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An Experimental Investigation of the Differential Verification Times Related to Negation, Falsification, and Sentence Voice in the Spanish Language

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AN EXPERIMENTAL INVESTIGATION OF THE DIFFERENTIAL VERIFICATION TIMES RELATED TO NEGATION, FALSIFICATION, AND SENTENCE VOICE IN THE SPANISH LANGUAGE

by

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VITA

The author, Ruth Riley Crockett, is the daughter of Drs. Russell Joseph and Georgia Campbell Riley. She was born November 16, 1930 in Muskegon, Michigan.

Her elementary education was obtained in the public schools of North Muskegon, Michigan. Her secondary education was completed in 1949 at the Frank E. McKee High School in the same city.

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CHAPTER I

INTRODUCTION

Information processing, now the dominant paradigm in the field of cognitive experimental psychology, focuses on normal, rational behavior and views man as an active seeker and user of information. The analogy of Turing's theoretical Universal Machine, or its modern day realization, the computer, to the mind has provided a nomenclature and theoretical base for studying the higher mental processes. Of particular interest to information-processing psychologists has been that which occurs in the mind between input and output. Information processing psychologists view the mind as a system capable of carrying out complex mental tasks and these tasks take place in measurable units of time.

Much of the research in information processing psychology is designed to determine what stages of processing underlie psychological events, what happens when these processes occur and how long they take. One area of interest to information processing psychologists has been that which deals with how the mind judges whether verbal information is true in relation to its perception of the environment. Most of the research designed to study this

mental process has made use of choice reaction time and differential latencies of response. If a person is asked whether a statement is true or false, the speed of his decision is reportedly related to the cognitive processing of the syntactic structure of the sentence. Wason (1959) was the first to show that people take longer to respond to negative sentences and to judge a statement false than to judge it true. Subsequent research findings related to the processing of implied and explicit negatives and negative qualifiers have confirmed differential negation and falsification latencies.

Several cognitive models have been developed to account for the mental processes responsible for the longer verification latencies. Carpenter and Just (1975) developed a model of cognitive processing which was based on their own research and that of the Clark and Chase (1972) match-mismatch model. Predictions based on the model accounted for a high percentage of the variance between means. In the sentence verification study by Carpenter and Just (1975), subjects were instructed to read a sentence, look at an array of red, black or green dots on a card and judge whether the sentence was true or false in regard to the color of the dots. Response time, accurate to the millisecond (ms), was registered by use of a two button decision apparatus. There were three sentence types: (1) affirmative (It's true the dots are red);

(2) negative predicate (It's true the dots are not red); and (3) denial (that is, the scope of the negation covered the whole sentence) (It's not true the dots are red.) Each statement could be true or false and all possible combinations of negation and falseness were presented for each color. The six possible combinations were: true affirmative (TA), false affirmative (FA), false predicate negative (FP), true predicate negative (TP), false denial (FD), and true denial (TD). From their model Just and Carpenter (1975) predicted additive increases in verification latencies for each condition: TA < FA < FP < TP < FD < TD. The linear predictions from the derived model accounted for 97.7% of the variance in the study.

Two additional studies by Carpenter and Just (1975) altered the word order of the sentences and the resultant latencies indicated that the differential cognitive processing of negative and positive sentences is relatively independent of the surface structure variations of language.

The question remains, however, "Does the increased sentence verification time for negation and falsification result from underlying universal cognitive processes or is it related to the structure and processing of the English language?" If the verification times are the result of additive effects of match - mismatch processing as outlined in the Just and Carpenter model, then they should be

replicable in other languages. To test this, Carpenter and Just (1975) have replicated one of their studies in Chinese and carried out a related study in Norwegian. In these studies the line of best fit accounted for 91.8% of the variance in the embedded sentence study done in Chinese and 96.2% of the variance in the study using negative quantifiers in Norwegian.

The overall purpose of Experiment I of the present study is to replicate in Spanish (a Latin based language), the embedded sentence study carried out by Carpenter and Just (1975) first in English (a Germanic based language) and then in Chinese (Just and Carpenter, 1975), (an Oriental language).

Experiment II was designed to assess the differential verification of active, passive and reflexive verbs in Spanish. Gough (1966) found longer verfication times for passive sentences than for active. Control for sentence length did not eliminate the differential latency. In addition, a three second delay between presentation of the sentence and presentation of the picture to allow the subject to convert the passive sentence to its deep structure (simplified active form) did not eliminate the difference. Passive sentences were still verified more slowly than actives. This would indicate that the passive sentences were being held in short term memory and processed in their passive surface structure format. Gough

interpreted the longer verification time in English for passive sentences as due to a processing 'mismatch' resulting from the subject's having to pass over the object to retrieve the subject and then return to the object.

Tannenbaum and Williams (1968), Wright (1969), and Olson and Filby (1972) tested hypotheses related to the concept that the use of the passive voice shifts emphasis to the logical object. Olson and Filby's research on perceptual focus indicated that when, through instructions, perceptual focus was placed on the logical object, the passive sentences were generated and verified faster than active, but they were not verified as fast as active sentences when the focus was placed on the logical subject.

Slobin (1966) studied reversible passive sentences, (ie., those in which the object and subject can be reversed). For example, "the boy was kicked by the girl" can be reversed to "the girl was kicked by the boy" and still be semantically correct. Slobin found that these reversible passive sentences took longer to verify than other passive sentences. Herriot (1969) identified much of this difference as being due to what he called expectancy effect. Herriot concluded that individuals make use of probability cues from life experience, and when this does not suffice, as in reversible sentences, attention is paid to the passive voice.

Wannamacher (1974) proposed a model of verification

of active and passive sentences based on the number of sentence elements which had to be compared before the decison could be made as to whether the sentence was true or false. False sentences were analyzed according to the point of mismatch. False sentences, where the mismatch was at the first noun, were verified faster than those with a mismatch at the verb, and both were verified faster than those with a mismatch at the second noun. True sentences had to be compared at all three points, but because no mismatch was involved, they were processed in slightly less time than sentences with a mismatch in the third position. There was a significant difference in verification time to each point of mismatch. However, reversibility and passive voice also had significant interaction effects (Wannamacher, 1974).

While most of the research on active-passive sentences finds passive sentences take longer to verify than actives, there may be several variables which interact to cause this observed difference: surface structure vs. deep structure encoding; reversibility vs. nonreversibility of the subject and object; point of mismatch on false sentences; conceptual focus of the picture or situation; unfamiliarity with the passive voice; appropriateness of the passive voice; and auditory vs. visual presentation of the sentence.

In sum, experiment II was designed to determine

whether the differential verification latencies for active and passive sentences are a peculiar function of the English language or whether these differential verification latencies would be found in Spanish. Careful control of sentence length and the elimination of reversible passive sentences make it possible to determine if the differential exists as a function of the use of the passive voice. The present study includes an equal number of active, passive and reflexive sentences. From a theoretical linquistic perspective, it is hypothesized that Spanish reflexive sentences will be verified more slowly than active sentences, but more rapidly than passive sentences. Verification latencies will also be analyzed as a function of the locus of the mismatch in false sentences.

CHAPTER II

REVIEW OF RELATED LITERATURE

In what follows, a selective review of literature is presented in three subsections. The first subsection presents a description of the information processing paradigm of cognitive psychology. In it, particular attention is paid to the conception of mental processes and the way the information processing paradigm has influenced research on these processes. The second subsection presents a description of the information processing models of negation and falsification and the research which led up to the formation of these models. The third subsection presents a discussion of the cogntive processing of active, passive and reflexive verb forms from an information-processing perspective.

Cognition - An Information Processing Perspective

Information processing psychology is currently the dominant paradigm in the study of adult cognitive processes. Cognitive scientists, and especially those operating within the information processing paradigm, are especially interested in the functioning and representation of higher mental processes. They are committed to

experimental observational methods of science. They have defined their area of study as "the way man collects, stores, modifies, and interprets environmental information or information already stored internally." (Lachman, Lachman and Butterfield, 1979, p. 7). They are interested in knowing how man adds information to his permanent knowledge of the world, how he accesses it again, and how he uses his knowledge in every facet of human activity. Information processing cognitive psychologists believe that such "collection, storage, interpretation, understanding, and use of environmental or internal information is cognition" (Lachman, et al., 1979, p.7).

Information processing provides a new way of looking at people. The Freudian paradigm of psychology focused on the forces shaping personality. It saw innate instinctual drives clashing with societal demands and focused on the resulting emotional and mental devastation. The paradigm which viewed man as a conditioned responder whose behaviorial responses could be predicted on the basis of animal behavior has given way to one which emphasizes man's innate capabilities and his normal, rational learned behavior. The change in terminology from stimulus and response to input, processing and output conveys the information processing psychologist's concept of human cognitive functioning.

Though the information processing paradigm has a new

view of man, new emphases, and new vocabulary, it has retained aspects of old paradigms, (Lachman, et al., 1979, p. 35). Information processing psychology has rejected the view of man as a simple responder but it has retained behaviorial science's emphasis on controlled laboratory experimentation, the necessity of empirical proof and the desirability of theories of generalized human behavior. (Lachman, et al., 1979, p. 41).

From the field of verbal learning, information-processing psychology took a strong interest in memory, well established experimental techniques, sophisticated laboratory equipment and many excellent scientists interested in how man learns and uses language. From the practical application of psychology in World War II and its emphasis on man as part of a man-machine team, information processing psychology took a view of man as an information receiver-transmitter and decision maker. Finally, from the field of mathematics and computer science, information processing psychology developed the analogy of the computer to the mind. (Lachman, et al., 1979, p. 41). It is an analogy which has proven to be very fruitful.

The Computer Analogy --> Man as a Symbol Manipulator

Working in the field of meta mathematics, Turing (1936) developed the abstract idea of a "Universal Machine" which with very few properties and capabilities could perform any logical or mathematical procedure that could be

fully specified, (Lachman, et al., 1979, p. 88). It was conceived as a symbol manipulating machine. Newell, Shaw and Simon, (1958) promoted the idea that the mind might also be considered a general symbol manipulating system. This analogy of the computer, the realization of Turing's Universal Machine, to the mind provided cognitive psychologists with a new way of looking at cognition. If man's mind is a symbol-manipulating information processor, then cognitive processes can be described in precise, concrete mathematical terms. In order to understand these cognitive processes better, scientists have turned to questions related to how people take in information, how they recode and remember it, how they make decisions, how they transform their knowledge states and how these internal states are translated into behaviorial outputs, (Lachman, et al., 1979, p. 99).

The Computer Analogy --> Theoretical Ideas

The computer analogy was the basis for the following important pre-theoretical ideas (Lachman, et al., 1979, p.90):

1. Symbol Manipulation. As a symbol manipulator it is possible that man's intelligent behavior may be accounted for by a few basic computational operations.

2. Representation. Since symbols are representations of information, information from each of the senses must be represented in the mind in some form.

3. Systems Approach. Man, as an interrelated set of capacities, is a system.

4. Constructive/Creative Processes. Man as an active information seeker brings his own internal capacities to bear on input and actually creates new knowledge.

5. Innate Capacities. Behavior is considered to be the result of innate capacities interacting with learning.

6. Mental Chronometry and the Isolability of the Subsystem. The view that psychological events occur in time means that the measures of processing time can provide a way of knowing what is happening inside the head. Measures of reaction time are thus frequently used to determine the course of processing or to decouple subsystems for study.

7. Sufficiency Conditions. Information processing psychologists are looking for theories that hold, not just in the laboratory, but in normal everyday life. (Lachman, et al., 1979, p.90).

Computer Analogy --> New Terminology

Information processing has taken more than theoretical ideas from the computer analogy. Scientists continue to appropriate computer terminology to describe mental functions. Cognitive scientists talk not only about input, output, and processing, but about storage, retrieval buffer devices, executive control, and networks.

Computer Analogy --> Concepts of Cognitive Processing

Computer programming itself has also had an influence on cognitive psychology. Although computers actually perform very few operations (they can store a symbol, retrieve a symbol, compare two symbols and determine which is larger, replace a symbol with another and perform the basic arithmetic operations), these operations can be packaged into complex combinations to guide a rocket in outer space or teach a child how to read. In principal a computer can carry out any instruction its human programmer can specify exactly, every relevant variable being taken into account. The information-processing psychologist makes the assumption that there are relevant commonalities between people and computers by virtue of their corresponding symbol manipulating capacities; therefore, complex human behavior should be able to be broken down into relatively few symbol manipulating operations. Through studying computer programs, subroutines, algorithms, storage, conditional decision making, recursiveness (the ability to change its own instructions), and simulation, scientists become aware of the specificity required in each instruction and of the complexity of possible combinations. Computer processing thus provides keys to understanding man's own processing and computer simulations and flowcharts provide ways of expressing and thinking about these cognitive processes.

The impact of the computer on cognitive psychology has been profound. It has supplied methodology, theory and ways of expressing that theory, new research ideas, new ways of looking at problems, concepts, vocabulary for studying internal events and a concept of man as a complex symbol manipulator who operates with incredible efficiency (Lachman, et al., 1979).

Verification of Positive-Negative, True-False Sentences

Donders, a nineteenth century Dutch physiologist was one of the first to use reaction time to look at mental processes. In 1868 he discovered that a subject responded more quickly when there was only one signal and one response than when there was more than one signal and more than one response. He hypothesized that reaction time could be used to estimate the speed of internal processes. Using a subtraction method, he separated simple reaction time from response selection and stimulus categorization (In Kostner, 1969). Following Donders, reaction time studies were used by others to study perception, performance limits, memory, and other higher mental processes. One line of research dealt with the effects of negation or falseness and matching. Wason (1959) established that it takes longer to complete negative than positive sentences, and false sentences than true sentences. Since then a number of studies have been carried out to predict the exact

circumstances under which these differences in negation and falsification occur and to develop a model of cognitive processing which would conform to the differential latencies established (Carpenter and Just, 1975, 1976; Clark, 1969; Clark and Chase, 1972; Trabasso, Rollins and Shaughnessy, 1971; Hoosain, 1973).

Differential Verification Times Related to Cognitive Processing.

It takes longer to complete false and negative statements than true and affirmative statements.

Wason (1959) not only demonstrated that people take longer to respond to negative than to positive sentences, but he was the first to show that a statement can be affirmative or negative and in binary form be true or false, thus making four possible combinations: (1) an affirmative statement that is true (TA), (2) an affirmative statement that is false (FA), (3) a negative statement that is true (TN), and (4) a negative statement that is false (FN).

Wason's research made use of four circles of different colors. The subject was asked to complete statements about these circles. These statements sampled equally all of the above possible combinations. For the affirmative statements, the subject was asked to fill in the colors which would make a statement such as the following true (or false), "There is both _____ in

circle 3 and _____ in circle 4." For the negative statements, the person had to complete a statement such as "There is not both _____ in circle 3 and _____ in circle 4." so as to make the statement agree with the situation (TN) or conflict with the situation (FN). The mean times in seconds to complete the sentences under each condition were: TA, 8.99; FA, 11.09; TN, 12.58; and FN, 15.17. Truth and semantic form were additive in their effects. Further research by Wason (1961) substantiated these effects. In his 1961 study, Wason asked subjects to select a digit which made true (or false) an affirmative (or negative) statement. They had to fill in the blank, "_____ is (or is not) an even number," so as to make the statement true (or false). The means in seconds for each condition were: TA, 1.72; FA, 2.46; TN, 2.77; and FN, 3.37. Wason analyzed the cognitive operations for this task as follows:

1. If the predicate is negative, transform it (e.g., not even - odd).

2. Search memory for a digit belonging to the category specified by the predicate.

3. If instruction asks for a true statement, stop when number is located.

4. If instruction asks for a false statement, add or subtract one to the digit. An alternate strategy was possible and the lower than predicted mean time for the FN,

as well as an analysis of the individual protocols indicated that half of the subjects had adopted a strategy in which the subject had classified the digit directly and verified it against the predicates. In this way the FN can be contradicted directly and the TN's require a transformation.

Following the work of Wason, several investigators tried to pin down the causes and scope of negative and affirmative differences.

It takes longer to indentify members of an exclusion class than members of a positively identified class.

Sheila Jones (1966) investigated the effect of a qualifying negative on task performance. She had two groups of subjects perform a cancelling task on a list of digits, each group cancelling the same digits but under different instructions. The first group was instructed to mark numbers 3, 4, 7, & 8 while the second group was instructed to mark all the numbers except 1, 2, 5, & 6. The second group took longer to perform the task and made more false positive errors. The difficulty in following instructions given in terms of an exclusion class appeared to be the result of having to search for one group of items but having to respond to the other.

This supported the earlier findings of Wallach (1959) who had observed that his subjects preferred dealing with classes positively identified and would avoid

exclusion classes as if there were additional "mental strain" involved in dealing with them.

It takes longer to verify negative quantifiers than their affirmative forms.

Just and Carpenter (1971) compared the processing of three negative quantifiers, "none," "few" and "a minority of" and their affirmative forms. Subjects were shown a two color dot array and then asked to judge whether the sentence describing the array was true or false. The sentences which contained the syntactic negatives such as "none" and "few" were processed differently than the sentences containing the semantic negative "a minority of" and all three negatives were processed more slowly than their affirmative forms, "all," "many," and "a majority of." A difference in the coding of the subsets accounted for the difference between the semantic and syntactic negatives. This was judged not only on the basis of verification latencies but also on the basis of eye movements (Carpenter & Just,1972).

It takes longer to verify presuppositions in sentences with a negative main verb.

Just and Clark (1973) used latency verification times to investigate the effect of affirmative and negative main clauses on the presuppositions and implications of sentences. In the following example from their study it can be seen that the presuppositions of the sentence remain

unchanged when the predicate is made negative and the implication also becomes negative.

Affirmative Form

Sentence: John managed to find his hat.
Presupposition: John tried to find his hat.
Implication: John found his hat.

Negative Form

Sentence: John didn't manage to find his hat.
Presupposition: John tried to find his hat.
Implication: John didn't find his hat.
(Just and Clark, 1973, p. 19)

The hypothesis in this study was that the subject could access the presuppositions and implications independently of each other and since the presupposition remained unchanged in the negative sentence, it would be unaffected by changing the predicate to negative. The hypothesis was rejected. Even though the presupposition remained unchanged, its verification time increased when the main verb was made negative. Thus Just and Clark were led to conclude that the subject scans the implications of the sentence before the presuppositions. It is possible to see from this how the latency verification time has become a powerful tool for analyzing cognitive processes.

<u>It takes longer to verify false statements than true and negative than positive.</u>

Gough (1966) conducted experiments to explore the relationship between the syntactic structure of a sentence and its verification. Subjects heard a sentence. This was followed by a three second delay and then a picture was

presented. The subject was to decide as rapidly as possible whether the picture confirmed or disconfirmed the sentence. The 128 sentences were constructed to sample active-passive, affirmative-negative, and true-false. Gough had assumed that the three second delay would permit subjects to transform the sentences to simple structure (active-affirmative) and therefore there would be no differences in latencies between the sentences. This was not the case, however. Instead, active sentences were verified faster than passive, and positive statements were verified faster than negative. In this instance, even though given time to transform their sentences to simple, active, affirmative, the subjects did not do so. Gough's explanation for the fact that positive sentences took less time to verify than negatives was that it evidently is easier to decide that two things match than to decide that they do not match. When the sentence was negative, the subject had to reverse his decision and this took longer.

It takes longer to answer "Are they different?" than "Are they the same?"

Seymour (1969) investigated various hypotheses related to matching words (circle, triangle, rectangle) with pictures of the shapes. As one part of the study, he found that when subjects were asked to judge word-shape pairs for congruence, there was a significant difference in response time when they were asked to respond "yes" or "no"

to the questions "Are they the same?" or "Are they different?" The mean response times to "Are they the same?" were 650 - 750 ms. The mean response times to "Are they different?" were 800 - 920 ms.

It takes longer to decide that two things do not match than to decide that they do match.

Chase and Clark, (1972; Clark, 1969) carried out several sentence-pictue verification tasks in which the subject had to decide whether the sentence matched the picture. Sentences were of the type:

"Plus is (not) above star. ($\begin{smallmatrix}+\\*\end{smallmatrix}$)"

"Star is (not) below plus. ($\begin{smallmatrix}*\\+\end{smallmatrix}$)"

When the sentences matched the pictures, verification times were shorter than when they did not. Order of presentation of the sentences and pictures was varied in the experiment. When the sentences and pictures were presented simultaneously the ordering of verification times was TA < FA < FN < TN (Clark, 1969; Chase & Clark, 1972). The ordering of the verification times was explainable on the basis of matching or congruence. The finding that it takes less time to decide that two things match than that they do not match has been found by many investigators (Gough, 1966; Trabasso, et al., 1972; Wallach, 1959; Carpenter and Just, 1975).

Models of Cognitive Processing

The Chase and Clark Model.

Clark and Chase (1972) proposed a processing model based on principles of congruence which accounted for the ordering and verification time of the results of their experiments with the sentences "Plus is (not) above star," and "Star is (not) below plus." The model proposed by Clark and Chase had four stages and each stage could contain one or more mental operations. In stage one, sentences had to be represented in the mind in terms of elementary propositions. Stage two involved the encoding of the picture in the "same interpretive format" (Clark and Chase, 1972, p.472). The first and second stages were postulated on the logical basis that two things to be compared must be in a similar format. Stage three consisted of a comparison of the two codes in a series of mental operations that contributed additively to the verification latencies. Stage four consisted of the output of the final response. Table 1 presents the stages, mental operations and result for the verification of the sentence "Star is above plus." when the picture was a star below the plus.

Table 1

Mental Operations and Stages in Sentence Verification

MENTAL OPERATION	RESULT
Stage 1: Represent the sentence. (Star is above plus).	Above (*,+)
Stage 2: Represent the picture. (Star below plus).	Above (+,*)
Stage 3: Compare the two representations.	
Rule 0: Set Truth Index at true.	Truth Index = True
Rule 1: If 1 does not match 2, change Truth Index to its opposite.	Truth Index= False
Stage 4: Respond with final value of the TruthIndex.	Press "false" button

(modified from Clark & Clark, 1977, pg. 103)

The Trabasso, Rollins and Shaughnessy Model.

Trabasso, Rollins and Shaughnessy, (1971) added to the growing body of information on stages in the cognitive processing of negation with a series of 10 studies and a theoretical model similar to that of Clark and Chase. Trabasso, Rollins and Shaughnessy (1971) were interested in separating storage and verification stages. They used the verification of concept instances to determine under what circumstances transformation from negative to positive occurred and how negative instances affected processing time. In one study they were able to separate storage and verification time for processing simple sentences and

and verification time for processing simple sentences and were able to demonstrate that when subjects verified affirmative descriptions of colored cards more rapidly than negative, the latency differential occurred in the verification stage, not in the storage stage. In another study under a binary choice condition, there was evidence that subjects transferred negative values to positive values during the storage stage. Thus the binary condition made it possible for the subjects to adopt a strategy which permitted a trade off between the storage and the verification times. This of course was not possible under the four color condition where the "not _____" description had to be held in mind.

In several of the studies, the description was presented to the subject before the picture, and time for transforming negative descriptions to positive descriptions resulted in verification times in the following order: TA < FA < TN < FN. In one experiment of Trabasso, Rollins and Schaughnessy (1971), where the picture was presented before the description, there was a reversal of the times for TN and FN. This they accounted for on the basis of the fact that when the picture was presented first, the TN sentences involved two additional operations (mismatch of feature and a transformation) while the FN's required only one, (change of response due to the negative indicator).

The model of cognitive processing and storage

verification proposed by Trabasso, Rollins and Shaughnessy (1971) is similar to that developed independently by Chase and Clark (Clark, 1969; Clark and Chase, 1972). It also is based upon coding and matching operations which occur serially and are either self-terminating at the point of "match" or exhaustive depending upon the structure of the concept. During the coding operations, the person tries to represent input in an affirmative form since this allows "direct search and compare operations on features and events in the real world," (Trabasso, et al., 1971, p. 280).

Trabasso, Rollins & Shaughnessy describe the operation of their model as follows:

> The S begins by coding the features of the first input. Negative inputs are represented by features plus a negative indicator. If the values are binary, the S may transform into the affirmative complement. Then he codes the second input so that its features may be matched against those of the first input. The S is set to match identical codes so that responses such as TRUE or SAME are primed. If a mismatch occurs, he engages in other activity such as rechecking features and resetting his response to FALSE or DIFFERENT. Then a final check on negation is made. If one negation is present, the response dictated by the matching outcome is changed. If both codes are affirmative or negated, then no response change is made (Trabasso, et al., 1971, p. 280).

According to the above model, the operations occur serially, but some comparisons have a longer duration than others. The total latency is the result of the sum of the times required for the comparisons.

The Just and Carpenter Model.

Just and Carpenter (1971; Just and Clark, 1973; Carpenter and Just, 1975) have used sentence verification to investigate many aspects of negation and falsification and have developed a model based on their research and the research of others. In their 1971 sentence verification study, (Just and Carpenter, 1971) the subject was shown an array of either all red dots or all black dots and then a sentence such as, "The dots are red" or "The dots aren't red." The subject was timed while he decided if the sentence was true or false. On any one trial the statement could be affirmative or negative and it could also be true or false. As in other studies (Wason and Jones, 1963; Trabasso, et al., 1971; Chase and Clark, 1972), true affirmatives were verified faster than false affirmatives and false negatives than true negatives (TA < FA < FN < TN). In their preliminary analysis of this study, Carpenter and Just made use of Clark's congruence model which states that true affirmatives are easier to process than false affirmatives and false negatives than true negatives because of their greater similarity. However, after reviewing the data from the 1971 study, Carpenter and Just (1975) developed a cognitive model of their own which differed in important ways from the models of Chase and Clark, and Trabasso, Rollins and Schaughnessy.

Carpenter and Just separated the latency time into two components. They termed the extra time involved in a

color mismatch "falsification time" and the "difference in latencies between negative and affirmative sentences" they called "negation time," (Carpenter and Just, 1975, p. 46). Falsification time dealt with whether the predicates of the sentence and picture mismatched; negation time dealt with whether the polarity markers mismatched. The two together accounted for verification latencies. In examining the data from their own and others' experiments, Just and Carpenter discovered a persistent relationship between the values of the two parameters. Negation was either 2 or 4 times greater than falsification time. This led them to postulate that both negation and falsification parameters were being determined by a single cognitive operation which was being repeated. Therefore, the reaction time was additive and directly proportional to the number of times the cognitive operation was repeated. This theory led to the development of their "constituent comparison model," (Carpenter and Just, 1975). As on earlier models of sentence verification, (Trabasso, et al., 1971; Clark and Chase, 1972; Anderson and Bower, 1973), Carpenter and Just made the assumption that verbal and visual input had to be represented in some similar form before comparison could take place. The assumption that the two representatives had to be similar was made on the basis of logic. That the representation of information, or encoding, was not part of the comparison process had been established by Trabasso

Rollins, and Shaughnessy (1971). They had separated the encoding and comparison stages by prolonging first one stage and then the other by changes in task requirements.

A second assumption of Just and Carpenter was that the internal representations of both visual and verbal input were in abstract propositional form. Propositions, the smallest meaningful units that can be verified, are relational units composed of a predicate and one or more arguments. Parentheses are used to denote the predicate argument so the representation of the sentence, "The dots are red" in the Just and Carpenter study, (1971) would be (red dots) or [aff,(red dots)]. The negative sentence "The dots are not red" would be represented [neg,(red dots)]. A picture of red dots could also be encoded either (red dots) or [aff,(red dots)], since propositions are assumed to be affirmative unless otherwise marked. Carpenter and Just assumed that once the two propositions had been put into similar propositional form, they could then be compared.

The main focus of the Carpenter and Just model (1975) is on the operations that compare the sentence and picture representations (Just and Carpenter, 1975). The corresponding constituents from the two representations are retrieved and compared, pair by pair. The number of these find and compare operations is assumed to be the primary determinant of the pattern of verbal latencies. The propositional structure and embeddings provide the order or

sequence in which propositions are compared. The inner propositions are compared first and then the positive-negative markers. Pictures are generally encoded affirmatively and the absence of a marker in either picture or sentence is interpreted as affirmative. The affirmativeness of all statements not specifically marked negative is a language universal (Greenberg, 1966).

According to the model the find and compare operations are serial and iterative. When two corresponding constituents are compared and do not match, they are tagged and the truth index changed. On following comparisons they are then treated as a match. Each mismatch causes the process to reinitialize. (See Appendix A, Figure 1 for details). The total number of comparisons, and, therefore, the total latency, increases with each mismatch. A mismatch that occurs late in the process results in more recomparisons than one occurring earlier in the process. In this way, the total latency is a function of both the number of mismatches and their location in the sentence.

The goal of the comparison process is to compute a "truth index" that will result in the right decision (Clark and Clark, 1977, p. 103). People start with the truth index set at true. If the two representations match in every respect, the truth index is left unchanged. If there is a mismatch, the truth index is changed to false, (Clark

and Clark, 1977, p. 103), and the constituents tagged. A second mismatch would cause the truth index to change from false to true and those constituents would be tagged and the comparison started again until all constituents matched (Just and Carpenter, 1975). The final stage of the verification model is the response indicating the final value of the truth index (Clark and Clark, 1977, p. 103).

The model postulates that verification latencies are a direct function of the number of comparisons. The single parameter is based on the time to find and compare a single pair of constituents. The true affirmative sentence involved k comparisons, the false affirmative, k+1; the false negative, k+2; and the true negative, k+3; (Carpenter and Just, 1975).

Analyzing their 1971 study according to this model, Just and Carpenter found that with each additional comparison there was a linear increase in latency. There was a slope of 215 ms per constituent comparison and the model accounted for 98% of the variance.

A more rigorous sentence verification study was undertaken by Carpenter and Just (1975). The purpose was to vary the scope of the negative (i.e., the number of constituents to which it would apply). The sentences from their 1971 study were embedded in superordinate clauses. The affirmative "It's true that the dots are red can be negated in two ways. First, "It's true the dots aren't

red," (negative predicate, small scope) and second, "It's not true the dots are red," (denial, large scope). The first of these sentences (Just and Carpenter, 1975) described as predicate negation. In the second sentence, the negative in the superordinate clause negates the whole inner clause and is large in scope. This type of negation Just and Carpenter referred to as "denial". The representation of the two kinds of sentences would also be different. "Its true the dots aren't red" would be represented [neg,(red dots)] while "It isn't true the dots are red" would be represented {neg,[aff,(red dots)]}. The predicted number of constituent comparisons based on their model were:

Sentence Type	Number of Comparisons
True Affirmative (TA)	k
False Affirmative (FA)	k+1
False Negative (FN)	k+2
True Negative (TN)	k+3
False Denial (FD)	k+4
True Denial (TD)	k+5

The representations for the six conditions appear in Appendix A. The means of the latencies for each condition increased with the hypothesized number of constituent comparisons an average of 200 ms per condition. The newly developed model accounted for 97.7% of the variance in this study.

Just and Carpenter followed up the above study with a second in which there was a two second delay between the presentation of the sentence and the picture. This allowed

time for reading and representation. There was no significant difference between the slopes in the two experiments and the model accounted for 97.9% of the variance. The results indicated that reading and representation time is a negligible component of the estimated time per operation. Practice has the effect of making verification time faster, but it does not change the slope (Carpenter and Just, 1975).

While the model of Chase and Clark, (1972) and that of Trabasso, Rollins and Shaughnessy (1971) are similar to the model of Just and Carpenter in some respects, they are different in that the former assume different kinds of operations for different comparisons. They also attribute some of the negation time to additional time needed for reading and encoding a negative. The most convincing argument for the Just and Carpenter constituent comparison model is related to the difference found in verification times between predicate negatives and denials. If one compares the two sentences, "It's true that the dots are not red," and "It's not true that the dots are red," one sees that both sentences contain "not." Both are negative and both contain exactly the same number of words. Yet the denial takes twice as long to verify. The Chase and Clark model does not account for this. (Carpenter and Just, 1975; Clark and Clark, 1977).

In the second investigation of Just and Carpenter

there was a reversal of verification times between true and false predicate negatives after the first set. The true predicate negatives were verified faster after practice than the false. Several other studies have also shown that under picture first conditions some subjects recode negative sentences to affirmative (Carpenter, 1973; Trabasso, 1972; Trabasso, et al., 1971), and in these instances the verification latencies for true predicate negatives and false predicate negatives are reversed. The Just and Carpenter constituent comparison model accounts for these differences on the basis of the number of comparisons plus the recoding time.

Just and Carpenter applied their model to the results of earlier sentence verification studies (Wason, 1959; Clark and Chase, 1972; Gough, 1965, 1966; Wason and Jones, 1963). These are described in Just and Carpenter's (1975) article on "A Psycholinguistic Processing Model of Verification." Their analysis showed that though the mean times differed due to sentence complexity and practice effects, the ratios and linear relationships were remarkable consistent with the predictions of their model.

Just and Carpenter (1975) replicated their embedded sentence study with native Chinese speakers drawn from staff and students at Carnegie-Mellon University. In this study, using sentences written in Chinese characters, the latencies showed an average increase of 210 ms per

constituent comparison and the predictions made from the model accounted for 91.8% of the variance. The linearity of the measures in Chinese where the negatives are expressed somewhat differently than in English, indicates that the internal representations of information are relatively independent of the surface structure. It also lends weight to the idea that the cognitive processes involved are not dependent upon particular linguistic characteristics.

The Just and Carpenter (1975) model may not apply equally to all sentence verification tasks or all subjects. In a recent study by MacLeod, Hunt and Mathews (1978), seventy university undergraduates verified sentence-picture pairs of the type used by Chase and Clark (1972), i.e., "Plus is above star" or "Star is not above plus." Each individual's results were analyzed according to goodness of fit to the Carpenter and Just constituent comparison model (Carpenter and Just, 1975). The group was then divided into three subgroups: (1) the 43 subjects who were well fit by the model, (2) the 11 subjects who were of intermediate fit, and (3) the 16 subjects who were poorly fit by the model. The reaction time pattern of the poorly fit group suggested a pictorial-spatial strategy. The subjects using the pictorial-spatial strategy had previously scored markedly higher on tests of spatial ability and their choice of that strategy was predictable from psychometric

measures of cognitive abilities. It seems that in some instances a linguistic model and a pictorial model are needed to account for the processing and representation of data in memory.

The fact, however, that the Carpenter and Just (1975) model accounted for the 97.8% of the variance of the well fit group and that the well fit group was the largest group confirms the usefulness of this model in understanding the cognitive processes in the verification of positive-negative, true-false sentences.

Verification of Active and Passive Sentences

A second important line of research was initiated when, in the late 50's, Chomsky (1957) developed his ideas of transformational grammar. He felt that complex sentences are derived from "fundamental sentences" (simple, active, affirmative, declarative sentences). He thought that more complicated sentences were derived from the fundamental sentences by the application of rules which permit the expression of the kernel sentence as an interrogative, a negative, a passive, or a combination of these. Chomsky's ideas influenced linguists and cognitive psychologists in their study of language acquistion and comprehension, and in their interpretation of their research.

Mehler (1963) in studying sentence recall found that

the kernel sentences were recalled significantly more often and with fewer errors than negatives, passives, or interrogatives. He postulated that the kernel sentences are stored in memory with some kind of tag indicating negativeness, passiveness, or interrogativeness.

Miller and McKean (1964) found that transforming actives to passives required more time than the transforming of actives to negatives. Other researchers found that passive sentences are more difficult to comprehend and generate and the ability to code a picture in passive is developmentally later than the ability to code it in English (Turner and Rommetveit, 1967).

In sentence verification studies, Gough (1965) and Slobin (1966) found that not only were positive sentences verified more rapidly than negative, but that active sentences were verified more rapidly than passive. This had been predicted on the basis of the "decoding hypothesis" which assumed that when a person heard a complex sentence he had to undo the transformation to comprehend the kernel sentence (Gough, 1965; Miller, 1962).

In Gough's (1965) study, subjects had been read a sentence and then shown a picture that confirmed or disconfirmed the sentence. The subject was timed from the appearance of the picture to the pressing of the decision button, As mentioned, active sentences were verified significantly more rapidly than passives. However, since

the passive sentences had been longer than the active sentences, Gough (1966) carried out another study in which he compared the active ("The girl hit the boy"), not with the passive ("The girl was hit by the boy"), but with the truncated passive which omits the agent ("The girl was hit"). The passive sentences still took longer to verify than the active. In still another study Gough (1966) had the sentence read to the subject and after a three second delay the picture was presented. The delay was long enough for subjects to transform passive sentences to active and negative sentences to positive. It was hypothesized that following such transformation, the verification time for all sentences would be equal. Active sentences, however, were still verified faster than passive and positive sentences faster than negative. Gough interpreted this to mean that complex sentences are not transformed immediately to their underlying structure but are held in short term memory and processed in their surface structure form. Gough also theorized that the difference could not be one of speed of understanding, since the three second delay allowed for this. (Gough, 1966). Gough attributed the fact that passive sentences took longer to verify to the less familiar order of the passive sentence and to the fact that the initial scan of the sentence had to pass up the first object to reach the subject.

The nature of the active - passive difference has

been the subject of other studies. It is inherently different from the true-false or positive-negative difference for the latter two pairs are opposite in meaning while the active and passive forms of the same kernel sentence can be regarded as essentially redundant. Either may be used to represent a situation. (Tannenbaum and Williams, 1968). Passives occur more frequently in written English than in spoken English (Hasegawa, 1968). A study by File and Jew (1973) sought to determine if there was a differential effect associated with the use of the passive in written or in spoken English. The investigation was carried out in a natural situation. Airline passengers were given emergency landing instructions either visually or auditorily and in four forms: active affirmative, active negative, passive affirmative or passive negative. Subjects were then asked to write down what they could remember of the instructions. There were very few errors so the variable of interest was the number of instructions recalled and the form in which they were recalled. Contrary to expectations, there was no difference in recall between passive sentences presented auditorily and those presented visually. Active affirmative sentences were recalled in their original form. Instructions given in passive or negative form were frequently recalled in active affirmative with more transformations being made from the passive than from the negative.

Tannenbaum and Williams (1968) believed that the active-passive difference was not just a stylistic one but a subtle functional difference, a difference of focus. In English, the main focus in on the first noun in the sentence. In an active sentence, the main focus is on the subject, but in a passive sentence shifting the logical object to the first part of the sentence shifts the focus to it. Tannenbaum and Williams (1968) carried out a study in which subjects were required to generate an active and a passive sentence to a stimulus picture. When instructions were used to place the conceptual focus on the subject, active sentences were generated more rapidly than passives with an average latency difference of 2 seconds. When the instructions focused attention on the object, active sentences were still generated more rapidly than passives but the average latency difference was only .5 seconds. The conclusion reached was that when attention is on the acted-upon subject (the logical object), the passive voice form may rise in the hierarchy of possible responses. (Tannenbaum and Williams, 1968). Johnson-Laird (1968) also found that the passive voice was used to place emphasis on the logical object of the sentence.

A study by Wright (1969) found that the ease of answering a question about a previously read sentence was related to the surface structure of the sentence and of the question. A passive question was more easily answered

about a passive sentence and an active question more easily answered about an active sentence. This would not only indicate that in some circumstances passive sentences are as easy to use as active sentences, but it also is in line with Gough's findings that passive sentences need not be converted to deep structure but may be responded to directly.

Olson and Filby (1972) did a series of five experiments on the ease of processing active and passive sentences. The first three experiments were picture-sentence verification tasks using sketches of a car and truck. The focus was manipulated from one object to the other. Sentences were of the type, "The truck hit the car," "The car was hit by the truck," "The car hit the truck," and "The truck was hit by the car." In the first two experiments the focus was manipulated through instructions such as, "Notice the vehicle coming down the hill," or "Notice the vehicle on the left." In the third experiment the focus was manipulated through a series of pictures which depicted the action. Overall, passive sentences took longer to verify than active, and false took longer than true. However, as predicted, when the picture coding was passive, passive sentences were verified somewhat faster than actives. Olson speculated that the reason the passives under the passive picture coding condition were not verified as rapidly as the actives under

active picture coding was due to a longer time needed to assign the passive coding, a longer time needed to read the passive sentences, or a longer processing time. Each of these operations, singly or in combination, could be affected by subjects' lack of familiarity with the passive form. Nonetheless, the fact that passive sentences under passive picture coding were verified as rapidly as actives under passive coding led him to conclude that (a) comprehension of the passive does not involve transferring it to the active base sentence, (b) "passive sentences are not invariably more difficult to comprehend than active sentences, and (c) the short term memory code appears to retain the untransformed surface structure word order," (Olson and Filby, 1972, p. 369).

Olson and Filby's (1972) fourth experiment used active and passive sentences to describe the car or truck hitting (or being hit by) the car or truck. The subject then answered questions about "Who hit?" or "Who was hit?" The answers "truck" and "car" were keyed to two telegraph keys. Answering the passive question "Who was hit?" took longer than answering "Who hit?" Olson and Filby's (1972) 5th experiment was the same as the 4th except that the questions were presented visually. Again passive questions took longer to answer than active. These last two studies indicate that it takes longer to identify the object of the action in a picture than the actor even when the subject is

set to look for it. This may mean that in picture-sentence verification tasks, an additional factor, passive picture coding, must be taken into account (Olson and Filby, 1972).

Another factor which has been found to affect comprehension and verification of passive sentences is reversibility, (i.e., whether the subject and object can logically be in either position). A reversible sentence would be, "The girl was kicked by the boy." Its reversed form, "The boy was kicked by the girl" is semantically correct. A non-reversible sentence "the meat was eaten by the dog," would be contrary to life experiences if it were to be reversed to "The dog was eaten by the meat." Passive sentences in which the subject and object may be reversed take longer for both adults and children to verify, (Slobin, 1966). Such reversible sentences have been shown to be harder for children to imitate, comprehend and produce, (Turner and Rommetveit, 1967). Herriot (1969) had subjects extract the sentence subject from active and passive, reversible and nonreversible sentences and found that expectancy effects, or probability cues based on life experiences were a stronger factor than voice in picking out the logical subject and logical object. Semantic voice cues were used only when expectancy cues did not suffice, as in the reversible sentences.

Jill Wannamacher (1974) in a picture verification study analyzed active and passive sentences, and

reversible and nonreversible sentences. Consideration was also given to the location of the mismatch in false sentences. Sentences were presented auditorily and followed by the presentation of the picture. False sentences were analyzed according to the point of mismatch and true sentences were assumed to have been verified at all points. In the active sentences, the point of mismatch could occur at the subject, the verb, or the object, and in passive sentences at the logical object, the verb, and the logical subject. Assuming that comparisons were done in order and on the sentence in its surface structure format, the first comparison would be on the first noun in the sentence (the subject in the active sentence and the logical object in the passive sentence), the second comparison would be on the verb and the third comparison would be on the second noun (the object in the active sentence and the logical subject in the passive). Verification times confirmed serial matching on surface structure. Mean verification times for mismatches involving the first noun averaged 514 to 767 ms. Mismatches involving the verb averaged 1388 to 1721 ms, and mismatches involving the third position averaged 1836 to 2378 ms. True sentences required matching at all three points and averaged 1657 to 2218 ms. Thus the point of mismatch had a significant effect on verification time.

Reversibility and voice also had an effect for there

was a significant difference between sentence types to the point of first mismatch. Active non-reversible sentence had a mean verification time of 514 ms, passive non-reversible sentences, a mean verification time of 753 ms, active reversible sentences had a mean verification time of 750 ms, and passive reversible sentences had a mean verification time of 767 ms. Comparable differences occurred at each point of mismatch.

In a second experiment by Wannamacher (1974), the pictures and auditory sentences were presented simultaneously. This resulted in an average increase of 175 ms for sentences that were false at the first point of mismatch. This difference in time was attributed to picture encoding time. While the mean verification time to mismatches at the first noun was 175 ms longer than in the previous experiment, the increases were greater for some sentence conditions than for others. The mean increases by sentence type to the first mismatch were: active reversible 206 ms, passive reversible, 200 ms, active nonreversible, 113 and passive nonreversible, 70 ms. Thus the reversible sentences required more time for encoding as well as more time for verification. Wannamacher felt that this additional verification time for reversible sentences in the encoding stage might be evidence of a second differential factor in the processing of reversible sentences. The mean verification latencies to the verb

mismatch, to the second noun mismatch, and for true sentences remained the same as in the first experiment. Wannamacher interpreted the fact that latencies were extended on only the latencies to first noun mismatch to mean that simultaneous processing was occurring. The picture encoding and comparison processes were being carried on at the same time and the effects were not additive after the first mismatch point.

Wannamacher proposed that the information processing sequence of verification could best be thought of as a loop consisting of an encoding, a comparison, and a response decision stage applied to each sentence constituent. The constituents were matched in the order they occurred in the sentence (Wannamacher, 1974. p.559).

A study carried out by Glucksberg, Trabasso, and Wald (1973) in the same year as Wannamacher's study used a similar mismatch procedure except the sentences were presented visually. Quite different results were obtained. Passive sentences were not processed in the surface structure format and the comparison process was not initiated until after the entire sentence had been encoded.

In summary, while the research on active-passive sentences usually finds passive sentences take longer to verify than actives, there may be several variables which interact to cause this observed difference: surface structure vs. deep structure encoding, reversibility vs.

nonreversibility of the subject and object, point of mismatch on false sentences, conceptual focus of the picture or situation, unfamiliarity with the passive voice, appropriateness of the passive voice, and auditory vs. visual presentation of the sentence.

The present study seeks to determine whether the differential verification latencies for active and passive sentences found in many of the studies mentioned will occur in a sentence verification task in Spanish.

In Spanish, as in English, the passive voice is used much less frequently than the active, and the passive voice appears more frequently in written language than in spoken language. In Spanish, however, the active-passive difference is bridged by various verb forms known as "false passives," "medio passives," and "reflexives." This latter class is the subject of considerable controversy among linguists. Some linguists say the reflexives are passive forms, (Green, 1975; Sabatini, 1977), others say they are actives with an accusative subject (Suner, 1974) and still others say reflexives are clitic verb forms (Babcock, 1970).

According to Green, "There is no foolproof formal-syntactic or semantic criterion which will permit a watertight partition of Spanish reflexives into 'true reflexives' and 'passive equivalents'" (Green, 1975, p. 347).

The official position of the Royal Academy (Bello, 1928, Real Academia Espanola, cited in Suner, 1976; 1931 cited in Green, 1975) is that true passives are those using the two verbs "to be" (ser and estar) plus the past participle and the reflexive verbs which may be considered as substitutes for the true passives are those in which there is an inanimate subject incapable of performing the action of the verb, as in, la comida se sirva a mediodia (the meal is served at noon). In a frequencey count of passive and passive substitute constructions in written material, Green (1975) found that over half of the reflexive verb forms were used with an inanimate subject. Though some linguists would disagree, the dominant and traditional view seems to be that both historically and semantically, the reflexive occupies a position between the true passive and the active verb forms.

It is hypothesized in Experiment II of this investigation that active sentences will be verified more rapidly than reflexive sentences and reflexive sentences more rapidly than passive.

Careful control of sentence length and the elimination of reversible sentences will make it possible to determine if the differential exists as a function of the use of the passive and reflexive voice. Point of mismatch on false sentences will also be analyzed for conformity to a point-of-mismatch model of processing.

Recapitulation

The information processing paradigm of psychology has had as its primary focus the understanding of man's higher mental processes. It has borrowed heavily from past paradigms and from the concept of man as a symbol manipulator (Newel, 1972) and information processor. As a symbol manipulator, man's complex mental operations may be describable in terms of combinations and repetitions of comparatively few basic operations. As an information processer, man takes in information, stores it, accesses it, manipulates it and creates new information.

The idea that mental operations take place in measurable units of time gave rise to research designed to study mental processes through reaction time measures. The early experiments of Donders in 1869 (In Kostner, 1969) showed that response time to a signal varied with the number of possible responses and the number of signals. This led to a great deal of research on choice reaction time, memory, and perception. Wason (1959), in attempting to have subjects complete sentences from memory, discovered that it took longer to complete negative than positive sentences and false statements than true. This differential processing time associated with negation and falsification has been confirmed by many investigators (Chase and Clark, 1972; Trabasso, et al., 1971; Just and Carpenter, 1971; Carpenter and Just, 1975).

Because the sentence verification task is so similar to real life experiences in which people judge whether facts are or are not true in relation to reality, or their perception of reality, the sentence verification task has become an important tool for looking at cognitive processes. Simple sentences can be used to study how the mind takes in information, searches memory, verifies information from more than one sensory modality, perceives a stimulus, or focuses attention. Through variations in the task, varying one part of the task while holding another constant, or determining verification times for separate stages, information processing psychologists have been able to decouple processes and gain information about one stage of processing or another. Knowing verification times for various processes and knowing that certain elements such as falsification, negation and mismatches add to verification time has led to the development of numerous models of processing based on that information (Trabasso, et al., 1971; Wannamacher, 1974; Carpenter and Just, 1975; Clark and Clark, 1977).

The Carpenter and Just (1975) model based on comparing sentence constituents through a serial, iterative, process with only one parameter, the time to find and compare one pair of constituents, accounted for an exceptionally high percentage of the variance in many sentence verification studies involving falsification or

some form of negation. (Carpenter and Just, 1975; Shoben, 1978). Developing in parallel with the body of information related to falsification and negation has been a body of research related to differential verification times for active and passive sentences. The active-passive difference is not one of opposites for essentially they are different ways of saying the same thing. The factors responsible for the additional time needed to verify a passive sentence have been the subject of several stassive difference is not one of opposites for essentially they are different ways of saying the same thing. The factors responsible for the additional time needed to verify a passive sentence have been the subject of several studies. The research of Gough (1966) indicated that it was not due to time spent in transforming the passive sentence to the active, nor was it due to the longer length of the passive sentence. He hypothesized that it might be due to the fact that the first noun must be passed over to reach the logical subject.

Reversibility adds to the verification time of passive sentences. Shift in attentional focus to the logical object permits passive sentences to be verified as rapidly as active sentences but not as rapidly as active sentences when the focus of attention is on the logical subject. Under certain conditions, the active-passive difference seems almost to disappear.

The present study, through continuing the research in these two parallel lines of study, was designed to add information to what is already known about the cognitive processing of (a) negation and falsification and (b) active and passive sentences. Utilizing a sentence verification task conducted in Spanish, it is expected that differential verification latencies related to negation and falsification will be documented. This would indicate that underlying cognitive processes are responsible for the verification latencies since they are consistent across a language boundry and are not affected by changes in surface structure. Although differential latencies conforming to the Carpenter and Just (1975) constituent comparison model would not prove that model true, it would indicate that the model provides a reasonable explanation for the negation and falsification latencies. The present study also was designed to determine if the differential verification latencies found in English for the active and passive voice will be found in Spanish. In addition, the investigator seeks to determine if the reflexive mode will be processed as some linguists say it functions, that is, in an intermediate position between active and passive verbs. Differential verification times for sentences in the active, passive and reflexive voice would indicate that this difference is due to more than surface structure variations. Differential latencies to the point of

mismatch in false sentences would also indicate whether passives are processed in passive surface structure form and whether the matching of constituents is the primary source of differential verification times.

CHAPTER III

METHOD

Experiment I

HYPOTHESES:

The following null hypotheses were tested in Experiment I:

I. There are no significant differences among the means of the verification latencies across the following sentence conditions: true affirmative (TA), false affirmative (FA), false negative (FN), true negative (TN), false denial (FD), and true denial (TD).

II. There is no linear increase in mean verification times with the increase in the number of comparisons hypothesized by the Just and Carpenter (1975) sentence verification model (k, k+1, k+2, k+3, k+4, k+5).

III. There is no correlation between the means of the error rates across sentence conditions and the means of the verification times across sentence conditions (k, k+1, k+2, k+3, k+4, k+5).

It is predicted that null Hypothesis I will be rejected and that there will be a significant difference between mean verification latencies for the sentence types TA, FA, FN, TN, FD, and TD. In addition, it is predicted that Hypothesis II will be rejected and that mean latencies per sentence type will increase linearly with the number of hypothesized comparisons, (Just and Carpenter, 1975). The

latency increase per comparison should be close to the 210 ms found in the Carpenter and Just (1975) study since (a) the Spanish sentences will be close to the same length as the English sentences, (b) the reading ease is approximately the same, and (c) the amount of practice permitted will be the same. If the verification latencies in Spanish conform to the Just and Carpenter model (1975) it will add to the evidence that the differential latencies are relatively independent of surface structure. The longer verification times found for falsification, predicate negation and large scope negation are therefore more likely the result of universal cognitive processes. If null Hypothesis II is not rejected, however, it would indicate that sentences containing negation and falsification may require more processing time in some languages than in others or in some situations than others. Finally, it is predicted that null Hypothesis III will be rejected. This would indicate that the processing of true affirmative sentences is easier than false affirmative sentences, and that the number of additional comparisons made necessary by negation, large scope negation and falsification all add to the difficulty in processing sentences. However, if Hypothesis III is not rejected, it would indicate that the difficulty in processing false and negative sentences is dependent upon the situation and requires further study as to the circumstances under which

it is found.

Exprimental Setting: El Centro Escolar Venustiano Caranzo, a Secondary school in Tehuacan, Mexico. Tehuacan is located 200 miles south of Mexico City, approximately 700 miles south of the United States-Mexican border. It is an urban community of approximately 30,000.

Schools in Mexico may be religious, private, public (city) or public (state). El Centro Escolar Venustiano Caranzo, appeared to be a well run school, administered by the state of Puebla. It has a morning student body of 650, an afternoon student body of 470 and a night school student body of 275. The director granted permission for the 11th year students of the morning school to participate in the study when teachers permitted their absence from class or during afternoon hours when their school was not in session. The experiment was conducted in a room equipped with the necessary tables, chairs and electrical outlets. Unfortunately, the room was not distraction free. The heat prevented closing the window and some students lined up outside the window to see what was going on inside. Outside conversation, marching bands, and playground drills appeared to be a problem for some students. Very long verification times due to students talking to friends outside the window, or to interruptions of electrical power, were noted by the computer operator and later eliminated from the study.

Subjects: An equal number of male and female students were selected by a random procedure from the 11th year students at the Centro Escolar Venustiano Caranzo, Tehuacan, Mexico. The native language of all of the students was Spanish and none had studied more than one year of high school English. The 118 sixteen and seventeen year old students in the 11th year were divided into subsets by sex. Each subset was assigned consecutive numbers according to an alphabetical listing of the group. From a computer generated list of random numbers, two groups of 15 boys and two groups of 15 girls were selected as subjects. The assignment of one male subset and one female subset to Experiment I was done by flipping a coin. One student asked to be excused from participation and two were unable to participate because of scheduling difficulties. The three students next in order on the randomized list were then asked to participate, and did so.

Stimuli: The stimulus sentences were Spanish translations of the sentences used in the embedded sentence experiment conducted by Carpenter and Just (1975).

Es verdad que los puntos son rojos.
(It's true that the dots are red.)

Es verdad que los puntos no son rojos.
(It's true that the dots aren't red.)

No es verdad que los puntos son rojos.
(It is not true that the dots are red.)

An additional six sentences were made by substituting the Spanish adjectives for black (negro) and green (verde) in

each of the above three sentences. Each sentence was paired with an array of 16 dots of either black, red, or green. The sentence types were: True affirmative, false affirmative, true negative, false negative, true denial, and false denial. Each affirmative and each false negative sentence could be false in regard to two colors and so the corresponding true pictures were presented twice. The total number of sentence-picture combinations was 36 (See Appendix B for details). Each sentence was typed in elite type on a tachistascope card 2 1/2 inches high by 4 1/8 inches wide (6.4 cm. x 10.5 cm). The 4 x 4 array of dots was placed below the sentence and subtended 2.5 x 2.5 degrees of visual angle. It should be noted that in the Carpenter and Just study (1975), the dots were drawn on the tachistoscope cards. However, in the present study Dennison pres-a-ply self sticking signal dots were used to obtain more even and more vivid colors. Each stimulus card was viewed through a tachistascope at a distance of 26.5 cm. and subtended 20 degrees of visual angle. In sum, the cards, testing apparatus, timing and procedure conformed as nearly as possible to those used by Carpenter and Just (1975).

Apparatus: The apparatus consisted of a Lafayette Instrument Company model 40020 individual selectro tachistoscope (see diagram in Appendix C). A revolving drum held 100 stimulus cards 4 1/8" wide by 2 1/2" high.

Depressing the advance lever automatically rotated the drum to the next stimulus card. The tachistascope had been adapted so that exposure was auto-controlled by an Apple II+ computer. A two button decision apparatus was also connected to the computer. The decision button apparatus not only registered the decision but was also used to signal readiness for the next trial. Through a computer activated relay, the card was lighted 500 ms after one of the two decision buttons had been pressed to indicate readiness. The card remained in view until the subject indicated his or her decision by again pushing one of the two decision buttons. An Apple Clock by Mountain Hardware, Inc., controlled the lighting and auto-recorded time in milliseconds from exposure of the card to pressing of the decision button. The Apple II+ computer was equipped with a power protector, an annuciator output, a tachistoscopic trigger, a "game" port interface, two disk drives, a spare disk drive and a printer. The power protector and many duplicate parts were necessary because of the irregular power supply in Mexico and the near impossibility of getting repair parts.

Procedure: Subjects were instructed to read a sentence, to look at an array of dots below the sentence and then to decide whether the statement was true or false in regard to the array. The computer recorded the time from the presentation of the sentence to the pressing of the

decision button.

Subjects were tested individually. When the subject came into the room, the investigator introduced herself and the computer operator. The investigator then told the subject that he or she was being asked to take part in a study on decision making and approximately 40 minutes would be required for completion of the task. The subjects were asked if they would be willing to participate. If they indicated yes, they were asked to read and sign a statement indicating that (a) their participation in the study was voluntary, (b) they had been informed there was no personal danger involved, and (c) they were aware of the fact that their participation or lack of participation would have no effect on academic grades. (A copy of the original statment and an English translation appear in Appendix D.)

The investigator presented the equipment that would be used (the computer, the tachistoscope and the decision button apparatus) and indicated the place where the subject would work. After the subject was seated in front of the tachistascope, the investigator read the following instructions outlining the procedure: (English translation follows. The original appears in Appendix D.)

> In here (investigator pointed to the scope of the tachistascope) you will be able to see a series of cards which have dots of different colors, red, green or black. Like this (investigator showed sample card). Above the dots is a sentence. You need to read the sentence and decide if the sentence is true or false. Here are two buttons (investigator indicated two button

decision apparatus). This button is for a false sentence and this for a true sentence (Investigator pointed out labels on buttons). You will be able to indicate with these buttons if the sentence is true or false. When you are ready to see the card, you may push either button to indicate it. In one-half second, the card will be illuminated and you will be able to see the card. Please indicate you answer as soon as possible. After giving the response for a card, you will need to push the button again in order to indicate that you are ready for the next card. Again, in one-half second you will be able to see the card. Are there any questions? (If there were questions, they were answered, and if there were none, the investigator continued.)

There are ten practice cards. After each of these I will tell you if the answer is correct or not. Are you ready for the practice cards? If so, press either of the buttons and you will be able to see the first card.

The subject initiated the trial by pressing either of the two decision buttons. The stimulus card appeared 500 ms later and remained in view until the subject responded. Dominant hand assignment to the true button was balanced across subjects.

A practice session consisted of 10 trials selected at random from the 36. Each subject was given feedback on the correctness of his or her response only during this practice session. Following this practice, each subject completed three sets of the 36 stimulus cards. Stimulus cards had been placed on the tachistascope drums according to a computer generated random number list. In addition, selection of the drums to be used for each subject was determined by using a random number list. A five minute rest was given between the second set and third set. The

testing sessions averaged 45 minutes.

The Carpenter and Just (1975) study used five blocks of the 36 cards. This was not possible in the present investigation because of two factors. The first factor was time. The high school students worked more slowly than the university students in the Just and Carpenter study. Students were younger and the group was not as homogeneous from the standpoint of ability. Students had been given permission to be out of class only one hour and few of the students could have completed five sets of stimulus cards in an hour. The second factor was fatigue. Some of the students showed signs of fatigue at the end of the second set of cards and nearly all by the end of the third set. Results and participation could have been affected if subjects had been required to complete five sets.

After completing the three sets, each student was thanked, conversed with a short time and offered a package of "Bubble-yum" gum or a Coca Cola.

Design and Statistical Analyses: Experiment I is a repeated measures design analyzed for the presence of a linear or nonlinear trend among the means of the verification times for each sentence type (TA, FA, FN, TN, FD, TD). The main independent variable is the linguistic complexity of the sentence and the main dependent variable is verification time.

The hypothesized model, which the experiment is

designed to test, assumes an equal interval between conditions on the independent variable. The independent variable represents one parameter, the time to perform one find and compare operation. Each condition (k through k+5) is hypothesized to contain one additional equivalent mental operation by virtue of the fact that the six sentence types were designed to require that additional comparison (each sentence type and the hypothesized comparisons appear in Appendix A).

The dependent variable, verification time, was measured in milliseconds (ms). Only the verification latencies for correct responses were used in calculating the means of each condition.

An analysis of variance with repeated measures was performed to determine if there were significant differences in mean verification times across the six conditions and to determine if there was a significant difference between trials. A Tukey Studentized Range (Honest Significant Difference [HSD]) test was used to examine the differences among the means. The means of the dependent variable for each condition were next analyzed for the presence of a trend (F= MS bg/MS ba). Following this, the experimenter determined whether a linear equation provided a satisfactory fit to the data at hand. A method of orthogonal polynomials was used to examine the data. A test for departure from linearity was performed

to determine the proportion of variance accounted for by the linear trend and the proportions due to nonlinear trends. Lastly, a correlational analysis was performed to determine if there was a relationship between the error rate and the mean verification times across conditions (k, k+1, k+2, k+3, k+4, k+5).

Experiment II

HYPOTHESES:

The following null hypotheses were tested in Experiment II:

I. In the sentence-picture verification task, there are no significant differences among the means of the verification times for those Spanish sentences containing active verbs, those containing passive verbs and those containing reflexive verbs. (Latencies were assessed in milliseconds from the presentation of the stimulus to its verification on a two button decision apparatus.)

II. In the sentence-picture verification task, there is no significant difference in mean verification times between those sentences which are true in relation to the picture and those which are false in relation to the picture.

III. There is no correlation between the percentage of error responses and the means of the verification times across the following six possible combinations of sentence voice and truth or falseness: true active (TA), false active (FA), true passive (TP), false passive (FP), true reflexive (TR), and false reflexive (FR).

It was expected that because of their frequency in the Spanish language and because the position of the object

of the verb is nearly equivalent to the position of the subject of the verb, reflexive verb forms will be processed as efficiently as active verb forms, (i.e., the sentence verification latencies will be equal). Although true passive verbs which express the agent are relatively rare in Spanish (Green, 1975), as in English, it is anticipated that because of the intermediary effect of reflexive verbs, the differences in sentence verification latencies between active and passive sentences will be smaller in Spanish than in English. It is expected that some differential may still exist due to the fact that the scanning of the sentence will involve passing the first object in the passive sentence in order to locate the subject, (Gough, 1966). The elimination of reversible passive sentences from this study means that verification time due to reversibility will not be confounded with verification time due to use of the passive voice.

Verification latencies for false passive sentences may not be greater than verification latencies for false active sentences since previous studies have not always found this difference when the sentences were presented visually (File and Jew, 1973).

If null Hypothesis I is rejected, it would indicate that the longer latencies for passives and reflexives may be due to underlying cognitive processes, perhaps a constituent matching type of processing. However, if null

Hypothesis I is not rejected it would indicate that the longer latencies for verifying passive sentences in English may be due to surface structure variations, lack of familiarity with the passive form, or some cause yet unknown. In sum, failure to reject null Hypothesis II would indicate that the latencies are not due to underlying, universal cognitive processes.

If null Hypothesis II is rejected, it would indicate that there is a difference in the cognitive processing of true and false sentences. This difference has been found by many investigators in English (Carpenter and Just, 1975; Trabasso, et al., 1971; Wason, 1963) and in Chinese by (Just and Carpenter, 1975). It is therefore anticipated that true sentences (active, passive and reflexive), will have shorter mean verification latencies than false sentences. Significantly longer verification times for false sentences than true sentences would contribute evidence that this difference in processing is due to underlying cognitive processes and not due to surface structure variations in language. If Hypotheses II is not rejected, it would indicate that differences in verification latencies may occur in some languages and not others or in some situations and not others and therefore such differences are likely due to surface structure variations in languages and not to underlying cognitive processes.

If null Hypothesis III is rejected it would indicate that the difficulty in understanding the sentences is related to the effects of falseness and sentence voice which in turn result in longer verification times. The failure to reject Hypothesis III would mean that in Spanish, the combinations of sentence voice and truth or falseness have no systematic effect upon difficulty of comprehension.

Experimental Setting and Apparatus: The experimental setting and apparatus are the same as described in Experiment I.

Subjects: Experiment I describes the random procedure for selecting two male and two female subsets of students from the 11th year students at the Centro Escolar Venustiano Caranza in Tehuacan, Mexico. One male and one female subset were assigned to Experiment I by flipping a coin. The other male and female subset became the subjects of Experiment II. There were no subjects assigned to Experiment II who asked to be excused or who were unable to attend the testing session.

Stimuli: The stimulus sentences consisted of six types: true active, false active, true reflexive, false reflexive, true passive, and false passive. There were 17 sentences of each type making a total of 102 sentences. Paired with each sentence was a hand sketched picture clearly indicating the truth or falsity of the sentence.

The stimulus sentences were typed in elite type at the top of a tachistascope card 2 1/4" high by 4 1/8" wide (6.4 cm. x 10.5 cm.), Below the sentence was the picture confirming or disconfirming the sentence. The cards were viewed through an individual tachistascope at a distance of 26.5 cm. at a visual angle that subtended 20 degrees. Copies of the pictures and Spanish sentences (reduced 20%) along with the English translations of the sentences appear in Appendix E.

Procedure: The picture-sentence verification task consisted of the subject's reading a sentence, looking at a picture below the sentence and deciding whether the sentence was true or false in relation to the picture. Verification time consisted of time in milliseconds from exposure of the card to pressing of the decision button.

Before taking part in the study, subjects read and signed a statement indicating that their participation was voluntary and that they knew their participation or lack of participation would have no effect on academic grades. (See Appendix D for copy of student consent form.)

Subjects were told they were taking part in a study on decision making. Apparatus for the experiment was demonstrated and directions explaining procedure were read (English translation appears under Procedure for Experiment I and the Spanish original in Appendix D.) Subjects were instructed to read the sentence, look at the picture and

decide as quickly as possible whether the sentence was true or false in regard to the picture.

The subject initiated the trial by pushing either button of the two button decision apparatus. The stimulus card appeared 500 ms later. Both the sentence and the picture were viewed through a tachistoscope at a distance of 26.5 cm. A two button decision apparatus was used with the dominant hand assignment to the true button balanced across subjects.

A practice session consisted of ten trials selected by a random number procedure from the entire set of stimulus cards. The subject was given feedback on the correctness of his or her response only during this practice session. Subjects were given no feedback on verification time.

Following the practice session each subject completed two sets of the 102 cards with a five minute rest between set one and set two. The 102 stimulus cards had been placed on the tachistascope drums according to a computer generated list of random numbers. The selection of the drums to be used for each subject was also done according to a random number list. The testing sessions averaged 50 minutes.

Following the testing session, subjects were offered American-made bubble gum and thanked for their time and participation in the study.

Design and Statistical Analyses: Experiment II, like Experiment I, is a repeated measures design that was analyzed for the presence of linear and nonlinear trends. The main independent variable is the linguistic complexity of the sentence and the main dependent variable is verification time.

Analysis 1: In this instance, no assumption of equal intervals between conditions on the independent variable was made. The hypothesis of differences among conditions was based on three factors: (a) Mean verification time for false sentences has been found to be longer than mean verification time for true sentences, (Gough, 1966; Trabasso, et al., 1971; Clark and Chase, 1972). (b) Mean verification time for passive sentences has sometimes been found to be longer than mean verication time for active sentences (Gough, 1966; Seymour, 1969: Shoben, 1976). (c) Linguistic analytic theory places the functioning of reflexive verbs as between that of active and passive verbs (Babcock, 1970; Green, 1975). The dependent variable, verification time, was measured in milliseconds. Only verification times for correct responses were used in calculating the means of each condition. Each subject completed two sets of 102 cards. The two sets of data were collapsed and an analysis of variance with repeated measures was used to determine if there was a significant difference among means. A Tukey (HSD) statistic was used

to examine the differences among the means as they related to voice and falseness. In addition, the error rates across sentence conditions were correlated with the means of the verification times across sentence conditions (k, k+1, k+2, k+3, k+4, k+5). Error rates correlating with sentence voice or falseness would indicate that these conditions added to the difficulty in verifying the sentences.

Analysis 2: The verification latencies for active, passive and reflexive sentences were also examined as a function of the locus of the mismatch in the sentence. The four sentence conditions of the independent variable were: (1) False sentences which were false by virtue of a mismatch at the first noun in the sentence, (2) false sentences which were false as the result of a mismatch at the verb, (3) false sentences which were false due to a mismatch at the predicate adjective or object, and (4) true sentences which matched at all points. Again, verification time, the dependent variable, was measured in milliseconds, and only correct responses were used in calculating the means of each condition. The four means were analyzed for the presence of a trend. A method of orthogonal polynomials was used to determine the linearity of the trends and an analysis of variance procedure was used to determine whether identified trends accounted for a significant portion of the variance. An analysis of variance of active

and passive subgroups of the first and third points of mismatch was performed to determine if sentence voice resulted in a difference in the order of processing sentence elements.

CHAPTER IV

RESULTS

The results of this investigation are organized and presented in relation to the hypotheses they were designed to test. Experiment I and the results related to the hypotheses of that experiment are discussed first. The analyses and the results are presented in a format similar to the results of the Just and Carpenter (1975) study. Since the experiment replicates in the Spanish language the Just and Carpenter (1975) study, the similar presentation makes for ease of comparison. The results related to the testing of the hypotheses of Experiment II are presented next. This sentence-picture verification task dealt with effects of sentence voice and falseness. Different assumptions underlie Experiment II than Experiment I, and therefore different analyses were performed. The results of these analyses appear with the hypotheses they were designed to test. Finally, the data collected for Experiment II was subjected to a secondary analysis. These results appear near the end of chapter IV.

Results Related to Experiment I

Error Responses. The latencies for error responses were discarded, and only the verification times for correct

responses were used in the analyses. The range of errors for individual subjects was from 0 to 40 with a mean number of errors per subject of 12.07. The total number of errors was 338, or 11.35%. The mean error rate is higher than that in similar studies, (Just and Carpenter, 1975; Carpenter and Just, 1975; Trabasso et al, 1971; Clark and Chase, 1972). Four students whose total errors ranged from 23 to 40, accounted for 36% of the errors. If the four subjects with the highest number of errors were eliminated, it would result in a reduction of the mean number of errors to 9.00 and a reduction of the percent of errors to 8.36. Thus, these four students with a very high number of errors made a disproportionately large contribution to the mean error rate and to the total percent of errors.

The following results were obtained in testing null Hypotheses I. (There are no significant differences among the means of the verification latencies across the following sentence conditions: true affirmative [TA], false affirmative [FA], false negative [FN], true negative [TN], false denial [FD], and true denial [TD].)

The first analysis performed in connection with testing Hypothesis I was a two way analysis of variance using a repeated measures design. The independent variable, verification time, was examined in respect to effects of treatments and trials. As can be seen on Table

2, there is a significant difference among conditions. On the basis of a statistically significant p value (p = .0001), null Hypothesis I was rejected. From this finding, it appears that the sentence types, TA, FA, FN, TN, FD, and TD do have a significant effect on verification times (F (5, 120) = 32.71, p = .0001). In this experiment, the subjects had completed three trials of 36 items. As can be seen in Table 2, there was no significant difference among these trials. F (2, 48) = 1.000, p = .3741, and no significant interaction effects between conditions and trials (F (10, 240) = 0.96, p = .4820).

Table 2

ANOVA for Treatment Effects on Reaction Time
Dot Sentences

Source	Sum of Squares	DF	Mean Square	F	Tail Prob.
Mean	5491.126	1	5491.126	330.12	.0000
Error	399.214	24	16.634		
Conditions	209.760	5	41.951	32.71	.0000
Error	153.883	120	1.28		
Trials	1.933	2	0.966	1.00	.3740
Error	46.212	48	0.963		
Interaction	3.874	10	0.387	0.96	.4820
Error	97.129	240	0.405		

Since there was no significant difference between trials and no interaction effects, the data was collapsed and the

subjects' scores were the means of the correct verification times for each condition across the three trials. (The means and standard deviations for each subject appear in Appendix F.)

The means and standard deviations of the sentence conditions are presented in Table 3. In addition, Figure 1 presents a graph of the means of each condition.

Table 3

Means and Standard Deviations of the Dot Sentence Conditions

Sentence	Condition	Mean	St. Deviation
K	(TA)	2.480	0.619
K+1	(FA)	3.124	0.874
K+2	(FN)	3.644	1.246
K+3	(TN)	3.937	1.278
K+4	(FD)	3.970	1.190
K+5	(TD)	4.700	1.798

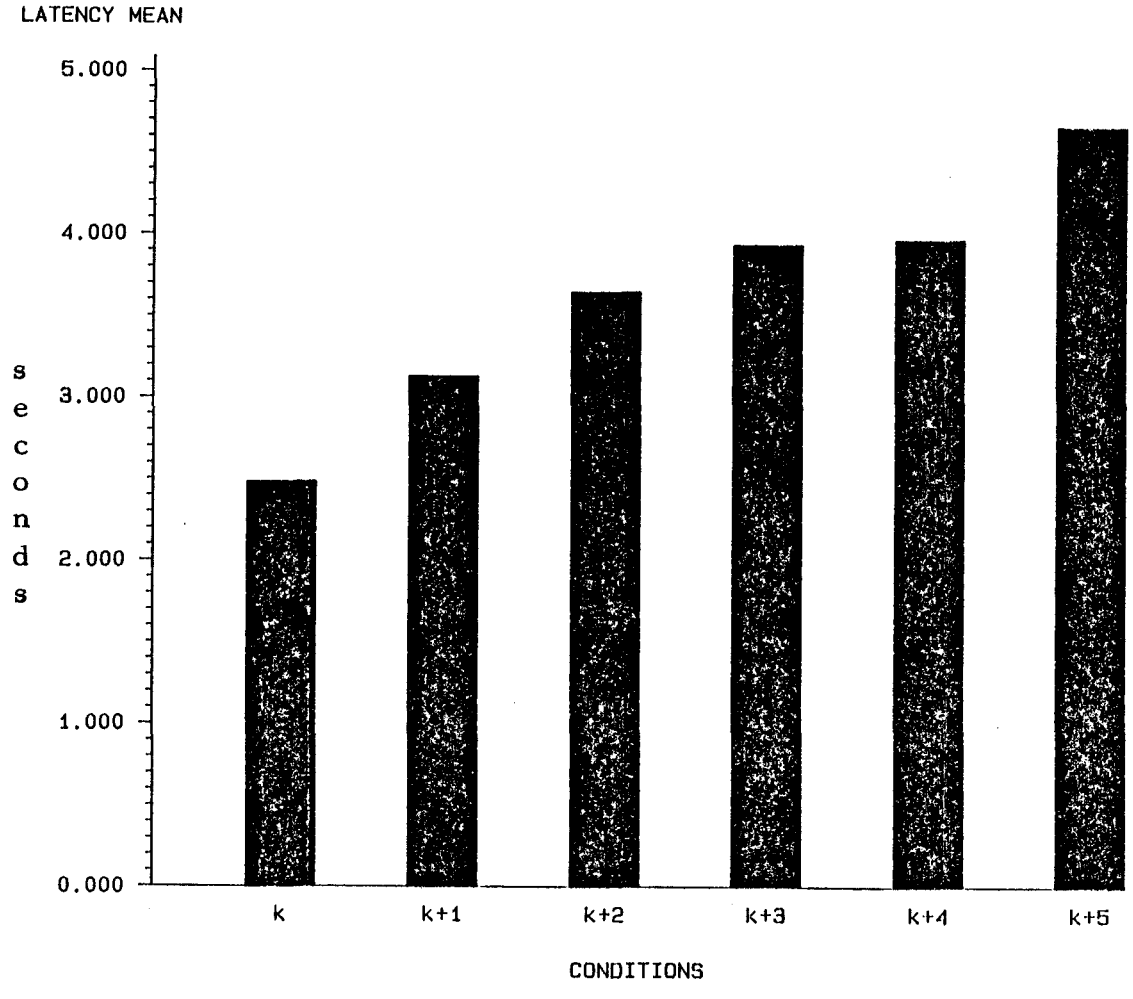
T = True, F = False, A = Affirmative, N = Predicate negative, D = Denial.

The second analysis performed in relation to testing Hypothesis I was a multiple comparison test (the Tukey [HSD] statistic) on the means of the six conditions. Using the degrees of freedom derived from the error term in the

Figure 1

Bar Chart of Mean Verification Times

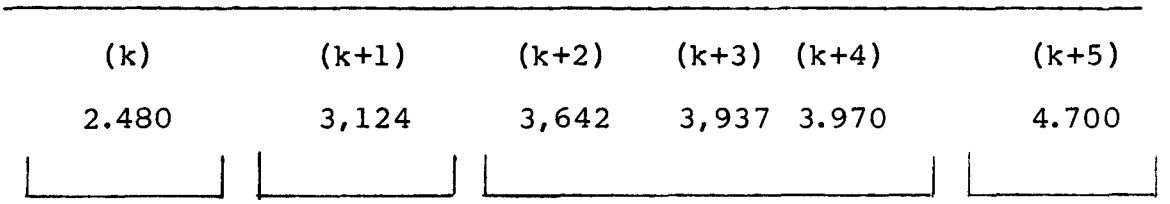
Dot Sentences



repeated measures design at the .05 alpha level, the least significant difference was found to be .1532 with 135 degrees of freedom. As can be seen in Figure 2, the Tukey test showed significant differences between the means of k and k+1, k+1 and k+2; and between k+4 and k+5. The differences among the means of k+2, k+3, and k+4 proved to be non-significant.

Figure 2

Tukey's Studentized Range (HSD) Test for Verification Time Means



The first analysis performed in connection with testing null Hypothesis II, (there is no linear increase in mean verification times with the increase in the number of comparisons hypothesized by the Just and Carpenter (1975) sentence verification model, (k, k+1, k+2, k+3, k+4, k+5)), was a trend analysis with repeated measures using coded vectors. Linearity of the means was established, [F (1) = 163.67, p = .0001], (see Table 4 for details). Therefore null Hypothesis II was also rejected. The criteria for using a trend analysis with repeated measures had been met.

The differences among conditions on the independent variable are quantitative with each level representing an equal increase in the amount of a single, common, continuous variable, (the number of hypothesized mental comparisons), and the dependent variable is also a quantitative variable with each subject having a mean score for each condition. Since both variables are quantitative and there is a mean of each condition for each subject, a trend analysis for repeated measures was appropriately used. Compared with a general linear analysis, the repeated measures design results in a lower error term and a more sensitive analysis (Kerlinger, 1973). The linear trend component can be seen in Table 4.

Table 4

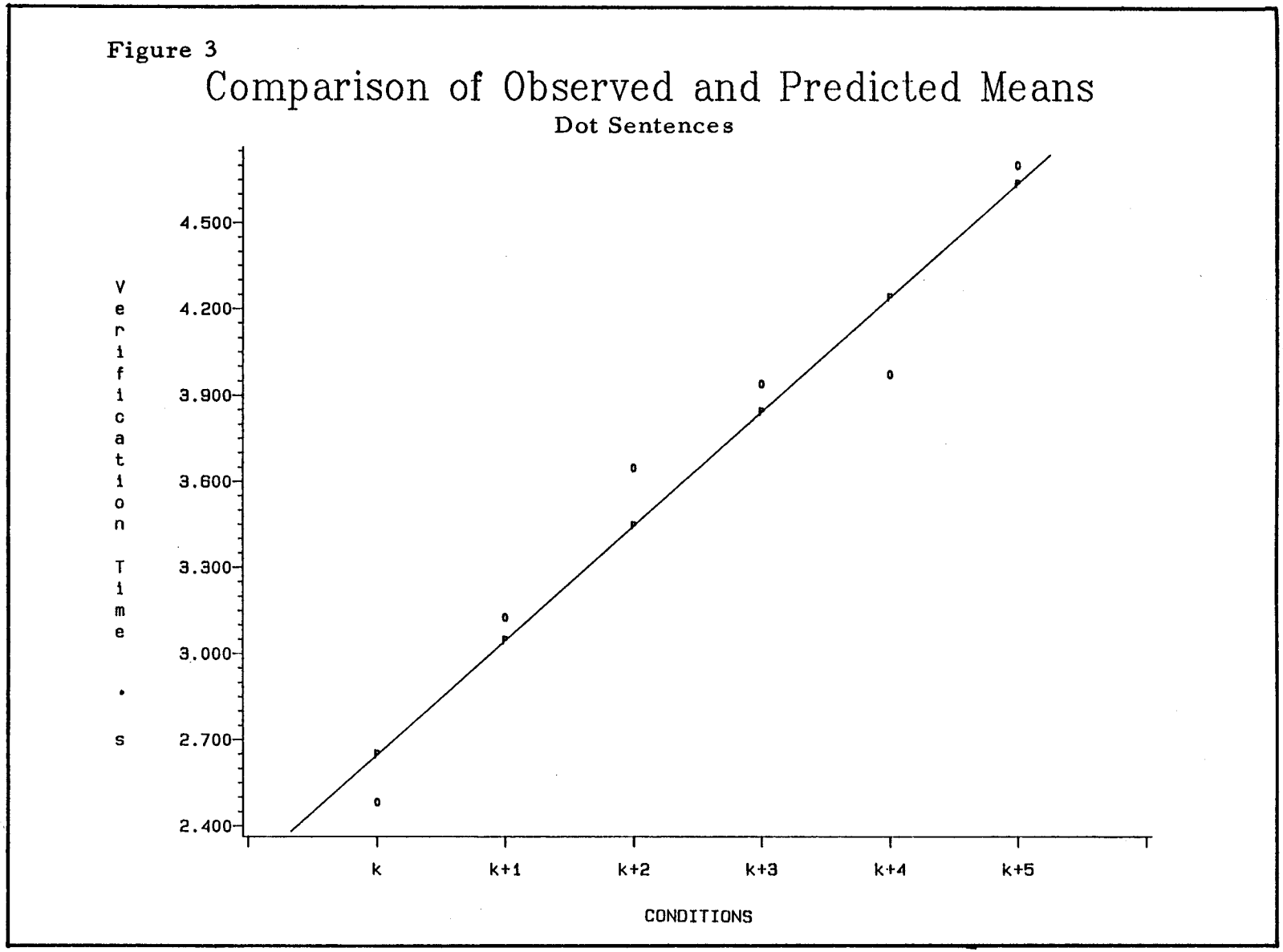
Trend Analysis with Repeated Measures
for Verification Time Means
Dot Sentences

Parameter	Estimate	T for HO: Parameter=0	PR > T	Std.Error of Estimate
Vect-02	.01808	-1.27	.2050	.014199
Vect-03	.02225	2.29	.0233	.009700
Vect-04	.03788	1.54	.1258	.024593
Vect-05	.00364	.44	.6576	.009198

The analysis of linearity showed an intercept of 4.832 and a coefficient of estimation of .199 The average increase per condition was 444 ms. This is higher than the 200 ms found in Carpenter and Just's (1975) study or the 210 ms found in the study with Chinese university students (Just and Carpenter, 1975). The best fitting straight line has a slope of .199 and a standard error of .0158. The root mean square deviation (RMSD) of .702 is large in relation to the 444 ms parameter. Figure 3 presents a comparison of the observed means with the linearly predicted means of the Carpenter and Just model (1975).

The data was also tested for departure from linearity. There was no quadratic trend but there was a cubic trend [$F(1,135) = 5.26$, $p = .0233$], as can be seen in Table 4. Although the cubic trend reached the level of significance, the linear trend accounted for 23.91% of the variance between conditions and was significant at the $p = .0001$ level while the cubic trend accounted for only .77% of the variance between conditions and was significant at the lower $p. = .0233$ level, (see Table 4 for details). The linear component represents more than 30 times as much variance as the cubic component, yet because of the large sample size, the small percentage of variance accounted for by the cubic trend reached significance. Kerlinger (1973,

Figure 3


Comparison of Observed and Predicted Means
Dot Sentences
Verification Time . s
4.500
4.200
3.900
3.600
3.300
3.000
2.700
2.400
k
k+1
k+2
k+3
k+4
k+5
CONDITIONS

p. 224) states that under these conditions the cubic trend should not be considered meaningful and the data should be described as linear.

The proportion of variance due to linearity (23.91%) was calculated as recommended by Hayes (1965) and Kirk (1968). This method uses a proportion derived from the sums of squares due to linearity and the total sums of squares. The results of these calculations are found in column six of Table 5. An alternative method is a proportion derived from the sums of squares due to the trend in relation to the total sums of squares of explained variance. The results of this method of calculating the proportion of variance due to trends can be seen in parenthesis in column six of Table 5. These calculations yielded a higher proportion of the variance due to trends, in this instance 29.78% due to linearity (cf. 23.91%) and .96% due to the cubic trend (cf .77%).

Table 5

Proportion of Variance due to Linearity and Nonlinearity - Dot Sentences

Source	Sum of Squares (1)	DF	Mean Square (2)	F (3)	% of Total Variance (% of Explained Variance) (4)
Between Groups	260.5764	32	8.1430	17.17***	80.28% (100.00%)
Linear	77.6052	1	77.6052	163.65***	23.91% (29.78%)
Departure from linearity	182.9712	31	5.9023	12.44***	56.37% (70.22%)
Quadratic	0.7690	1	1.6217	1.6217	0.24% (0.30%)
Cubic	2.4955	1	0.24955	5.26*	0.77% (0.96%)
Other	179.7067	29	6.1968	13.06***	55.36% (68.97%)
Error	64.0130	135	0.4742		19.72%
Total	324.5895	167			

* p = .05.
** p = .01
*** p = .001

Null Hypothesis III stated that there is no correlation between the means of the error responses across sentence conditions (k, k+1, k+2, k+3, k+4, k+5), and the means of the verification times across sentence conditions. The means of the error responses over

conditions are as follows: k = 0.29, k+1 = 0.68, k+2 = 1.82, k+3 = 2.93, k+4 = 1.96, and k+5 = 3.79. A bar graph of the error rate means is presented in Figure 4. Mean error rates across conditions and mean verification times across conditions are highly correlated, (r = .9547, p =

also rejected. As predicted, a relationship does appear to exist between error responses and verification times. Figure 5 presents a comparison of the relationship between mean errors per condition and mean verification time for that condition.

An analysis of variance with repeated measures was performed on the means of the error rates across conditions. There was a significant difference among the error rates across conditions, (F = [5, 135] = 10.82, p = .0001). Using coded vectors, a trend analysis with repeated measures was performed on the means of errors responses across conditions. A linear trend appears to be evident (see Table 6 for details), though considerable nonlinearity appears to exist due to variablity between subjects. A comparison of the linearly predicted means with the observed means is shown in Figure 6.

Figure 4

BAR CHART OF MEAN ERROR RATES

Dot Sentences

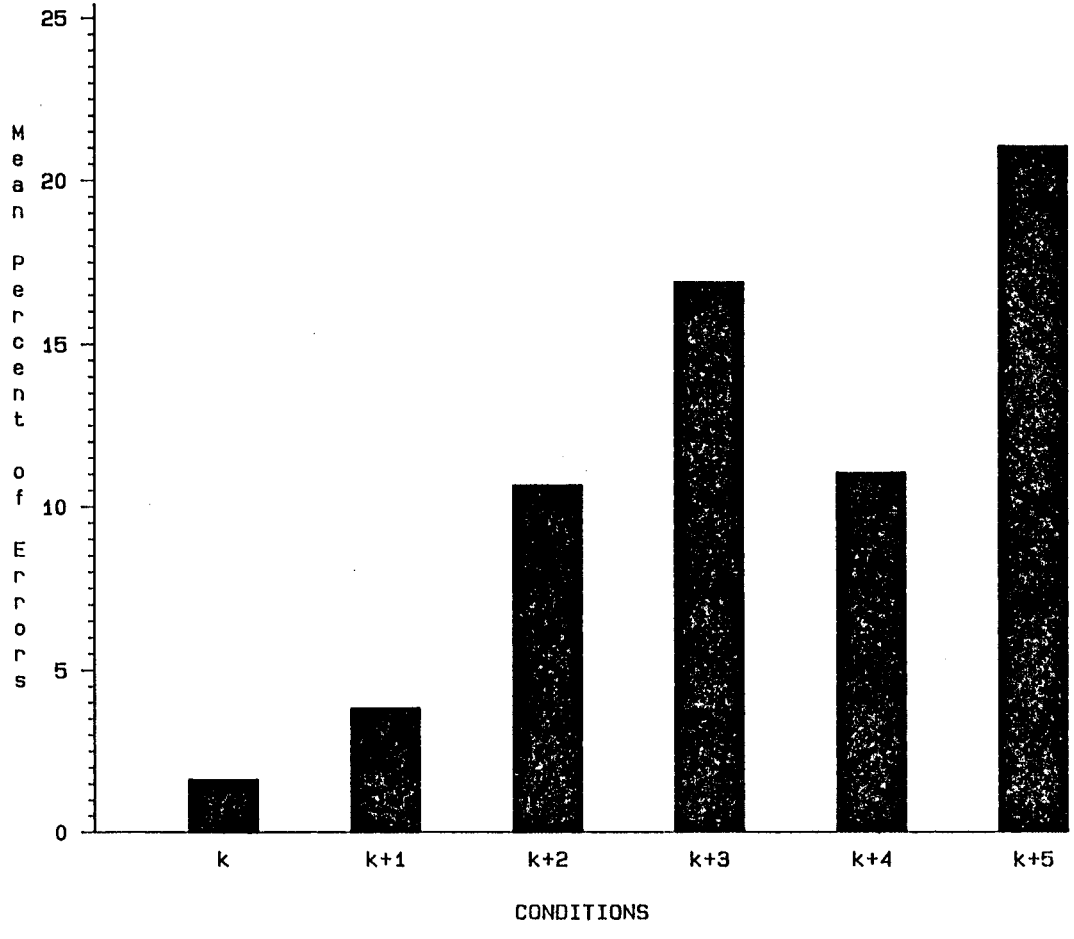


Figure 5

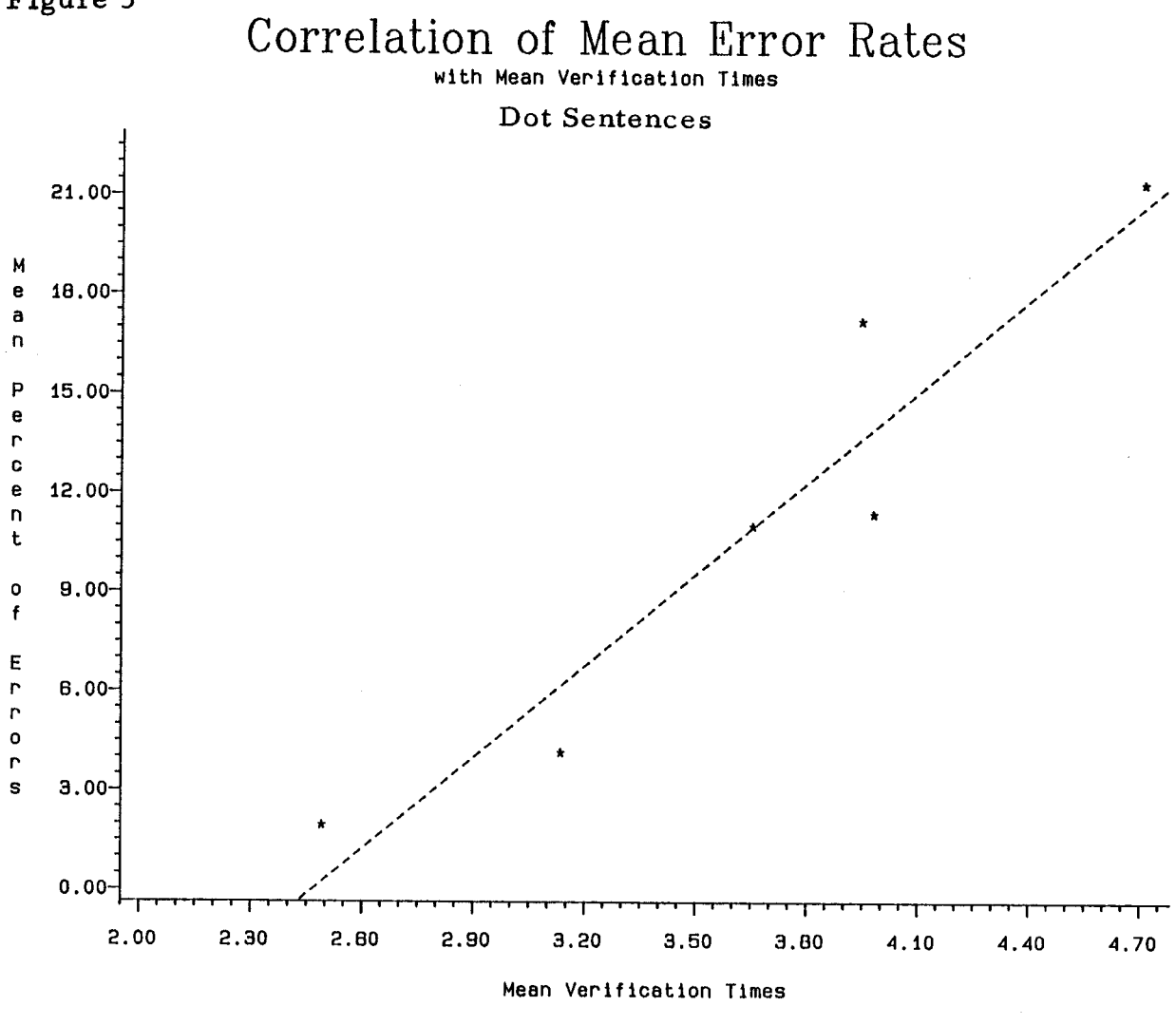

Correlation of Mean Error Rates
with Mean Verification Times
Dot Sentences
Mean Percent of Errors
21.00
18.00
15.00
12.00
9.00
6.00
3.00
0.00
2.00
2.30
2.60
2.90
3.20
3.50
3.80
4.10
4.40
4.70
Mean Verification Times

Figure 6

Comparison of Observed and Predicted Means-Error Rates

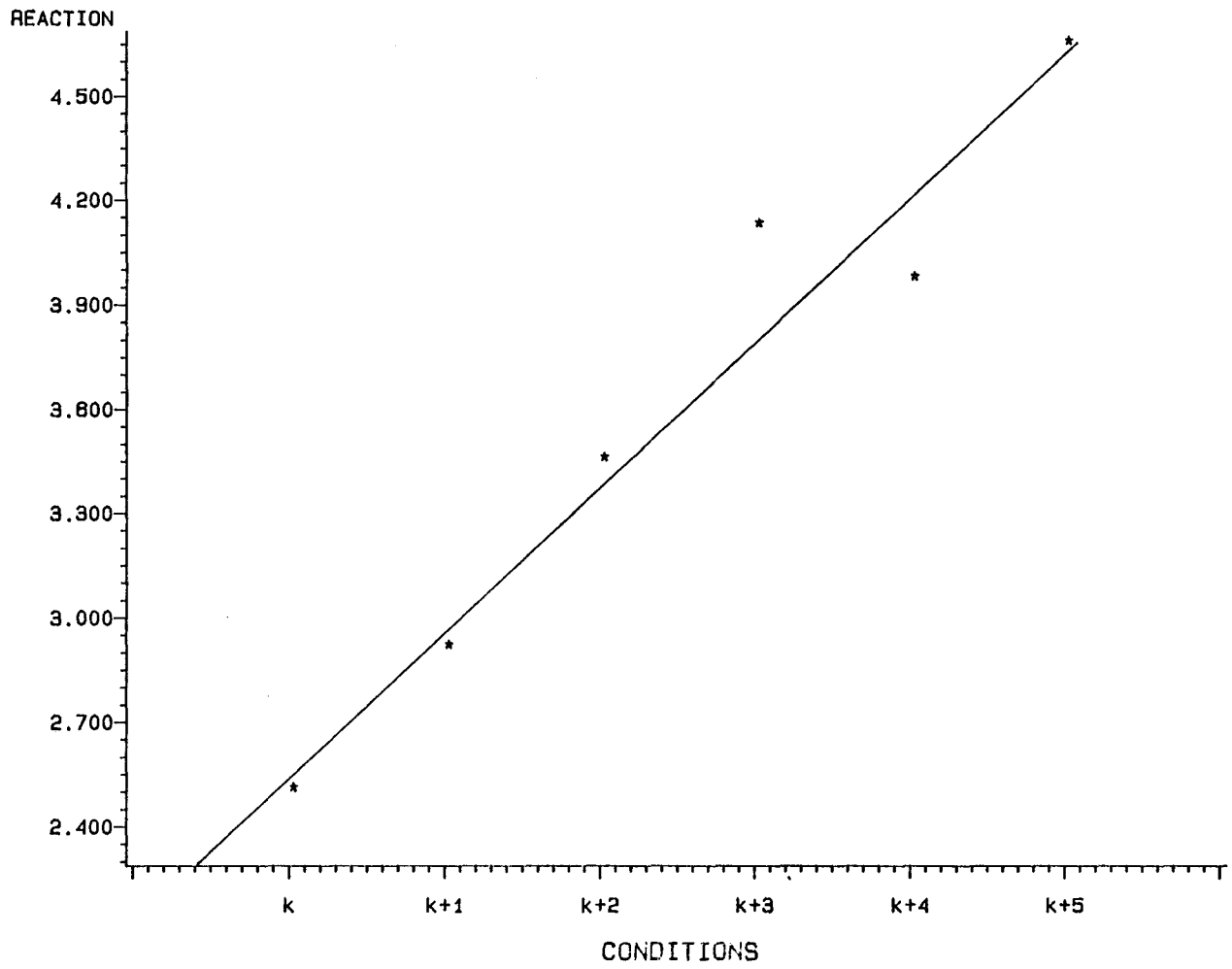


Table 6

Trend Analysis -- Error Rates Across Conditions
Contribution of Linear and Nonlinear Trends
Dot Sentences

Source	Sum of Squares	DF	Mean Square	F	Variance Actual (Explained)
Between Groups	21686.614	32	677.143	4.76***	53.02 (100.00%)
Linear	6247.347	1	6247.374	53.90***	15.27 (28.81%)
Departure from linearity	15439.241	31	498.040	3.50*	37.75 (71.19%)
--Quadratic	44.671	1	44.671	0.31	0.11 (0.21%)
--Cubic	74.564	1	74.5649	0.52	0.18 (0.34%)
--Quartic	1099.760	1	1099.760	7.73**	2.69 (5.07%)
--Quintic	230.640	1	230.640	1.62	0.56 (2.45%)
--Subjects	13989.604	27	518.133	3.64*	64.51
Error	19211.892	135	142.310		
Total	40898.507	167			

* $p < .05$.
** $p < .01$
*** $p < .001$.

In summary, the analyses of the data related to Experiment I resulted in the rejection of all three null hypotheses. Using an analysis of variance with repeated

measures design, a significant difference was found among the means of the verification times across conditions. A repeated measures design using coded vectors established linearity of the means, and lastly, a correlation was established between error responses and mean verification times across conditions.

Results Related to Experiment II

Analysis I - Sentence Voice Conditions

The analyses of the data collected for testing the null hypotheses of Experiment II are presented below.

Error Responses. The range of errors for individuals was from 0 to 21 with a mean of 9.957. The total number of errors was 345 or 4.708%. Only correct responses were included in the analyses.

Hypothesis I. The first analysis performed to test null Hypothesis I (In the sentence-picture verification task, there are no significant differences among the means of the verification times for those Spanish sentences containing active verbs, those containing passive verbs and those containing reflexive verbs) was a two way analysis of variance with repeated measures. The results of this analysis of effects of treatments and trials on verification times are presented in Table 7. It can be seen that a significant difference exists in mean

verification times across sentence conditions, [F (5, 170) = 7.72, p = .0001]. Null Hypothesis I was therefore rejected.

Table 7

ANOVA for Treatment Effects on Verification Time
Sentence Voice Conditions

Source	Sum of Squares	DF	Mean Square	F	Tail Prob.
Mean	1957.887	1	1957.8876	467.10	.0001
Error	4.191	34	4.1916		
Conditions	1.581	5	0.316	7.72	.0001
Error	6.960	170	0.041		
Trials	22.933	1	22.934	71.81	.0001
Error	10.858	34			
Interaction	0.426	5	2.60	0.271	.3660
Error					

Not only is there a significant difference between conditions, but a significant difference is also found between trials, (F [1, 34] = 71.81, p = .0001). The mean of the verification times on the second trial was 20% faster than the mean of the verification times on the first trial. In addition, it can be seen in Table 7 that there is some interaction effect between trials and conditions, (F [5, 170] = 2.6, p = .027). The practice effect not only resulted in faster verification times on the second trial but practice affected some of the sentence types

differentially.

Although the interaction effect is recognized as problematical, in this instance, it was felt that the interaction effect was not large enough to warrant the decision to discard the data from the second trial. The decision was made to collapse the data for the two trials. Each subject's scores were the means of the correct verification times for each condition across the two trials. The means and standard deviations of each subject's scores appear in Appendix F. The means and standard deviations of the sentence conditions appear in Table 8 and a visual presentation of these means appears as Figure 7.

Table 8

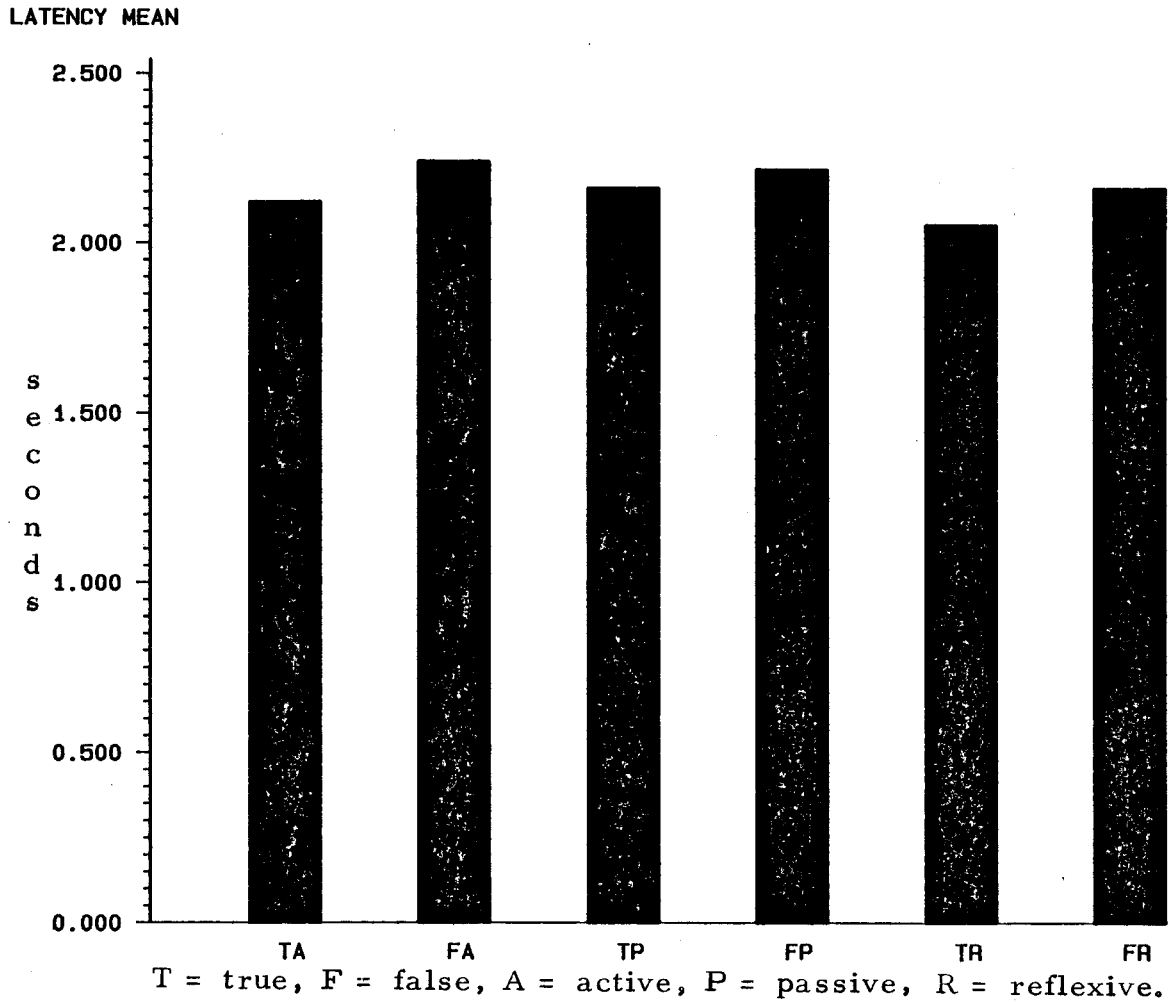
Means and Standard Deviations of the Sentence Voice Conditions

Sentence Condition	Mean	Standard Deviation
True Active	2.1200	0.5436
False Active	2.2398	0.6060
True Passive	2.1619	0.6937
False Passive	2.2170	0.5923
True Reflexive	2.0534	0.5993
False Reflexive	2.1625	0.5868

Figure 7

Bar Chart of Mean Verification Times

Sentence Voice Conditions

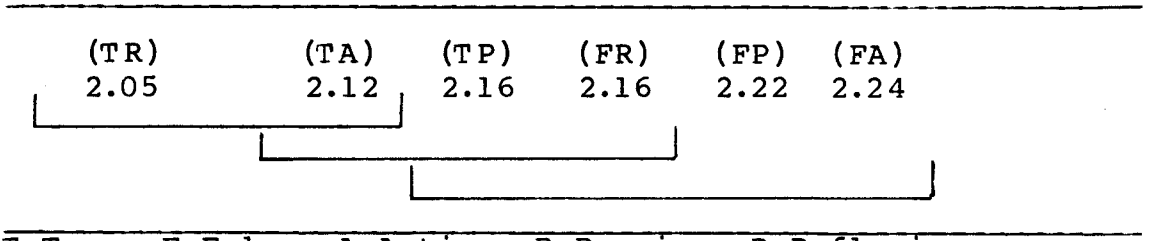


T = true, F = false, A = active, P = passive, R = reflexive.

The Tukey HSD multiple comparison test was then applied to the means of the six groups. Using the degrees of freedom (170) derived from the error term in the repeated measures design at the .05 alpha level, the Least Significant Difference was found to be .0986. The results of this range of significance test appear in Figure 8.

Figure 8

Tukey's Studentized Range (HSD) Test
for Verification Time Means
Sentence Voice Conditions



T=True, F=False, A=Active, P=Passive, R=Reflexive

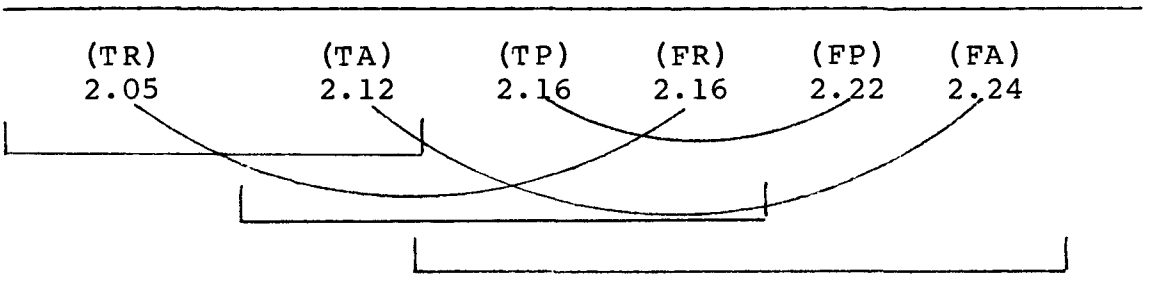
At first glance it appears that the overlap of ranges is such that there is little of significance in this analysis. However, in comparing the means of the true sentence conditions, one sees that the order of the means is, true reflexive < true active < true passive. While the difference between reflexive and active is not statistically significant and the difference between active and passive is also not significant, the difference between the reflexive and the passive is significant. The peculiar importance of this finding is discussed in chapter five.

Hypothesis II. The Tukey HSD statistic used in analyzing the data for Hypothesis I is examined again in relation to

testing Hypothesis II (In the sentence-picture verification task, there is no significant difference in mean verification times between those sentences which are true in relation to the picture and those which are false in relation to the picture). Figure 9 presents the same multiple comparisons of means as Figure 8 with the addition of curved lines indicating the relevant comparisons. From this it can be seen that with alpha at the .05 level and 170 degrees of freedom, a significant difference in means is found between true reflexive and false reflexive sentences. There is also a significant difference between true active and false active sentences. Based on this, null Hypothesis II is rejected. The difference between the mean verification times of true passive and false passive sentences did not reach the level of significance.

Figure 9

Tukey's Studentized Range (HSD) Test
for Verification Time Means



T=True, F=False, A=Active, P=Passive, R=Reflexive

Hypothesis III. The mean error rates for the sentence

conditions were true active, 6.08; false active, 5.21; true passive, 5.06; false passive, 4.89; reflexive, 3.33; and false reflexive, 3.68. The correlation analysis indicated that no correlation exists between the means of the error rates across conditions and the means of the verification times across conditions, ($r = .4113$, $p = .4179$). Therefore, null Hypothesis III (There is no correlation between the percentage of error responses and the means of the verification times across the following six possible combinations of sentence voice and truth or falseness: true active [TA], false active [FA], true passive [TP], false passive [FP], true reflexive [TR], and false reflexive [FR]) was not rejected. This finding of no correlation means that the determination of truth or falseness is not systematically related to verification times for active, passive and reflexive sentences.

A one way analysis of variance with repeated measures was performed on the means of error rates across conditions. The differences among means reached the level of statistical significance. However, because there is no correlation between error responses and mean verification times, it was important to look at the source of the differences. The design of the study had been such that perfectly designed stimulus materials would have resulted in all students having all items correct. Analysis of the source of the errors indicated that errors were not due to

a few students contributing many errors, or to a particular condition resulting in many errors. Rather, a few picture-sentence combinations accounted for many errors. Pictures missed by more than one-third of the students had been removed, but there were several pictures which had been missed by 10 to 13 students which had not been eliminated. An uneven distribution of these high error count pictures appeared to be responsible for the differences among conditions. These high error count pictures were due to the inability of the investigator to eliminate all ambiguities from the sentence-picture combinations.

In summing up the analysis of the data for Experiment II, it may be said that null Hypothesis I was rejected as a result of finding a significant difference between the means of passive and reflexive sentences. Null Hypothesis II was rejected as a result of finding significant differences between the mean verification times of true reflexive and false reflexive sentences and between true active and false active sentences. Null Hypothesis III was not rejected as there was no correlation between percent of error responses across conditions and mean verification times across conditions.

Analysis II - Mismatch Conditions

A secondary analysis of the data related to Experiment II was also performed. The sentences were

regrouped under four conditions, the true sentences (T), the sentences that were false at the first noun, the first point of mismatch (1 M), the sentences that were false at the verb, second point of mismatch (2 M), and the sentences that were false at the predicate noun or adjective, the third point of mismatch (3 M). This regrouping of the sentences into conditions according to point of mismatch was done to determine whether mental processes in verifying the stimulus materials were (a) serial or parallel, (b) self-terminating or exhaustive and (c) performed on deep structure or surface structure format.

Error responses. The total number of errors, the percent of errors, and the mean number of errors per subject were the same as in Analysis I of this experiment. In looking at the mean error rate across the mismatch conditions, it can be seen that there were no significant differences among conditions, $F(3, 102) = 1.52$, $p = .2136$. There was also no correlation of mean error responses with mean verification times across conditions ($r = .2049$, $p = .7951$). Error responses were discarded and only correct responses were used in the remaining analyses.

An analysis of variance with repeated measures was performed on verification times across trials and across sentence conditions according to point of mismatch. The results of this analysis are presented in Table 9. The results show that there is a significant difference among

conditions [F (3,102) = 4.77, p = .0038], and also between trials [F (1, 34) = 62.62, p = .0000]. There is no significant interaction between trials and conditions, [F (3, 102) = 2.09, p = .1056].

Table 9

ANOVA for Treatment Effects on Verification Times
Mismatch Conditions

Source	Sum of Squares	DF	Mean Square	F	Tail Prob.
Mean	1320.2215	1	1320.2215	463.19	.0000
Error	96.9094	34	2.8502		
Mismatch	0.5726	3	0.1908	4.77	.0038
Error	4.0854	102	0.0400		
Trials	14.6257	1	14.6251	62.62	.0000
Error	7.9405	34	.2335		
Mt	0.2445	3	.0815	2.09	.1056
Error	3.9697	102	.0389		

Since there was no interaction between trials, the data for the two trials was collapsed and each subject's scores were the means of the verification times of the correct responses for each sentence condition. The means and standard deviations for each subject on each condition appear in Appendix F. The means and standard deviations for each condition appears on Table 10 and a visualization of the means appears as Figure 10.

Figure 10

Bar Chart of Mean Verification Times

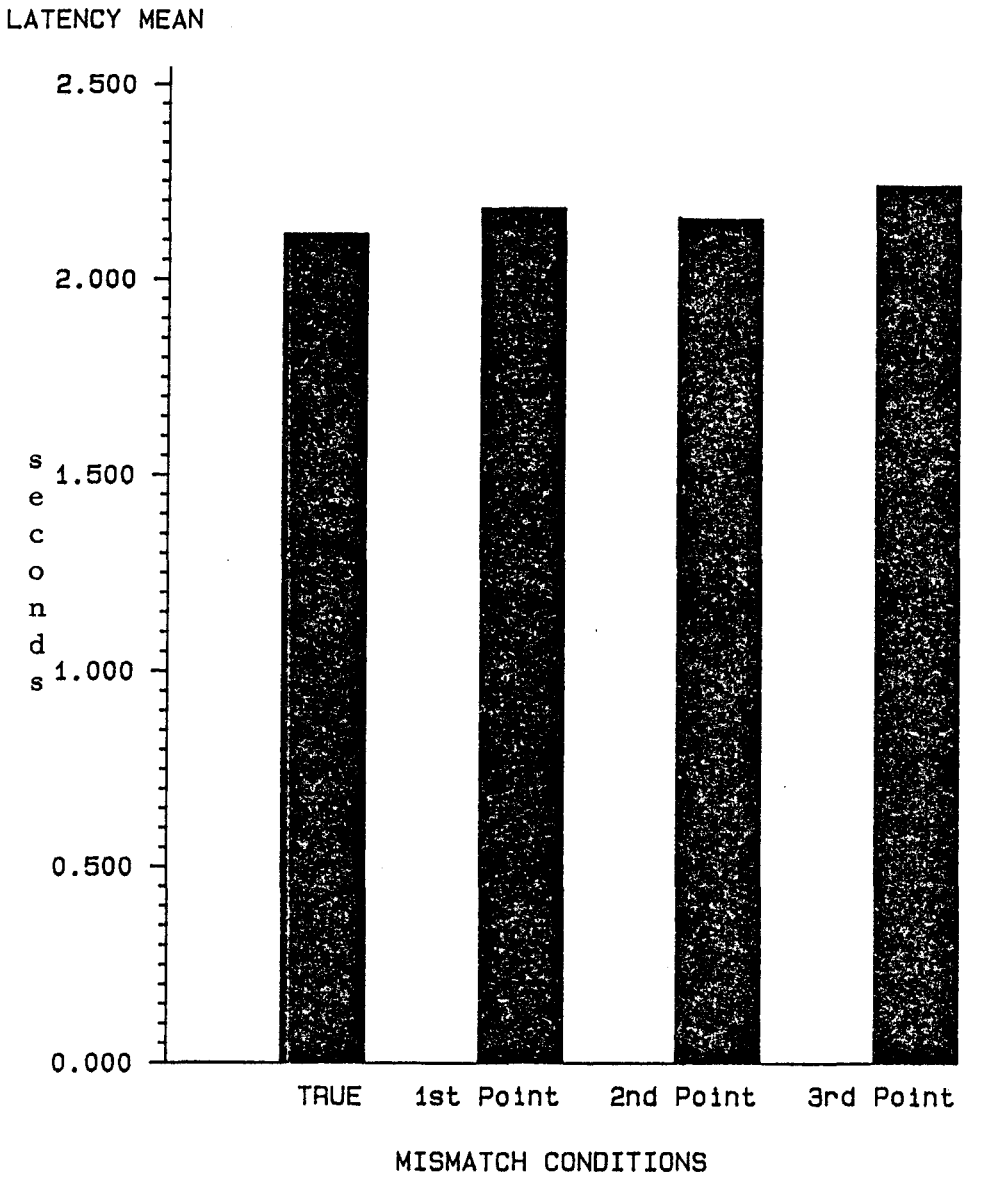


Table 10

Means and Standard Deviations for Verification Times
Mismatch Conditions

Sentence Condition	Mean	Standard Deviation
True	2.1135	0.6047
1st M	2.1800	0.5835
2nd M	2.1541	0.6689
3rd M	2.2381	0.5757

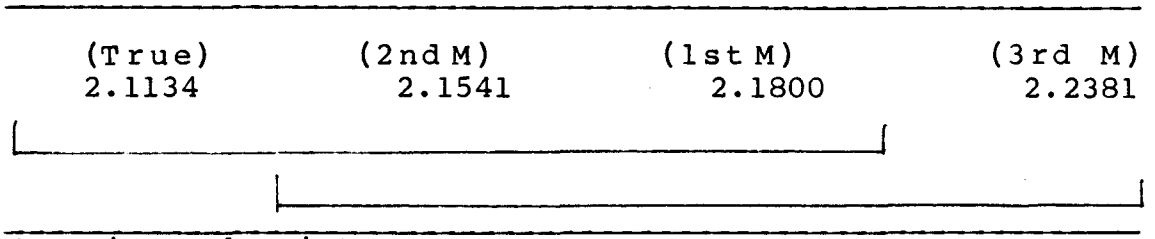
M = Mismatch point

Using the degrees of freedom derived from the error term in the repeated measures design, the Tukey (HSD) multiple comparison of means test was applied to the means of the four conditions (see Figure 11). The least significant difference was found to be .0884 ms. As can be seen, a significant difference is found between true sentences and sentences false at the third point of mismatch. The true sentences, had to be checked at all three points to be verified as true, and yet they were verified significantly more rapidly than false sentences which also had to be checked to the third point of mismatch. This would support the idea that subjects had a mental "set" to answer true and answering false required an additional process such as the changing of a truth index (Just and Carpenter, 1975; Clark and Chase, 1972; Glushko and Cooper, 1978). While the means of those statements

judged false at the first and second points of mismatch are shorter than the mean of those judged false at the third point of mismatch, these differences do not reach the level of significance.

Figure 11

Tukey's Studentized Range (HSD) Test for Verification Time Means - Mismatch Conditions



M = Mismatch point

A trend analysis for repeated measures was performed using coded vectors. The criteria for using a trend analysis with repeated measures had been met, namely, the independent and dependent variables are both quantitative and each subject has a mean score for each condition. The trend analysis established linearity of the means (see Table 1), [$F(1) = 10.54$, $p = .0015$].

Table 11

Trend Analysis with Repeated Measures
for Verification Time Means - Mismatch Conditions

Parameter	Estimate	T for HO: Parameter=0	PR > T	Std. Error of Estimate
Vect-01	.01741	3.25	.0015	.00535
Vect-02	.00436	0.36	.7162	.01196
Vect-03	.01011	1.89	.0615	.00535

The analysis of linearity shows an intercept of 1.932 and a coefficient of estimation of .0174. The average increase per condition is 41 ms. Figure 12 shows a comparison of the means with the best fitting straight line. The standard error is .0053 and the Root Mean Squared Deviation (RMSD) of 142 ms. is again large in relation to the 41 ms parameter.

The data was also tested for departure from linearity. There was no significant departure from linearity (i.e., the quadratic and cubic trends did not reach the level of significance). However, a large proportion of the variance was due to subjects. As can be seen on Table 12, 0.42% of the variance is due to the linear component and 95.41% is due to variance among subjects. Linearity was established although a great deal

Figure 12

Comparison of Observed and Predicted Means

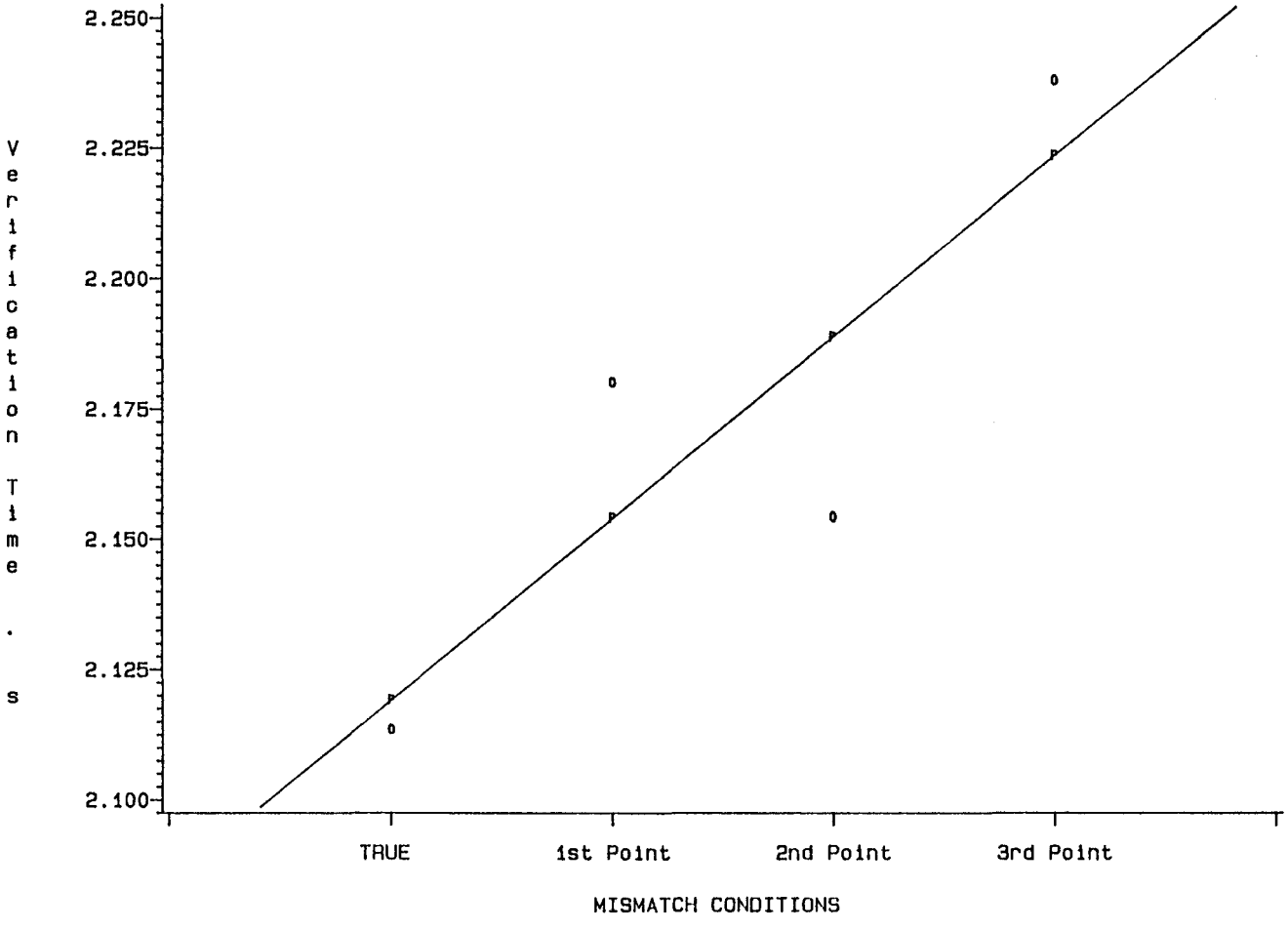


Table 12

Proportion of Variance Due to Linear and Nonlinear Components Mismatch Conditions

Source	Sum of Square	DF	Mean Square	F	% of Total Variance (% of Explained Variance)
Between Groups	48.7410	37	1.3173	65.78***	95.98 (100.00)
Linear	.2121	1	0.2121	10.59***	0.42 (0.44)
Departure from linearity	48.5289	36	1.3480	67.40***	95.56 (99.56)
*Quadratic	.0027	1	0.0029	0.13	.005 (.005)
*Cubic	.0716	1	0.0716	3.58	.14 (.15)
*Subjects	48.4546	34	1.4251	71.26***	95.41 (99.41)
Error	2.0427	102	0.0200		
Total	50.7837	139			

*** p. = .001

of nonlinearity also existed, due primarily to differences among subjects.

In order to determine if active and passive sentences were being converted to deep structure before verification, the sentences that were false at the first point of mismatch and those sentences that were false at the third point of mismatch were subdivided according to whether they were active or passive. If passive sentences are not

processed in their surface structure format but are changed to their deep structure, active form, the verification times would be more similar to the verification times of the opposite category, that is, mismatches at the first point would become mismatches at the third point and vice versa.

An analysis of variance with repeated measures was done on the verification means across these four conditions and across trials (see Table 13 for details). A

Table 13

ANOVA with Repeated Measures of Verification Time Means - Across Mismatch Conditions and Trials Active - Passive Subgroups

Source	Sum of Squares	DF	Mean Square	F	Tail Prob.
Mean	1370.4578	1	1370.4578	517.85	.0000
Error	89.9735	34	2.6464		
New-Mix	1.2630	3	0.4210	6.34	.0005
Error	6.7684	102	0.0663		
Trials	18.3037	1	18.3037	54.32	.0000
Error	11.4570	34	0.3369		
Mt	.4397	3	0.1459	1.48	.0000
Error	10.0764	102	0.9879		

significant difference was found among conditions ($F(3,120) = 6.34$, $p. = .001$) and across trials $F(1,34) = 54.32$, $p = .001$. No interaction was present [$F(3,102) = 1.48$, $p = .225$], and so the two trials were collapsed.

As shown in Table 14, the means of the subgroups distribute in the following order: first mismatch point - active < 3rd mismatch point - passive < first mismatch point-passive < 3rd mismatch point - active. Figure 13 presents a bar chart of these means.

Table 14

Means and Standard Deviations - Mismatch Conditions
Active - Passive Subgroups

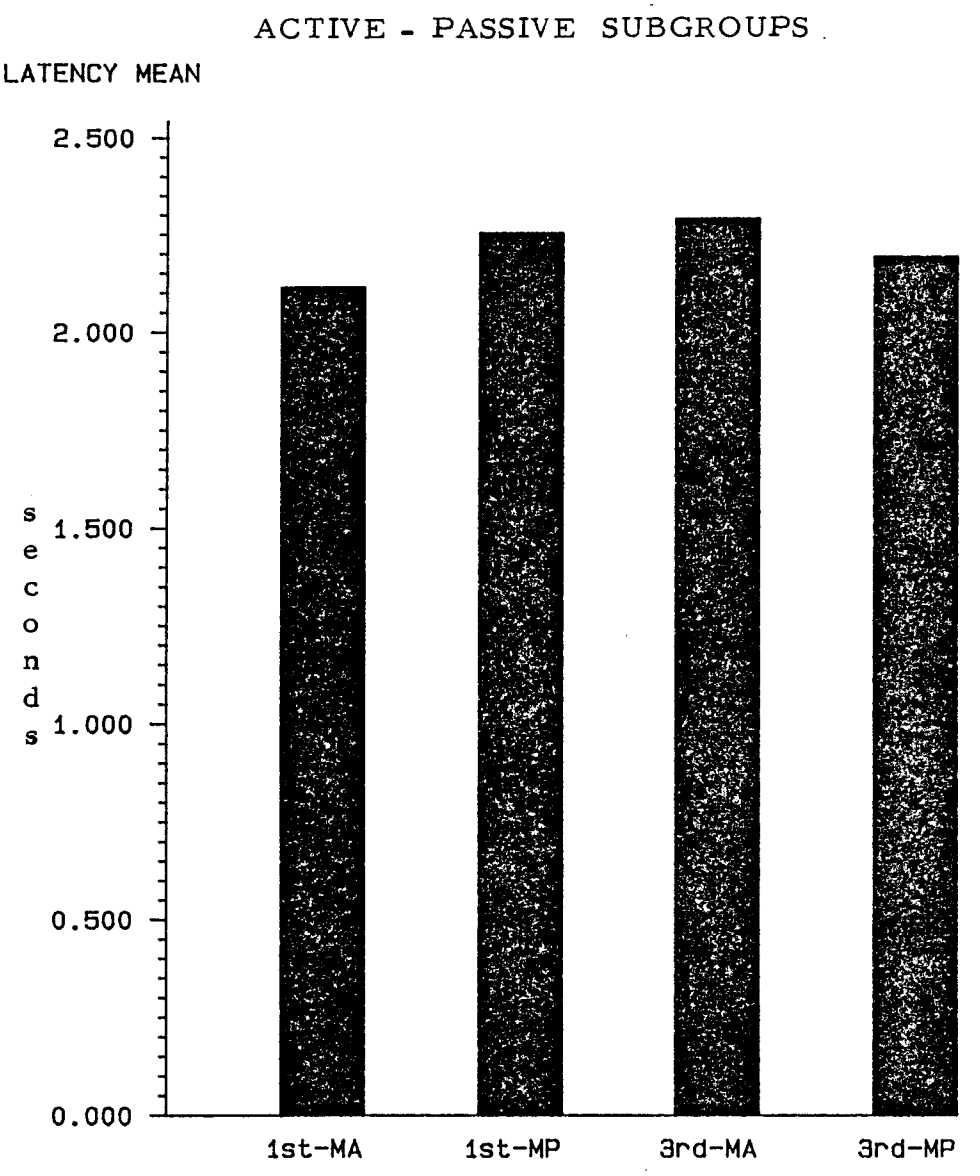
Sentence Condition	Mean	Standard Deviation
1 MA	2.1135	0.58066
1 MP	2.1800	0.62460
3 MA	2.2381	0.59349
3 MP	2,1541	0.58586

M = Mismatch Point, A = Active, P = Passive.

Using the degrees of freedom derived from the repeated measures design, a Tukey (HSD) multiple comparison of means test was performed. The least significant difference was .114. In Figure 14 it can be seen that the mean verification time for active sentences to the point of mismatch is significantly longer than the mean verification time for active sentences to the first point of mismatch. The difference in mean verification for passive sentences which were false at the first and third point of mismatch did not reach the level of statistical significance. It

Figure 13

Bar Chart of Mean Verification Times

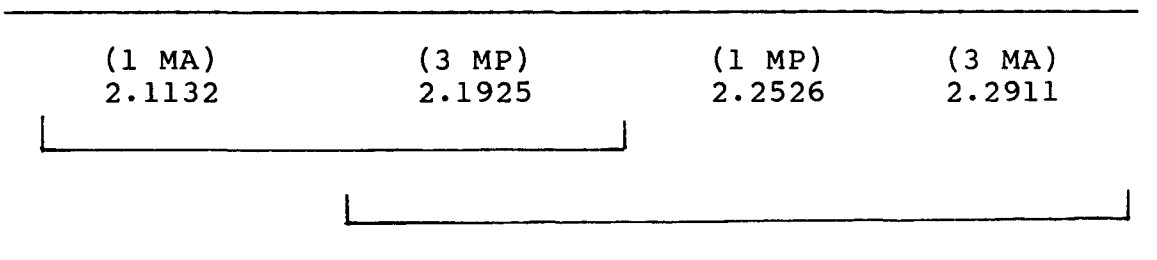


M = mismatch, A = active, P = passive.

should be noted, however, in either Figure 13 or Figure 14 that the direction of the difference on passive sentences was reversed with passive sentences false at the third point of mismatch being verified more rapidly than passive sentences false at the first point of mismatch.

Figure 14

Tukey's Studentized Range (HSD) Test for Verification Time Means - Mismatch Conditions Active - Passive Subgroups



M = Mismatch point, A = Active, P = Passive.

The following points summarize the results of the secondary analysis related to Experiment II:

1. True sentences were verified significantly more rapidly than false sentences which had to be verified at the same three points.

2. Linearity of the means for true sentences and false sentences grouped according to point of mismatch lends support to those models of mental processing which maintain that processing occurs serially and terminates when the sentence is judged true or at the first mismatch point which permits its verification as false.

3. When the sentences which were false at the first

point of mismatch and the third point of mismatch were divided into active and passive subgroups, the active sentences which were false at the first point of mismatch were verified significantly more rapidly than the sentences which were false at the third point of mismatch. In addition, a reversal of this order occurred for passive sentences although the magnitude of the difference did not reach the level of statistical significance.

CHAPTER V

Discussion

Overview

The overall purpose of this sentence verification study was to determine whether verification latencies related to falsification, negation, and sentence voice which have been found in English would be found in the Spanish language. Experiment I was designed to systematically replicate the embedded sentence study of Carpenter and Just (1975) and determine whether effects related to negation and falsification would be similar to those found by them in the English language (Carpenter and Just, 1975) with university students and in the Chinese language (Just and Carpenter, 1975) with Chinese students and staff at Carnegie-Mellon University. Experiment II was designed to determine if different verification times related to active and passive voice (Gough, 1965; 1966; Wannamacher, 1974; Olson and Filby, 1972) would be found in Spanish. In addition, since the Spanish language has a third verb form, the reflexive, the study was designed to determine whether the function of the reflexive voice was more similar to that of the active voice or the passive voice.

In Chapter V a discussion of the results related to Experiments I and II is presented. This discussion includes interpretive information about the statistical procedures, the relative importance of the research findings and how these findings relate to other research. The discussion is organized and presented in relation to the hypotheses of Experiments I and II and the results found in testing those hypotheses. Implications for further research are also included where appropriate. Chapter V concludes with a summary of the discussion and the contributions of this research study to the fields of linguistics and cognitive psychology.

Discussion of Results Related to Experiment I

The analysis of variance performed in testing null Hypothesis I (there are no significant differences among the means of the verification latencies across the following sentence conditions [TA, FA, FN, TN, FD, TD]) resulted in the rejection of that hypothesis. There was a significant difference among the means of the verification times across conditions (p=.0001). It appears, therefore, that in Spanish, as well as in English, the sentence conditions of the Carpenter and Just (1975) study result in significant differences in verification times. As expected, the means of the verification times increased with the number of hypothesized mental comparisons

necessary to verify the sentence. The mean verification times for sentence conditions k, k+1, and k+5 were significantly different from all others but the means of k+2, k+3, and k+4 were not significantly different from each other.

There was a marked practice effect across the three trials. The second and third trials were completed more rapidly than the first trial and there was a decrease in the slope. This practice effect is similar to that found in other studies (Trabasso et al, 1971; Olson and Filby, 1972; Carpenter and Just, 1975; Singer, 1977). However, there was no interaction effect. The absence of an interaction effect over trials indicates that while subjects performed the task more rapidly with practice, the mental processes and strategies remained the same. In other studies using binary conditions or a picture first presentation, some subjects apparently recoded the predicate negatives as they became more practiced, (Carpenter and Just, 1975). This was concluded from the fact that true predicate negatives were verified faster than false predicate negatives. When predicate negatives are recoded to the affirmative, it results in one fewer mental comparison for the false condition and one additional for the true condition. The verification times for true and false predicate negatives then reverse. (Carpenter and Just, 1975). This phenomenon did not occur

in the present investigation, or if it did, it was not of sufficient magnitude to cause a statistically significant interaction.

A trend analysis with repeated measures resulted in the rejection of null Hypothesis II (There is no linear increase in mean verification times with the increase in the number of comparisons hypothesized by the Just and Carpenter [1975] sentence verification model). The linear component was established ($p=.0001$) and it accounted for 23.9% of the variance. The linearity of the means supports the Just and Carpenter model and the postulate that a single iterative operation underlies the processing of affirmative and negative sentences. It also supports the processing model of Just and Carpenter (see Appendix A) which conceptualizes the mental processes involved as a series of find and compare operations resulting in a match, or in the case of a mismatch, the changing of the truth index and the tagging of the mismatching constituents so that they are treated as a match on subsequent comparisons. Each mismatch comparison reinitiates the comparison process on the next set of elements until all elements have matched or been tagged and then treated as a match. The verification time is, therefore, a function of the number of mismatches and their scope. The Carpenter and Just (1975) analysis of the sentence representations and hypothesized comparisons appears in Appendix A. The number

of comparisons ranges from k through k+5. The intercept at k includes time for reading, encoding, and the two comparison operations needed for the true affirmative sentence. These two comparison operations establish the baseline, or k. Each succeeding sentence condition involves one additional find and compare operation. Repetitions of the find and compare operation should result in equal interval increments from k through k+5. The fit of the obtained means in this study to the straight line predicted by the Just and Carpenter model is presented in Figure 3. The difference between obtained and predicted means in the present experiment appears to be somewhat greater than that found in the 1975 Carpenter and Just study, in English, but it appears similar to that found in their study (Just and Carpenter, 1975) in the Chinese language. The finding of linearity in Spanish as well as in English and Chinese supports the idea that the linearity of the means is the result of underlying universal mental processes.

The finding of linearity also supports the proposition that broad scope negatives (denials) required more comparison operations than did the predicate negatives as they required more verification time. This is as predicted by the Carpenter and Just (1975) model and their analysis of the number of comparisons for broad and narrow scope negatives, (see Appendix A, Table 14 for details).

The greater variability found in this study than in the Carpenter and Just (1975; Just and Carpenter, 1975) studies is likely due to the more heterogeneous pool of subjects. MacLeod et al. (1978) in describing sentence verification studies said that the subjects of many of these experiments have been drawn from student bodies such as Stanford and Carnegie-Mellon which "follow restricted admission policies. The types of processes observed within such a restricted range of abilities as is found in these populations may be quite unrepresentative of the problem-solving processes encountered in the general population." (MacLeod et al., 1978, p. 506). In this investigation, the use of Spanish high school students samples a much broader segment of the population, a younger group developmentally and a different cultural and language background. Given the much broader population base, greater variability is to be expected. At the same time, the finding of linearity of the means in this study supports even more strongly the universality of the process and the "psychological reality of the operation," (Singer, 1977).

In the Just and Carpenter study, the average time for each additional comparison was 200 ms, and in the Chinese study it was 210 ms. Studies such as that by Clark and Chase (1972; Trabasso et al, 1971; MacLeod et al., 1978) which used sentences such as "star is above plus," have shown somewhat higher parameters, but the parameter of

420 ms found in this study is considerably larger than that described in other studies. This larger parameter, appears to be due to the greater heterogeneity of subjects. Support for the idea that the 420 ms parameter is related to intellectual and educational factors can be gained from the fact that MacLeod, et al. (1978) in a sentence verification task similar to that of Clark and Chase (1972) found a significant correlation of reaction time and slope with the verbal and spatial abilities scores of the Washington Pre-College Test, a scholastic aptitude test similar to the widely used Scholastic Aptitude Test (SAT). Also, Hunt, Lunnenborg, and Lewis (1975) found that sentence verification times do covary with tests of verbal ability. It appears, therefore, that verification times are affected by some of the same factors as are measured by many psychometric tests. This would mean that a group of highly selected university students would show less variability and a smaller parameter, that is, they would perform the task more rapidly, than the population as a whole. The younger Spanish students, who were not as selectively grouped by ability or educational attrition, would, therefore, be expected to show a larger parameter, which they did.

The analysis of the data related to testing null Hypothesis III, (There is no correlation between the means of the error responses across sentence conditions [k, k+1,

k+2, k+3, k+4, k+5] and the means of the verification times across sentence conditions) resulted in the rejection of that hypothesis. The mean number of error responses per condition correlated highly (r = .95) with the verification times. A linear trend across the sentence types was also established. This indicates that the number of hypothesized comparisons from k through k+5 resulted not only in longer verification times but also added substantially to the difficulty in deciding whether the statement was true or false.

Some researchers interpret rising verification times across conditions accompanied by rising error rates as an indication that there is no speed-accuracy tradeoff (MacLeod, et al., 1978). This view appears simplistic. The speed-accuracy tradeoff is undoubtedly a continuum. From observations made at the time of testing, it appeared that some students were able to comprehend all of the conditions easily and took only a short time longer on the more difficult conditions. For other students, however, the very high error rate on conditions k+4 and k+5 appeared to be accompanied by an unwillingness to persevere long enough to make all of the comparisons required. Effort and persistence appeared to drop off. There may also have been some students who were incapable of making all the comparisons. Some students found the broad scope negatives so difficult that they missed between one-half and three-

fourths of the items in those categories. It was the opinion of the researcher and her assistant that if the students who found the task the most difficult had been willing and able to make the comparisons necessary, the differences between conditions would have been greater, and that there was, in fact, some speed-accuracy tradeoff.

The mean error rate per student in this study was 11.4%. This is higher than the error rates of 3.4% to 4.7% found in the studies of Just and Carpenter (1975; Carpenter and Just, 1975). This indicates that the subjects in the present study found the task more difficult than did the subjects in the other studies mentioned. Once again, it is likely that this is due to the use of high school students in this study vs. the use of university students in the Carpenter and Just (1975) studies.

Summary:

Both the linearity of the means and the significant differences among the means of the verification times across conditions support the Carpenter and Just (1975) model. While it is not possible to prove that the mind works as depicted by the model, from the linearity of the means across language and cultural boundaries it appears that the additive times are not the result of language or culture, but of the way man decides whether this type of information is or is not true. The Carpenter and Just (1975) analysis of the increasing number of hypothesized

comparisons across conditions and the mental operations required to make the comparisons provides a reasonable and parsimonious explanation for the linearity found. Correlation of mean error rates and mean verification times across conditions indicates that as the number of hypothesized comparisons increases, so does the time needed to verify the sentence and so also does the difficulty in verifying the sentence. The larger parameter and greater variability found in the present study are likely due to the use of a younger and more heterogeneous group of students.

Discussion of Results Related to Experiment II

Sentence Voice Conditions

In Experiment II, the first null hypothesis, (In the sentence-picture verification task, there are no significant differences among the means of the verification times for those Spanish sentences containing active verbs, those containing passive verbs and those containing reflexive verbs) was rejected ($p = .0001$). On the Tukey HSD test, a significant difference was found between reflexive and passive sentences. However, no significant difference was found between active and passive sentences.

Some linguists have hypothesized that the reflexive voice functions as an intermediate form between active and passive sentences. Other linguists have maintained that

the reflexive functions as an active sentence with an accusative subject or even as a clitic verb form. In the present investigation, it was hypothesized that there would be a significant difference between the three sentence voice conditions and that the reflexive would fall between the active and passive in mean verification time. Contrary to expectations, the mean verification time of the reflexive sentences did not fall between the active and passive but reflexive sentences were verified more rapidly than active sentences, (see Figures 7 and 9 for details). The difference between the mean of the reflexive sentences and the mean of the passive sentences was statistically significant. The reflexive verb form may appear similar to the passive in that the subject receives the action of the verb. However, that may be the extent of the similarity. The fact that reflexive sentences are verified significantly more rapidly that passive sentences indicates that the reflexive form is high in the hierarchy of availability and functions as a primary form of expression in the appropriate situation. While the passive exists as a semi-redundant form useful for stylistic variety or for shifting emphasis to the logical object (Olson and Filby, 1972; Johnson-Laird, 1968; Tannenbaum and Williams, 1968). This is not true of the reflexive. In those instances where the reflexive verb has an active and passive form, the reflexive verb has a

particular meaning or use. The reflexive form is often used when the action is performed by the subject on itself (I burned myself), and where this is not the case, the reflexive form has evolved its own distinct verb meaning.

In English, the passive verb form is not the dominant verb form and it is learned later than the active form (Brown and Hanlon, 1970). However, the Spanish reflexive may be a form which is high in the hierarchy of availability and is acquired early developmentally. The toddler who in English says, "me cut my finger," or "me hurt" may be using a form more similar to the reflexive verb form than is the passive. Research aimed at determining the age of acquisition of the three verb forms in Spanish might shed additional light on the relative dominance and availability of these forms.

The results of the present study support the position of those linguists who maintain that the reflexive functions as an active verb with an accusative subject or that it is a clitic verb form. The findings reported here do not support the position of those linguists who maintain that the reflexive verb functions as a "medio" (half) passive.

No statistically significant difference was found between the mean verification time of active and passive sentences in this study. Historically, the difference between active and passive sentences has been elusive.

Early studies, which found that passive sentences took longer to verify than active sentences (Gough, 1965), did not contain controls for sentence length. Control of sentence length sometimes decreased the difference but did not cause the difference to disappear, (Gough, 1966). Reversibility was also found to be a factor which resulted in longer verification times for passive sentences. When reversibility was eliminated passive sentences were sometimes verified nearly as rapidly as active sentences (Slobin, 1966). While in these studies the passive sentences often took longer to verify, the difference between the two frequently was not statistically significant (Olson and Filby, 1972; Wannamacher, 1974). Explanations for the somewhat longer verification times for passive than for active sentences were usually couched in terms of the passive being "less familiar" or "less appropriate" to the particular situation. At other times this statistically nonsignificant difference was explained in terms of having to pass over the logical object in order to check first the logical subject (Gough, 1966).

In the present study, the passive sentences averaged 9.47 syllables, the active sentences 9.59 syllables and the reflexive sentences 10.06 syllables. Thus, sentence length did not contribute to longer verification times for passive sentences. Reversible passive sentences were not included, so reversibility was also eliminated as a factor

which might have contributed to longer verification times for passive sentences. Although the mean verification time for passive sentences was slightly longer than for active sentences, it was not statistically significant. It appears, therefore, that when appropriate to the situation, Spanish passive sentences are responded to nearly as easily as active sentences. These findings are similar to those of Wannamacher, (1974) and of Olson and Filby, (1972).

In analyzing the data related to testing null Hypothesis II, (In the sentence-picture verification task, there is no significant difference in mean verification times between those sentences which are true in relation to the picture and those which are false in relation to the picture), the Tukey HSD statistic indicated there were statistically significant differences between true and false active sentences and between true and false reflexive sentences. Null Hypothesis II was, therefore, rejected. (The difference between true and false passive sentences did not reach the level of statistical significance.) It was predicted that verification times for false sentences would be longer than for true sentences as many studies dealing with truth and falseness have found this to be true. Therefore, most models of mental processes involved in verification assume there is a mental "set" to answer true, and answering false requires an additional mental operation such as the resetting of a truth index. From the

fact that the false active and false reflexive forms took significantly longer to verify than the true forms and from the fact that in Experiment I, the false affirmative sentences (k+1) took significantly longer to verify than the true affirmative sentences (k), it appears that in Spanish, as well as in English, a mental set to answer true is present, and answering false requires an additional mental operation.

That the mental set is capable of being manipulated was demonstrated by Singer (1981) and McCloskey and Glucksberg, (1979). They found that a "set" to answer "don't know" could be induced. Under these circumstances, answering "false" required longer verification times than "don't know." In the present study, no effort was made to manipulate the truth index. In fact, an equal number of true and false responses was used in part to prevent such an occurrence. From the longer times found for falsification in this study and in many studies in English, it appears that both Spanish and English persons normally approach a task with a mental set toward answering true. Additional research would be needed to determine whether in certain circumstances, interactions, or individuals, this mental set is reversed.

The analysis of the data related to testing null Hypothesis III indicated that there was no correlation between the mean number of errors and the mean verification

times across conditions. Null Hypothesis III, therefore, was not rejected. From this, it can be concluded that neither falseness nor voice added systematically to the difficulty in responding to the items. From an error analysis by picture, it was obvious that a few sentence-picture combinations had been missed by many students and the chance grouping of these items had resulted in the finding of a statistically significant difference in the mean number of errors among conditions. The sentence-picture combinations had been designed so that the true and false answers would be obvious. A high error rate on a particular picture indicated that either the picture was ambiguous or the Spanish vocabulary inappropriate. A pilot study at the Inner City Impact Center in Chicago had been used to identify ambiguous pictures and sentences and these had earlier been changed or eliminated. Nevertheless, the error analysis indicated that four sentence-picture combinations were missed by more than one-third of the students. Consultation with a British translator in Tehuacan confirmed the researcher's judgment that three of the cards were ambiguous due to the regional use of a word that differed from the use of the word in the Spanish language in general. These three stimulus cards were therefore discarded (see Appendix F, discarded sentences 1, 2, and 3). The fourth card which was marked incorrectly by more than one-third of the students

contained the Spanish translation of, "The flag was raised." Children from a relatively high socioeconomic or more literate background use one word to describe a flag being raised and children from a lower socioeconomic background, or one in which the parents have little education, use a different word. In discussing this with the British translator and with students, it was discovered that not only was a different word preferred by the different students, but a sentence containing the word preferred by the higher socioeconomic level children was frequently not understood by the children from the lower economic and educational background. In addition, when the word preferred by the children from the lower socioeconomic background was used, the children from the higher economic and educational background judged the sentence false when it should have been true. This card also had to be discarded (see Appendix F, discarded sentence number four.

Even with the four cards removed, there were still several items with a comparatively high error count. The uneven distribution of these cards across conditions resulted in an unpatterned finding of significant differences among conditions.

The elimination of the four cards missed by the highest number of students combined with the fact that the stimulus cards had been designed so that the answers would

be obvious, resulted in the low error rate of 4.7%. This error rate is similar to the error rate of 3.5% of Wannamacher (1974) whose stimulus materials were similar in design.

Experiment II - Mismatch Conditions

In the secondary analysis of the data for Experiment II, the sentences were divided into four categories, true, false at the first point of mismatch, false at the second point of mismatch and false at the third point of mismatch. In this analysis, the researcher sought to determine if the mental operations used in comparing the pictures to the sentences were (a) exhaustive or self terminating, (b) serial or parallel, (c), affected or unaffected by sentence voice.

If the search were exhaustive, there would be no systematic difference in reaction time as a function of the point of mismatch. Each sentence would have been read, encoded and verified at all points and the mean verification times for the three mismatch points would have been equal. Although the differences in the mean verification times of the sentences grouped according to mismatch categories were small, The linearity of the means indicated that the process terminated when a mismatch made it possible to identify the sentence as false. The linear trend also indicated that the mental operations involved in

comparing the sentence elements were carried out serially. In order to determine more precisely the effect of sentence voice on verification times to the mismatch points, the mismatch categories were subdivided into active and passive subgroups. Because there were few items that were false at the verb (second point of mismatch), that category was discarded in looking at the active passive subgroups.

On the basis of findings by Wannamacher (1974) and Olson and Filby (1972), it had been anticipated that when the sentences that were false at the first and third points of mismatch, were subdivided according to whether they were active or passive, there would be no difference between active and passive subgroups to each mismatch point. However, when active sentences were considered alone, (see Figures 13 and 14) the difference between the means of the sentences that were false at the first mismatch point and those that were false at the third mismatch point increased reaching statistical significance. When the passive sentences to the first and third points of mismatch were considered alone, they did not follow this pattern. The difference between the means of the passive sentences was nonsignificant, but, it is clear that something different occurred than with the active sentences. The two passive means not only were closer together, but they reversed in order. Passive sentences to the third point of mismatch were verified somewhat more rapidly than those to the first

point of mismatch. If the mental processes were carried on in serial order on surface structure, the verification times for active to the first mismatch point and passives to the first mismatch point should have been the same. Instead, actives to the first mismatch point were significantly different from actives to the third mismatch point and from passives to the first mismatch point, and actives to the third mismatch point were significantly different from actives to the first mismatch point and from passives to the third mismatch point. These findings are at variance with those of Wannamacher (1974). In her study, actives and passives were processed in surface structure format and there was a clear linear ordering from first through third points of mismatch for actives and passives alike. Wannamacher (1974) also found much larger differences in verification times to each point of mismatch. In that study, however, the picture was presented first and the sentences were read to the subjects. Reaction time was measured from the auditory presentation of the first noun in the sentence. True sentences were verified only slightly slower than the sentences which were false at the third point of mismatch but there was a significant difference between mean verification times for mismatch points one, two and three. Wannamacher proposed that a processing loop had been applied to each sentence element. This loop consisted of

an encoding, a comparison and a decision. This may have occurred under the circumstances of her investigation as the slower oral presentation would have permitted the checking of each sentence element as it was presented. In the present study, the smaller differences between sentence conditions indicates that the sentence and picture were encoded before the comparison process began. This would also account for true sentences being verified more rapidly than the sentences which were false at the first point of mismatch. (cf. In Wannamacher's 1974 study, true sentences were verified only slightly more rapidly than sentences that were false at the third point of mismatch.)

The oral presentation used by Wannamacher (1974) may also have placed a constraint upon subjects to process in surface structure format. It would appear that in the present study, without this constraint, passive sentences were not all processed in the same order as active sentences. Two explanations are possible for this difference. The first is that the pictures may have been given an active encoding. Verification, therefore, might have proceeded in the order of the nouns in the active picture encoding. An alternative explanation is based on the finding of Glucksberg, Trabasso and Wald, (1973) in whose sentence verification study, verb mismatches were detected the most rapidly, then mismatches of the grammatical subject, and finally mismatches of the

grammatical object. Glucksberg, et al. (1973) maintained that verification of the verb is first as it is the sentence unit which carries the most information. Agent nouns are the next most important element and so are verified second. Finally the recipient of the action is checked. If all of these fail to satisfy the need for information, then feature and syntactic information must be checked. This model borrows from the theories of case grammar of Rumelhart, Lindsay, and Norman (1972, cited in Glucksberg et al., 1973). This theory provides a very good fit to the data of the present Experiment (see analysis in Appendix G). However, because there were so few members of the category that were false at the verb, this ad hoc explanation, while it may be the correct one, is not strongly supported by the results reported here. A study designed specifically to determine active and passive processing to each of the mismatch points could more accurately determine the order in which the elements of passive sentences are verified.

Summary

The importance of this sentence verification task in Spanish is that it examines the verification times for sentence-picture verification tasks from three perspectives: (1) the effects of sentence voice, (2) the effects of falseness, and (3) the effects of the locus of the mismatch.

In looking at sentence voice, a statistically significant difference was found between reflexive and passive sentences both in their true and false conditions. Reflexive sentences were verified more rapidly than passive sentences. They were also verified more rapidly than active sentences but not significantly so. It appears that the reflexive verb functions as a primary verb form and is high in the hierarchy of availability. Its function does not appear similar to the passive voice which is used primarily for stylistic variety and to shift emphasis to the logical object.

The proposition that falseness increases verification time was supported by the results of both the primary and secondary analysis. When the sentences were grouped according to sentence voice, falseness resulted in significantly longer verification times for false active and false reflexive sentences, two of the three sentence voice conditions. The false passive sentences were somewhat longer than the true passive but the difference was not statistically significant. When the sentences were grouped according to the point of mismatch, the true sentences were verified significantly more rapidly than the false which had to be verified at the same three mismatch points. This longer verification time for falseness supports those models of cognitive processing which include a mental operation such as the resetting of a truth index

for false responses (Carpenter and Just, 1975; Clark and Chase, 1972; Trabasso et al., 1971. MacLeod, et al., 1978).

There was no indication that falseness or sentence voice correlated with the mean number of errors per condition. Instead, errors seemed to be associated with individual sentence-picture combinations and to be the result of ambiguity or inappropriate vocabulary.

In looking at the effects of the locus of the mismatch, the mean verification times of the sentences grouped according to point of mismatch showed a linear trend. The percent of variance (10%), accounted for by the linear trend was low but statistically significant. Thus there was some support for the position that sentence verification occurs serially and is self terminating at the point of mismatch.

Finally, the subdivision of sentences false at the first point of mismatch and those that were false at the third point of mismatch according to active and passive voice, indicated that there is a difference between the mental processing of active and passive sentences to the first and third points of mismatch. With active sentences it is very clear that the mental processes are serial and self-terminating at the first point of mismatch that makes truth or falsity determinable. For passive sentences, the picture is not as clear. The difference between the means is not only nonsignificant, but the order of the means is

reversed. This may have been due to the fact that the picture received an active encoding and the nouns were verified in the order of the active picture encoding (Olson and Filby, 1972), or it may have been due to the fact that people tend to verify according to the elements which provide the most information, that is, (a) verb, (b) agent, (c) object, regardless of their locus in the sentence. Either process, used by part of the students, or part of the time, would have resulted in the findings reported in the present investigation. From the results of the analysis of active and passive subgroups of the mismatch categories, it appears that the passive voice does not result in a statistically significant difference in the verification times between the active and passive voice, but it does affect the order in which the sentence elements are compared.

Theoretical and Practical Implications

Because of the nature of the present study, the primary implications are theoretical. Considerable cross cultural research has dealt with language and linguistic universals, but the present study was designed to contribute to man's knowledge of processing universals. Mapping the way man thinks and finding that other languages and cultures follow the same principles helps in understanding those universals.

The processing universals supported by the present cross language study are:

1. Differential verification times for falseness, negation and broad scope negation are the result of the number of comparison operations necessary for their processing.

2. The mismatch due to a false condition results in longer verification times due to a mental process such as the resetting of a truth index.

3. Broad scope negation results in longer verification times than narrow scope negation due to additional find and compare operations.

4. In sentence picture verification tasks, processing is serial and self-terminating.

5. There are differences in the processing order of active, passive and reflexive sentences.

6. The elements of active sentences are verified in the order of the locus of the mismatch in the sentence.

While the present study was primarily theoretical in nature, there were also some practical implications. In the sentence verification task using active, passive and reflexive sentences, the results indicated that when appropriate to the situation, passive sentences are as easy to understand as active sentences. Therefore, in writing and translation work, when the passive voice is desired for stylistic effect or to shift emphasis to the logical

object, the use of the passive voice need not be avoided.

From the fact that the reflexive voice was verified more rapidly than the active and significantly more rapidly than the passive, it appears that the function of the reflexive is quite different from the passive. Native speakers of Spanish have probably intuitively sensed the dominance of the reflexive verb. The practical implications of the present study would seem to be that students learning Spanish as a second language should be helped to grasp the importance and power of the reflexive voice. Using the direct English translation, even though it is ungrammatical, might be a way of getting at the directness of the reflexive expressions. "Me hurt," "Him happy," and "Him called Jim" gives a very different feeling from "It hurts me," "It pleases him," and "He is named Jim." Explaining to students that the reflexive functions as an active sentence with an accusative subject or as a shortened form similar to "pidgin" English might result in the verb form being easier to learn. It might also result in students placing the reflexive verb in the important place it deserves based on its function in the Spanish language.

There is also one finding of the present study which, while it was not the primary focus of the research project at hand, is mentioned here because of the fact that research related to this finding could have important

educational implications. In the replication of the Just and Carpenter (1975) study, there was a small percentage of students who were unable to verify correctly even half of the broad scope negatives and one person who was unable to verify correctly even half of the narrow scope negatives. Correlation of psychometric ability tests with the Just and Carpenter error scores could be used to determine if persons below certain levels of ability on abstract thinking or short term memory are unable to process broad, or even narrow scope negatives. The results of such a study could be important in (1) identifying children who have difficulty in processing negatives, (2) preparing educational materials used with children who have difficulty in processing these negatives or (3) determining if special teaching could aid children in learning how to process these negatives.

Research Recommendations

Future research related to the Just and Carpenter study should focus on the following:

1. Correlation of scores on psychometric tests with the slope and error rates obtained on the sentences. This would indicate whether certain abilities are related to the ability to process negatives and to the strategies used in that processing.

2. Varying the instructions to determine the effect

on the slope. Instructions which would encourage less capable students to do their best might result in some students completing the process even though it was difficult for them. This might result in a more accurate slope for those individuals.

3. Replication of the study in an unrelated language and culture. This could provide additional support for the proposition that underlying universal processes are responsible for the differential verification times.

Future research related to active, passive and reflexive voice should focus on the following:

1. An extension of the present study so as to include equal numbers of active, passive and reflexive sentences with an equal number of sentences in each mismatch category. The results of this design would more accurately reflect the order of processing for all three sentence types.

2. The use of the technique of holding one mental process constant while varying another as advocated by Sterberg (1969a, 1969b). A picture-first vs. a picture-second presentation would make it possible to determine if an active picture encoding was responsible for the processing order of the sentence elements in the passive sentences.

3. The establishment of models to account for the differences in processing.

4. A study of the age of acquisition of active, passive and reflexive forms in Spanish similar to what has been done in English. This would yield additional information about the way these verb forms function in Spanish.

5. Correlations with psychometric tests. Since research has indicated that different people may adapt different processing strategies for the same task (MacLeod et al., 1978) and that the same person may change strategies under different circumstances (Carpenter and Just, 1975), correlation with other psychometric tests may be a useful way of identifying and looking at individual differences in processing and strategy choice.

6. The use of increasingly sensitive electronic equipment. The use of newer, more sensitive electronic equipment as it becomes available will help to reduce error variability due to physical conditions.

7. The use of Event Related Potentials (ERPs) as measured by encephalograms (Squires, Donchin and Squires, 1977). Recently, ERPs have been shown to be associated with a variety of cognitive processes including attention, memory search, response expectations and response preparation. A recent study by Fischler, Bloom, Childers, Roucos and Perry (1983) has shown higher negative scalp potentials for false affirmative sentences than for true affirmative sentences and higher negative scalp potentials

for true sentences when the sentence itself contained a negative (i.e., the higher negative scalp potentials reflected a semantic mismatch). Future research in cognitive processing needs to correlate data from existing studies with data obtained using the ERPs. In future sentence verification studies, the use of ERPs should be considered as a way of obtaining more accurate measurement and additional types of information.

CHAPTER VI

SUMMARY

In this experimental investigation carried out in the Spanish language, two sentence picture verification tasks were used to evaluate systematic differences in verification time related to falsification, negation and sentence voice in Spanish. Experiment I was a systematic replication of the Just and Carpenter (1975) embedded sentence study designed to test their "constituent comparison model" of the mental processes involved in verifying affirmative, negative, and broad scope negative sentences which could in turn be true or false. Spanish translations of the sentences were presented to sixteen year old high school students in the interior of Mexico. The results of the repeated measures design indicated there was a statistically significant difference among the means of the sentence conditions presented to sixteen year old high school students in the interior of Mexico. The results of the repeated measures design indicated there was a statistically significant difference across the means of the sentence conditions ($p=.0001$). In addition, findings indicated that verifiction times increased linearly with the number of hypothesized comparisons of the Just and

Carpenter model across the sentence conditions, (true affirmative, false affirmative, false negative, true negative, false denial [broad scope negative] and true denial). The linear component accounted for 23.9% of the total variance. The average increase per condition was 444 ms. Compared with the findings of the Just and Carpenter (1975) study, the Spanish high school students showed greater variability, a larger intercept, a larger parameter and a higher error rate. Overall, the linearity found in the present study supports the Carpenter and Just constituent comparison model as well as the thesis that the linearity is the result of underlying universal cognitive processes.

Experiment II was designed to evaluate the differences in verification times related to active, passive and reflexive voice in Spanish. Cartoon style drawings were paired with an equal number of active, passive and reflexive sentences. The order of the means of the true conditions was: reflexive < active < passive. The difference between the reflexive and the passive was found to be statistically significant. Given these results, it appears that the reflexive verb functions as a primary form that is high in the hierarchy of availability.

A secondary analysis of the data divided the sentences into four categories based on the locus of the mismatch (i.e., [1] sentences false at the first noun, [2]

sentences false at the verb, [3] sentences false at the final noun or adjective and [4] true sentences which had no mismatch.) Linearity of the means was established indicating mental processing was serial and self terminating ($p = .0015$). A further subdivision into active and passive subgroups of the sentences that were false at the first and third nouns indicated that active sentences were processed in surface structure order according to the locus of the mismatch in the sentence but passive sentences were not. Active sentences which were false at the first mismatch point were verified significantly more rapidly than actives false at the third mismatch point and passives which were false at the first mismatch point. In addition, actives which were false at the third mismatch point were verified significantly more slowly than actives which were false at the first mismatch point and passives which were false at the third mismatch point. All things considered, findings indicated that there is no statistically significant difference in the duration of verification times for active and passive sentences but the active and passive voices do result in a significant difference in the order in which sentence elements are processed.

REFERENCES

Anderson, J. R. & Bower, G. H. (1973). Human associative memory. Washington, D.C.: Wiley.

Babcock, S. S. (1970). The syntax of Spanish reflexive verbs. The Hague, Netherlands: Mouton.

Bello, A. (1928). Gramatica de la lengua espanola. Madrid: Real Academia Espanola.

Brown, R., & Hanlon, C. (1970). Derivational complexity and the order of acquisition in child speech. In Hayes, J. R. (Ed.), Cognition and the development of language. New York: Wiley.

Carpenter, P. A. (1973). Extracting information from counterfactual clauses. Journal of Verbal Learning and Verbal Behavior, 12, 512-521.

Carpenter, P. A.,& Just, M. A. (1972). Semantic control of eye movements during picture scanning in a sentence picture verification task. Perception and Psychophysics, 12, 61-64.

Carpenter, P. A., & Just, M. A. (1975). Sentence comprehension: A psycholinguistic processing model of verification. Psychological Review, 82, 45-73.

Carpenter, P. A., & Just, M. A. (1976). Models of sentence verification and linguistic comprehension. Psychological Review, 83 (4), 318-322.

Chase, W. G., & Clark, H. H. (1972). Mental operations in the comparison of sentences and pictures. In L. Gregg (Ed.) Cognition in Learning and Memory, New York: Wiley.

Chomsky, A. N. (1957). Syntactic structures. The Hague: Mouton.

Clark, H. H. (1969). Linguistic processes in deductive reasoning. Psychological Review, 76, 387-404.

Clark, H. H., & Chase, W. G. (1972). On the process of comparing sentences against pictures. Cognitive Psychology, 3, 472-517.

Clark, H. H., & Clark, E. V. (1977). Psychology and language. New York: Harcourt Brace Jovanovich.

Donders, F. C. (1869). Over de snelheid van psychische processen. Onderzoekingen gedaan in het Psyiologish Laboratorium der Utrechtsche Hoogeschool: Tweede Reeks, II. Translated by W. G. Koster in W. G. Koster (Ed.), Attention and Performance II. Acta Psychologica, 1969, 30, 412-431.

File, S. E., & Jew, A. (1973). Syntax and the recall of instructions in a realistic situation. British Journal of Psychology, 64, 65-70.

Fischler, I., Bloom, P. A., Childers, D. G., Roucos, S. E., & Perry, N. W., Jr., (1983). Brain potentials related to stages of sentence verification. Psychophysiology, 20 (4), 400-409.

Glucksberg, S., Trabasso, T., & Wald, J. (1973). Linguistic structures and mental operations. Cognitive Psychology, 5, 338-370.

Glushko, R. J., & Cooper, L. A. (1978). Spatial comprehension and comparison processes in verification tasks. Cognitive Psychology, 10, 391-421.

Gough, P. B. (1965). Grammatical transformations and speed of understanding. Journal of Verbal Learning and Verbal Behavior, 4, 107-111.

Gough, P. B. (1966). The verification of sentences: The effects of delay of evidence and sentence length. Journal of Verbal learning and Verbal Behavior, 5, 492-496.

Green, J. N. (1975). On the frequency of passive constructions in modern Spanish. HS, LII, 345-362.

Greenberg, J. H. (1966). Language universals. In T. A. Seboek (Ed.). Current Trends in Linguistics 3. The Hague: Mouton.

Hays, W. L. (1963). Statistics for psychologists. New York: Holt, Rinehart and Winston.

Herriot, P. (1969). The comprehension of active and passive sentences as a function of pragmatic expectations. Journal of Verbal Learning and Verbal Behavior, 8, 166-169.

Hasegawa, K. (1968). The passive construction in English. Language, 44, 230-243.

Hoosain, R. (1973). The processing of negation. Journal of Verbal Learning and Verbal Behavior, 12, 618-616.

Hunt, E., Lunneborg, C., & Lewis, J. (1975). What does it mean to be high verbal? Cognitive Psychology. 7 194-227.

Johnson-Laird, P. N. (1968). The choice of the passive voice in a communicative task. British Journal of Psychology, 59, 7-15.

Jones, S. (1966). The effect of a negative qualifier in an instruction. Journal of Verbal Learning and Verbal Behavior, 5, 497-501.

Just, M. A., & Carpenter, P. A. (1971). Comprehension of negation with quantification. Journal of Verbal Learning and Verbal Behavior, 10, 244-253.

Just, M. A., & Carpenter, P. A. (1975). Comparative studies of comprehension; an investigation of Chinese, Norwegian, and English. Memory and Cognition, 3, 465-473.

Just, M. A., & Clark, H. H. (1973). Drawing inferences from the presuppositions and implications of affirmative and negative sentences. Journal of Verbal Learning & Verbal Behavior, 12, 21-31.

Kerlinger, F. N., & Pedhazur, E. J. (1973). Multiple regression in behavioral research. New York: Holt, Rinehart and Winston.

Kintsch, W. (1970). Learning, memory and conceptual processes. New York: Wiley.

Kirk, R. E. (1968). Experimental design: Procedures for the behavioral sciences. Belmont, California: Brooks/Cole.

Lachman, R., Lachman, J. E., & Butterfield, E. C. (1979). Cognitive psychology and information processing: An introduction. New York: Halstad Press.

Lantolf, J. P. (1976). Concerning the deep structures of Spanish reflexive sentences. General Linguistics, 16, 101-206.

MacLeod, C. M., Hunt, E. B., & Mathews, N. N. (1978). Individual differences in the verification of sentence-picture relationships. Journal of Verbal Learning and Verbal Behavior, 17, 493-507.

McCloskey, M., & Glucksberg, S. (1979). Decision process in verifying category membership statements. Implications for models of semantic memory. Cognitive Psychology, 11, 1-37.

Mehler, J. (1963). Some effects of grammatical transformations on the recall of English sentences. Journal of Verbal Learning and Verbal Behavior, 2, 346-351.

Miller, G. A. (1962). Some psychological studies of grammar. American Psychologist, 17, 748-762.

Miller, G. A., & McKean, K. (1964). A chronometric study of some relations between sentences. Quarterly Journal of Psychology, 16, 297-308.

Newell, A. (1972). A theoretical exploration of mechanisms for coding the stimulus. In A. W. Melton & E. Martin (Eds.), Coding Processes in Human Memory. Washington, D.C.: Winston.

Newell, A., Shaw, J. C., & Simon, H. A. (1958). Elements of a theory of human problem solving. Psychological Review, 65, 151-166.

Olson, D. R., & Filby, N. (1972). On the comprehension of active and passive sentences. Cognitive Psychology, 3, 361-381.

Sabatini, R. N. (1977). The origin of se as impersonal and passive particles. Hispania, 60, 524.

Seymour, P. H. K. (1969). Response latencies in classification of word-shape pairs. British Journal of Psychology, 60, 433-451.

Shoben, E. J. (1976). The verification of semantic relations in a same-different paradigm: An asymmetry in semantic memory. Journal of Verbal Learning and Verbal Behavior, 15, 365-380.

Shoben, E. J. (1978). Theoretical Note. Choosing a model of sentence-picture comparisons: A reply to Catlin and Jones. Psychological Review, 85 (2), 133-137.

Singer, M. A. (1977). A constituent comparison model of a picture-first verification task. Memory and Cognition, 5, 269-272.

Singer, M. A. (1981). Verifying the assertions and implications of language. Journal of Verbal Learning and Verbal Behavior, 20 (1), 46-60.

Slobin, D. I. (1966). Grammatical transformations and sentence comprehension in childhood and adulthood. Journal of Verbal Learning and Verbal Behavior, 5, 219-227.

Squires, N. K., Donchin, E., & Squires, K. C. (1977). Bisensory stimulation: Inferring decision-related processes from the P300 component. Journal of Experimental Psychology: Human Perception and Performance, 3 (2), 299-315.

Sternberg, S. (1969a). Mental processes revealed by reaction-time experiments. American Scientist, 57, 421-457.

Sternberg, S. (1969b). The discovery of processing stages: Extensions of Donder's method. In W. Koster (Ed.), Attention and performance, II. Acta Psychologica, 30, 412-431.

Suner, M. (1976). Demythologizing the impersonal se in Spanish. Hispania, 59, 268-275.

Tannenbaum, P. H., & Williams, F. (1968). Generation of active and passive sentences as a function of subject or object focus. Journal of Verbal Learning and Verbal Behavior, 7, 246-250.

Trabasso, T. (1972). Mental operations in language comprehension. In J. B. Carroll & R. O. Freedle (Eds.), Language comprehension and the acquisition of knowledge. Washington, D. C.: Winston.

Trabasso, T., Rollins, H., & Shaughessy, E. (1971). Storage and verification stages in processing concepts. Cognitive Psychology, 2, 239-389.

Turner, E. A., & Rommetveit, F. (1967). The acquisition of sentence voice and reversibility. Child Development, 38, 649-660.

Wallach, M. A. (1959). The influence of classification requirements on gradients of response. Psychological Monographs, 73, (whole no. 478).

Wannemacher, J. T. (1974). Processing strategies in picture-sentence verification tasks. Memory and Cognition, 2 (3), 554-560.

Wason, P. C. (1959). The processing of positive and negative information. Quarterly Journal of Experimental Psychology, 11, 92-107.

Wason, P. C. (1961) Response to affirmative and negative binary statements. British Journal of Psychology, 52, 133-142.

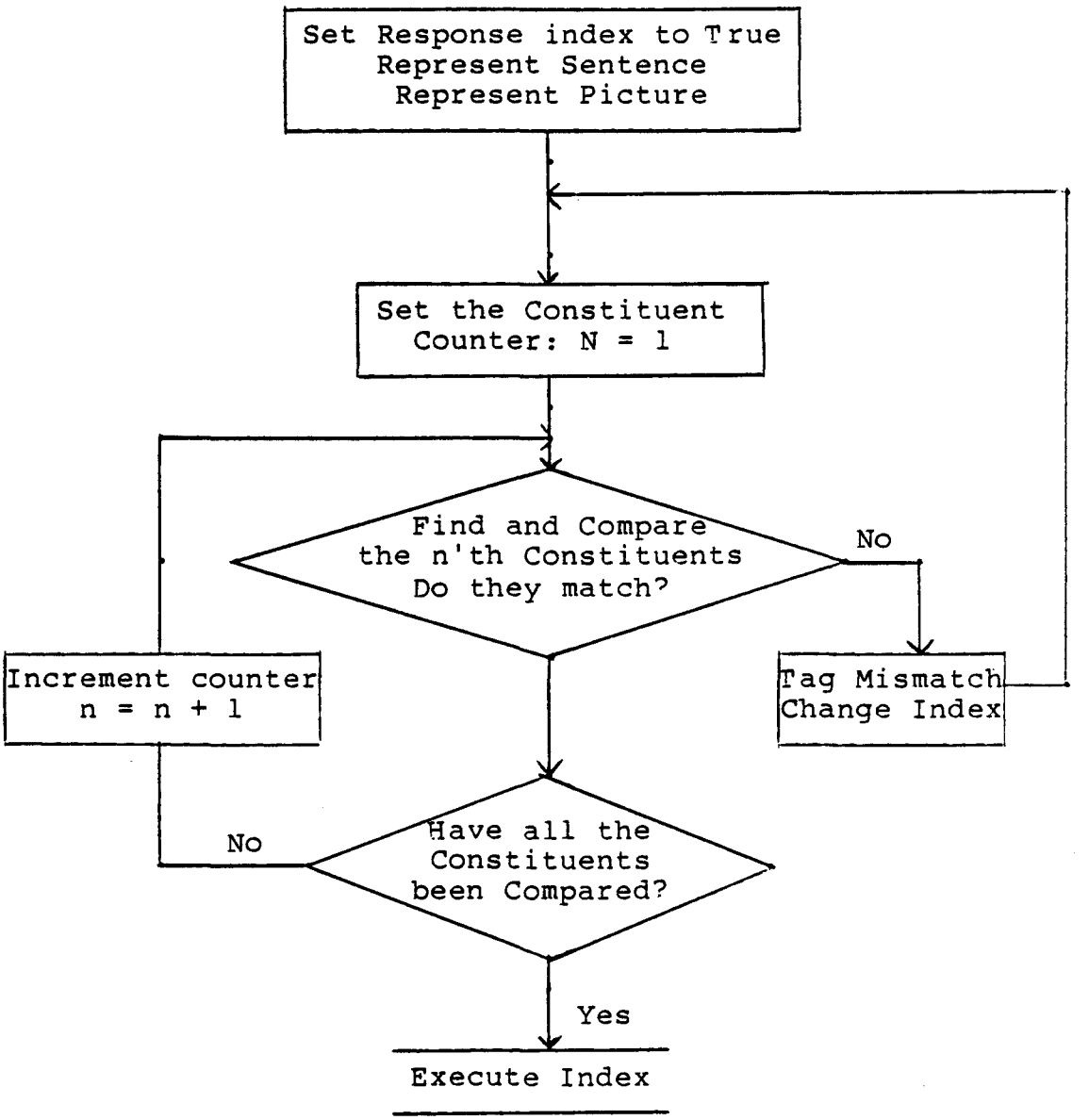
Wason, P. C., & Jones, S. (1963). Negatives: Denotation and connotation. British Journal of Psychology, 54, 299-307.

Wright, P. (1969). Transformations and the understanding of sentences. Language and Speech, 12, 156-166.

APPENDIX A

Figure 15

The Constituent Comparison Model



(From Carpenter & Just, 1975, p. 48).

Table 15

Representations and Predictions for the Six Information Conditions

Stimuli and Representations	True Affirmative	False Affirmative
Sentence	It's true that the dots are red	It's true that the dots are red.
Picture	Red dots	Black dots
Sentence rep.	[AFF, (RED,DOTS)]	[AFF, (RED,DOTS)]
Picture rep.	(RED,DOTS) + +	(BLACK,DOTS) - index=false + + response = false
	response = true k comparisons	k + 1 comparison
	False Predicate Negative	**True Predicate Negative**
Sentence	It's true that the dots aren't red.	It's true that the dots aren't red.
Picture	Red dots	Black dots
Sentence rep.	[NEG,(RED,DOTS)]	[NEG,(RED,DOTS)]
Picture rep.	(RED,DOTS) - + index=false + + response = false	(BLACK,DOTS) - index=false - + index=true + + response = true
	k + 2 comparisons	k + 3 comparisons
	False denial	**True denial**
Sentence	It isn't true that the dots are red.	It isn't true that the dots are red.
Picture	Red dots	Black dots
Sentence rep.	{NEG,[AFF,(RED,DOTS)]}	{NEG,[AFF,(RED,DOTS)]}
Picture rep.	(RED,DOTS) - + + index=F + + + Response = false	(BLACK,DOTS) - index=F - + + index=T + + + Response = true
	k + 4 comparisons	k + 5 comparisons

Note. Plus and minus signs denote matches and mismatches of the corresponding constituents. Each horizontal line of plus and minus signs indicates a reinitialization of the comparison process. (Table from Carpenter and Just, 1975, p. 52) Abbreviations not in the original: Representation (rep), True (T) False (F).

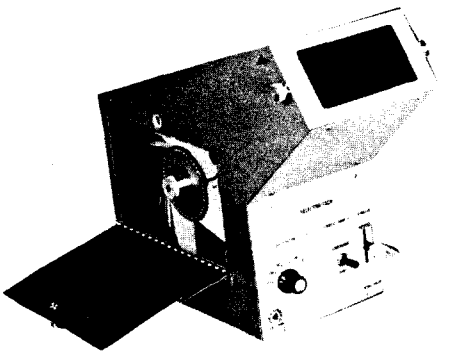
APPENDIX B

Stimulus Sentences - Experiment I

	Sentences	Picture	T-F
1.	It's true the dots are red.	red dots	T
2.	It's true the dots are red	red dots	T
3.	It's true the dots are red.	black dots	F
4.	It's true the dots are red.	green dots	F
5.	It's true the dots are not red.	red dots	F
6.	It's true the dots are not red.	red dots	F
7.	It's true the dots are not red.	black dots	T
8.	It's true the dots are not red.	green dots	T
9.	It's not true the dots are red.	red dots	F
10.	It's not true the dots are red.	red dots	F
11.	It's not true the dots are red.	black dots	T
12.	It's not true the dots are red.	green dots	T
13.	It's true the dots are black.	black dots	T
14.	It's true the dots are black.	black dots	T
15.	It's true the dots are black.	green dots	F
16.	It's true the dots are black.	red dots	F
17.	It's true the dots are not black.	black dots	F
18.	It's true the dots are not black.	black dots	F
19.	It's true the dots are not black.	green dots	T
20.	It's true the dots are not black.	red dots	T
21.	It's not true the dots are black.	black dots	F
22.	It's not true the dots are black.	black dots	F
23.	It's not true the dots are black.	green dots	T

24.	It's not true the dots are black.	red dots	T
25.	It's true the dots are green.	green dots	T
26.	It's true the dogs are green.	green dots	T
27.	It's true the dots are green.	red dots	F
28.	It's true the dots are green.	black dots	F
29.	It's true the dots are not green.	green dots	F
30.	It's true the dots are not green.	green dots	F
31.	It's true the dots are not green.	red dots	T
32.	It's true the dots are not green.	black dots	T
33.	It's not true the dots are green.	green dots	F
34.	It's not true the dots are green.	green dots	F
35.	It's not true the dots are green.	red dots	T
36.	It's not true the dots are green.	black dots	T

APPENDIX C



LAFAYETTE
INSTRUMENT
COMPANY, INC.

Individual Tachistoscopes

40020 SELECTRO TACH

This unit is functionally identical to the 40010 Electro-Tach above with the added feature of placing up to 100 stimuli on a revolving drum. Depressing the "Advance" lever automatically rotates the drum to the next stimulus card. Five hundred stimuli are again provided plus two drums. See the 40010 description for specific stimulus lists. Blank 4-1/8" wide x 2½" high cards may be ordered below for generating custom stimulus material.

ACCESSORIES

40201 Extra Drum (Holds 100 stimuli)
40202 Blank Cards, 100
40203 Blank Cards, 1,000
40210 Carrying Case

APPENDIX D

(Consent Form)

Yo, _____ soy mayor de 16 años de edad y quiero participar en este investigaciòn sobre el procedimiento de hacer decisiones conducido por la Sẽnora Ruth Crockett. Ella me diò explicaciòn completa del razonamiento y la manera de conducir esta investigaciòn. Entiendo que no corre ningun riesgo personal. Tambièn, entiendo que puedo renunciar de esta investigacion en cualquier momento y mi participaciòn o falta de participaciòn no influenciarìa sobre mi èxito acadèmico.

_____ _____

Fecha Firma

English translation of the above form:

I, _____ am older than 16 and wish to participate in this research study dealing with decision making being conducted by Mrs. Ruth Crockett. She has given me a complete explanation of the rationale and method of conducting the study. I understand that there is no personal danger. I also understand that I may withdraw from the study at any time and that my participation or lack of participation will have no effect on my academic grades.

_____ _____

(Date) (Signature)

INSTRUCTIONS

Aquì dentro (investigator pointed to scope of the tachistascope) usted verìa una seria de tarjetas que tienen puntos de distintos colores, rojos, verdes o negros ("dibujas" was substituted in Experiment 2). Como esta tarjeta (investigator showed a sample card). Arriba de los puntos (la dibuja) hay una oraciòn. Necesitarìa leer la oraciòn y decidir si la oraciòn es verdadera o falsa. Aquì hay dos botones (investigator indicated decision button apparatus). Este botòn es para una oraciòn falsa y este para una oraciòn verdadera (investigator pointed out labels on buttons). Podrìa indicar con estos botones si la oraciòn es verdadera o falsa.

Cuando usted està listo ("lista" was substituted each time the subject was a girl) para ver la tarjeta, tendrìa que empujar cualquier botòn para indicarlo. Dentro de medio segundo la tarjeta estarà iluminada y podrìa ver la tarjeta. Indicarìa su respuesta tan pronto como sea posible. Despuès de indicar la respuesta para una tarjeta, tendrìa que empujar uno de los botones para indicar que esta listo (lista) para la pròxima tarjeta. Otra vè, en medio segundo podrìa ver una tarjeta. Hay preguntas? (If there were no questions, the investigator continued.)

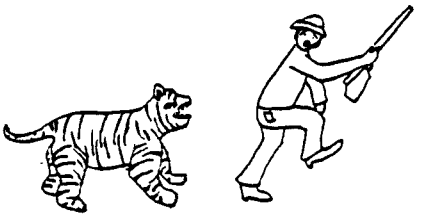
Empezarèmos con diè tarjetas de practica. Despuès de

cada tarjeta de practica, le dirè si la respuesta es correcta o no. Esta listo (lista) para las tarjetas de practica? Si esta listo (lista), oprima cualquier botòn y podrìa ver la primera tarjeta.

APPENDIX E

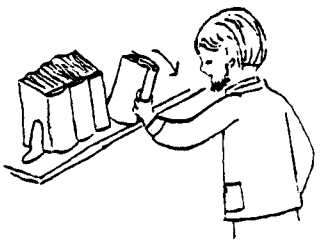
True Active Sentences

El tigre espanta al cazador.



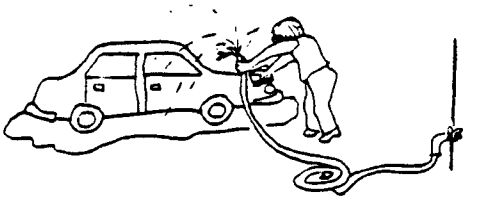
1

El señor coge el libro.



2

El joven lava el carro.



3

El padre casa la pareja.

4

La mujer quema el papel.

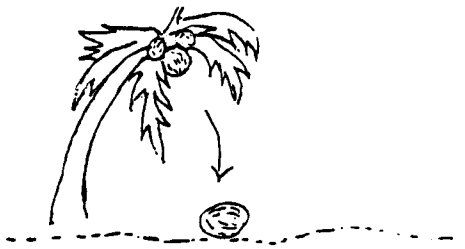
5

El estudiente levanta la mano.

6

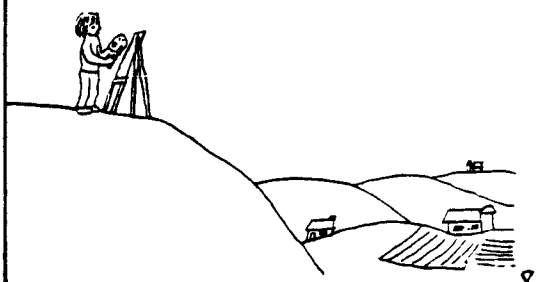
1. The tiger frightens the hunter.
2. The man takes a book.
3. The boy is washing the car.
4. The priest is marrying the couple.
5. The woman is burning the paper.
6. The student is raising his hand.

El coco grande cayó del arbol.



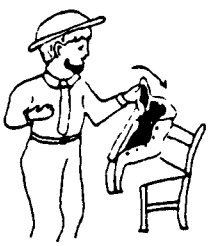
7

El artista pinta el paisaje.



8

El hombre pone el abrigo en la silla.

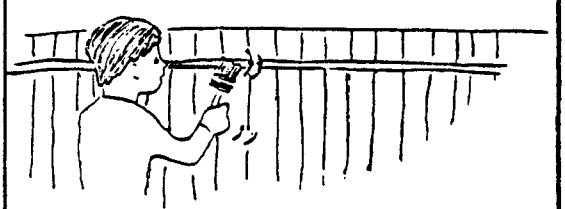


9

El niño baña el perro.

10

El niño pinta la cerca.

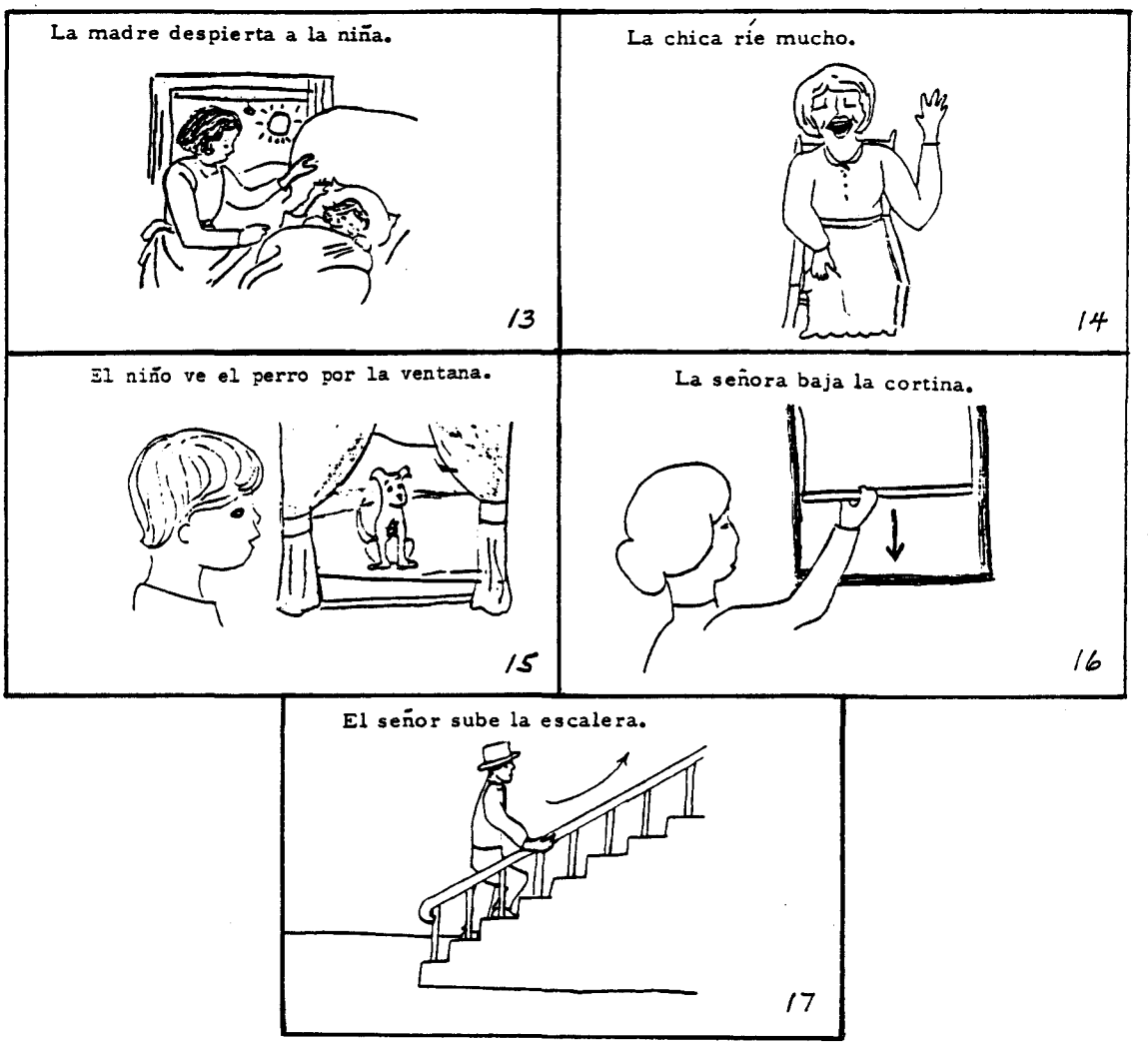


11

La madre acuesta a su hija.

12

7. The large coconut fell from the tree.
8. The artist is painting the countryside.
9. The man is putting his coat on the chair.
10. The boy is bathing the dog.
11. The boy is painting the fence.
12. The mother is putting her daughter to bed.



13. The mother wakes up the girl.

14. The girl is laughing hard.

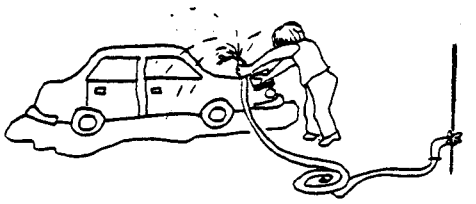
15. The boy sees the dog through the window.

16. The lady lowers the shade.

17. The man is going up the stairs.

False Active Sentences

El joven lava la bicicleta.



1

El padre abre la puerta.

2

El plátano cayó del arbol.

3

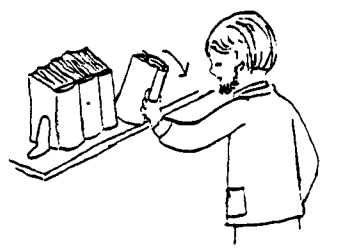
La madre pasea a su hija.

4

El estudiente saluda la bandera.

5

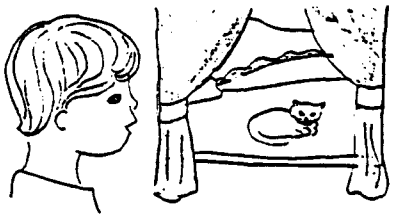
El niño pone la pelota en la mesa.



6

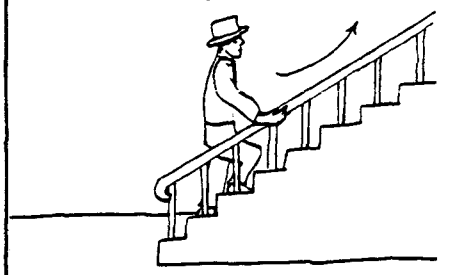
1. The boy is washing the bicycle.
2. The priest is opening the door.
3. The banana fell from the tree.
4. The mother is taking her daughter for a walk.
5. The student is saluting the flag.
6. The boy is putting the ball on the table.

El niño ve el perro por la ventana.



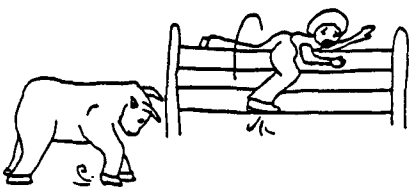
7

El señor baja la escalera.



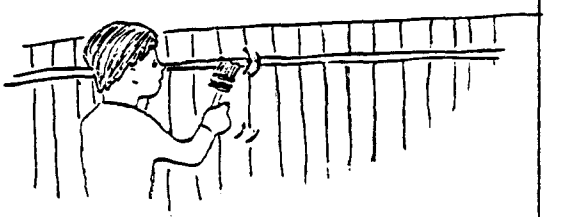
8

El tigre espanta al cazador.



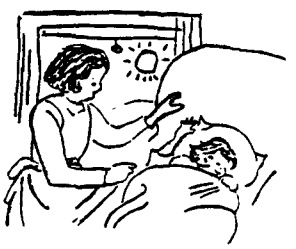
9

El niño pinta el carro.



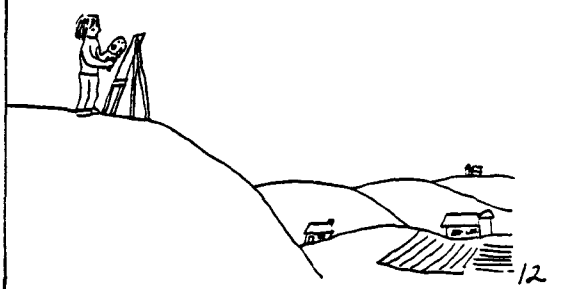
10

La niña despierta a la madre.



11

El artista pinta el mar.



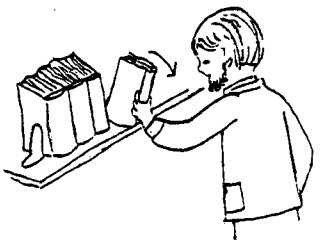
12

7. The boy sees the dog through the window.
8. The man descends the stairs.
9. The tiger frightens the hunter.
10. The boy is painting the car.
11. The girl is waking up her mother.
12. The artist is painting the sea.

La chica hace un pastel.

13

El señor coge el gato.



14

La niña baña la nene.

15

La señora le corta el pelo.

16

La chica baila mucho

17

13. The girl is making a dress.

14. The man picks up the cat.

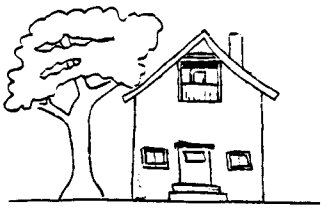
15. The girl is bathing the baby.

16. The woman is cutting her hair.

17. The girl is dancing a lot.

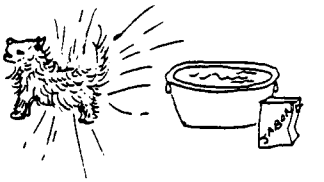
True Passive Sentences

La casa fue pintada azul.



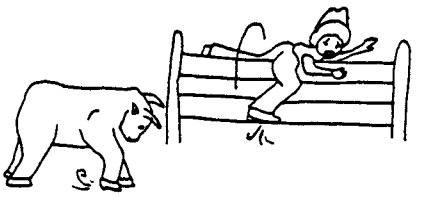
1

El perro fue bañado.



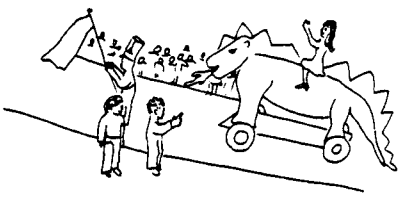
2

El jóven fue espantado por el toro.



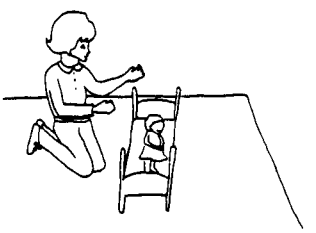
3

El desfile es visto por los niños.



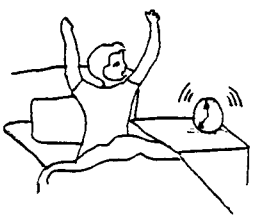
4

La muñeca fue acostada por la niña.



5

El chico fue despertado.



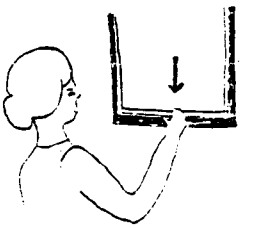
6

1. The house was painted blue.
2. The dog was bathed.
3. The youth was frightened by the bull.
4. The parade is seen by the children.
5. The doll was put to bed by the girl.
6. The boy was awakened.

El pastel esta hecha a mano.

7

La cortina fue bajada.

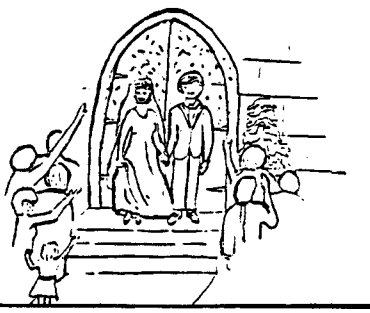


8

El juguete fue pintado por el niño.

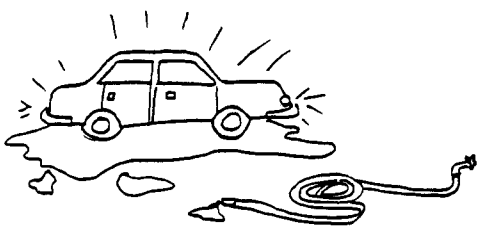
9

El matrimonio fue casado.



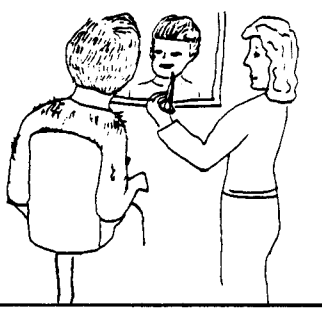
10

El carro fue lavado.



11

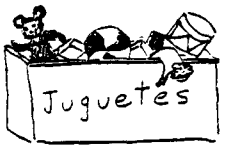
El pelo fue cortado.



12

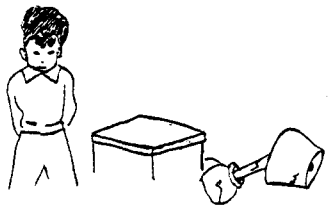
7. The cake is being made by hand.
8. The shade was lowered.
9. The toy was painted by the boy.
10. The couple was married.
11. The car was washed.
12. His hair was cut.

Los juguetes fueron puestos en la caja.



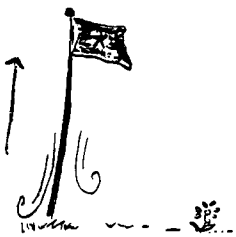
13

La lámpara fue rota por el niño.



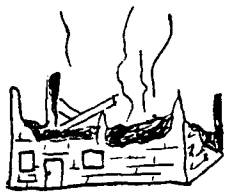
14

La bandera fue izada.



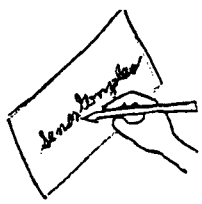
15

El edificio fue quemado.



16

El sobre fue escrito a mano.



17

13. The toys were put in the box.

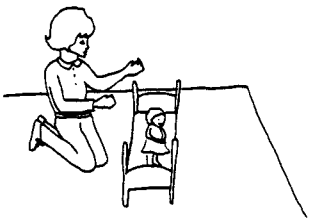
14. The lamp was broken by the boy.

15. The flag was raised.

16. The building was burned.

17. The envelope was written by hand.

La torre fue construida por la niña.

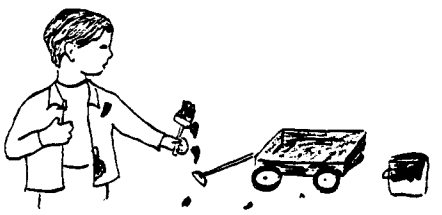


1

El matrimonio fue herido.

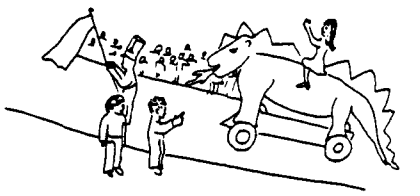
2

La bicicleta fue pintada por el niño.



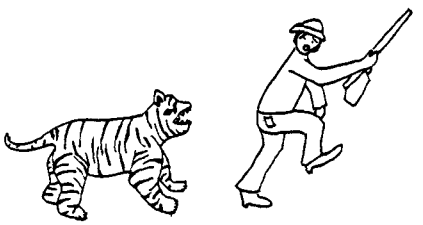
3

El autobús es visto por los niños.



4

El jóven fue espantado por el toro.



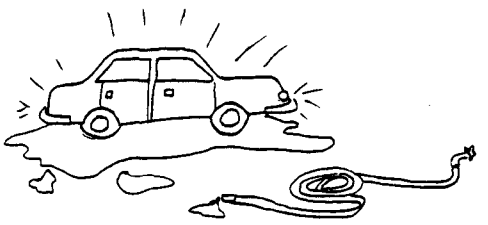
5

La casa fue pintada azul.

6

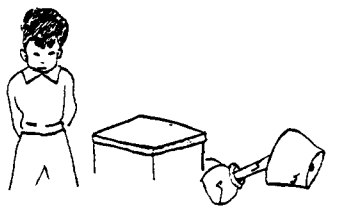
1. The tower was constructed by the girl.
2. The couple was wounded.
3. The bicycle was painted by the boy.
4. The bus is seen by the children.
5. The youth was frightened by the bull.
6. The house was painted blue.

El perro fue lavado.



7

El juguete fue roto por el niño.



8

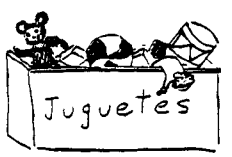
El joven fue castigado.

9

El nene fue bañado.

10

Los juguetes fueron puestos en la mesa.

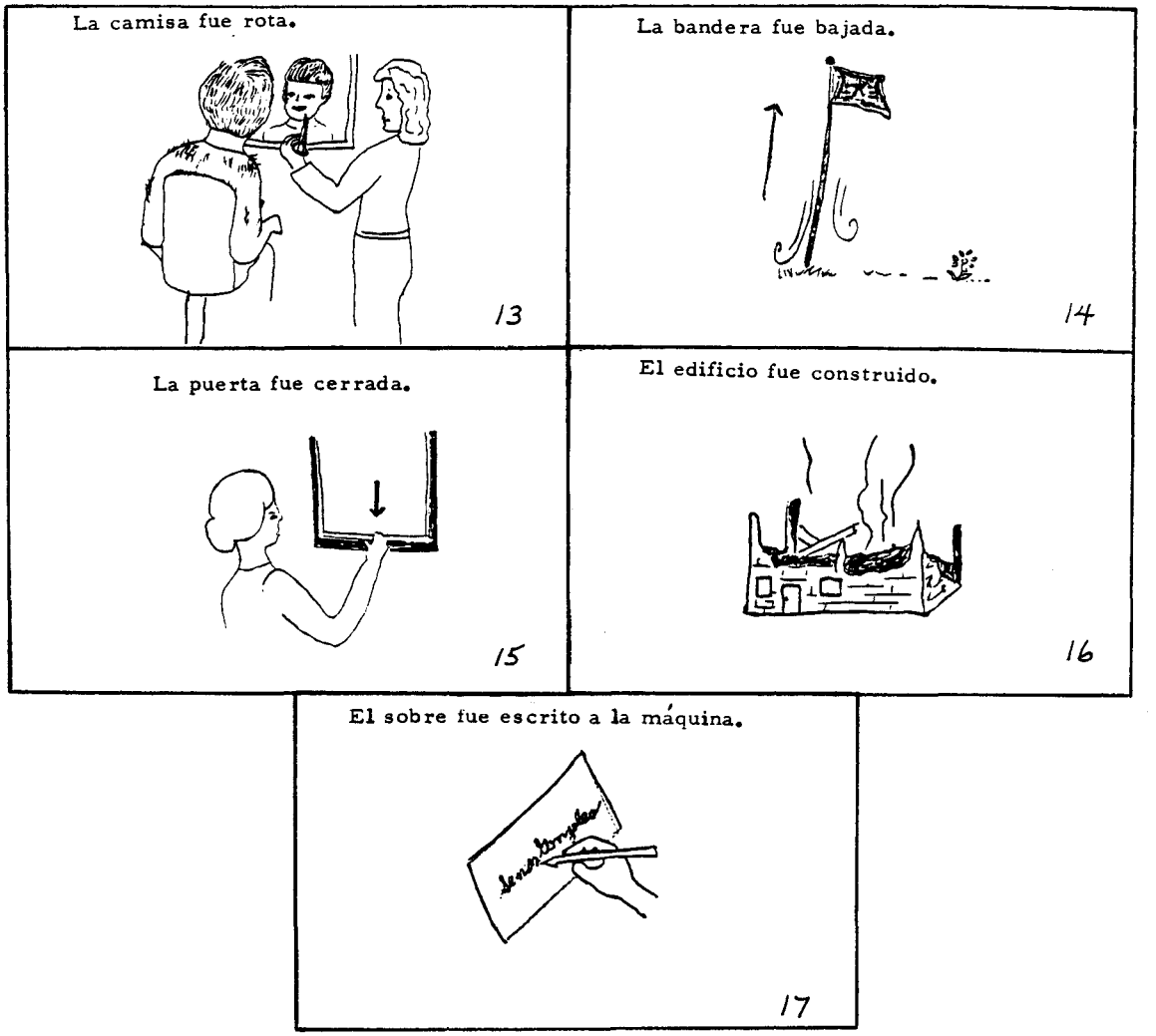


11

La tela esta hecha a mano.

12

7. The dog was bathed.
8. The toy was broken by the boy.
9. The boy was punished.
10. The baby was bathed.
11. The toys were put on the table.
12. The cloth is being made by hand.



13. The shirt was torn.

14. The flag was lowered.

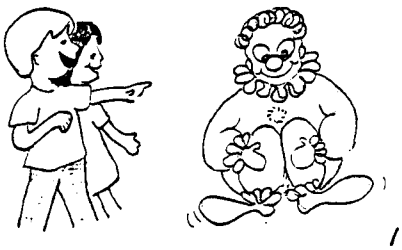
15. The gate was closed.

16. The building was constructed.

17. The envelope was typed.

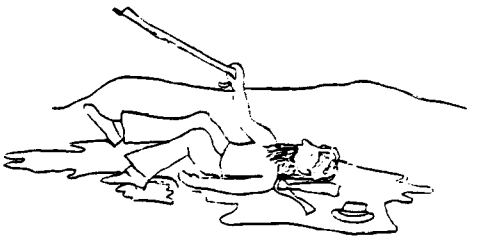
True Reflexive Sentences

Los chicos se rien del payaso.



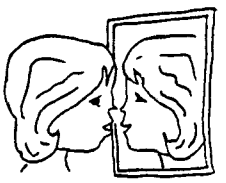
1

El señor se cayó.



2

La niña se mira en el espejo.



3

El hombre se levanta de la silla.

4

La pareja se casa en la iglesia.

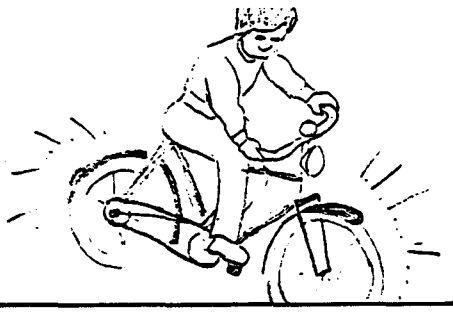
5

Los niños se asustan del perro grande.

6

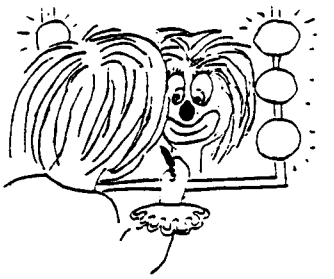
1. The children are laughing at the clown.
2. The man fell down.
3. The girl is looking at herself in the mirror.
4. The man is getting up from the chair.
5. The couple is getting married in the church.
6. The children are afraid of the big dog.

El niño se divierta con su bicicleta nueva.



7

El payaso se pinta la cara.



8

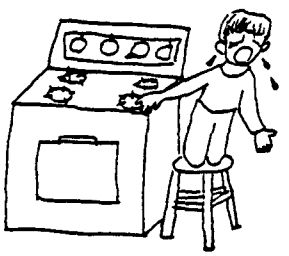
El chico se lava las manos.

9

Alguien se baja del autobus.

10

El niño se quemó el dedo.

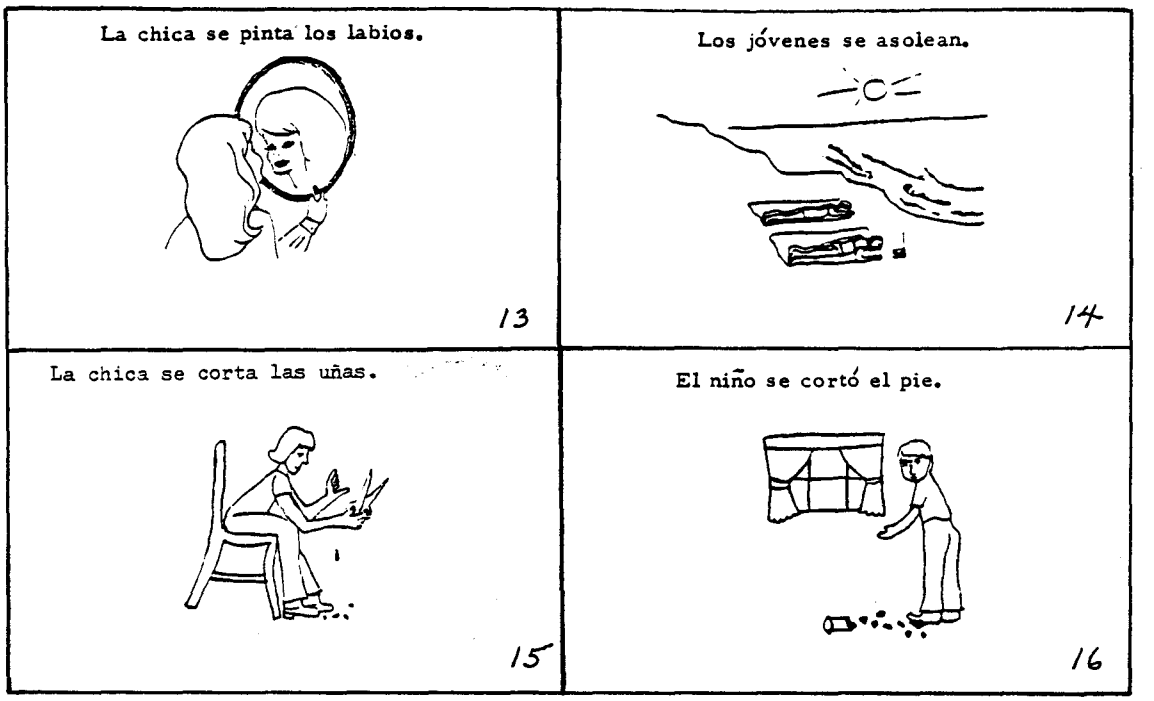


11

El hombre se pone el abrigo negro.

12

7. The boy is enjoying himself on his new bike.
8. The clown is painting his face.
9. The boy is washing his hands.
10. Someone is getting off the bus.
11. The boy burned his finger.
12. The man is putting on the black coat.



13. The girl is putting on lipstick.

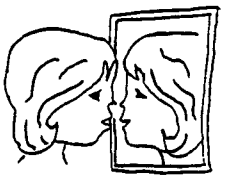
14. The youths are sunbathing.

15. The girl is cutting her nails.

16. The boy cut his foot.

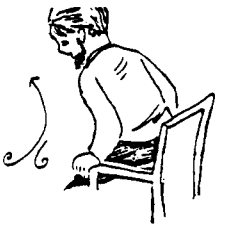
False Reflexive Sentences

La niña se sienta en la silla.



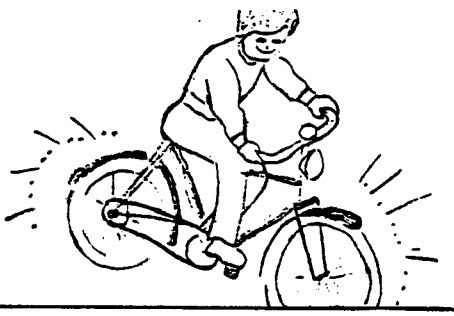
1

El hombre se levanta de la cama.



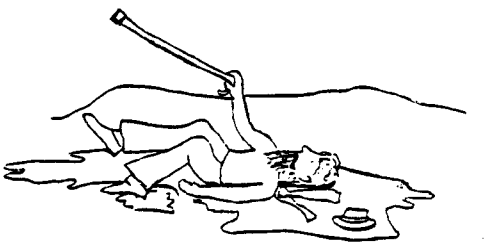
2

El niño se divierta con su carro nuevo.



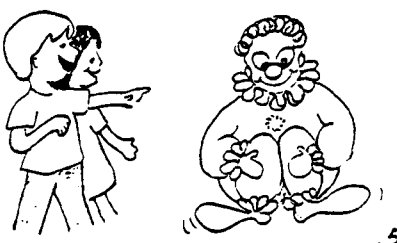
3

El señor se levantó.



4

Los chicos se rien del perro.



5

Los niños se asustan del tigre grande.

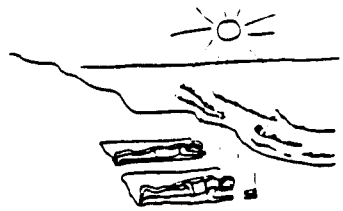
6

1. The girl is sitting on the chair.
2. The man gets up from the bed.
3. The boy enjoys himself with his new car.
4. The man got up.
5. The children are laughing at the dog.
6. The children are afraid of the large tiger.

El chico se lava los pies.

7

Los jóvenes se golpean.



8

La chica se corta el pelo.

9

La pareja se casa en el jardín.

10

El hombre se pone el pantalón negro.

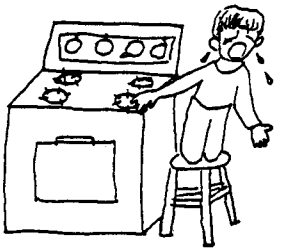
11

El payaso se pinta la cara.

12

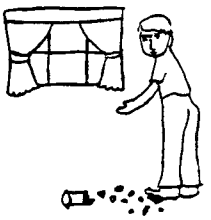
7. The boy is washing his feet.
8. The youths are fighting.
9. The girl is cutting her hair.
10. The couple is being married in the garden.
11. The man is putting on black pants.
12. The clown is painting his face.

El niño se quemó la boca.



13

El niño se cortó los labios.

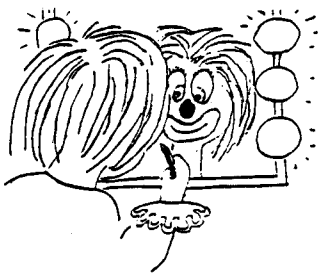


14

Alguien se sube al autobus.

15

La chica se pinta los labios.



16

13. The boy burned his mouth.

14. The boy cut his lips.

15. Someone is getting on the bus.

16. The girl is putting on lipstick.

Discarded Sentences

1. The woman is burning her apron.
2. The woman is shortening the dress.
3. The woman is raising the shade.
4. The girl is making a cake.

APPENDIX F

Table 16

Individual Means for Each Condition
(Standard Deviations)

Experiment I - Dot Sentences

Subject No	Conditions					
	K	K+1	K+2	K+3	K+4	K+5
64	3.280	4.393	4.827	4.245	4.395	5.568
	(0.214)	(0.247)	(1.040)	(0.637)	(0.547)	(0.956)
65	2.276	2.687	2.815	3.349	3.477	3.243
	(0.093)	(0.122)	(0.206)	(0.464)	(0.275)	(0.501)
77	1.630	1.908	1.905	1.871	1.974	2.200
	(0.174)	(0.194)	(0.019)	9).173)	(0.127)	(0.075)
94	3.714	4.016	4.525	4.986	4.944	6.825
	(0.106	(0.512)	(0.515)	(0.117)	(0.780)	(0.669)
95	2.245	2.822	2.886	2.827	2.610	3.038
	(0.283)	(0.300)	(0.115)	(0.306)	(0.332)	(0.721)
97	3.852	4.169	3.866	3.360	4.771	5.665
	(0.254)	(0.701)	(1.613)	(1.395)	(0.139)	(0.826)
99	2.262	3.256	2.969	3.332	3.709	3.114
	(0.198)	(0.909)	(0.250)	(0.835)	(0.455)	(0.881)
100	2.927	3.150	4.147	5.047	3.990	5.899
	(0.323)	(0.586)	(1.368)	(1.596)	(0.949)	(1.530)
101	2.531	2.869	3.673	4.262	4.780	4.233
	(0.247)	(0.664)	(0.643)	(0.793)	(0.966)	(0.067)
102	2.355	3.1610	3.895	3.544	4.515	4.329
	(0.334)	(0.279)	(0.723)	(0.443)	(0.176)	(0.445)
106	1.391	1.988	2.336	2.305	3.068	3.459
	(0.310)	(0.310)	(0.199)	(0.473)	(0.682)	(1.154)
107	3.395	3.747	4.351	3.910	4.338	4.131
	(0.295)	(0.167)	(0.007)	(0.434)	(0.658)	(0.998)
109	2.483	3.827	5.484	4.234	5.120	4.317
	(0.332)	(0.170)	(0.856)	(0.737)	(0.601)	(1.106)

110	1.361	1.679	1.748	1.978	1.770	2.193
	(0.218)	(0.212)	(0.192)	(0.030)	(0.171)	(0.274)
111	2.400	2.956	3.137	3.329	3.214	5.380
	(0.222)	(0.459)	(0.416)	(0.263)	(0.403)	(0.730)
112	2.023	2.330	2.513	2.796	2.390	2.582
	(0.208)	(0.149)	(0.459)	(0.486)	(0.442)	(0.848)
113	2.905	4.127	4.350	6.907	4.956	6.836
	(0.260)	(0.717)	(0.411)	(1.285)	(0.340)	(1.697)
114	2.803	3.301	3.862	6.316	4.301	7.459
	(0.495)	(0.209)	(0.790)	(2.218)	(0.668)	(0.836)
115	1.724	1.999	2.317	2.689	2.352	2.384
	(0.075)	(0.288)	(0.298)	(0.549)	(0.402)	(0.234)
116	1.954	2.489	2.857	3.538	3.144	3.671
	(0.148)	(0.556)	(0.252)	(0.618)	(0.186)	(0.182)
117	2.103	2.584	2.677	2.705	4.358	4.154
	(0.451)	(0.265)	(0.048)	(0.373)	(0.993)	(1.947)
118	2.584	2.494	2.936	3.998	4.019	5.122
	(0.193)	(0.372)	(0.547)	(0.814)	(1.178)	(1.271)
120	2.443	4.191	5.533	5.260	5.456	7.125
	(0.346)	(1.077)	(0.981)	(1.740)	(0.820)	(1.869)
121	2.402	2.801	3.180	3.750	3.818	4.479
	(0.202)	(0.494)	(0.831)	(0.184)	0.313)	(0.589)
122	2.517	2.774	3.304	3.6788	3.096	3.526
	(0.194)	(0.172)	(0.371)	(0.388)	(0.364)	(0.568)
123	2.552	3.55	3.856	4.541	3.957	4.124
	(0.377)	(0.249)	(0.542)	(0.410)	(0.789)	(1.223)
124	3.102	5.299	7.468	6.029	6.903	8.046
	(0.880)	(0.971)	(1.573)	(0.812)	(1.289)	(1.273)
125	2.236	2.455	4.628	5.446	5.719	8.508
	(0.280	(0.630)	(1.707)	(1.504)	(0.725)	(1.821)

Table 17

Individual Means for Each Condition
(Standard Deviations)

Experiment II - Sentence Voice Conditions

Subj	Conditions					
	TA	FA	TR	FR	TP	FP
50	3.069	2.956	3.478	2.880	3.087	3.533
	(0.582)	(0.354)	(0.528	(0.360)	(0.450)	(1.093)
51	3.016	2.738	3.098	2.909	2.816	2.624
	(0.377)	(0.105)	(0.118)	(0.581)	(0.457)	(0.077)
52	2.832	3.521	3.246	3.445	2.821	3.457
	(0.713)	(0.464)	(1.203)	(0.910)	(0.419)	(0.900)
53	2.210	2.217	2.194	2.161	2.257	2.210
	(0.025)	(0.056)	(0.171)	(0.125)	(0.222)	(0.059)
54	3.427	3.734	3.710	3.447	3.712	3.364
	(0.159)	(0.141)	(0.890)	(0.071)	(0.444)	(0.259)
55	2.542	2.845	2.715	2.651	2.553	2.462
	(0.863)	(1.062)	(0.949)	(0.782)	(0.812)	(0.460)
57	2.111	2.209	1.946	2.013	1.917	2.544
	(0.001)	(0.064)	(0.078)	(0.244)	(0.061)	(0.551)
58	2.179	2.288	2.135	2.238	1.997	2.098
	(0.254)	(0.148)	(0.321)	(0.261)	(0.064)	(0.168)
59	2.108	2.420	2.071	1.929	2.340	2.131
	(0.145)	(0.211)	(0.289)	(0.238)	(0.204)	(0.236)
60	2.437	2.582	2.831	2.576	2.628	2.448
	(0.977)	(0.670)	(0.325)	(0.910)	(0.614)	(0.127)
61	1.691	1.832	1.702	1.830	1.695	1.836
	(0.174)	(0.093)	(0.104)	(0.228)	(0.177)	(0.244)
62	1.121	1.321	1.107	1.253	1.088	1.271
	(0.392	(0.290	(0.356)	(0.310)	(0.273)	(0.309)
63	1.186	1.298	1.163	1.330	1.201	1.423
	(0.135)	(0.162)	(0.135)	(0.169)	(0.111)	(0.164)

66	2.504	2.777	2.590	2.698	2.468	2.694
	(0.167)	(0.585)	(0.704)	(0.741)	(0.263)	(0.476)
67	1.445	1.462	1.388	1.297	1.383	1.435
	(0.132)	(0.203)	(0.229)	(0.062)	(0.248)	(0.013)
68	2.022	2.003	1.944	1.820	1.672	1.886
	(0.038)	(0.360)	(0.069)	(0.174)	(0.097)	(0.224)
69	1.574	1.849	1.536	2.063	1.283	1.643
	(0.429)	(0.053)	(0.105)	(0.543)	(0.157)	(0.111)
70	1.633	1.638	1.528	1.751	1.578	1.646
	(0.147)	(0.137)	(0.281)	(0.550)	(0.301)	(0.152)
71	1.921	2.036	1.670	1.934	1.719	1.871
	(0.234)	(0.221)	(0.359)	(0.427)	(0.209)	(0.299)
72	2.604	2.923	3.257	2.775	2.494	2.789
	(0.749)	(1.210)	(1.407)	(1.263)	(0.474)	(1.038)
73	2.373	2.427	2.541	2.599	2.380	2.386
	(0.195	(0.539)	(0.731)	(0.094)	(0.343)	(0.589)
74	2.195	2.205	2.981	3.268	1.943	2.149
	(0.749)	(1.210)	(1.407)	(1.263)	(0.474)	(1.038)
73	2.373	2.427	2.541	2.599	2.380	2.386
	(0.195	(0.539)	(0.731)	(0.094)	(0.343)	(0.589)
74	2.195	2.205	1.981	2.268	1.943	2.149
	(0.636)	(0.446)	(0.631)	(0.618)	(0.357)	(0.656)
75	1.862	1.960	1.854	1.809	1.666	1.893
	(0.152)	(0.315)	(0.222)	(0.372)	(0.143	(0.259)
76	1.577	1.490	1.397	1.691	1.395	1.557
	(0.182)	(0.329)	(0.233)	(0.275)	(0.268)	(0.305)
78	1.512	1.636	1.457	1.656	1.391	1.536
	(0.255)	(0.170)	(0.239)	(0.201)	(0.056)	(0.103)
79	1.516	1.492	1.396	1.552	1.401	1.513
	(0.093)	(0.044)	(0.198)	(0.357)	(0.256)	(0.192)
80	1.963	1.924	1.823	1.746	1.834	1.876
	(0.229)	(0.021)	(0.226)	(0.245)	(0.199)	(0.185)
81	2.479	2.851	2.942	3.004	2.559	2.542
	(0.294)	(0.714)	(0.568)	(1.022)	(0.427)	(0.880)

82	2.297	2.367	2.145	2.488	2.331	2.218
	(0.140)	(0.236)	(0.346)	(0.341)	(0.114)	(0.172)
83	2.385	2.398	2.295	2.702	2.238	2.187
	(0.291)	(0.093)	(0.362)	(0.453)	(0.318)	(0.015)
85	1.587	1.558	1.440	1.481	1.439	1.572
	(0.392)	(0.509	(0.306)	(0.326)	(0.240)	(0.397)
86	1.696	1.916	1.842	1.948	1.837	1.739
	(0.279)	(0.436)	(0.420)	(0.674)	(0.407)	(0.380)
89	2.475	2.515	2.668	2.640	2.312	2.311
	(0.217)	(0.108)	(0.329)	(0.099)	(0.141)	(0.026)
96	2.290	3.033	2.7289	2.923	2.599	2.972
	(0.385)	(0.361)	(0.317)	(0.592)	(0.417)	(0.301)
98	1.961	1.935	1.847	2.086	1.833	1.871
	(0.156)	(0.135)	(0.071)	(0.179)	(0.315)	(0.131)

APPROVAL SHEET

The dissertation submitted by Ruth Riley Crockett has been read and approved by the following committee:

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The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

4/15/86
Date

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Director's Signature