters ח , ר and ע , will cause the largest number of errors for native speakers of English. The remaining three letters א,מ,פ are all easily articulated and should pose no difficulty.

The model of phonemic perception presented in this paper would suggest yet a different set of hypotheses. According to the model, sounds in L_2 will be processed in PM, according to their auditory features into letter codes (or letter-name codes) of L_1 . The process will then be reversed in VM.

Unlike the previous appraches, the critical feature is the degree of auditory similarity between L_1 and L_2 . The interaction between the two language codes is hypothesized to result in the following outcomes: (1) Close match between L_1 and L_2 would result in positive transfer, facilitating performence on set 1. (2) In the second set there is no matching

between L_1 and L_2 . This set should yield no transfer. (3) The third set contains elements with partial matching between L_1 and L_2 . This partial match, we predict, is likely to result in interference or negative transfer.

Syntactic Level

Comprehension of sentences involves syntactic and semantic transformations of the information provided by the sentences (Kintsch, 1974). Simmons (1973) proposed a theory of representation in semantic memory. According to the theory, information is represented by a set of propositions. These propositions, similar to those suggested by Filmore (1968) are processed through a series of transformations, the number of transformations determining the depth of processing.

Simmons (1973) defines both syntactic and semantic transformations. Syntactic transformations are those which do not alter the basic lexical items. Semantic transformations alter lexical items.

Bromuth's theory of achievement test items (1970) maintains that test items should be a defined set of transformations of the originally presented material : "...by specifying the transformations necessary to produce different types of test items from the original material, the relationship to the original material is known..." In the context of the present study this argument would indicate that "...variation in task

demand results in variations in the cognitive processes required, and by systematically varying the task demands, the inferred cognitive processes may be investigated..."(Cf. Alston, Doughtie, & Raphaeli, 1975, note 3).

If a test item involves matching of the processed-encoded information with the test item, it is reasoned that the closer the test item represents the encoded information, the fewer transformations will be needed and hence, the possibility of error is smaller. This thesis is supported by Mehler & Miller's (1964) findings that recall of word sequences was better the more the syntactic structure approximated that of English.

Mehler and Miller therefore conclude that transformations represent additional information, and have to be stored along with the raw kernel information (Neisser,1967,p.272). More transformations take more "storage space" (and) provide more opportunity for error (Ibid p.273).

The processing model presented in figure 2 suggests that a sentence presented in a newly acquired language undergoes a series of simple transformations by which its elements are reorganized into their English equivalents in semantic memory. These are then further processed.

It is therefore hypothesized that if a task requires comprehension storage and retrieval of Hebrew sentences, the larger the number of syntactic transformations required by subjects to match a Hebrew test sentence with its English semantic equivalent, the more difficult the task will be.

The first experiment designed to test this hypothesis follows the technique developed by Mehler (1963). Six Hebrew sentences categories have been constructed. The different categories present different degrees of syntactic complexity reflecting between language (Hebrew to English) and within-language differences. The between-language differences reflect the number of surface transformations from English to Hebrew (or vice versa). The within-language differences refer to surface to deep-structure transformation. Positive and negative sentences were used as the two within-language categories .

$\bar{S}$s are presented, in random order, with 4 sentences from each of the categories - 24 in all. Following the presentation a multiple choice recognition test was given and subjects were asked to identify the 'old sentences'. In view of the assumptions, it was hypothesized that success on the memory task for each category, would be inversely related to the number of syntactic transformations required, whether they are within-language or between-language transformations.

Mehler's technique and his interpretation of the results were rejected by Martin and Roberts (1966) who contend that the effects attributed to transformational processes are actually the result of the different structural depths of the sentences used, and that this structural complexity, as measured by Yngves' (1960) structural index, is independent of the sentence syntactic properties.

A second drawback of this design, a criticism which can

be levelled at most studies of syntactic complexity, is the lack of control over frequency. Positive sentences occur more frequently in the language than negative, active more than passive, etc. Differences found between syntactic categories can therefore be attributed to amount of practice, subjects' expectancy, or other frequency related factors.

The second experiment in this set is designed to overcome both these difficulties and to test directly the hypothesis that grammatical transformations between languages actually represent additional information. The experiment utilizes the principle of "overflow" as developed by Savin and Perchonock (1965) in an ingenious experiment worth describing. Their study was based on the hypothesis that short term memory has a limited capacity. The amount of storage occupied by a sentence could be assessed, according to this notion, by seeing how much <u>additional</u> material the subject could remember - "overflow". This notion is interesting because it enables us to measure processing even after an accuracy criterion has been reached. The sentences used were a simple active sentence and ten transformations. The procedure was to give a sentence followed by 8 unrelated words. The subject was asked to recall the sentence verbatim and as many of the words as he can. It was hypothesized that sentences with more transformations would be more difficult and hence fewer words would be recalled after them. The results supported this assumption.

Mean Number of Words Recalled After Each of the Sentences.

Sentence Type	Mean No. of Words Recalled
Active Declarative	5.27
WH - Question	4.78
Question	4.67
Passive	4.55
Negative	4.44
Negative Question	4.39
Emphatic	4.30
Negative Passive	3.48
Passive Question	4.02
Negative Passive Question	3.85
Emphatic Passive	3.74

(Savin & Perchonock, 1965,p.351)

These results, however, impressive as they might seem, encountered growing opposition (Bacharach et al 1972; Epstein 1969; Foss and Cairns 1970; Rohrman et al 1970).

The objections stemmed from a growing tendency to question the notion that deep structure has an independent psychological validity (Johnson & Laird, 1974), as well as the availability of alternative explanations to the findings such as Yngves' depth and lexical density, or the frequency assumption mentioned in connection with the first experiment.

While the application of the 'validity-of-deep-structures' argument, to the between-language-transformations stipulated by the present model, is questionable, it still might render verification of the model difficult. A complete new design was therefore devised to overcome this difficulty as well as the frequency hypothesis. The new design retains the basic overflow idea, but changes the procedure and, most important, adds a control condition.

The following experiment attempts to measure Hebrew sentences' syntactic complexity for American students through the effect it has on their memory for the lexical meaning of the sentence constituents. The assumption was that increased syntactic complexity would result in poorer memory for semantic elements, (i.e., the lexical meaning of the individual Hebrew words in the sentences). The experiment itself is an incidental learning situation in which subjects are presented with 15 Hebrew words : 5 nouns, 5 verbs,and 5 adjectives, the English translation is given for each word. Two grammatical rules are provided for combining words into two word sentences : One which is <u>identical</u> to English (i.e., verbs follow noun) and one which differs from English (i.e., adjective follows noun).

A common argument raised against similar inter-language measurements is that by utilizing one language to explain the rules of a second, interference is created by the <u>very</u> conditions of the experimental design. To overcome this difficulty the miniature linguistic system developed by Esper (1925) has been

used. This system provides combinatorial rules for simple sentence construction by means of a matrix. Foss (1968) demonstrated that such a matrix indeed taught subjects a rule. Two matrices were therefore constructed - one for each of the two grammatical rules. The matrices are represented in Appendix C.

After studying the matrices by filling in some of the cells, $\bar{S}$s are asked to form 20 practice sentences - 10 in each grammatical category.

Immediately following the practice $\bar{S}$s are presented with the 5 adjectives and 5 verbs in Hebrew, in random order, and are asked to translate them into English. It is hypothesized that due to the "overflow" effect fewer adjectives will be remembered than verbs.

The control group recives the same task but the order on matrix II is reversed : i.e., adjective precedes noun as in English. It is hypotheseized that in this condition no difference will appear between the memory for adjective and memory for verbs.

Chapter IV

Method

A. Phonemic Level

Experiment No. 1 : Sound - Letter Matching.

Subjects

Subjects consisted of native English-speaking undergraduate college students (N-62), from four different psychology classes. All subjects had no previous knowledge of Hebrew.

Materials

Materials consisted of a slide projector, tape recorder, and an answer sheet. Six Hebrew phonemes, each represented by one letter were selected, their sound was recorded on audio tape by a native Israeli speaker of Hebrew, and their letter-character represented on projector slides. Each of the six letters employed appeared on a printed answer sheet. Representation used conventional Hebrew orthography of the six letters representing the phonemes selected. The six letters were divided into three sets: One set comprised of two phonemes which have close phonetic counterparts in the English language.

The second set of two phonemes, consisted of phonemes not having similar English phonemes. The third set consisted of two phonemes with partial matching to English phonemes.

The two Hebrew characters in set 1, have closely similar phonetic counterparts in English (viz., /מ/ -/m/ as in ma, /ק/ - /k/ as in key).

The two Hebrew characters in set 2 represent phonemes in Hebrew which have no phonetic counterpart in English (viz., ח ע).

The two Hebrew characters in set 3 represent partial matching (viz., ר ≈ R, א ≈ A).

Procedure

A. Presentation : Each phoneme was presented once acoustically and graphically. For each phoneme subjects simultaneously heard the sound of the phoneme on audio recorder and saw its corresponding character on a slide.

B. Test : 30 minutes after acoustic-graphic presentation, subjects were given an answer sheet (Appendix A) on which each of the six letters appeared with a corresponding number. The sounds associated with each graphic shape were presented acoustically on tape. Each phoneme comprised one trial, and each phoneme was repeated three times in the course of testing for retention, so that there were 18 trials in all. After hearing each phoneme, subjects were required to mark the

appropriate letter number in the blank provided for that trial number.

No control was exercised over students' activities during the 30 minutes interval. A regular lecture in psychology was given in all four classes.

The test was conducted in 4 different classes. In each class different characters were matched with the same sound in order to minimize confounding due to visual similarity.

Analysis

The data were treated as random block design where subjects are treated as a variable. Two way analysis of variance was conducted. Comparisons between cells employed Newman-Keuls multiple comparison analysis (Kirk, 1968).

B. Syntactic Level

Experiment No. 2 : Sentence Recognition.

Subjects

Subjects were 50 students with 1-4 years of training in Hebrew. The native language of all subjects was English. Subjects were selected from the Houston Independent School District (27), and the South Texas Hebrew Academy (23).

Materials

Six Hebrew sentence-categories were constructed. The different categories represent different degrees of syntactic complexity reflecting both between-language and within-language differences. The between-language differences reflect the number of surface transformations from English to Hebrew (or vice versa). The within-language differences refer to surface to deep structure transformations. Positive and negative sentences were used as the two within-language categories. The six categories were characterized as follows : (1) Positive phrases not differing in structure and transformation rules from their English translation. (2) Positive phrases differing on one transformation rule. (3) Negative phrases differing on one transformation rule. (4) Negative phrases differing on two transformation rules. (5) Negative phrases differing on two transformation rules. (6) Negative

Phrases differing on three transformation rules. It should be noted that categories (4) and (5) differ in type of transformation rule, but not in number of rules. Complete analysis of the six categories follows. (Figures 3,4,5,6,7,8).

Transformational grammar analyses are utilized here in a descriptive capacity - as means of constructing a syntactic index of disparity between contrasted surface structures.

72 phrases, 12 in each category were constructed. The vocabulary for all phrases had been selected from Mansoor(1976) "Contemporary Hebrew" and was assumed to have been mastered by all students.

Of the 12 phrases in each category, 4 were randomly selected and produced on projector slides, 24 in all.

A multiple choice questionnaire with 24 items was constructed (Appendix B). Each item contained 3 alternative phrases : One phrase which had been produced on a slide, and two other phrases from the same category.

Procedure

24 phrases, 4 from each category were randomly slected and produced on projector slides. The 24 slides were presented to the students in random order at the beginning of a class period. Following the presentation a regularly scheduled lesson was conducted in all 8 classes. No control was available over the lesson content. Thirty minutes later, a questionnaire containing the original 72 sentences was presented

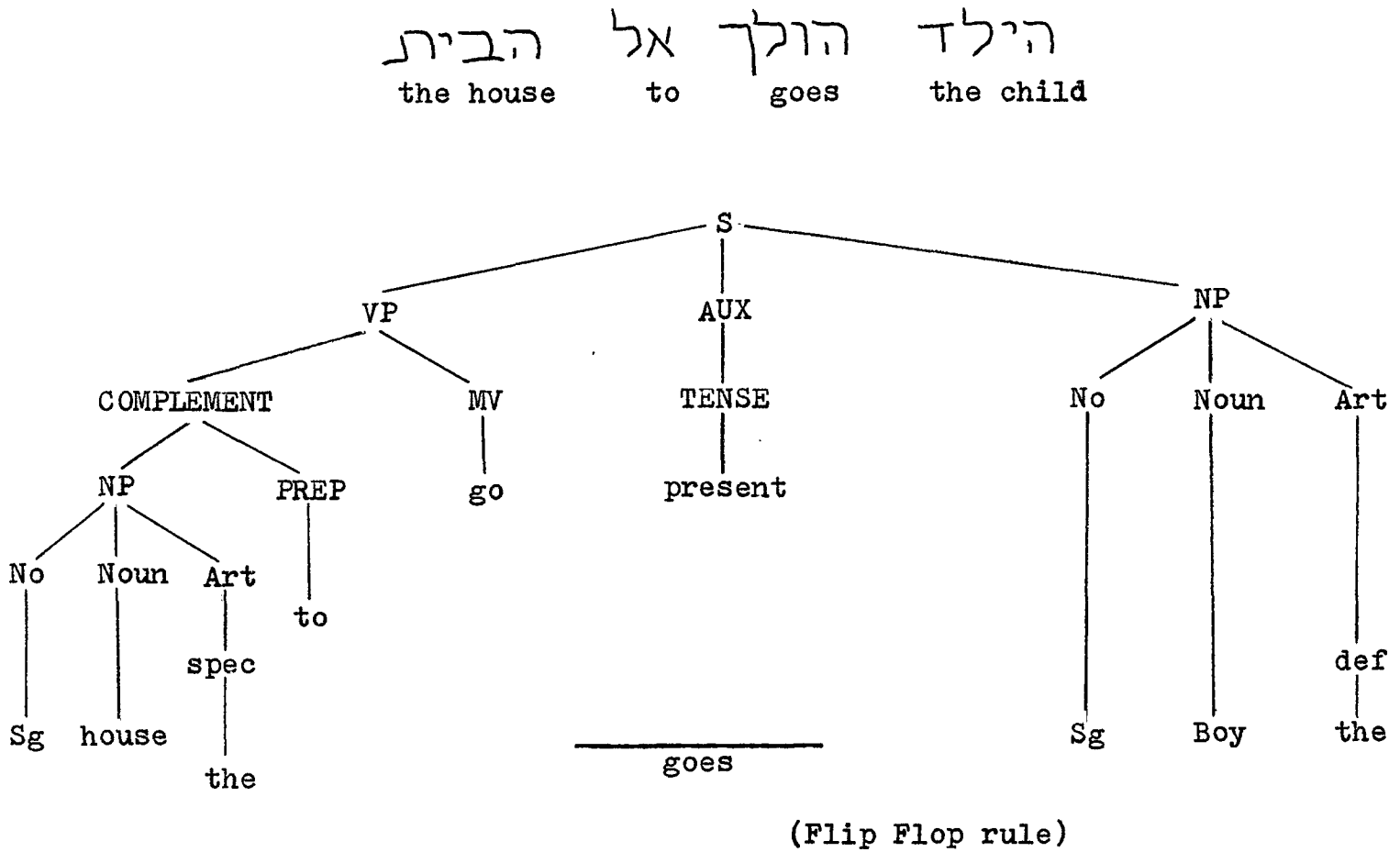


Figure 3 : Category 1 - Positive Structure, not Differing from Hebrew in Structure and Transformation Rules.

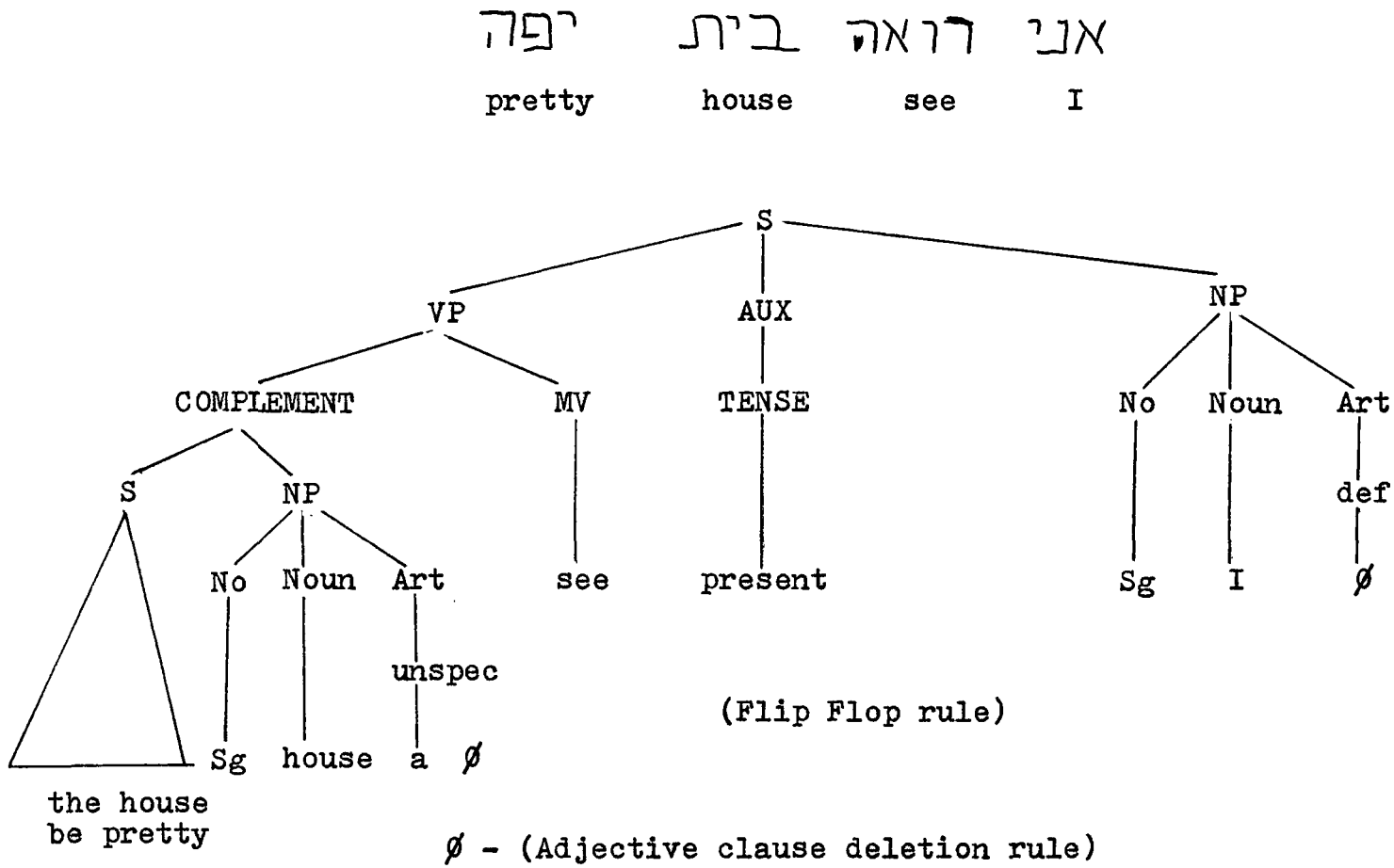


Figure 4 : Category 2 - Positive Sentences Differing on one Transformation Rule (Adjective Switch rule)

אני לא רואה כלב

dog see no I

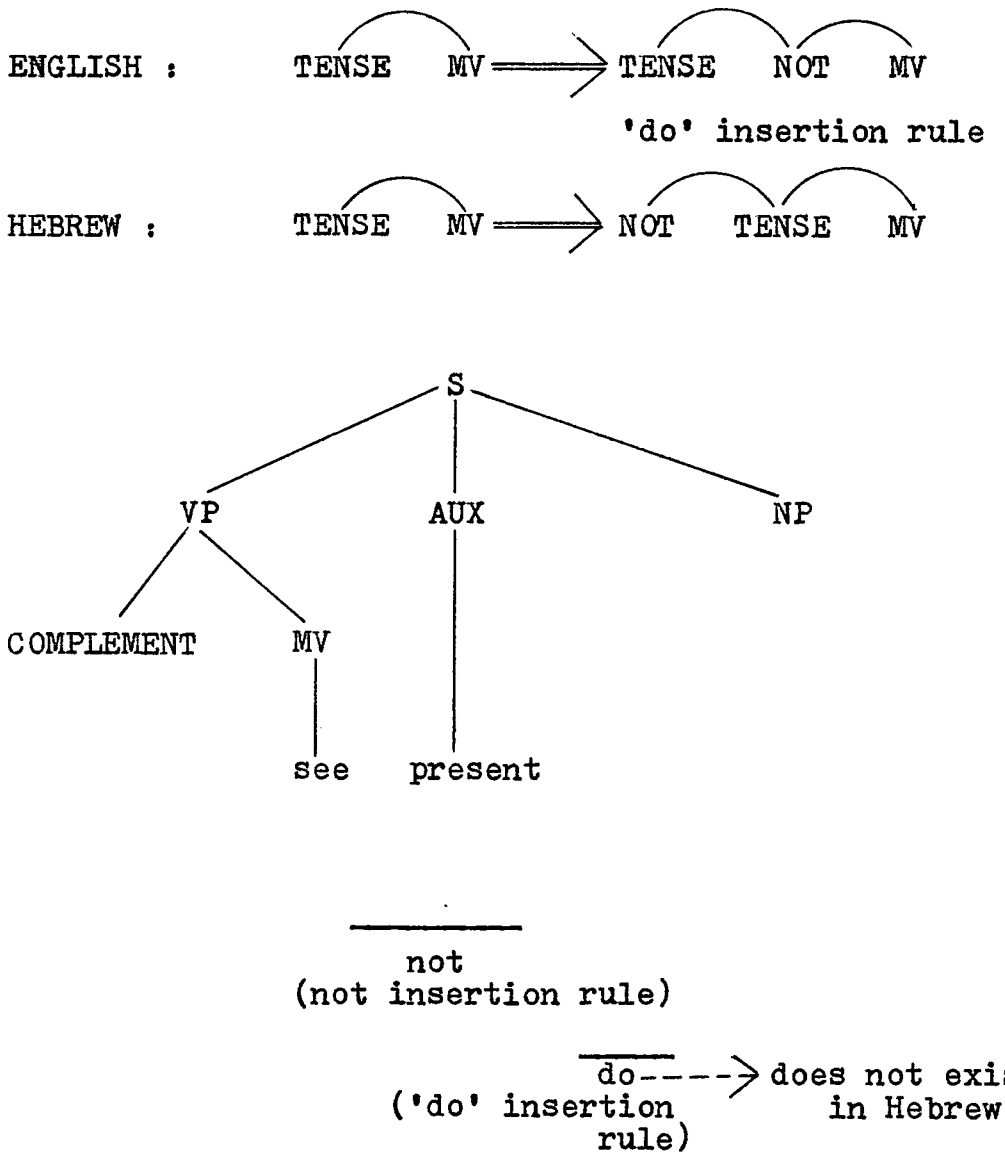


Figure 5 : Category 3 - Negative Sentences I
Differing on One transformation rule ('do' insertion rule)

A Combination of Categories 2 & 3

גדול	לא	הלבן	הבית
big	no	the white	the house

Figure 6 : Category 4 - Negative Sentences Type II Differing on Two Transformation Rules ('do' insertion rule: Adjective switch rule)

A Combination of Categories 2 & 5

יפה	הארוך	השיר	אין
pretty	the long	the song	no

Figure 7 : Category 6 - Negative Sentences Type IV Differing on Three Transformation Rules

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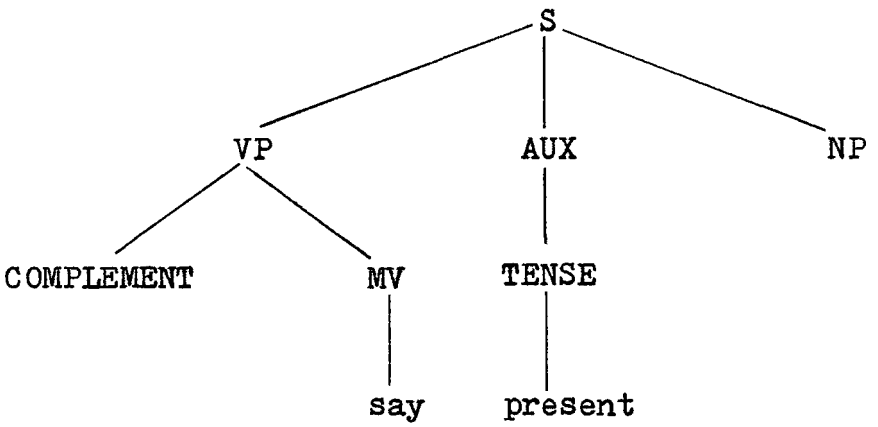
Note : Transformation rules were labelled according to Lester (1971).

אין אני אומר שלום

no I say hello



NOT ⟶ Positive in Hebrew

(not insertion rule)

DO ⟶ Does not exist in Hebrew

(do insertion rule)

Figure 8 : Category 5 - Negative Sentences Type III
Differing on Two Transformation rules
('no' insertion rule, 'do' insertion rule)

(Appendix B). 24 multiple choice questions, each with three alternatives, were given. $\bar{S}$s task was to identify the 'old' sentence.

Analysis

Data were treated as random block design where subjects are treated as a variable. Two way analysis of variance was conducted. Comparisons between cells employed Newman-Kuels multiple conparison analysis (Kirk, 1968).

Syntactic Level

Experiment No. 3 : Word Recall.

Materials

A. Two sets of artificial language system matrices were constructed. Each set contained two matrices : One containing five Hebrew nouns and five Hebrew verbs, and the second containing five Hebrew nouns and five Hebrew adjectives.

Each matrix provided a grammatical rule for combining words into two-word phrases. Two types of rules were provided : One which is identical to English (e.g. verbs follow nouns), and one which differs from English (e.g. adjectives follow nouns). An example of the matrices is given in figures 9 and 10.

The two sets contained the following matrices:

Set I : (1) Verb follows noun. (2) Adjective follows noun.

Set II : (1) Verb follows noun. (2) Adjective precedes noun.

B. The adjectives, verbs, and nouns, presented in the sets of matrices, were used to construct twenty two-word English phrases. Half of the phrases consisted of noun+adjective, and half consited of noun+verb. Each adjective and each verb was used in two of the phrases.

C. A list containing the Hebrew form of the five adjectives and five verbs which were introduced in the matrices.

	yoshev (sits)	ruts (runs)	nofel (falls)	bah (comes)	oved (works)
kelev (dog)		X		kelev bah. (A dog comes)	
ish (man)		Ish ruts.	X		Ish oved. (A man works)
yeled (boy)			yeled nofel.		
pakid (clerk)	pakid yoshev. (A clerk sits.)			pakid bah.	X
ben (son)				ben bah.	

Figure 9 : Artificial Language System Matrix I - Syntax identical to English

	gadol (big)	katan (small)	tov (good)	yafeh (nice)	rah (bad)
kelev (dog)		kelev katan.		X	
ish (man)			Ish tov. (A good man)		X
yeled (boy)	yeled gadol. (A big boy)			yeled yafeh.	
pakid (clerk)		X	pakid tov.		
ben (son)	ben gadol.				ben rah. (A bad son)

Figure 10 : Artificial Language System Matrix II - Syntax differing from English

The materials are presented in Appendix C.

Procedure

Subjects were divided into two groups: An experimental group and a control group. The experimental group received set I of the 'artificial language system' matrices and the control group received set II. Both groups then followed the same steps :

Step 1 - Acquisition : Subjects were instructed to write the appropriate phrase in the marked three squares in each matrix. The protocols of subjects who did not complete this step successfully were not scored.

Step 2 - Practice : Subjects were required to translate the twenty English sentences in list B. Subjects were permitted to consult the matrices. No time limit was imposed.

Step 3 - Test : Subjects were presented with list C. Subjects were asked to translate the ten words (5 adjectives, and 5 verbs) into English from memory. Subjects were not informed in advance of this step.

Analysis

The data were treated as a mixed design. The group factor is the random variable, and the word-category factor is the fixed variable. A two way analysis of variance was conducted.

Chapter V

RESULTS

A. Phonological Level.

Experiment I.

A summary of the descriptive statistics for the dependent variable can be seen in Table 1. The means and standard deviations for the correct scores are reported.

The test for the main effects was significant for the correct scores ($p < .01$). The result are presented in Table 2.

Differences between cell means were compared with the Newman-Kuels test. The results are presented in Table 3. The findings support the hypothesis that performance on set 1 - "matched" phonemes - will be significantly better than performance on sets 2 and 3. The direction of the mean differences does not support the hypothesis that performance on set 3 - ' no match ' - will be better than on set 2 - 'partial match'.

B. Syntactic Level.

Experiment II.

A summary of the descriptive statistics of the dependent variable is reported in Table 4. The table lists means and standard deviations for the correct scores.

Table 1

Descriptive Statistics for Correct Scores

Category	Correct Scores	
	M	S.D.
Set 1	4.164	2.04
Set 2	3.492	2.22
Set 3	3.082	1.87

Set 1 - Close match with English.

Set 2 - Partial match with English.

Set 3 - Minimal match with English.

Table 2

Test of Main Effects - Correct Scores

Source	SS	DF	MS	F
Between Categories	43.55	2	21.775	12.436**
Between Subjects	546.08	60	9.10	5.197**
Residual	210.12	120	1.751	
Total	799.75			

** $p < .01$

Table 3

Newman-Kuels Comparisons of Mean Differences- Correct Scores

		Set 1	Set 2	Set 3
Set 1 -	4.164	-	0.672*	1.082*
Set 2 -	3.492		-	0.410
Set 3 -	3.082			-

* $p < .05$

Table 4

Descriptive Statistics for Correct Scores

Category	Correct Scores	
	M	S.D.
POS_0	3.46	0.68
POS_1	3.18	0.87
NEG_1	2.92	1.01
NEG_{2a}	2.96	0.90
NEG_{2b}	2.96	0.83
NEG_3	2.50	1.18

POS_0 refers to positive sentences, the syntax of which does not differ from their English semantic equivalent. POS_1 is a positive sentence differing in one transformation. NEG_1 is a negative sentence differing in one transformation rule. NEG_{2a} and NEG_{2b} differ from their English semantic equivalent in two transformation rules. NEG_3 differs on three transformation rules.

The test for main effects was significant for the correct scores ($p < .01$). The results are presented in Table 5.

Differences between cell means were compared by the Newman-Kuels multiple conparisons test. The results are presented in Table 6. The order of magnitude of the means was in the direction predicted by the number of transformation with one exception, the reversal in the relative position of $\overline{NEG_1}$ and $\overline{NEG_{2(a\&b)}}$. As can be seen in row one the POS_0 condition resulted in significantly higher scores than $NEG_{2(a\&b)}$ and NEG_3 . These signigicant differences are in the direction predicted. In row two, $\overline{POS_1}$ is significantly higher than $\overline{NEG_3}$, in row four condition NEG_{2b} resulted in significantly higher correct scores than condition NEG_3 , and in row five, $\overline{NEG_1}$ is significantly higher than $\overline{NEG_3}$. All the results are in the predicted direction. All the significant differences can be attributed to two factors : Type of sentence (i.e., positive/negative), and number of transformations. The hypothesis that the effect of the two factors is independent is clearly supported by the increasing magnitude of the means in row one, and especially in row two where $\overline{POS_1}$ is not significantly higher than $\overline{NEG_1}$ or $\overline{NEG_2}$, but is significantly higher than $\overline{NEG_3}$. As predicted, the nature of the between language transformation rule had no effect, as manifested by the results obtained on NEG_{2a} and NEG_{2b}. The above sentence-categories differ from English by the same number (2) of transformations but the transformation rules are different. No significant difference was found between the means of the two categories, in fact they are identical.

Table 5

Test of Main Effects for Correct Scores

Source	SS	DF	MS	F
Between Categories	31.17	5	6.234	9.19**
Between Subjects	101.66	49	2.075	3.06**
Residual	166.16	245	0.678	
Total	298.99	299		

** $p < .01$

Table 6

Newman-Kuels Multiple Comparisons of Mean Differences - Correct Scores

			$\overline{POS_0}$	$\overline{POS_1}$	$\overline{NEG_{2(a\&b)}}$	$\overline{NEG_{2(a\&b)}}$	$\overline{NEG_1}$	$\overline{NEG_3}$
$\overline{POS_0}$	-	3.46	-	0.28	0.50*	(0.50*)	0.54*	0.96**
$\overline{POS_1}$	-	3.18		-	0.22	0.22	(0.26)	0.68**
$\overline{NEG_{2a}}$	-	2.96			-	0	0.04	(0.46)*
$\overline{NEG_{2b}}$	-	2.96				-	0.04	0.46*
$\overline{NEG_1}$	-	2.92					-	0.41
$\overline{NEG_3}$	-	2.50						-

* $p < .05$; ** $p < .01$

Note: $\overline{NEG_{2a}}$ and $\overline{NEG_{2b}}$ are identical and their relative positions are arbitrary. Combining them into one category has not affected any of the results.

Experiment III.

A summary of the descriptive statistics for the independent and dependent variables can be seen in Table 7. The means and standard deviations for each factor, as well as the cell means and the standard deviations are reported.

The tests for the effects of the word-category factor and the group-treatment factor are reported in Table 8.

The effect of the word category factor was not significant ($p < .05$) and the interaction of the two factors was not significant ($p < .05$). The group effect was significant. These results were predicted by the hypothesis that the difference in correct scores for adjectives and verbs was the result of the required syntactic transformation, but the type of lexical information had no effect on the scores. Comparison between cells showed that the experimental group performed significantly better on the verb category then on the adjective category ($t_{15} < .05$). No significant difference was found for the control group between the two categories. The results are in accordance with the stated hypotheses.

Table 7

Descriptive Statistics for Correct Scores

Word Category / Treatment	Adjectives	Verbs	Total
Experimental	M - 0.94 SD - 0.96	M - 2.00 SD - 1.27	M - 2.93 SD - 2.56
Control	M - 2.06 SD - 1.20	M - 2.31 SD - 1.36	M - 4.37 SD - 2.04
Total	M - 1.5 SD - 1.22	M - 2.16 SD - 1.32	M - 3.66 SD - 2.15

Table 8

Test for Main Effects for Correct Scores

Source	SS	DF	MS	F
Between Categories	7.374	1	7.374	2.40
Between Groups	8.782	1	8.782	5.62*
Interaction Cat. x Gr.	3.070	1	3.070	1.96
Explained	18.971	3	6.324	4.051
Residual	92.108	59	1.561	
Total	111.079	62		

* $p < .05$

Chapter VI

DISCUSSION

Kintsch (1974) presented a theory of representation in semantic memory. The theory hypothesized that language information is represented by a set of propositions and their case relationships or "text base." In order to evaluate the comprehension of sentences, it is not important to specify the surface features of the text base. What is needed is to specify the transformation of information needed to be performed on the information in order to meet the task demand (Alston,1975,note 1). This paper advanced the thesis that different levels, or degrees, of processing (i.e., transformation) were required for L_1 and L_2 text bases. It further attempted to present a model enabling predictions as to the type of transformations required for comprehending text bases in L_1 and L_2 .

The assumption was made that L_2 elements are mapped onto the cognitive structures of L_1 , which then undergo further processing. This position implied a depth-of-processing model (e.g. Craik & Lockhart, 1972), in which the same elements could be encoded and stored at different levels according to the degree of processing they received. Within this model, two types of processes were identified, (1) passive processes which do not require attention, and (2) active processes requiring

attention (Cf. Morman, 1969). Automatic processing facilitates performance on complex tasks, such as language behavior, by eliminating the need for sequential processing, thus reducing the task demand.

All of these features were incorporated in the model of second language processing developed in this paper. The model proposed two additional basic assumptions. First, the assumption was made that L_1 is processed automatically, while L_2 elements require attention. Second, if an L_2 code could be translated into a corresponding L_1 code, the L_2 code could then utilize the automatic information-flow route activated by L_1 .

The model thus enabled the definition of the difficulty of an L_2 item as the cumulative effect of the number of transformations required for a translation into L_1 , the "between language" component, and the number of transformations required for the processing of the L_1 code, the "within language component". This formulation enabled the generation of testable hypotheses. Two sets of experiments were carried out : One assessing the number of syntactic transformations, and the second assessing phonological processing.

The proposed model suggested that a new language acquired in adulthood must be mediated by existing language structures (Stern,1970). "...Regardless of which language ultimately dominates, the early stages of second language learning are inevitably mediated by the first language; that is, the learner maps his conceptualizations onto the native language and then

translates to the new language..."(Lachman & Lachman, 1976). "...the older the individual is, the more the rules and habits of the first language interefere with the acquisition of the second..."(McLaughlin, 1977). The interdependence should manifest iteself in both the type of errors being made in the usage of a newly acquired second language, and the relative ease with which new language elements will be acquired.

The experiments described in this paper have therefore been designed and conducted, to test the assumptions at the phonemic and syntactic/semantic levels.

The results obtained on the syntactic experiments were all in the expected direction. The first of the two syntactic experiments compared recognition memory for L_2 categories differing in difficulty on both the within language component, and the between language component. The results were strongly supportive of the model. While not all the comparisons were significant, the significant results were all in the predicted direction. Furthermore, the significant results reflected the effect of both between and within language transformations, in accordance with the stated hypotheses.

The findings strongly support the position advocated in this paper that L_2 elements are processed, organized and anchored in L_1, structures. These results would suggest immediate possible educational applications. Curriculum development could be based on contrastive analysis of L_1 and L_2. Conducting such analyses would result in curricula and texts which are

language specific. For example, a text of "Engliah as a second language" would be replaced by a series of texts, each one directed to a specified language population.

The advocates of 'natural' sequencing, who oppose the mediated approach, point in their support to the results abtained by Ervin-Tripp (1970); George (1972); Richards (1971); Ervin-Tripp(1969); Dulay and Burt (1972); Milon (1974); Ervin-Tripp (1974). These studies found that the majority of errors in L_2 were not traceable to L_1 , and that strategies employed by children were similar in both L_1 and L_2 acquisition. On the basis of these studies , McLaughlin concluded that the acquisition of L_2 is independent of L_1 . (In the context of the present discussion there was no need to refute the studies. It should be noted that a plethora of studies report findings reflecting differences in learning strategies and error patterns between L_1 and L_2 ,e.g., Ravem 1974; Brown 1968; Halle 1962; King 1969; Sapporta 1966; Wilkins 1972,1974). But even accepting these results does not necessarily necessitate the acceptance of the McLaughlin contention. The argument that errors in L_2 must always reflect certain surface features in L_1 can hardly be supported. This argument equates functional stimuli with externally defined criteria. "...such identification may be acceptable in a few fortuitous cases, but mostly it must be a mistake. How to define or identify subjective representation is the central problem..."(Martin, 1972). The position advocated is, therefore, that interactions between existing cognitive

structures and knowledge can be studied only within the context of a processing model which allows for encoding variability. This is important because it implies that similar task demands might result in different error patterns.

This interpretation was bolstered by the results on the second syntactic experiment. In this experiment, syntactic difficulty was evaluated in terms of the effect on the recall of lexical information. The assumption was that the more difficult the syntactic task, the lower the expected recall score on the lexical items. This hypothesis was confirmed by the results. In this experiment, item difficulty was measured in terms of the degree of automaticity (or conversely, active attention) involved in its processing, and the number of transformations required for the processing. The results of heavy loading on these factors may be manifested in many forms, and, as seen in the experiment, will not necessarily have a direct effect on any given task but may "overflow" and affect another task.

Once again, it can be seen that only a better understanding of the processing system will enable us to make correct interpretations. Specifying the relationships between the information to be processed and the transformations to be performed upon it, allows the investigation to the nature of the processor and the functional organization of the processor. Such investigation is necessary for the formaulation of theories and methodologies of language learning.

Beyond the theoretical arguments made, the results also suggest a possible utilization of the "overflow" technique as a measure of linguistic competence. A measure which will make possible the assessmant of the relative difficulty of different language structures for a given language community, furthermore, the technique lends itself to the assessment of the level of language competence attained by an individual, even after an accuracy criterion has been reached. This is important because it extends the measurement of language competence into hetherto poorly defined areas such as fluency and bilingualism.

Results of the second test of the model, the test of phonological processing, were only partially successful. A careful analysis suggested that the fault might not lie with the model and its underlying assumptions, but with the way the model was analysed and used (or misused) for the generation of the hypotheses tested. The model, indeed, suggests that performance can be predicted on the basis of the interrelations between L_1 and L_2 . Hypotheses were generated on the basis of the relations between the external-nominal features of L_1 and L_2 . This action violated the stimulus variability argument raised in this very paper. The following analysis is offered as a viable alternative.

According to the model of letter perception in visual and phonemic memory (Figure 1),sounds will be processed, according to their features, into letter codes (or letter-name codes) of

the dominant language, and then recoded into the corresponding letter in the second language.

Errors are most likely to occur at two points:

A. In phonemic memory by associating the sound with the wrong letter name in L_1 .

B. Between phonemic memory and visual memory by associating the letter name in L_1 with the wrong character in L_2 .

The first type of errors can be ascribed to failure to select and attend to the relevant features of the stimulus sound. This possibility increases whenever the stimulus phoneme in L_2 shares fewer features with the matched phoneme in L_1 , and decreases with more shared features. The result of this failure to attend to the appropriate auditory features can be either a failure to evoke a letter name code, or evoke a wrong code.

The second category of errors reflects the possibility that a phoneme in L_2 shares features with more than one phoneme in L_1 . The result of such phonemic ambiguity is the creation of alternative (and erroneous) information flow routes.

Figure 11 presents a simplified version of the two error categories in the perception of a Hebrew letter.

This analysis would indicate that the interplay between two factors determines the generation of errors : The number of features shared by an L_2 phoneme and the targeted L_1 phoneme, and the number of features shared by L_2 phoneme and untargeted (or undesired) L_1 phoneme. The effect of that interplay can

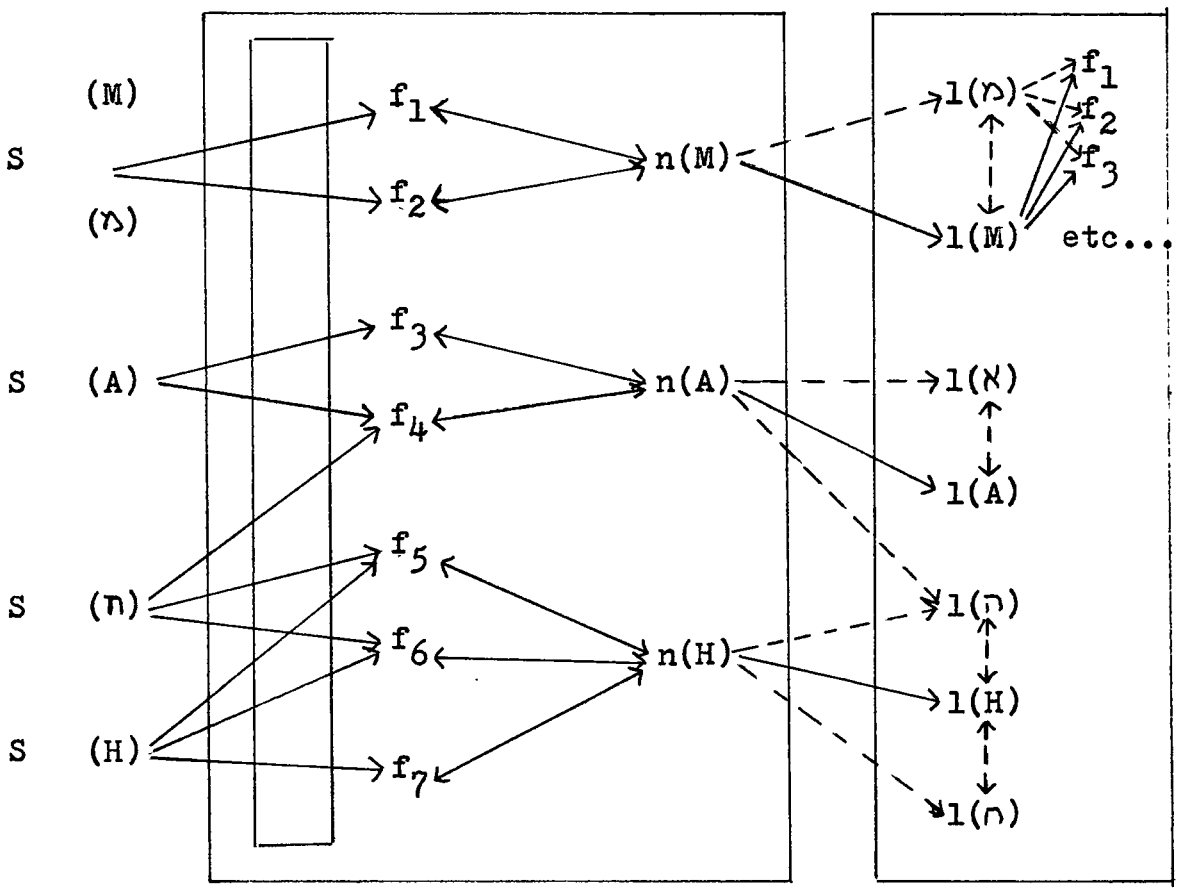


Figure 11 : A Model of Error Generation

Simplified model of the perception of the two Hebrew phonemes /נ/ and /ה/ and the two error categories. /נ/ and /M/ share the same features. /ה/ shares features with both /A/ and /H/. /ת/ and /א/ indicate possible errors.

S - Auditory stimulus.
f - Sensory features.
n - Letter name code.
l - Visual letter code.
⟶ - Flow not requiring attention.
- - → - flow requiring attention.

Table 9

Descriptive Statistics-Phonological Experiment

Breakdown by Individual Phonemes

Set I				Set II				Set III			
Close Match to English (ק, כ)				Partial Match to English (ר, א)				No Match in English (ע, ח)			
Correct		Incrrect		Correct		Incorrect		Correct		Incorrect	
ק	כ	ק	כ	ר	א	ר	א	ע	ח	ע	ח
128	126	55	57	133	80	50	103	78	111	105	72
Total		Total		Total		Total		Total		Total	
254		112		213		153		189		177	

be represented in the following formula:

$$K \times \frac{\text{\% possible of correct phonemic matching}}{\text{\% possible of incorrect phonemic marching}} = \text{\% correct perception}$$

K- Constant

In accordance with the formula, a new set of hypotheses can be generated : The phonemes of the first set /מ/ and /ק/ are almost identical to the target phonemes in English and hence should be processed without difficulty. The phonemes of the second set, however, present a different picture, no longer do they belong to the same category. /ר/ , the guttural Hebrew equivalant to /R/ shares many features with the English equivalent. The unshared features, however, are unique to Hebrew and will not affect its preception. /א/, on the other hand, shares features with /A/ , /O/ , /U/ , and other English vowels. Therefore, though quite similar to several English phonemes performance will be negatively affected.

The last two phonemes, /ע/ and /ח/ , share fewer elements with both the target phoneme and non target phonemes. The performance, on these two phonemes, should, therefore, yield similar scores.

These hypotheses were confirmed by the results shown in Table 9 . At the same time, like most post-hoc arguments,

this analysis should be viewed with caution. At this stage, the value of the phonological model is questionnable.

Two more comments should be made before closing the present discussion.

First, the study borrows terms, notations and concepts from models of reading comprehension. It cannot be over-emphasised that this does not imply that the two processes are similar or analogous. Instead, the similarity between the models denotes that both reading and second language comprehension operate under a common conceptual umbrella and are processed within the same Human Information Processing system.

Second, this paper aims to measure memoric processes as indicators of learning. This is done because learning is inextricably bound, by definition, implication, and application with memoric-retention processes. The nature of a learning experience itself implies the relative permanence and retentive nature of that which is learned. Many definitions of learning suggest this connection. More specifically, the nature of an academic situation in its most central role of transmitting knowledge (Ausubel, 1968,p.23) illustrates an emphasis on re-taention.

> Implicit in any educators' beliefs is the idea that he must somehow "teach" his class to retain the information he is giving them. In a very real sense, what is meant by "learning" is really " re-membering."
>
> (Cermak, 1972,p.4)

In summary, the majority of the results support the hypothesis that L_2 elements are processed into L_1 structures. This interdependence is manifested in the relative ease with which L_2 elements are processed.

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Appendix A

Materials used in Phonological Experiment.

6	5	4	3	2	1
ע	א	ק	ר	ח	מ

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Appendix B

Materials used in Syntactic Experiment No. 1

1. א. דָּוִד אוֹהֵב אֶל יַעֲקֹב
   ב. הַכֶּלֶב אוֹכֵל תַּחַת הַשֻּׁלְחָן
   ג. הוּא שׁוֹמֵר עַל הַבַּיִת

2. א. הָאִישׁ לֹא נוֹתֵן כֶּסֶף
   ב. שְׁלֹמֹה לֹא שׁוֹמֵעַ שִׁיר
   ג. אֲנִי לֹא סוֹגֵר דֶּלֶת

3. א. אֲנִי טָר שִׁיר עִבְרִי
   ב. הוּא אוֹכֵל לֶחֶם לָבָן
   ג. הוּא קוֹרֵא סֵפֶר אָרוֹךְ

4. א. הַסּוּס הַשָּׁחוֹר לֹא הוֹלֵךְ
   ב. הָאִישׁ הַגָּדוֹל לֹא יוֹשֵׁב
   ג. הַסֵּפֶר הַיָּפֶה לֹא טוֹב

5. א. אֵין אַתָּה עוֹבֵד קָשֶׁה
   ב. אֵין הַיֶּלֶד רוֹאֶה כֶּלֶב
   ג. אֵין הַדּוֹד גּוֹמֵר סֵפֶר

6. א. אֵין הַסּוּס הָרַע הוֹלֵךְ
   ב. אֵין הַבַּיִת הַגָּדוֹל יָפֶה
   ג. אֵין הַיֶּלֶד הָרַע יוֹשֵׁב

7. א. אֵין הָאִישׁ יוֹשֵׁב פֹּה
   ב. אֵין הוּא שׁוֹמֵעַ סִפּוּר
   ג. אֵין יוֹסֵף לוֹקֵחַ תַּפּוּחַ

8. א. הַיֶּלֶד נוֹפֵל מִן הַכִּסֵּא
   ב. אֲנִי קוֹרֵא מִן הַמַּחְבֶּרֶת
   ג. הָאִישׁ יוֹשֵׁב עַל הַכִּסֵּא

9. א. הַדּוֹד הֶזָּקֵן לֹא אוֹכֵל
   ב. הָאִישׁ הֶזָּקֵן לֹא עוֹמֵד
   ג. הַמּוֹרֶה הֶצָּעִיר לֹא טוֹב

10. א. הָאִישׁ אוֹמֵר פֶּקַר טוֹב
    ב. הוּא גּוֹמֵר עֲבוֹדָה קָשָׁה
    ג. אֲנִי רוֹאֶה בַּיִת יָפֶה

11. א. אֵין הַכֶּלֶב הַקָּטָן שָׁחוֹר
    ב. אֵין הַסֵּפֶר הַגָּדוֹל קָשֶׁה
    ג. אֵין הָאִישׁ הֶזָּקֵן עוֹמֵד

12. א. אַתָּה לֹא אוֹהֵב שִׁיר
    ב. הַיֶּלֶד לֹא קוֹרֵא סֵפֶר
    ג. הוּא לֹא לוֹקֵחַ תַּפּוּחַ

13. א. הָאִישׁ שָׁב אֶל הָאָרֶץ
ב. הַיֶּלֶד הוֹלֵךְ אֶל הַבַּיִת
ג. הוּא גָּר עַל־יַד שָׂרָה

14. א. הַבַּיִת הַלָּבָן לֹא גָּדוֹל
ב. הַכְּפָר הַקָּטָן לֹא יָפֶה
ג. הַתַּלְמִיד הָרַע לֹא לוֹמֵד

15. א. אֵין הָעֵץ הַגָּדוֹל עוֹמֵד
ב. אֵין הַסְּפוּר הַיָּפֶה קַל
ג. אֵין הַשִּׁיר הָאָרוֹךְ יָפֶה

16. א. דָּוִד לֹא יוֹדֵעַ עִבְרִית
ב. אֲנִי לֹא רוֹאֶה כֶּלֶב
ג. הוּא לֹא אוֹכֵל לֶחֶם

17. א. אֵין הַיֶּלֶד שׁוֹלֵחַ מִכְתָּב
ב. אֵין הוּא כּוֹתֵב שִׁיר
ג. אֵין אֲנִי לוֹמֵד הַיּוֹם

18. א. הַדּוֹד כּוֹתֵב מִכְתָּב אָרוֹךְ
ב. הַיֶּלֶד כּוֹתֵב שִׁיר יָפֶה
ג. אַתָּה רוֹאֶה יֶלֶד צָעִיר

19. א. הַסּוּס קָם מִן הָאָרֶץ
ב. הוּא שָׁב מִן הַכְּפָר
ג. אֲנִי עוֹמֵד עַל־יַד הַלּוּחַ

20. א. הַיֶּלֶד הַקָּטָן לֹא הוֹלֵךְ
ב. הָעֵץ הַגָּדוֹל לֹא נוֹפֵל
ג. הַשֻּׁלְחָן הַשָּׁחוֹר לֹא יָפֶה

21. א. הוּא שׁוֹמֵר בַּיִת קָטָן
ב. דָּוִד לוֹמֵד סֵפֶר קַל
ג. הָאִישׁ נוֹתֵן סֵפֶר גָּדוֹל

22. א. אֲנִי לֹא לוֹמֵד עִבְרִית
ב. הוּא לֹא גּוֹמֵר שִׁיר
ג. אַתָּה לֹא שׁוֹלֵחַ כֶּסֶף

23. א. אֵין אֲנִי אוֹמֵר שָׁלוֹם
ב. אֵין הוּא חוֹשֵׁב הַרְבֵּה
ג. אֵין שְׁלֹמֹה רוֹאֶה סוּס

24. א. אֵין הַתַּלְמִיד הַקָּטָן לוֹמֵד
ב. אֵין הָאִישׁ הַגָּדוֹל לוֹמֵד
ג. אֵין הַמּוֹרֶה הַטּוֹב כּוֹתֵב

Appendix C

Materials used in Syntactic Experiment No. 2

Directions :

The following matrices demonstrate how meaningful sentences and phrases are formed in language X.

Study these matrices and then complete the exercises

	gadol (big)	katan (small)	tov (good)	yafeh (nice)	rah (bad)
kelev (dog)		kelev katan.		X	
ish (man)			Ish tov. (A good man)		X
yeled (boy)	yeled gadol. (A big boy)			yeled yafeh.	
pakid (clerk)		X	pakid tov.		
ben (son)	ben gadol.				ben rah. (A bad son)

	yoshev (sits)	ruts (runs)	nofel (falls)	bah (comes)	oved (works)
kelev (dog)		X		kelev bah. (A dog comes)	
ish (man)		Ish ruts.	X		Ish oved. (A man works)
yeled (boy)			yeled nofel.		
pakid (clerk)	pakid yoshev. (A clerk sits.)			pakid bah.	X
ben (son)				ben bah.	

Directions : Now that you have studied the matrices complete the following exercises.

Exercise I : Fill in the squares marked X in the matrices.

Exercise II : Translate the following sentences from English into language X.

1. a big dog.....
2. A son works.....
3. a small boy.....
4. A clerk runs....
5. a nice clerk....
6. A dog sits.....
7. a small man.....
8. A boy runs.....
9. a good dog.....
10. A boy sits.....
11. a big man.....
12. A son falls.....
13. a good boy.....
14. A dog falls.....
15. a small son.....
16. A clerk falls...
17. a good son.....
18. A man sits.....
19. a big clerk.....
20. A boy works.....

The following words were used in the sentences you have just constructed.

Try and translate into English :

1. Gadol

2. Katan

3. Yoshev

4. Tov

5. Over

6. Nofel

7. Ruts

8. Yafeh

9. Rah

10. Bah