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COMPREHENSION OF SPOKEN SENTENCES CONTAINING
RELATIVE CLAUSES BY ADULTS OF VARYING AGE

by

CLAUDETTE D. FEIER

A dissertation submitted to the Graduate
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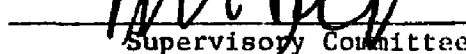
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Abstract

COMPREHENSION OF SPOKEN SENTENCES

CONTAINING RELATIVE CLAUSES

BY ADULTS OF VARYING AGE

by

Claudette D. Feier

Adviser: Professor Louis J. Gerstman

In order to determine whether language comprehension abilities diminish with normal aging, sixty adults within four age groups, 18-25 years, 52-58 years, 63-69 years, and 74-80 years, were compared. The stimuli used in this study, four types of sentences containing relative clauses, were particularly selected because they have been found difficult to interpret in previous studies. The research was designed to determine the order of difficulty among the sentence types, and to test several competing hypotheses which purport to account for that difficulty.

Both self-embedded and right-branching sentences were heard, half of each containing subject relative clauses and half containing object relatives. The listeners' task was to enact the sentences by manipulating small objects; the enactment task was selected because it provided a basis for inferring the heuristic strategies employed by subjects as they attempted to comprehend the sentences.

Sentences were heard in isolation and after narratives, so as to determine whether a contextual antecedent facilitates comprehension. The narratives occurred in both nonthematized and thematized versions. In a nonthematized narrative, each character is mentioned with equal frequency and all play an equally important role in the events. In a thematized narrative, one character assumes a central position; she is referred to more often than the others and events are seen through her eyes or assume their importance through her participation.

In addition to quantitative scoring for errors among the varying sentence types and contextual conditions, performance was evaluated qualitatively on a number of parameters. Assessment was made of the verbal expressions used by subjects as they performed the task -- requests for repetition of the test sentences, verbalization of the sentences as an accompaniment to enactment, and recall of events heard in the narrative. These verbal expressions provided an index to subjects' attention, memory, verbosity, and self-confidence.

Finally, a syntactic analysis was made of each enactment error, with particular regard to whether it represented a heuristic strategy that might have been predicted from earlier studies. The order in which subjects enacted the two clauses of each sentence, although not a factor in judgments of correct or erroneous performance, was compared with the pattern of errors for main and subordinate clauses.

It was found that subjects in the two youngest age groups did not differ in error rate, but that performance began to decline

among subjects in their sixties and continued to drop sharply thereafter. Although spans of immediate recall were comparable among the four age groups, as evidenced by the Digit Span subtest of the WAIS, a memory deficit for meaningful language was revealed in all three older groups.

No relationship was found between context, thematized or nonthematized, and error rate or sentence type.

Self-embedded subject relatives and right-branching object relatives were found to be the easiest to comprehend, while self-embedded object relatives caused subjects a great deal of difficulty. A temporal strategy was identified in our subjects which, interacting with the parallel function strategy described in the literature, accounted for the majority of errors.

In interpreting self-embedded sentences, subjects generally enacted the embedded, subordinate, clause first, whereas in right-branching sentences, the main clause was generally enacted first. Subjects tended to make fewer errors in the first of the sentence's two clauses which were enacted than in the second, and also tended to make fewer errors in subordinate than in main clauses. The latter finding was interpreted in light of current theories regarding the salience of the main clause, which provides the asserted, or new, information of the sentence over the subordinate clause, which provides the presupposed, or given, information.

*In loving remembrance of my father
Louis Deutsch
-- a gentle man*

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If there were a Martian who studied man as we study fruitflies, he would have no reason to doubt that language is as much an organ of the body as the heart, the lungs, or the liver.

Noam Chomsky, 1975

CHAPTER I

INTRODUCTION

Perusal of literature devoted to speech and psycholinguistics over the years reveals little interest in the aged. Within the field of speech pathology, the relatively few studies of geriatric communication have usually focused on the accuracy of speech sound production or on voice quality (Ptacek, Sander, Maloney, and Jackson, 1966; Cooper, 1970). The bulk of language studies which include aged persons are of pathological populations, i.e., stroke victims (Brown, 1972; Goodglass and Blumstein, 1973; Schuell, 1974; Bliss, Guilford, and Tikofsky, 1976; Duffy and Ulrich, 1976).

The psycholinguistic literature is largely dominated by the subjects of children's acquisition of language and college undergraduates' linguistic performance. Research in language acquisition has been fruitful, for example, in identifying regularities in the stages in which particular linguistic forms are acquired in comprehension and production (C. Chomsky, 1969; Brown, 1973; Bloom and Lahey, 1977), in discovering the relationships which obtain between structure, content, and function in children's language (Bloom and Lahey, 1977; Slobin, 1973), in relating linguistic and conceptual development (Vygotsky, 1962; Sinclair-de-Zwart, 1969; Slobin, 1973; Morehead and Morehead, 1974).

Adult psycholinguistic research focuses on college students not only because of their presence in vast numbers in the university

settings that generate most of that research (admittedly a convenience), but more importantly, because persons of that age group have been demonstrated to be approaching the peak of their intellectual powers. (Chapter II contains a discussion of intellectual changes throughout the life span). With language abilities clearly tied to brain function, adults in their prime are indeed appropriate subjects for studies of optimal linguistic performance. However, only by expanding the horizons of research to include adults throughout the entire life span can we learn whether that performance changes as the adult ages.

Since language abilities expand when cognitive abilities are on the ascendancy, it is reasonable to anticipate that when cognitive abilities decline, so might language abilities. If language dissolution does occur with normal aging, it should be determined whether the changes occur randomly or, as seems more likely, in a predictable order of regression. Furthermore, investigation should be made into possible relationships between the order of language acquisition and of language loss, particularly with regard to whether the linguistic forms and strategies employed by very young children are those retained longest in the aged.

This investigation of the effects of aging upon language comprehension springs from a tripartite motivation:

1. To increase our store of knowledge about language processes throughout the life span.
2. To contribute toward maintaining optimal interactive abilities in the elderly population.
3. To develop a better understanding of aphasia, which afflicts aged persons in disproportionate numbers.

The first of these motives is based upon the belief that any attempt to describe or explain human language performance must be deemed incomplete if it does not include study of the geriatric language user. The worth of such study lies not only in the information it will provide about geriatric linguistic processes specifically, but also in the potential for strengthening and expanding existing psycholinguistic theory about language in general. It has become increasingly clear over the last fifteen years that we can gain insights into normal language processes by scrutinizing linguistic behavior that deviates from that of the normal young adult. Three such illuminating areas of "deviance" which leap to mind are child language, aphasia, and "split-brain" surgery. Let us briefly consider how research in these areas has contributed to our understanding of linguistic processes, keeping in mind the strong suggestion that psycholinguistic research with aged persons can likewise prove valuable.

The view is no longer widely held that child language is but an imperfect imitation of adult language (Leopold, 1948) and that it gradually approaches the refinements of the latter through classical or instrumental conditioning (Mowrer, 1960; Skinner, 1957). Rather, child language is currently viewed as a self-contained rule system through which "every human child constructs for himself the grammar of his native language" (Slobin, 1971).

Notwithstanding the demarcation that has been drawn between child and adult language, or perhaps even more so because of that demarcation, evidence from child language is often used to support general hypotheses about language. A case in point is the frequently observed phenomenon

of children's overregularization of inflections. After an initial period of correct usage, children learning English tend to inflect irregular verbs and nouns in the same manner that they inflect regular verbs and nouns, e.g., "comed," "goed," "childrens" (Ervin, 1964). Since there is no adult model for this behavior, it indicates that the young language-learners have induced morphological rules from the language input, and overgeneralized them. The phenomenon is taken as support for the hypothesis that the induction of linguistic rules is an important aspect of language acquisition, and further, that rules applicable to larger classes are developed before rules relating to their subdivisions. Slobin (1971) posits that the strategy employed by children in producing the overgeneralizations just described can be characterized as "avoid exceptions."

Like child language research, investigations of aphasic disturbances have contributed to our understanding of normal adult linguistic processes. Luria (1972) described one facet of aphasia study as "the neuropsychological attempt to establish the factors primarily disturbed as a result of local brain lesions and thereby to understand the basic mechanisms underlying language." Such an attempt is exemplified by the work of Weigl and Bierwisch (1970), who stated that the disturbance of one component of linguistic performance in the company of other, undisturbed components comprises evidence that those components are autonomous, even in normal performance. They hypothesized that aphasia is a disturbance of the performance system, i.e., of access to knowledge (competence) that remains intact. Offered as evidence for that hypothesis was aphasics' frequent great fluctuation in performance even within a single component, e.g., auditory analysis;

such fluctuation would be impossible if competence were lost. The act of "deblocking" (transference of a performance act from an intact component or modality to a disturbed one) was offered as further support for intact competence in aphasia.

The Weigl and Bierwisch view of aphasia is far from widely accepted; if one believes that competence is represented in the brain of the language-using organism, then it seems obvious that damage to the brain could result in a loss of competence (see Whitaker, 1971).

Before discussing the research in our third area of "deviance," split-brain surgery, let us set the stage with a brief overview of the topic of hemispheric specialization.

It is well known that the left cerebral hemisphere plays a dominant role in language functions for most persons, regardless of handedness; rarely does a lesion in the right hemisphere result in aphasia. Although it was long suspected that anatomical asymmetry existed related to the functional differences, only recently was such asymmetry confirmed. Geschwind and Levitsky (1968), in 65 percent of their sample of adult brains, found gross left-right morphological asymmetry, observable by naked eye, in the area of Wernicke, which is important for language function; this region was greater on the left side.

Witelson and Pallie (1973) searched for the ontogenetic onset of this structural asymmetry, motivated in large part by studies of speech perception in which infants as young as four weeks of age were observed to discriminate acoustic differences in synthetic speech patterns. Infant subjects were able to discriminate a 20-msec difference in voice onset time when phonemic boundaries were crossed

which are relevant for linguistic classifications and are universal across cultures (Eimas, Siqueland, Jusczyk and Vigorito, 1971; Trehub and Rabinovitch, 1972). Eimas (1974) also reported that infants by the age of 2 months were able to perceive differences in the acoustic correlates of place of articulation when stimuli were from different phonetic categories. These findings suggest that speech perception may be biologically pre-programmed early in life.

The specific goal of the Witelson and Pallie study was to determine whether the area of the superior surface of the temporal lobe known to mediate language in the adult is larger in the left than in the right hemisphere in the human neonate. Toward that end, post-mortem dissection was performed on 16 adult and 14 infant brain specimens; in none of the cases was the cause of death neurological pathology. Postnatal ages of the infants ranged from 1 day to 3 months, with a median age of 12 days. In all cases the left side was found to be significantly larger, with the size of the left-right differences in the neonates proportionately at least as large as in the adult sample. These findings at such a young postnatal age suggest that asymmetries cannot be accounted for by environmental experiences such as language acquisition or preferred hand usage; rather, the biological structure of the left hemisphere predisposes it to become dominant in mediating language functions.

Notwithstanding this predisposition, the young brain, to about 13 years, has a plasticity of function that enables the right hemisphere to assume linguistic functions when its left hemisphere language area counterpart is damaged. By the onset of the teens, that right hemisphere area is firmly committed to perceptual functions and can no

longer take over linguistic ones (Penfield, 1965).

Until recently there has been little opportunity to discern specifically what functions occur in each hemisphere of the brain. When brain damage occurs, function can be inferred from relating the loss of abilities to the area of lesion, but in most cases the site of lesion cannot be specifically pinpointed. Furthermore, under ordinary circumstances it cannot be ascertained which hemisphere is responding to a stimulus.

A relatively new and still uncommon surgical procedure, separation of the commissures that separate the hemispheres of the brain, now enables testing of the left and right hemispheres separately to demonstrate lateral specialization. "Split-brain" surgery, as it has come to be known, is undertaken to prevent interhemispheric spread of epileptic seizure activity.

Gazzaniga and Sperry (1967) reported on two patients whom they felt displayed a fairly pure "cerebral disconnection syndrome." (Four others who underwent the surgery were considered atypical in that they had sustained considerable brain damage before surgery and/or had various post-surgical complications.)

Using tachistoscopic procedures described elsewhere (Gazzaniga, Bogen, and Sperry, 1962), visual stimuli (numbers, letters, words, or pictures) were presented separately to either the right visual half field (left hemisphere) or the left visual half field (right hemisphere). The results were impressive; whereas spoken descriptions of stimulus material projected to the left hemisphere showed little or no impairment, the right hemisphere in similar testing appeared to be totally incapable of generating speech.

These findings were consistent with previous reports of minor hemisphere "word deafness" and "word blindness" following callosal lesions (Geschwind, 1962). However, thus far the evidence left unanswered the question of whether the minor hemisphere was incapable of recognition and comprehension of language and other symbolic information, or whether such recognition and comprehension existed but was not evident for lack of any means of expression.

To investigate the latter possibility, tests were applied to separate the comprehension of language from its expression. In one such test, for example, subjects were required to select from an array of several objects the one which matched the tachistoscopically presented stimulus. These tests produced quite different results from those which required verbal responses; the subjects were indeed able to make a correct manual response to a stimulus projected to the right hemisphere. For example, if a picture of a ship were flashed into the left visual field, subjects would proceed to pick up (with the left hand, whose main motor control is in the right hemisphere) the card with "ship" written on it, from a series of ten different cards arrayed before them; yet they had previously verbally denied having seen anything.

Results from this admittedly inadequate sample suggest that, in contrast to the highly lateralized organization of verbal expression, the comprehension of single words, both spoken and written, can be achieved in the minor as well as in the major hemisphere. More recently (Science News, July 12, 1975; Zaidel, in press) evidence has been found that the right hemisphere is capable of processing syntax with some degree of sophistication. Indeed, in tests where stimuli

were sentences of increasing complexity, the right hemisphere understood basic grammar, including tenses and active-passive differences, and in all cases tested, scored at least at the level of 5 year-olds.

The foregoing discussion of research in child language, in aphasia, and in split-brain surgery was intended to suggest how similar research among the aged population might likewise contribute to our general knowledge of linguistic processes. Just as predictable stages have been identified in language acquisition (McNeill, 1970; Chomsky, 1969; Bloom and Lahey, 1977), so might regularities be identified in the linguistic changes that could occur with aging. Just as relationships have been found between physiological characteristics and linguistic abilities in children (Lenneberg, 1967) and in aphasics (Luria, 1973), so might such relationships be found in the elderly.

*If we do not know what we are
going to be, we cannot know what
we are: let us recognize ourselves
in this old man or in that old woman.*

de Beauvoir, 1972

The second motive for this research has been shared by a number of experimenters in recent years who established programs aimed at increasing the awareness, community involvement, and/or social interaction of aged persons (Kastenbaum and Slater, 1964; Weinstock, 1971; Shapiro, 1973). Well-intentioned as they may be, such programs cannot be optimally effective if the geriatric participants are laboring under unrecognized communicative burdens. Only by determining the extent and nature of any linguistic losses which the aged may have sustained can we formulate realistic rehabilitative programs and sensible

procedures for engaging them once again in socialization and activities that will be rewarding both to themselves and to the community. If it should be found consistently that language impairment occurs as a function of aging, then a revised view of speech pathology services for the aged would be in order. In particular, therapy programs should be more widely inclusive of normal aging persons and should not be, as they are now, almost the exclusive province of those with highly specific deficits, i.e., stroke patients and the hearing impaired. Therapeutic effort should be devoted not only to remediation of deficits, but also to helping aged individuals retain their existing language abilities throughout the life span.

The third motivational force for this research, to increase our understanding of aphasia, stems from the overlap in aphasic and elderly populations and from some evidence of shared behavioral tendencies in the two groups. In truth, little is known about the linguistic similarities and differences characterizing the brain deterioration that occurs with aging and the organic brain damage of aphasia (see Pichot, 1955; Reed and Reitan, 1963). Most of the evidence (reviewed in Chapter II) that aged persons at times behave like the brain-damaged was derived through audiological or psychological testing in laboratory settings, rather than from investigation of comprehension of meaningful language.

One aim of the present investigation was to determine normal parameters of language comprehension in the aged against which to evaluate the effects of brain damage. Should additional research consistently find language disabilities in normal aged persons, there would be strong implications for reassessing our current thinking about aphasia

rehabilitation. We would have to address the question of what can reasonably be considered a deficit in the geriatric brain-damaged person. The answers to that question should lead us to formulate more realistic goals for such a patient and to alter therapeutic procedures so as to obtain maximal remediation and/or compensation for the losses common to both normal and brain-damaged aged persons.

The definition of "aged" is, of course, a relative one, for aging is a gradual and continuous process. While some studies consider subjects in their sixties as their "aged" or "elderly" populations, others reserve those designations for subjects in their seventies and beyond.

The present study is concerned with language comprehension abilities in adults between 18 and 80 years of age. The hypothesis that age-related changes occur in language comprehension seems justified by a combination of well-documented medical and psychological phenomena (reviewed in Chapter II). We cannot ignore the findings that elderly persons sustain organic changes that could interfere with language and that, in fact, they frequently report experiencing communicative difficulties. Nor can we overlook their defects in memory and other cognitive functions, and the similarity of their performance in certain test situations to that of children or brain-damaged individuals. For their sakes and for the sake of enriching our understanding, it seems a valuable and long overdue project to study linguistic abilities and performance throughout adulthood.

For listeners of any age, the ability to decode a linguistic message is not a unitary phenomenon, but is a composite of various interrelated cognitive processes. Apparently, in understanding spoken

language, at least the following psychological processes take place and interact:

1. Attending to the message
2. Perceiving what is heard
3. Comprehending the words
4. Processing the syntax
5. Remembering what is heard
6. Inferring information which is not linguistically expressed

Various theoretical models have been formulated to describe the cognitive processes assumed to underlie those operations (Aten, 1972; Fodor, Bever, and Garrett, 1974; Harris, 1974; Carpenter and Just, 1975; Cairns and Cairns, 1976; Studdert-Kennedy, 1976). Aged persons generally reveal performance decrements in tests of these cognitive, or "central" processes, e.g., their ability to attend selectively is reduced (Rabbitt, 1965), their memorial abilities are also diminished (Taub, 1968; Gilbert and Levee, 1971), they cannot discriminate and integrate auditory signals as well as young adults can (Bergman, 1971), they require more time to process signals than younger persons require (Simon, 1968), their ability to conceptualize abstract phenomena is reduced (Riegel and Birren, 1967).

The influence of these central processing deficits upon the language comprehension abilities of the elderly remains to be determined. Despite ample documentation of these losses, despite observations that some elderly persons tend to misinterpret verbal messages, and despite reports of communicative difficulties by the elderly themselves (Sanderson, 1971), we currently have little information about geriatric characteristics of processing natural spoken language.

Of the six language comprehension processes previously noted, this research primarily deals with syntactic processing. Vocabulary and memory demands of the experimental tasks were considered minimal; attention was facilitated through the use of an arousal bell preceding each stimulus.

Although it is recognized that a complete accounting of the ability to perceive and comprehend speech must draw evidence from both the speech scientist and the psycholinguist, only psycholinguistic evidence was considered here. In particular, we sought to determine what heuristic strategies listeners use in attempting to understand complex sentences.

A further goal of this research was to determine the effects of thematization upon comprehension of the stimulus sentences. Toward that end sentences were heard in three narrative contexts, differing from one another in the condition of thematization. Consideration was also given to thematization in a second sense, that of distinguishing between the presupposed and asserted, (or given and new), information contained within the sentence itself. Chapter II presents a model of language comprehension and a detailed discussion of thematization.

While not central to this study, it should be noted that a major focus of speech science investigation has been the endeavor to ascertain the units in which speech is perceived. There is evidence for the psychological reality of units of various sizes, e.g., features, phonemes, syllables, and clauses, and it is conceivable that all of these units operate simultaneously during comprehension of natural speech, each performing a different function and interacting with the others (Liberman, Cooper, Shankweiler, and Studdert-Kennedy,

1967; Ladefoged, 1967; Studdert-Kennedy, 1970; MacNeillage, 1970; Kim, 1971; Fromkin, 1973; Studdert-Kennedy, 1976).

It is hoped that, in addition to increasing our store of information about linguistic performance throughout adulthood, this investigation will be seminal in motivating other investigators to enter this practically untrod territory. Life-span developmental psychology is a relatively new phenomenon; only since 1945 has the American Psychological Association included a Division on Maturity and Old Age (subsequently renamed "Division of Adult Development and Aging"). Perhaps in the near future the disciplines of speech and psycholinguistics will also recognize the need for such an area of research.

CHAPTER II

REVIEW OF RELATED LITERATURE

While information regarding linguistic abilities of the aged is meager, there is a substantial body of literature describing organic and behavioral changes associated with aging. That literature will be reviewed here, with regard to those changes that might bear upon linguistic abilities.

Additionally, literature dealing with language comprehension abilities and with strategies for learning and problem-solving will be reviewed, insofar as it has relevance for this research.

Organic and Behavioral Characteristics of the Aged

A number of age-related changes in brain activity have been documented through EEG studies. Normal elderly persons have a high incidence of focal temporal lobe disturbance, often with little or no behavioral manifestation even in the presence of gross brain abnormality (Busse, 1959). In the aged, general brain activation, once started, subsides more slowly than in the young (Welford, 1959). Old persons have a slower alpha rhythm than do younger persons (Surwillo, 1968).

When organic impairment of brain function occurs in the aged, it is usually secondary to circulatory insufficiency or neuronal atrophy (Kinsbourne, 1974). The degree of aging can be appreciated by comparing the average 30 year-old age group with the average 75 year-old

group. In the older group, reduction in blood flow to the brain is about 20 percent; in brain weight, about 10 percent; in the number of nerve fibers in large nerves, about one-third; and in the velocity of nerve conduction, about 10 percent (Noback and Demarest, 1975).

It must be remembered, however, that averaging of data obscures important individual differences, and that, within the aged population, there is great variability in the integrity of the nervous system. For example, atherosclerosis, a major factor in circulatory insufficiency, is not a necessary concomitant of aging, but is a specific disease which occurs in some, but not all aged persons (Kallman and Jarvik, 1959).

In the area of auditory functioning, it has been demonstrated that the normal aged person, even with adequate hearing performance on standard audiometric tests, is likely to have difficulty understanding spoken messages which are presented under less than ideal listening conditions, eg., in crowds, in noise, at rapid rates, at a distance, and over the telephone (Bergman, 1971). These comprehension problems are generally attributed to presbycusis, the rather loosely defined loss of auditory abilities that accompanies aging (Davis, 1970; Nash and Wepman, 1973).

A similar phenomenon, detectable through sophisticated audiometric procedures (Bocca, Calero, Cassivari, and Migliavacca, 1955; Katz, Basil, and Smith, 1963; Speaks and Jerger, 1965; Welsh, Luterman, and Bell, 1969) has been termed "central auditory dysfunction." This impairment occurs in normal persons as a function of the aging process, as well as in brain-damaged individuals. Even with adequate

hearing on standard tests, the person with central auditory dysfunction has difficulty discriminating and integrating speech signals under specific laboratory conditions.

Psychological studies too, reveal differences between young and older adults. In cross-sectional studies of the Wechsler Adult Intelligence Scale (WAIS), scores reach their maximum peak between the mid-twenties and thirty years of age; then there is an uninterrupted and progressively rapid decline. Different abilities peak at different ages, but most peak by age thirty (Wechsler, 1972). Longitudinal studies indicate somewhat longer retention of abilities, with scores reaching a plateau between thirty and forty years of age, and not declining significantly until the fifties (Horn, 1970).

From about forty years of age, normal subjects perform "abnormally" on tests to assess brain damage (Bromley, 1970). For example, a battery of psychological tests which differentiated normal from brain-damaged persons was also found to differentiate younger (mean age 44.7 years) from older (mean age 55.3 years) adults, leading to the conclusion that the "normal" aged sustain undetected cerebral pathology (Reed and Reitan, 1963).

Raven's Progressive Matrices are described as a "test of a person's capacity to form comparisons, reason by analogy, and develop a logical method of thinking, regardless of previously acquired information" (Raven, 1938). Because test performance is affected equally by right and left hemisphere brain damage, Kinsbourne (1974) considers the Matrices to be a "first approximation to a behavioral index of diffuse cerebral damage," and interprets differences found between test

performance of adolescent (mean 16.0 years) and aged (mean 77.8 years) subjects as an indication that the older group had sustained diffuse and fairly uniform cortical damage.

In the domain of language abilities throughout the life span, perhaps the most information exists regarding vocabulary. The Vocabulary subtest is the least vulnerable of all the WAIS subtests to pathology and to aging (Zimmerman and Woo-Sam, 1973); scores rise throughout most of life, but fall off somewhat, even before senescence (Wechsler, 1972). Because performance on the Vocabulary subtest is highly correlated with performance on the entire WAIS, that subtest is considered by many to be the best single index of intellect (Zimmerman and Woo-Sam, 1973). It is commonly used as a control of general intellect in order to measure the age decline of particular functions in persons of reasonably comparable intelligence (Gilbert and Levee, 1971), and is so used in the present study.

Language Comprehension

A Model of Language Comprehension

"Clearly, a complete model of linguistic performance must specify how the information in a sentence arriving at the mind of a listener is integrated with the information awaiting it" (Gough, 1971). Psycholinguists have not yet achieved such a model; a number of false starts were made along the way and several promising avenues had to be abandoned for lack of experimental support. Yet a great deal of progress has been made toward that end in recent years. This review will describe a model of language comprehension which encompasses aspects of psycholinguistic theory that are widely accepted; such a model can serve as a framework for considering the two experiments that comprise the present research.

It is generally accepted that the sentences which we speak and hear can be viewed at two levels -- the surface structure as revealed in the perceived string of speech sounds, and an underlying representation containing the information needed to assign meaning to the sentence. The underlying representation has been variously characterized -- most popularly as a deep structure consisting of simple atomic sentences, or "sentoids," which usually correspond to the clauses of the surface structure.

The listener's task in comprehending sentences is to infer from the surface structure the deep structure underlying it. To do so she employs certain heuristic strategies, i.e., from the surface structure she extracts clues to the deep structure. The listener must garner information which answers the following questions:

What sentoids are there in the deep structure of the sentence; in particular, which parts of the surface string belong to the same sentoid?

What grammatical relations hold among the elements of each sentoid?

How are the sentoids in the deep structure of the sentence arranged relative to one another? (Fodor, Bever, and Garrett, 1974).

For example, recovery of the deep structure of

(2 - 1) I think the baby is crying.

involves at least determining that "I think" and "the baby is crying" belong to different sentoids, and that the sentoid containing "I think" dominates the sentoid "the baby is crying." Let us consider how such determinations are made.

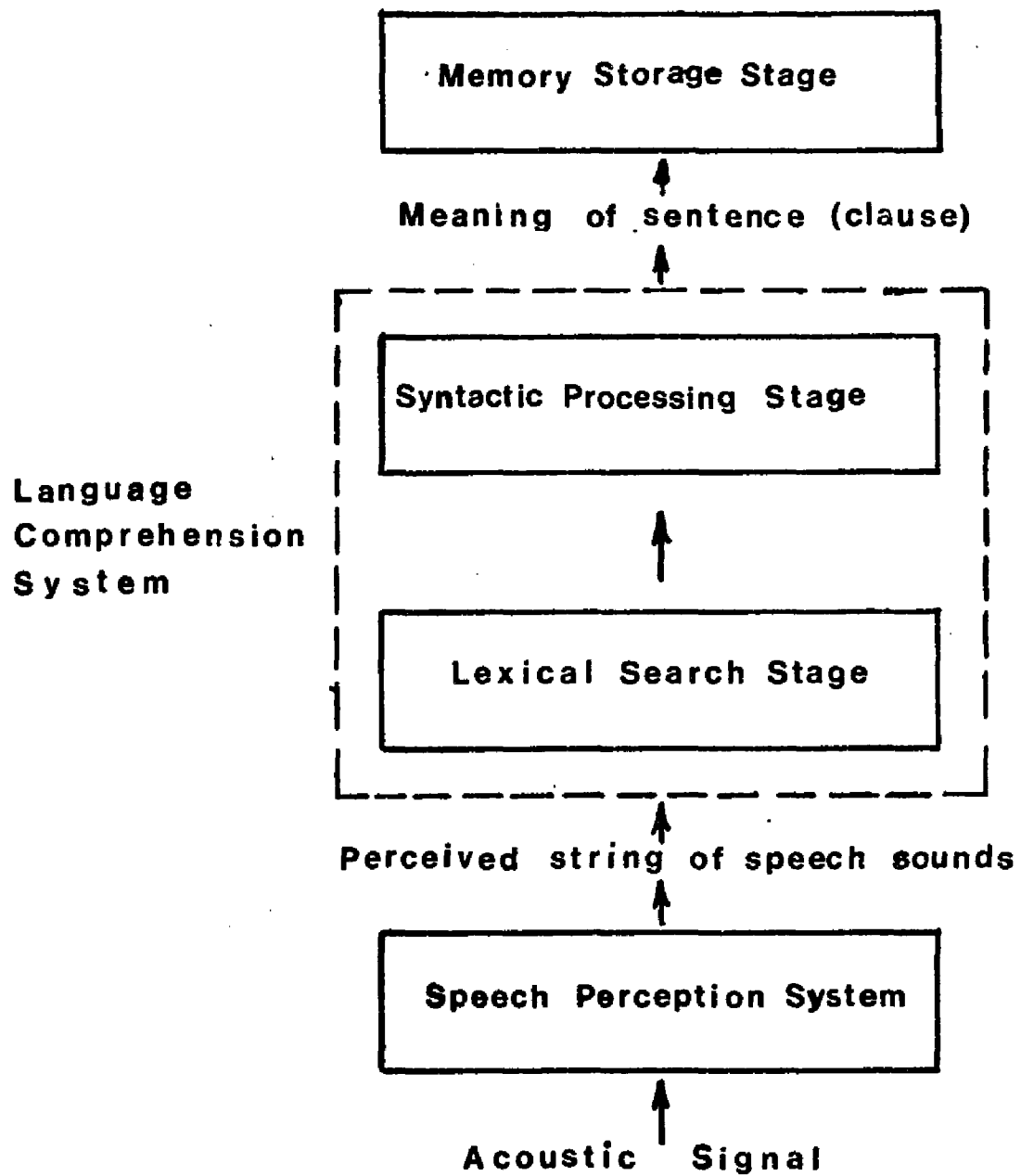
Cairns and Cairns (1976) have provided us with a useful model which they call the Language Comprehension System (LCS) (Fig. 1). The model illustrates the stages a sentence undergoes as it is understood. Although it is not yet known which of these stages occur simultaneously (in parallel) and which occur sequentially (in serial), we shall follow the authors' precedent of describing them in the most convenient manner; that is, as if they were discrete occurrences.

The sound waves which are generated by the speaker's voice comprise the acoustic signal that is processed by the listener's speech perception system. (The reader is referred to the following readings in speech perception: Studdert-Kennedy, 1974; Ladefoged, 1971; Öhman, 1966; Abramson and Lisker, 1965; Pisoni, 1973). The output of that process is the string of speech sounds which the listener perceives, and which in turn comprises the input to the LCS.

Figure 1

Language Comprehension System

From Cairns and Cairns (1976)



As each word reaches the lexical search stage (LSS) of the LCS, a search is made for its meaning from the vast quantity of words stored in each individual's mental lexicon. At this stage information is also specified about the grammatical relations into which the word can enter; for example, whether or not a verb is transitive or intransitive; whether or not it may appear with a complement sentence and if so, what complementizers may be employed with it.

After the word has been paired with its meaning it enters the syntactic processing stage (SPS) of the LCS. Here the listener uses his or her internalized grammar (knowledge of the language) to project hypotheses about the structural relationships that obtain among the lexical items of the sentence. A great deal of experimental evidence suggests that the clause is the primary unit of language processing, i.e., that the SPS segments the input string into clauses, which generally correspond to the underlying sentoids in the sentence's deep structure (Garrett, Bever, and Fodor, 1966; Jarvella, 1971; Caplan, 1972; Fodor and Bever, 1965).

Various heuristic strategies are apparently employed by the SPS to extract from the surface structure clues to its proper segmentation into sentoids. One such strategy, which focuses on the temporal order of the word string, has been described by Fodor, Bever, and Garrett (1974) as the "canonical-sentoid" strategy: whenever one encounters a surface sequence Noun phrase - Verb - Noun phrase (NP-V-NP), assume that these items are, respectively, subject, verb, and object of a deep sentoid. Such a strategy will usually yield correct interpretations, since most English sentences, such as (2-2) below, conform to subject-verb-object word order. However, passive sentences, such as (2-3) will be misinter-

preted with the canonical-sentoid strategy.

(2 - 2) The boy ate the cookie.

(2 - 3) The cookie was eaten by the boy.

Another comprehension strategy (Fodor and Garrett, 1967) can be appreciated by considering the following sentences:

(2 - 4) The man whom the dog bit died.

(2 - 5) The man the dog bit died.

Because (2 - 4) contains a relative pronoun, it is easier to comprehend than (2 - 5), which does not; the relative pronoun marks a clause boundary and additionally provides the listener evidence that the second NP is the subject, and the first NP is the object, of the transitive verb immediately following.

Upon segmentation of the word string into clauses, the SPS performs a syntactic analysis of the internal organization of each clause, combines that syntactic information with the meanings of each lexical item, and finally assigns all the grammatical relations within the clause. A meaning is thus assigned to the clause and transferred into the memory-storage stage (MSS) of the LCS. That meaning combines with the meanings of other clauses held in memory, and with other information (to be discussed presently) to yield an interpretation of the entire sentence. Depending upon the task demands of the listening situation, the meanings held in the MSS may soon be forgotten, or may be transferred into long-term storage.

In the next section of this review we shall discuss evidence that the content of the MSS, only seconds after input, is syntax-free; that is, the meaning of the sentence is recalled, but the word string which was heard is not recalled verbatim.

We shall also see that the basic meanings which are the output of the SPS are augmented in the MSS by information that is not explicitly provided by the sentence, so that what is ultimately stored in memory is an enriched meaning of the sentence.

Language Comprehension and Knowledge of the World

In attempting to describe how the basic meaning of a sentence is enriched during the memory-storage stage (MSS) of language comprehension, we must extend our discussion beyond the sphere of linguistic knowledge into the broader arena of world knowledge. By so doing we shall also explicate the rationale for the comparison made in this investigation between comprehension of isolated sentences (Experiment 1) and comprehension of similar sentences in a narrative context (Experiment 2).

At the outset, it will be of value to consider once again the quotation which introduced our discussion of language comprehension: "Clearly, a complete model of linguistic performance must specify how the information in a sentence arriving at the mind of a listener is integrated with the information awaiting it" (Gough, 1971). The presumption here is that the mind which receives an incoming sentence is an active storehouse of dynamic information rather than a tabula rasa. The integration that occurs in language comprehension depends upon a number of factors -- the nature of the information that is held in the mind, the nature of the sentence that arrives there, and the context (both linguistic and non-linguistic) in which the sentence occurs.

The creativity of the language comprehension process is clearly evidenced in studies of sentence memory. Whereas verbatim content is generally preserved in immediate memory, once a semantic interpretation has been assigned to a sentence, the listener loses the original wording and retains only the meaning. This phenomenon was demonstrated by Sachs (1967) who asked subjects to listen to tape-

recorded passages which were interrupted at varying intervals by a bell. Immediately following the bell subjects were shown a test sentence and were required to judge whether it was the same or changed from one that had been heard in the passage. After only 27 seconds, subjects were able to recognize changes in meaning, but not in form; for example, a passive-active change generally went unrecognized.

The need for recognizing the interrelationship of cognitive and linguistic factors was elaborated by Jenkins (1974) in an amusingly titled article, Remember That Old Theory of Memory? Well, Forget It! He distinguished between associationist and contextualist views of psychological research in the overlapping domains of memory and language comprehension -- a distinction which is crucial to the present research.

Associationists believe in some type or types of basic units, united through some relational mechanism, e.g., association. They hold that more complex behaviors are built of subassemblies of simple behaviors and are the same "in kind" as simple behaviors. They believe that behavior is automatic, and that an explanation of behavior consists of a description of the machinery that produced the behavior. Their account of most behaviors leans heavily on memory.

"This view," stated Jenkins, "is so pervasive in American psychology that it is almost coextensive with being an experimentalist."

The contextualist view is that what is comprehended and remembered depends on context. The events that comprise experience have a quality as a whole, or a total meaning, which results from the interaction of the experiencer and the world. For the contextualist, no analysis is "the complete analysis;" there is no single and unified account of

anything; analyses mean something only in terms of their utilities for particular purposes.

Brewer (1974) noted that almost all current research in linguistics and psycholinguistics uses sentences isolated from linguistic and nonlinguistic context. He reminded us of the longstanding argument that if meaning really interacts with the total knowledge network of the hearer, then treating sentences in isolation may produce severe methodological artifacts.

There is a mounting body of evidence that listeners infer from a linguistic stimulus meanings that are not linguistically expressed. In a widely cited experiment, Bransford, Barclay, and Franks (1972) presented Ss one of the following sentence types:

(2 - 6) Three turtles rested beside a floating log and a fish swam beneath them.

(2 - 7) Three turtles rested on a floating log and a fish swam beneath them.

It was predicted that for sentence (2 - 7), the subjects' knowledge of spatial relations would allow the inference that the fish swam beneath the log as well as beneath the turtles (since the turtles were on the log), but that the inference would be less probable for subjects hearing sentence (2 - 6). A recognition task did indeed bear out that prediction. Subjects who had heard sentences like (2 - 7) tended to think that they had actually heard novel sentences that expressed the probable inference (e.g., Three turtles rested on a floating log and a fish swam beneath it), whereas subjects who had heard sentences like (2 - 6) were less likely to think that they had heard its novel counterpart (e.g., Three turtles rested beside a

floating log and a fish swam beneath it). These data suggest that the hearer's knowledge of the world interacts with the linguistic message in creating semantic descriptions.

Barclay (1973) presented further evidence that alinguistic knowledge is a strong force in remembering language. In several experiments, he presented subjects with sets of sentences which gave a piecemeal account of relations between a series of five objects that were arrayed on some dimension, e.g., left-right; taller-shorter; faster-slower. The "comprehending" subjects were told that they would hear sentences describing the relations between the five objects, and that they were to listen carefully so that afterward they could properly line up the objects in order. The control subjects were told that they would hear a set of sentences about those objects, and that they were to try to remember the sentences that they heard.

The results were striking. The array of objects could be correctly constructed by 80-100% of the comprehending subjects, but by only 0-10% of those who were trying to remember the sentences. Furthermore, the comprehending subjects were excellent in discriminating true sentences from false ones, but could not remember which of the true sentences they had actually heard, i.e., they recalled no false sentences and "recalled" true sentences independently of whether they had heard them or not. In contrast, the group that was told to remember the sentences were poor at doing so and almost equally poor at separating true sentences from false ones.

Jenkins summarized by stating, "What is remembered is definitely not verbal and probably not even linguistic, but it plays a key role in determining which linguistic constructions are recognized and recalled."

Bransford and McCarrell (1974) also took the view that the hearer's general knowledge of the entities and events expressed in a sentence may be the major factor in interpretation of that sentence. For example, they noted that it seems reasonable to assume that the surface-structurally similar sentences "The mouse squeaked" and "The window squeaked" are understood differently not because one first discovers a deep structure and then interprets the meaning of the lexical items, but because one's knowledge of the differential behavior of mice and windows forces different semantic interpretations to be made (i.e., windows are not capable of self-initiated acts like squeaking, and therefore some other agent must have been involved).

Little investigative effort has been expended upon investigating how hearers comprehend connected discourse. Yet, as Brewer (1974) noted, "... natural language doesn't consist of sentences or words in isolation, and ... the study of sentences out of context should be carried out with the realization that it is a very artificial situation."

Language Comprehension and Thematization

By studying factors that are known to interact in language comprehension -- prior knowledge, sentence composition, and context -- investigators hope to arrive at an understanding of "thematization;" that is, how certain features of sentences and connected discourse are made more salient than others for the listener. It will be seen that in some studies, thematized portions of linguistic stimuli were better recalled and recognized than nonthematized portions, while in other studies the reverse was true. It seems apparent that these discrepancies can be attributed, at least in part, to the lack of consensus as to what constitutes a theme and to variations in the methods used to establish thematization. This review will describe investigations into thematization within the last decade, and will point out similarities and differences in approach.

Thematization Through Context. Pompi and Lachman (1967) found that by placing words in a narrative context, a "thematizing" effect was produced. They visually presented some of their subjects with a prose story and others with randomly ordered words from the story. In a post-test, subjects who had read the story made false positive recognition errors which were in keeping with the theme of the story, whereas those who had received the words in random order made no such thematic errors. The authors concluded that the meaning of connected discourse may be stored as surrogate structures (themes, images, schemata, and words), and that lexical associations may provide access to this surrogate system during retrieval.

To determine whether titling a narrative increases its thematization power, Dooling and Lachman (1971) visually presented college under-

graduates with short passages, some of which were titled to reveal their theme, and others which were not. Subjects had greater free recall for titled passages than for untitled ones.

In a follow-up study, Dooling and Mullet (1973) found that when the thematic title of a prose passage was presented before subjects read the passage, free recall was better than when the title was presented after reading, or not at all. Recall for the title-after-story condition was equal to the control (untitled) condition. The authors concluded that the locus of the thematic effect is at the initial storage of the material during input. They hypothesized that prior knowledge of a theme permits more efficient storage and may aid in setting up a retrieval plan which leads to better recall.

Of particular relevance to the present research is the work of Perfetti and Goldman (1974; 1975), who established thematization in narratives by having a central character acting as the focus, or theme, of the story. Reference was made to this character more frequently than to other characters in the story, and events assumed their importance by influencing, or being influenced by, her or him.

In both of the Perfetti and Goldman studies to be described, the effects of thematization were examined, while the effects of non-thematized discourse were not considered. In contrast, the present research uses both thematized and non-thematized narratives as stimuli. In a non-thematized narrative, all characters are mentioned with equal frequency. Events unfold with no character acting as the focus of the story, and with none assuming more importance than another.

An initial finding of Perfetti and Goldman (1974) was that meaning-preserving recall of isolated sentences was poorer than recall of the

same sentences appearing at the end of a related paragraph. The effectiveness of a particular word from the sentence as a retrieval prompt depended upon whether or not that word was the theme of the preceding narrative. Of greatest interest was the effect of a theme's syntactic function upon recall. While thematizing improved the retrieval power of the grammatical subject, it did not matter which noun had been thematized. That is, any thematizing allowed the subject to be a superior retrieval cue. When the subject of the sentence to be recalled had been the theme of the paragraph, the subject was a much better prompt than was the object. When the object of the sentence to be recalled had been the theme, subject and object had equal effectiveness as prompts. Only when the object was thematized, an event which does not usually occur in discourse, did the object improve in retrieval power to the level of the subject probe.

The authors concluded that understanding discourse requires "establishing reference" somehow; different designations must converge on a common referent for which predications are made. A thematized memory probe, for example, provides a preestablished referent for constructing representations of propositions, and later retrieving them.

In a later study (1975), Perfetti and Goldman found a relationship between thematization and topicalization, the linguistic device of ordering referential elements in a sentence. The distinction between the topic and the comment of a sentence has been made on various grounds by different linguists. Perfetti and Goldman used a simplified concept, defining the topic as the noun that occurs first in a sentence. Thus, in an active sentence, the agent is the topic (The girl hit the boy), while in a passive sentence, the recipient is the topic

(The boy was hit by the girl).

Perfetti and Goldman instructed subjects to read a thematized passage and to circle the sentence (active or passive) that best concluded it. The concluding sentences were semantically identical. Thematization was found to determine choice of topic; subjects showed a greater preference for passives (i.e., recipient topics) when the recipient had been thematized in the passage than when the agent had been thematized.

Wallach (1977) tested children's comprehension of four relative clause sentence types heard after both thematized and non-thematized narratives. The theme (i.e., the frequently repeated referent) served as the grammatical subject of sentences in the narrative. No significant differences were found in error rate between the two conditions. However, differences were found related to the grammatical function of the word selected from the relative clause to be the theme of the narrative. Comprehension was facilitated for test sentences in which the relative clause subject was thematized; conversely, thematizing the object of the relative clause had a debilitating effect on comprehension.

A likely explanation for those results is revealed by comparing the grammatical functions of the thematized referent in the narrative and in the test sentence. When the relative clause subject is thematized, there is a congruence of grammatical function (and of underlying relations) between the test sentence and the narrative sentences; but when the theme is drawn from the relative clause object, that congruence no longer exists. (Wallach's use of the theme solely as the syntactic subject of narrative sentences made it impossible to determine

whether effects were due to thematization per se, or to the thematized referent's grammatical function within the narrative. The present investigation thematizes by repeated reference of subject or object of the narrative sentences, thus allowing that determination; see Methods, Chapter III).

In addition to the effects of thematic referent, Wallach also found differences in comprehension of the four sentence types. Those results will be reviewed in our discussion of relative clause sentences.

Thematization Through Sentence Characteristics. We have seen evidence that surrounding context can act as a thematizing force for linguistic materials. It has also been found that portions of even an isolated sentence may be thematized if the sentence contains certain surface structure or lexical characteristics. Hornby (1972) examined those characteristics in a study designed to demonstrate that the distinction between topic and comment is independent from notions of logical and grammatical subject and predicate.

Hornby described the topic, or psychological subject, as that part of an utterance (usually the beginning) which refers to facts that may be taken for granted, and thus does not greatly contribute to the information provided by the utterance. The comment, or psychological predicate, contains the new information to be conveyed by the sentence, and thus increases the knowledge of the listener or the reader. (As we shall presently see, the same distinction has been made by other investigators in different terms, such as "presupposition-assertion;" "given-new.")

The logical subject of a sentence is the agent of the action (or, in sentences with a stative verb, the bearer of the state);

the logical predicate is the remainder of the sentence. (This distinction, based on the semantic relations of case, conforms to Chomsky's (1965) analysis wherein the subject is the NP immediately dominated by the sentence node in the deep structure).

The superficial, or grammatical, subject governs the main verb of the sentence with respect to such grammatical variables as concord (number, gender) and voice. The superficial, or grammatical, predicate is the remainder of the string. (For most sentence types, this distinction conforms to Chomsky's (1965) definition of the superficial subject as the left-most NP immediately dominated by the sentence node in the surface structure).

The three distinctions are illustrated by the following sentences:

(2 - 8) John seldom eats kumquats.

(2 - 9) Kumquats, John seldom eats.

(2 - 10) Kumquats are seldom eaten by John.

In sentence (2 - 8), John is the logical subject (agent of the action), the superficial subject (governs the number of the verb), and also the psychological subject (occurs at the beginning of the sentence).

In sentence (2 - 9), kumquats is the psychological subject (occurs at the beginning), whereas John is both the logical and superficial subject (agent of the action and governs the number of the verb).

In sentence (2 - 10), kumquats is both the psychological and superficial subject (occurs at the beginning of the sentence and governs the number of the verb), and John is the logical subject (agent of the action).

Hornby notes that the failure to distinguish between psychological and superficial subject-predicate dimensions probably occurs because these dimensions have often been related to the surface string order of constituents. For example, speakers often choose the passive voice to express an event where the object of the action is the psychological subject, i.e., they place the logical object at the beginning of the sentence, thus marking it as the psychological subject. (Evidence of this phenomenon lies in the Perfetti and Goldman (1975) study previously discussed).

The psychological subject-predicate relation in English may be marked in several other ways in addition to word order:

- a. Contrastive stress. A constituent produced with higher than normal stress may be marked as the psychological predicate, e.g., John ate the kumquats.
- b. Cleft sentence construction. The psychological predicate (underlined below) is stated in an introductory clause, e.g.,
 (2 - 11) It was John who ate the kumquats. (Cleft agent.)
 (2 - 12) It was the kumquats that John ate. (Cleft object.)
- c. Pseudocleft construction. The psychological predicate (underlined below) is stated as the grammatical object, e.g.,
 (2 - 13) What John ate was kumquats.
 (2 - 14) The one who ate the kumquats was John.
 (2 - 15) What John did with the kumquats was eat them.

Hornby's (1972) experiment had two goals:

1. To demonstrate the independence of the psychological subject-predicate distinction from superficial and logical subject-

predicate distinctions.

2. To examine the relationship between the psychological subject-predicate distinction and the following surface structure features of English:

- a. Word order in a sentence
- b. Grammatical structure (passive; cleft; pseudocleft)
- c. Contrastive stress

Subjects were shown pairs of pictures of an agent performing an action upon an object, e.g., an Indian building a tepee and an Eskimo building an igloo. They simultaneously heard an erroneous sentence (in one of the several grammatical forms being tested) which contained the agent from one picture and the object from the other, e.g.,

(2 - 16) It is the Eskimo who is building the tepee.

They were to indicate which picture the sentence described. Scores were the number of agent responses and the number of object responses; these were considered to be the psychological subject.

The results supported Hornby's position. Subjects did not consistently select the picture with the logical subject as the sentence's reference; nor did they consistently select the picture with the superficial subject. The selections were made independently of those distinctions, but were related to the previously described surface structure characteristics of grammatical construction, intonation, and word order.

Although Hornby did not refer to his findings in terms of "thematization," it seems clear that the distinction between psychological subject and predicate might also be viewed as a distinction

between thematized and non-thematized portions of a sentence. If it can be assumed that the more salient aspect of a sentence, e.g., the aspect which commands a response, constitutes its theme, then Hornby's "psychological subject" could indeed appropriately be accorded that designation. There is some conflicting evidence, however, that even when a theme has been identified, the a priori assumption of salience-equals-theme is not well founded. As a matter of fact, the converse has been found true; that is, portions of sentences which fit (at least some) descriptions of "theme" were found to be less salient than non-thematized portions. A review of the experimental evidence for those findings leads us into the area of "presupposition."

Hornby (1974) noted that the most generally accepted definition of "presupposition" was proposed by Strawson (1952): the relation between two statements, A and B, where the truth of A is a necessary condition for the truth or falsity of B. For example, the sentence

(2 - 17) Richard has stopped getting drunk every night.

contains two propositions:

1. (presupposed proposition). Richard at one time got drunk every night.
2. (asserted, or focused proposition). Richard no longer does this.

The presupposition in this case is established on a lexical basis, since "stopped" implies that an event had previously occurred, or had been occurring over a period of time. It will presently be seen that presupposition can also be established on the basis of a sentence's surface structure characteristics.

As was previously noted, Perfetti and Goldman (1974) concluded that thematizing is a means of "establishing reference." That conclusion might well be the rationale of a number of experimenters who view presupposition as a means of thematizing. Singer (1976), for example, uses the words "presupposition" and "theme" interchangeably. Thematization which is established by means of presupposition differs greatly from Perfetti and Goldman's method of thematizing by frequent repetitions of the referent element; yet both can be seen as establishing reference, or providing a fund of known information.

Haviland and Clark (1974) conducted a study of how listeners utilize presupposed (or, to use their term, "given") and asserted, ("new"), information in language comprehension. They presented subjects with pairs of sentences, each pair consisting of a context sentence followed by a target sentence. Subjects were to press a button as soon as they felt that they understood the target sentence. In half the context sentences, explicit mention was made of the NP which would follow in the target sentence, whereas in the other half, no such mention was made. For example, a subject might hear either of these context sentences:

(2 - 18) We got some beer out of the trunk.

(2 - 19) We checked the picnic supplies.

The target sentence which followed was:

(2 - 20) The beer was warm.

It was predicted that comprehension for the target sentence would be faster when it was preceded by sentence (2 - 18), which mentioned the target sentence's NP than by sentence (2 - 19),

which did not.

That prediction was borne out, leading to the conclusion that a Given-New strategy is used. Apparently the listener searches memory for an antecedent to Given information; when it is found, the New information is attached to it in memory. If there is no matching antecedent, the listener must construct it.

Clausal Saliency: Presupposition as a Factor in Thematization.

This research examined the order in which subjects enacted the two clauses that comprised each stimulus sentence, and additionally, compared error rates for main and subordinate clauses. Several other recent investigations have been similarly concerned with the differential importance or saliency of main and subordinate clauses in comprehension of complex sentences, and the role that presupposition plays in establishing that difference.

Clark and Clark (1968) found that subjects had greater difficulty recalling adverbial sentences whose subordinate clause occurred before the main clause, such as (2 - 21) than sentences whose main clause occurred first, such as (2 - 22).

(2 - 21) After Tom arrived, everybody left.

(2 - 22) Everybody left after Tom arrived.

Two alternate hypotheses which might explain those findings are the Main Clause First hypothesis (Bever, 1970a) and the Canonical-Order-of-Clause hypothesis (Holmes, 1973). The Main Clause First hypothesis states that in the perceptual organization of complex sentences, the main clause, which makes an assertion, has a primary role, whereas the subordinate clause, which expresses a presupposition, has a secondary role. On the basis of that hypothesis, it

would be detrimental to receive the subordinate clause before the main clause.

The Canonical-Order-of-Clauses hypothesis is an outgrowth of the previously discussed argument (Fodor and Garrett, 1967; Fodor, 1971) that the perceptual complexity of a sentence should be increased if the surface order of elements differs from the "canonical" English sentence order. Holmes (1973) extends this argument to include the order of entire clauses. Since the main clause always precedes the subordinate clause in the deep structure of adverbial sentences, preposed adverbials such as (2 - 21) above should be more complex than "basic" adverbials such as (2 - 22).

Since the Main-Clause-First hypothesis and the Canonical-Order-of-Clauses hypothesis make the same prediction in the case of adverbial sentences, Holmes (1973) sought to determine which has greater generality by considering two other types of complex sentences, relative clause constructions and noun-phrase complements. In relative clause sentences, the subordinate clause can occur before the main clause is completed (in self-embedded sentences) or after the main clause (in right-branching sentences). If it is important to complete the processing of the main clause before processing the subordinate clause, then self-embedded sentences like (2 - 23) should be more difficult to understand than sentences like (2 - 24).

(2 - 23) The clothes that Ed wore amused Mary.

(2 - 24) Mary hated the clothes that Ed wore.

However, this result would not be predicted by the Canonical-Order-of-Clauses hypothesis, for in both cases the order of elements in the surface structure is the same as that in the deep structure.

As with relatives, the order of clauses in noun-phrase complements can vary while still retaining correspondence between the surface and deep structure orders. If it is necessary to process the main clause first, it should be more difficult to understand subject complements such as (2 - 25) than object complements such as (2 - 26).

(2 - 25) Your arriving late worried us.

(2 - 26) We wanted you to go.

Again, the Canonical-Order-of-Clauses hypothesis would not make this prediction. (It should be noted that the semantic justification for the Main-Clause-First hypothesis does not apply here, for as Bever (1970) pointed out, the assertion-presupposition distinction cannot be made for noun-phrase complement sentences).

Holmes tested the Main-Clause-First hypothesis by tachistoscopically presenting subjects with the three types of sentence discussed: adverbials in basic and preposed form, relatives in right-branching and self-embedded form, and noun-phrase complements in object and subject form. Subjects were scored on the number of words they could subsequently recall from each sentence. The hypothesis was supported for both adverbial and complement sentences; basic adverbials were better recalled than preposed, and object complements were better recalled than subject complements. However, the hypothesis was not supported for relatives; self-embedded relatives were recalled better than right-branching relatives.

Holmes noted that the reasons for this latter finding are unclear, and speculated that the result might be due to ambiguity of reference of the relative clause, or to the need for greater storage for the

preceding input when processing right-branching relatives than when processing self-embedded relatives. (It should be pointed out that other experimenters, e.g., Slobin, 1971; Fodor, Bever, and Garrett, 1974) ascribed greater storage needs to the processing of self-embedded sentences). Holmes concluded that there is no general rule that perceptual complexity is increased if the main clause is not completely processed before a subordinate clause; each of the three syntactic constructions tested must be considered independently.

Offir (1973) and Clark and Clark (1977) noted that speakers select the particular form, or "thematic structure," of sentences based upon their judgments of the listener's state of knowledge. For example, the sentence

(2 - 27) I know the man who embezzled a million dollars. presupposes the knowledge (transmitted in the relative clause) that a million dollars was embezzled by some man; the new, or asserted, information (transmitted in the main clause) is that the speaker knows the embezzler (or "perpetrator," in the words of the New York City Police Department). A somewhat different perspective is presented in the sentence

(2 - 28) The man I know embezzled a million dollars. Here, the presupposed information (transmitted in the relative clause) is that the speaker knows a particular man, whereas the asserted information (what is said of that man) concerns the embezzling of a million dollars.

The elements of a sentence that are presupposed can often be identified by negating the entire sentence; such negation gen-

erally results in denying only the asserted proposition, and not the presupposed one. Let us negate our previous examples:

(2 - 29) It is false that I know the man who embezzled a million dollars.

(2 - 30) It is false that the man I know embezzled a million dollars.

Sentence (2 - 29) denies the assertion "I know the man," but does not deny the presupposition that a million dollars was embezzled. Sentence (2 - 30) does not deny the presupposition that the speaker knows a particular man, but does deny the assertion that a million dollars was embezzled (by that man).

Offir conducted an experiment to determine the value of presupposed information to listeners. Subjects listened to paragraphs, each containing a target sentence. Some of the target sentences contained assertions and presuppositions, while others contained only assertions. Afterward, subjects heard a test sentence and judged it "changed" or "unchanged" from the target sentence.

Offir hypothesized that subjects would be better able to discriminate between the changed and unchanged sentences which contained presuppositions than between those which contained only assertions. That hypothesis was supported; subjects were better at recognizing changes made in presuppositional sentences than in nonpresuppositional ones. Apparently, upon hearing a sentence, a listener stores information (constructs a semantic representation) that includes presupposed information. Offir concluded that recognition of a test sentence as changed or unchanged might be based upon the subject's judgment of whether it is congruent with that previously

stored semantic information.

Hornby (1974) pointed out that presupposition is correctly employed only when the speaker knows the presupposed proposition to be true and also believes that the listener knows it is true. An asserted, or focal, proposition is, correctly, something that the speaker believes is true, but believes the listener to be unaware of. Recognizing that a speaker might intentionally deceive by using a construction with a false presupposition or assertion, he constructed an experiment designed to determine whether a listener is more easily deceived by the same proposition when it is presupposed or when it is asserted. Consider the following cleft sentences, both of which stem from the same simple active sentence, "The girl is riding the bicycle."

(2 - 31) It is the girl that is riding the bicycle.

(2 - 32) It is the bicycle that the girl is riding.

In sentence (2 - 31), It is the girl is the asserted, or focal proposition which contains the new information, whereas in sentence (2 - 32), It is the bicycle is the asserted proposition containing the new information; the remainder of each sentence is comprised of the presupposed proposition containing "old," or "given," information.

Hornby 's subjects heard cleft and pseudocleft sentences, following each of which they briefly viewed a tachistoscopic picture involving a three-element scene, e.g., a girl petting a cat. They were to respond "true" or "false" as to whether the picture accurately depicted the sentence. In pictures that did not represent the sentences accurately, either the agent or the object was misrepresented, e.g., girl instead of boy; dog instead of cat. In half the sentences, the pre-

supposed part was misrepresented; in the other half, the assertion was misrepresented.

The results were scored as to the number of times subjects reported "true" when there had actually been a misrepresentation. These incorrect responses occurred more often when the presupposed proposition was misrepresented by the picture than when the asserted proposition was misrepresented, regardless of whether the sentence had cleft or pseudocleft construction, and regardless of whether the agent or object of the sentence had been misrepresented.

Apparently, listeners failed to notice discrepancies between the presupposed propositions and the pictures because they took for granted that this part of the picture was correct, and focused their attention on aspects of the picture more relevant to determining the correctness of the assertion. The small number of errors which occurred when the assertion was misrepresented indicates that this aspect of the sentence and picture was the focus of attention; if it was judged to be true, the listener would tend to assume that the entire statement was correct.

Because the case (agent or object) of the misrepresented element made no difference in listeners' judgments, they apparently relied heavily on grammatical structure to determine what is important in a sentence. Hornby therefore conducted a second experiment to determine which grammatical structures have greater presuppositional power, i.e., which distinguish better between presuppositions and assertions.

Subjects heard sentences of the following types:

(2 - 33) Pseudocleft active ... The one that is petting the
cat is the girl.

- (2 - 34) Pseudocleft passive ... The one that the cat is being petted by is the girl.
- (2 - 35) Cleft active ... It is the girl that is petting the cat.
- (2 - 36) Cleft passive ... It is the girl that the cat is being petted by.
- (2 - 37) Standard active ... The girl is petting the cat.
- (2 - 38) Standard passive ... The cat is being petted by the girl.

As in the first experiment, after each sentence subjects briefly viewed a tachistoscopic picture and responded "true" or "false" as to whether it accurately represented the antecedent sentence. Once again responses were scored as to the number of times a picture was reported "true" when it was not a correct representation of the sentence, i.e., when a misrepresentation was overlooked.

The results clearly supported the hypothesis that presuppositions are more strongly or more clearly marked in some sentence structures than in others. Subjects made more false positive responses to sentences in the passive voice than in the active voice; furthermore, there were more false positives for pseudocleft than for cleft constructions, and more for cleft than for standard constructions.

Hornby pointed out that it cannot be determined from these experiments whether those surface features contribute to the marking of the sentence's focus, its presupposition, or both. That is, a person might fail to notice a discrepancy between the presup-

position and the picture because she took the presupposition for granted, OR because her attention was drawn to the other part (the focus, or assertion) of the picture.

Although their studies differed in a number of respects and so cannot be directly compared, it should be noted that Hornby's (1974) results appear to contradict Offir's (1973). Hornby's subjects overlooked misrepresentations of presupposed propositions, but noticed misrepresentations of assertions; Offir's subjects were better at noticing misrepresentations (changes) in sentences which contained presuppositions and assertions than in sentences which contained only assertions. An explanation for the apparent discrepancy might lie in the fact that Hornby's experiment pitted presupposed propositions against asserted propositions within the same sentence, whereas Offir's study compared sentences containing presuppositions AND assertions, with sentences containing only assertions. It might be argued that a complete sentence containing both a presuppositional and assertive proposition provides a basis for discriminating change that a presuppositional proposition alone does not have.

Using the words "presupposition" and "theme" interchangeably, Singer (1976) conducted a series of four experiments to compare accuracy of memory for information associated with thematic and non-thematic portions of sentences. The results of all four experiments supported Hornby's (1974) findings that asserted (new) information was more salient and/or was examined more closely than was presupposed (given) information.

Cleft and pseudocleft sentences were used as stimuli in three of those experiments because, as we have seen (Hornby, 1974), those constructions distinguish best between presuppositions and assertions.

In the first experiment, a word recognition task, subjects recognized more words from antecedent assertions than from antecedent presuppositions.

The second experiment, a sentence recall task, found that prompts from asserted portions of sentences gave better recall than prompts from presupposed portions.

The third experiment was a test of recall of adjective modifiers. Subjects heard a list of sentences, each containing two nouns that were modified by adjectives. They were then given a list containing one noun from each sentence, and asked to supply the adjective that had accompanied the noun. Totalled over the entire experiment, recall was best for adjectives that had appeared in the asserted propositions of the antecedent sentences. (This advantage of "new" existed only in sentences with cleft and pseudocleft objects, it should be noted; the opposite effect -- where adjectives from presupposed portions were recalled best -- occurred in sentences with cleft and pseudocleft agents. However, this latter effect was smaller than the former).

The fourth experiment in the series was a word recognition task. Stimuli were simple active sentences that differentiated "new" from "presupposed" information by varying the article (definite vs. indefinite) that modified the agent and object of the sentences. For example,

(2 - 39) A king led the troops.

(2 - 40) The king led some troops.

It can be seen that the definite article "the" establishes pre-supposition, whereas the indefinite articles "a" and "some" establish assertion.

After hearing the sentences, subjects were presented with a word list containing one noun from each sentence, along with filler nouns. Their task was to respond "yes" or "no" as to whether the words had been in the antecedent sentences. The results were in keeping with the preceding three experiments; the elements that were qualified by indefinite articles (signalling new information) were more reliably recognized than those that were qualified by definite articles (signalling given, or presupposed information).

Singer discussed the apparent discrepancy between his findings and those of Perfetti and Goldman (1974) that thematized elements from stories were better recall prompts than nonthematized elements. One reason for the discrepancy might be that the two studies differed in their means of effecting thematization. Whereas Singer manipulated grammatic structure and the form of articles, Perfetti and Goldman used repeated reference to construct themes. Singer noted that it could be expected that repetition would yield reliable integration into semantic storage. He cited as another reason for the discrepant findings, differences in the nature of the language materials used in the two studies. Apparently, a listener uses thematic information efficiently from ongoing verbal messages such as those in the Perfetti and Goldman study; but with individual sentences, she or he integrates information most reliably from the nonthematic, or new, portion.

It can be argued that because the effects of presupposition and repeated reference are so different from one another, they should not be considered variations of the same phenomenon. Perhaps a review of which entities warrant the designation "theme" would be in order; in fact, discrepancies would disappear merely by recognizing the assertion, rather than the presupposition, as the theme of the sentence in which they both occur.

Comprehension of Relative Clause Sentences

This study draws upon the research of Wallach (1977), which compares language comprehension strategies employed by learning-disabled children with those employed by normally achieving children. The comprehension tasks used in that research and in the present study involve the interpretation of complex sentences containing relative clauses. Such stimuli have aroused the interest of psycholinguists for good reason; they are sometimes difficult to comprehend, for adults as well as children. The goals of psycholinguistic studies using relative clause sentences as stimuli have included testing hypotheses about how listeners comprehend language, identifying strategies used in interpreting those sentence types specifically, and determining which aspects of such sentences are responsible for variations in level of comprehension difficulty. These goals, of course, are interrelated and not mutually exclusive.

Definition of Terms. In order to understand better the relative clause sentences discussed in this review and used as stimuli in the present study, let us consider some of their characteristics and the terms that are used to describe them. Each relative clause sentence under discussion here can be described (Sheldon, 1974) as one

of these four sentence types: Ss, So, Oo, Os, where S represents "subject" and O represents "object." Examples of these four types can be found in Table I.

1. The first of the two letters in each two-letter sequence refers to the function, within the main clause, of the noun phrase (NP) that is modified by the relative clause. The relative clause modifies either the subject NP (in Ss and So sentences) or the object NP (in Oo and Os sentences) of the main clause.
 - a. Self-embedded sentence: relative modifies the subject NP.
In this type of sentence, where the subject NP of the main clause is modified by the relative clause, the relative clause is embedded within the main clause. That is, the relative clause is interposed between the subject NP and the verb of the main clause, interrupting the usual sequence of those related linguistic units.
 - b. Right-branching sentence: relative modifies the object NP.
Where the object NP of the main clause is modified by the relative clause, the relative clause is not embedded within the main clause, but follows it.
2. The second letter in the sequence refers to the function of the relativized NP within the relative clause.
 - a. Subject relative (in Os and Ss sentences). The relativized NP (represented in the relative clause by the pronoun "that") acts as subject of the relative clause. The relative clause retains common subject-verb-object word order.

TABLE 1
EXAMPLES OF RELATIVE CLAUSE SENTENCE TYPES
USED IN THIS STUDY

- Ss. The giraffe /that bumped into the cow/ ran away from the hippo.
So. The bear /that the lion crawled under/ kicked the alligator.
Oo. The giraffe ran away from the hippo /that the cow bumped into/.
Os. The bear kicked the alligator /that crawled under the lion/.

- b. Object relative (in So and Oo sentences). The relativized NP acts as object of the relative clause. Word order of the relativized clause is rearranged to object-subject-verb.
- 3. The functions of the coreferential NPs may be the same (parallel) in both the main and relative clauses, or they may be different (nonparallel).
 - a. Parallel function. The NP which is modified and the NP which is relativized are both the subject (in Ss sentences) or they are both the object (in Oo sentences) of their respective clauses.
 - b. Nonparallel function. The modified NP is the subject of the main clause and the relativized NP is the object of the relative clause (in So sentences) ... or, conversely, the modified NP is the object of the main clause and the relativized NP is the subject of the relative clause (in Os sentences).

Hypotheses. In attempting to understand how listeners process the four sentence types described, it will be of value to consider the following three hypotheses:

- 1. Interruption hypothesis. Listeners have more difficulty dealing with a sentence whose related parts are interrupted than with a sentence which contains no such interruptions (Miller and Isard, 1964; Chomsky, 1965; Slobin, 1973).
- 2. Canonical-sentoid hypothesis. The perceptual complexity of a sentence is increased if the surface order of elements

differs from the "canonical" English sentence order, i.e., the order in the deep structure, in which the first NP is the subject and the second NP is the object of a sentoid, or deep structure clause (Fodor and Garrett, 1967; Fodor, 1971).

3. Parallel function hypothesis. Processing is easier for relative clause sentences whose coreferential NPs have the same grammatical function in their respective clauses (i.e., both are subject or both are object), than for sentences whose coreferential NPs have different grammatical functions (Sheldon, 1974).

The first two of these hypotheses were represented among a number of universal acquisition constraints proposed by Slobin (1971). Children universally learn the canonical order of their language; in English that order is, for the most part, subject-verb-object (SVO). The constraint against interruptions would predict that sentences with self-embedded relative clauses (which interrupt the SVO sequence of the main clause) would be harder to process than sentences with right-branching clauses, which contain no such interruptions. It has been hypothesized that interruption of a NP subject-VP-NP object string by another string makes it difficult to integrate the NP subject of the first string with its appropriate VP (Miller and Isard, 1964; Chomsky, 1965; Baird, 1973). Presumably, the difficulty lies in holding the early part of the sentence in short-term memory until its related part is heard (Fodor, Bever, and Garrett, 1974). If that is indeed the problem, aged persons, with their well-documented short-term memory reductions, might be expected to experience even greater

difficulties in comprehending such sentences than are experienced by young adults.

Slobin's constraint against rearrangement of word order would predict that it would be easier to process the relativized NP in a subject relative clause, which retains SVO word order, as in sentence (2 - 41), than the relativized NP in an object relative clause, which takes OSV word order, as in (2 - 42).

(2 - 41) The boy /that hit Susie/ ran away.

(2 - 42) The boy /that Susie hit/ ran away.

The language comprehension strategy which would be predicted by that constraint in effect corresponds to the "canonical-sentoid" strategy described by Fodor, Bever, and Garrett (1974); in the interest of simplicity, we shall rename that strategy "SVO" strategy. In using SVO strategy, a listener initially hypothesizes that the order of surface elements corresponds to the deep structure (SVO) order. If that is not the case, as in (2 - 42) above or in passive sentences such as

(2 - 43) The boy was hit by Susie.

the listener must process cues leading to falsification of the hypothesis and construction of a more appropriate one.

Falsification of the initial SVO hypothesis is not always achieved by listeners, as evidenced by the type of errors they make in interpreting complex sentences. Fodor, Bever, and Garrett (1974) note that use of SVO strategy leads listeners to experience difficulty in understanding sentences such as

(2 - 44) The horse raced past the barn fell.

Subjects tend to interpret such sentences as simple actives until

they reach the final word, where upon they reassess their hypothesis, generally reaching the erroneous conclusion that they have heard an anomalous sentence. Comprehension of such a sentence would be facilitated if the relative pronoun and verbal auxiliary were not deleted:

(2 - 45) The horse that was raced past the barn fell.

Sheldon (1974), in an investigation that provides much of the basis for both the Wallach (1977) research to be described presently and this study, found no support for Slobin's proposed constraint against interruption or against rearrangement of linguistic units. Sheldon's subjects were children between 3.8 years and 5.5 years of age. In an object manipulation task like the one in this study, they enacted self-embedded sentences such as (2 - 46) as well as they did right-branching sentences such as (2 - 47).

(2 - 46) The lion /that the horse bumps into/ jumps over
the giraffe.

(2 - 47) The pig bumps into the horse /that jumps over the
giraffe/.

Furthermore, there was no difference between comprehension of subject relative sentences such as (2 - 48) (with SVO word order in the relative clause) and object relative sentences such as (2 - 49) (with OSV word order in the relative clause).

(2 - 48) The dog /that jumps over the pig/ bumps into the lion.

(2 - 49) The dog stands on the horse /that the giraffe jumps
over/.

Errors could be explained for the most part by Sheldon's "parallel function" hypothesis, and by the subjects' over-reliance on the rule

of "extraposition from NP." The parallel function hypothesis predicts that processing is easier for parallel relative clause sentences, with coreferential NPs that have the same grammatical function in their respective clauses, i.e., both are subject or both are object, such as (2 - 48) and (2 - 49), than for nonparallel sentences, in which the coreferential NPs have different grammatical functions, such as (2 - 46) and (2 - 47). This prediction was borne out in the study. Although Sheldon did not describe the nature of the errors made in the nonparallel sentences, it is conceivable that subjects used a strategy aimed at making the coreferential NPs serve the same function. This "parallel function" strategy, as we shall call it, is described later in this section.

The other predominant error in Sheldon's study can be explained by the extraposition rule which moves an embedded relative clause to the end of the main clause. Sentence (2 - 50) is related to (2 - 51) by the rule of extraposition from NP:

(2 - 50) A man /who was smoking a cigar/ entered the room.

(2 - 51) A man entered the room / who was smoking a cigar/.

Some children consistently used the extraposition rule, interpreting all relative clauses that followed the main clause as modifying the subject NP, thereby incorrectly interpreting sentences in which the relative clause modifies the object NP of the main clause. Thus, a right-branching sentence such as (2 - 47) above was interpreted as if it were the self-embedded sentence below:

(2 - 52) The pig /that jumps over the giraffe/ bumps into
the horse.

Sheldon concluded that the difficulties in processing sentences

with relative clauses lie in (a) determining which NP in the main clause is modified by the relative clause, and (b) finding the grammatical function of the relativized NP, i.e., of the NP which is deleted and replaced by the relative pronoun. One purpose of the present study was to determine whether Sheldon's findings would be repeated with adult subjects.

A number of other studies (Wanner and Maratsos, 1971; Walker, 1969; Brown, 1971) did find support for the canonical-sentoid hypothesis, i.e., the subject relative form (where the relative clause subject is replaced by a pronoun) was easier to process than the object relative (where the relative clause object is pronominalized). In these studies, the explanation was presumed to lie in the fact that subject relatives have constituents whose surface order parallels the SVO deep order, e.g.,

(2 - 53) The girl /who pushed Bob/ fell.

while object relatives,¹ on the other hand, have their surface constituents ordered differently from the deep order, e.g.,

(2 - 54) The girl /whom Bob pushed/ fell.

Further comparison of the two sentences, however, reveals that the coreferential NPs in sentence (2 - 53) serve the same function (subject) in both the main and relative clauses; on the other hand, in sentence (2 - 54) the coreferential NPs serve different functions (subject of main clause and object of relative clause). Thus,

¹It should be noted that terminology is inconsistent across studies. Sheldon would designate (2 - 54) a "subject relative sentence with a relativized object NP," rather than a "self-embedded object relative sentence," as it would be called in some other studies, including this one.

Sheldon's parallel function hypothesis could account for the greater ease in processing sentences of type (2 - 53). Clearly, in studying the order of difficulty among relative clause sentence types, strict control is required to avoid confounding the variables of locus of the relative clause and internal structure of the relative clause.

Employing such control and using paraphrase and phoneme-monitor tasks as measures of comprehension difficulty, Hakes Evans, and Brannon (1976) sought to test the interruption hypothesis, using college undergraduates as subjects. Stimuli were self-embedded and right-branching sentences, half of each type containing subject relative clauses and the other half containing object relatives. In sentences containing object relatives, phoneme-monitoring was faster for self-embedded than for right-branching sentences, a result in the opposite direction from that predicted by the interruption hypothesis. Although there was no significant difference in monitoring speed between self-embedded and right-branching sentences containing subject relatives, additional evidence was found that self-embedded sentences are easier to comprehend than right-branching ones; paraphrases were more accurate for the former type in both subject and object relative conditions. The authors concluded that previous findings in support of the interruption hypothesis were biased due to confounding of variables: the self-embedded sentences studied always contained object relatives, whereas the right-branching sentences always contained subject relatives.

Wallach (1977), testing comprehension of relative clause sentences in normally-achieving and learning-disabled children, found support for neither the interruption hypothesis nor the parallel

function hypothesis, but did find evidence supporting the canonical-sentoid hypothesis. Where thematization was not a factor, subject relatives (Ss and Os sentences) were understood better than object relatives (So and Oo). When sentences were heard after a thematized narrative, however, great changes were wrought in the order of difficulty for the four sentence types. Ss sentences, which had been understood best in the nonthematized condition, were most poorly understood after a thematized narrative, whereas, for So sentences, which had received the most errors in the nonthematized condition, comprehension was facilitated to about the level of the remaining sentence types, Os and Oo. The probable explanation for this finding was presented in our discussion of thematization earlier in this chapter. There was a huge differential in error frequency among Wallach's subjects, with the normally-achieving children erring in only 14% of their responses and the learning-disabled children erring 43% of the time.

Davis and Blasdel (1975) claimed to find support for the SV0 hypothesis. They compared the strategies of normal-hearing and hearing-impaired children in comprehending sentences containing self-embedded relative clauses. Subjects saw an array of four pictures, and then heard a sentence containing a self-embedded relative clause, e.g.,

(2 - 55) The man who chased the sheep cut the grass.

Each of two pictures represented one of the sentence's clauses, while the remaining two pictures were misrepresentations of events in the sentence. Thus, for sentence (2 - 55), pictures were seen of events that could be described as follows:

- (a) The man cut the grass. (Depicts main clause; N1-V2-N3: correct)
- (b) The man chased the sheep. (Depicts subordinate clause; N1-V1-N2: error)
- (c) The sheep ate the grass. (N2-V2-N3; introduces a new verb: error)
- (d) The sheep chased the man. N2-V1-N1: error)

Subjects were to point to the picture corresponding to the sentence they had heard.

Only response (a) was considered correct. The most common error was selection of a type (b) picture, which represented the subordinate clause. The authors stated that subjects who made this type of error were using a strategy observed by Bever (1970b) in four year-olds, in which the first N-V-N sequence is interpreted as S-V-O. It can be argued that the predominant error was in fact not an error at all, since the SVO sequence depicted in picture (b) was an accurate representation of an N (pronominalized)-V-N sequence that actually occurred in the sentence. Furthermore, while the predominant "error" was that of selecting the subordinate clause depiction to represent the entire sentence, it is equally erroneous to consider the authors' choice (main clause) as representative of the entire sentence. Perhaps the only conclusion that should be drawn from this study is that the major clause was more salient (received more selections) than the minor clause.

Baird and Koslick (1974) constructed an experiment to test both the canonical-sentoid and interruption hypotheses. They predicted that differences in relative clause sentence type should produce

differential effects in recall of the grammatical relations in the sentences. Specifically, they predicted that

- (a) subjects would make more errors in recalling V-NP object relations in object relative sentences than in subject relative sentences (termed "object focus" and "subject focus", respectively, in their study).
- (b) subjects would make more errors in recalling NP subject-V relations in self-embedded sentences (termed "nested" in their study) than in right-branching (not nested) sentences.

Subjects heard sentences of the four types used in the present study:

Self-embedded, subject relative (Ss)

(2 - 56) The boy /who kicked the ball/ chased the girl.

Self-embedded, object relative (So)

(2 - 57) The boy /whom the girl chased/ ran home.

Right-branching, subject relative (Os)

(2 - 58) The boy chased the girl /who caught the ball/.

Right-branching, object relative (Oo)

(2 - 59) The boy chased the girl /whom the dog bit/.

Subjects were then presented with four incomplete slides and were asked to fill in the missing element, e.g.,

_____ chased (NP_{subject}-V, main clause)

chased _____ (V-NP_{object}, main clause)

_____ kicked (NP_{subject}-V, subordinate clause)

kicked _____ (V-NP_{object}, subordinate clause)

Support was found for the first prediction; recall was poorer for V-NP_{object} relations in object relative sentences than in subject relative sentences. The second prediction was not supported; there was no difference in recall of NP_{subject}-V relations in self-embedded and right-branching sentences.

The authors pointed out that the difficulty in recalling V-NP_{object} relations in object relative sentences is due to the permutation of word order in the relative clause, and not to the fact that the NP_{object} is represented by a pronoun instead of a lexical item. If the latter reason were true, then the second prediction would have been supported, i.e., subjects would have had greater difficulty recalling NP_{subject}-V relations in self-embedded sentences than in right-branching sentences, for the NP_{subject} is replaced by a pronoun in the former type.

Baird and Koslick suggested that opposing results in previous studies (Miller and Isard, 1964; Baird, 1973) might be due to performance factors (perhaps retrieval ability), rather than to differences in encoding. This view was supported by Baird (1974), who found that although verbatim recall of self-embedded sentences was inferior to recall of right-branching sentences, recognition accuracy was not significantly different for the two types; that is, they were encoded equally well.

The present research provides a further test of competing hypotheses about the strategies that are used in comprehending relative clause sentences, and the order of difficulty among sentence types. The studies which were reviewed here suggested that the following characteristics of relative clause sentences should be considered

variables that might affect comprehension performance in this investigation:

1. Embeddedness: self-embedded clauses (in Ss and So sentences) vs. right-branching clauses (in Oo and Os sentences).
2. Function of relativized NP within relative clause (corollary: word order within relative clause): relativized subject (Ss, Os) with subject-verb-object word order vs. relativized object (Oo, So) with object-subject-verb word order.
3. Comparative functions of relativized NP in both main and relative clauses: parallel function (SS, Oo) vs. non-parallel function (So, Os).

Strategies. Having thus identified important variables of the stimulus sentences, it was then possible, based on findings from earlier studies, to predict the strategies that subjects might use in attempting comprehension; furthermore, it was possible to predict the types of errors which might result from inappropriate use of a particular strategy. Following are several linguistic strategies and resultant errors (underlined) which might conceivably have been expected:

Strategy 1: Extraposition from NP (Sheldon, 1974). Interprets all relative clauses that follow the main clause as modifying the subject of the main clause.

This strategy would result in errors in Oo and Os sentences; for example:

Test sentence (Type Oo):

(2 - 60) The giraffe ran away from the hippo /that the cow
bumped into/.

Response (manipulating objects; see Methods, Chapter III):

The giraffe runs away from the hippo; the cow bumps into the giraffe.

Strategy 2: Parallel function. Interprets coreferential NPs as having the same function (subject or object) in both the main and subordinate clauses. The function of either the relative pronoun (in the subordinate clause) or its antecedent NP (in the main clause) may be changed to conform to that of its coreferent.

This strategy would yield errors in the two nonparallel sentence types, So and Os, wherein the functions of the coreferents differ in their respective clauses; for example:

Test sentence (Type So):

(2 - 61) The bear /that the lion crawled under/ kicked the alligator.

Response a: The lion crawls under the bear; the alligator kicks the bear (main clause NP function change)¹ ... OR

Response b: The bear crawls under the lion; the bear kicks the alligator (subordinate clause pronoun function change).²

Strategy 3: SVO (Fodor, Bever, and Garrett, 1974) Interprets any surface NVN sequence as a deep structure subject-verb-object unit, ignoring clause boundaries.

Of the four relative clause sentence types under discussion, only type Ss would be vulnerable to an error as a result of SVO

^{1,2}Parallel function strategy entails errors in both NPs of the affected clause.

strategy, for it alone contains a contiguous NVN sequence which is not subject-verb-object of a deep structure sentoid. Such an error would take the following form:

Test sentence (Type Ss):

(2 - 62) The giraffe /that bumped into the cow/ ran away
from the hippo.

Response: The giraffe bumps into the cow; the cow runs away
from the hippo.

Cognitive and Linguistic Strategies

Identification of Strategies

A strategy was defined by Horn (1970) as a series of behaviors or thinking operations used for attainment of a concept. As we have seen in our discussion of relative clause sentences, previous studies have suggested certain linguistic strategies that subjects might be expected to use in this experiment, i.e., SVO strategy, extraposition from NP, parallel function. Additionally, certain strategies could manifest themselves which shall be called "behavioral," e.g., frequent requests to repeat the target sentence, omissions, perseveration of a preceding response mode. (The linguistic-behavioral dichotomy is used merely as a convenience; it is recognized that such a distinction can be questioned on various grounds).

In studies of memory and language comprehension, strategies are often apparent from the nature of the errors that subjects make, i.e., the errors indicate what went wrong. Error-free performance, on the other hand, seldom provides us with such direct clues as to "what went right," yet obviously, something did go right. It can be assumed that the subject who consistently responds appropriately to a linguistic input is understanding that input and is effectively using grammatical knowledge to do so.

Researchers in psychology and psycholinguistics have traditionally used reaction time to test hypotheses about strategies. Typically, they presume that a particular performance is achieved by one of several different strategies, or processes, which take unequal amounts of time for completion. From a subject's reaction time, or response latency, inferences are made regarding the complexity of the task, and hypotheses

are evaluated regarding the particular strategy employed in its performance. Swinney and Taylor (1971) used this general paradigm in a visual scan experiment (to be discussed presently) as did a number of psycholinguistic investigators, e.g., Foss (1970); Hakes and Cairns (1970); Hakes (1972); MacKay and Bever (1967); Foss and Jenkins (1973); Caplan (1972). In considering such studies, it should be remembered that, although the results might confirm hypotheses that particular strategies have been employed, they do not constitute direct proof.

The object manipulation task which is performed in the present research enables the experimenter to observe what would seem to be a fairly direct expression of strategy. It allows inferences regarding operations that are used in error-free performance, as well as those used in erroneous performance.

Strategies Used by the Aged

Because, in certain instances, normal old people have been noted to behave differently than the young in dealing with their environment, an age comparison of language comprehension strategies, or operations, is undertaken in this study.

The strategies of the aged in learning and problem-solving have been found to be inefficient and time-consuming, in some situations more closely resembling those of young children or brain-damaged persons than of normal young adults. Perhaps to compensate for diminution of such abilities as short-term memory and psychomotor speed, the aged generally try to reduce the risk of error by using more information than is strictly necessary. They perform redundant operations, not recognizing that they are redundant, or needlessly repeat

necessary ones. Rabbitt (1965; 1968) explained these inefficiencies in part as the inability of elderly persons to remember when they had disconfirmed an invalid hypothesis, their inability to relate experience gathered over successive trials, and their inability to ignore irrelevant information.

The latter problem was exemplified in a categorization task by the sharp increase in response-times of old people when the number of items in the stimulus array was increased; young subjects responded more quickly in general and were less affected by such increases (Rabbitt, 1965). The task required that subjects search through a pack of cards for those containing certain letters of the alphabet, e.g., A and B. Each letter might be alone on a card or among several others. The cards were to be sorted into separate piles. Those with the relevant letters had to be discriminated from each other and also from cards with irrelevant letters, which need not have been discriminated from each other. The task was varied in that Ss were required to search for either two or eight letters among varying numbers of irrelevant letters. The results suggested that young Ss sampled the irrelevant symbols in larger groups than did older Ss; the "perceptual sample-space" diminishes with increasing age, requiring older Ss to make more discriminations among the irrelevant stimuli than do their younger counterparts.

Warren and Warren (1970) found that the elderly resemble young children in their perception of repeated auditory stimuli. A word which is continually repeated will be perceived by young adults as undergoing a series of transformations into other words, e.g., the repeated word "rest" might be perceived as tress, dress, Esther, etc.

Five year-olds experience few or no verbal transformations, whereas about one-half of the six year-olds tested heard changes. By eight years, all the children tested heard changes. The tendency to experience such auditory illusions slowly declines during the middle years until, at about sixty-five, the rate is approximately that of the five-year old. The authors suggested that old persons, like young children, are stimulus-bound; they no longer have the functional capacity for skilled reorganization of the auditory stimulus.

Aged persons and young children alike are deficient in incidental learning, i.e., the acquisition of information or skill not relevant to the main purpose of a learning task (Botwinick, 1970). The deficit is explained differently for the two age groups -- failing ability in the aged, and increasing efficiency (focusing on what is relevant) in children. For whatever reason, the behavior once again is "stimulus-bound," as in the Warren and Warren study.

Rabbitt (1968) and Bromley (1970) described the aged as unable to select between critical and incidental aspects of a problem. Apparently, this inability serves to reduce performance in both intentional and incidental learning.

Using signal detection theory in audiometric testing, Rees and Botwinick (1971) found confirmation for the frequently reported cautious and conservative strategies of the aged. Old people avoided responding to low signals, although those signals were louder than their predetermined auditory thresholds. Apparently this behavior reflects a fear of taking risks or of being wrong. A further finding of this study was the increasing tendency with aging to give perseverative responses; such perseveration is also a common finding among

persons who have sustained brain damage (Luria, 1972).

In word association tasks, old persons, aphasics, and children produce a majority of syntagmatic responses, whereas normal young and middle-aged adults produce more paradigmatic responses (Riegel, 1970; Goldfarb, 1976). An explanation which is offered, at least in the case of children, is that their smaller vocabulary permits fewer in-class responses. That explanation might also serve for the aged, since vocabulary scores rise throughout most of life, but fall off somewhat, even before senescence (Wechsler, 1972).

The relatively good performance by the aged on vocabulary tests might be explained by Riegel's (1959) study in which he found that the performance decline of elderly persons in a series of word association tasks paralleled the decrease in redundancy, or predictability, between word lists and response words. Old subjects (beyond 65 years) performed best when required to select synonyms (the task in most vocabulary tests); this task offers much redundancy, since there are few synonyms for each word. A steady decline occurred as tasks progressively decreased in the amount of redundancy offered, e.g., selecting subordinates, selecting coordinates, and forming analogies. Young adults (mean age 18.6 years), on the other hand, performed equally well in all of these tasks.

Although old persons require more redundancy than young adults, Rabbitt (1968) reported their reduced efficiency in exploiting linguistic redundancy. In a sentence-completion task, as more of a sentence is heard, it becomes progressively easier to guess the remainder; yet aged persons do not optimally use the structure, or redundancy, in the sentence, and consequently take longer to complete

it than do younger persons.

Swinney and Taylor (1971) found differences in reaction times of aphasics and normals on a visual scan task, and concluded that aphasics use a different search strategy than do normals. If aphasics encounter the test stimulus when searching memory, they stop and respond without continuing to the end of the list; that is, they use a "self-terminating strategy." Normal persons, on the other hand, were found to use an "exhaustive strategy." They make a mental marker if the test stimulus is recognized, but continue to the end of the list. They then determine whether or not a marker has been set. The authors speculated that persons who use the self-terminating strategy will have greater difficulty than others in comprehending certain types of complex linguistic structures, such as self-embedded sentences, e.g., "The boy the girl saw hit the cat." In searching for the Noun Phrase + Verb which comprise a sentence, they would presumably stop at the word "saw," linking it with "the boy," thereby misunderstanding the sentence.

Unfortunately, that study used data from only six normal subjects whose mean age was 47.13; the age range is not documented. Furthermore, the normal subjects' reaction times were averaged, thereby obscuring possible age differences. It would seem worthwhile to pursue the Swinney and Taylor speculation regarding self-embedded sentences experimentally, comparing young and old normal adults.

To summarize, the operations used by aged persons in dealing with a number of aspects of their environment are qualitatively different than those used by younger adults. This research explored the possibility that those differences might interfere with the linguistic

comprehension of the aged, and, further, that particular language comprehension strategies might be more characteristic of one adult age group than another.

CHAPTER III

METHODS

This study is concerned with both quantitative and qualitative information. Because so little is known about the linguistic abilities of the aged, we began by asking whether old people comprehend as much or as well as young adults. Additionally, we considered whether language comprehension decrements that elderly persons may sustain occur gradually with aging or rather abruptly.

Another concern of this investigation was whether elderly persons use different language comprehension strategies,¹ or language processing operations, than do young adults, and if so, what they are. We sought to determine whether the language comprehension strategies of the elderly are related to strategies that they employ in other areas of performance, e.g., cautiousness; stimulus-bound behavior. Finally we asked whether, for persons of any age, language comprehension abilities and operations differ as a function of variations in linguistic context.

Specifically, then, the goals of this research were to:

1. Quantify, for four adult age groups, abilities in comprehending various types of complex sentences.
2. Identify and compare heuristic strategies used by subjects

¹In this study, the words "strategy" and "operation" will be used interchangeably, for we shall conform to Horn's (1970) definition of a strategy as a series of behaviors or thinking operations used for attainment of a concept or desired result.

in attempting to understand those sentences.

3. Identify relationships among the following processes:
 - a. interpreting isolated sentences
 - b. deriving information from contextual cues
 - c. employing particular strategies

To fulfill these goals, two experiments were undertaken in which subjects were assessed with regard to their performance in manipulating objects to demonstrate the meanings of sentences containing relative clauses. In Experiment 1, stimulus variations were wholly contained within the sentences themselves, whereas in Experiment 2, an additional source of variation was introduced by the narrative contexts in which the sentences occurred.

Experiment 1

Comprehension of Isolated Sentences

Containing Relative Clauses

A total of fifteen tape-recorded complex sentences was heard by each subject, produced as described in Appendix D. Subjects listened to each sentence and then manipulated objects to act out its meaning. Nine plastic animals were manipulated, three for each sentence. Subjects were instructed, "Listen to the sentence and make the animals do everything that it says. Each sentence contains two actions; it doesn't matter which one you do first, but remove the animals from one action before you start the next. Be sure that I can really see WHO is doing WHAT to WHOM."

Before testing, the experimenter identified the animals and demonstrated all the actions which would be represented in the sentences. Then, in order to verify that the task of acting out a sequence of two actions was understood, the subject was asked to perform two demonstration sentences, both of the conjoined type.

In order to preclude errors due to subjects' inability to select the correct animals, the experimenter placed the appropriate three animals before the subject before each sentence was presented.

Stimuli. Of the fifteen complex sentences, twelve contained relative clauses (three of each of the four types described in Chapter II) and three were conjoined sentences consisting of the coordinate structure counterparts to the relative clause sentences. For example,

Relative Clause Sentence

(3-1) The horse /that jumped
over the bear/ pushed the
camel.

(3-2) The elephant kicked
the giraffe /that the cow
pushed/.

Conjoined Sentence

(3-1¹) The horse jumped over
the bear and the horse pushed
the camel.

(3-2¹) The cow pushed the giraffe
and the elephant kicked the
giraffe.

Sentences were presented in random order with the constraint that there were no consecutive presentations of the same sentence type. The design of Experiment 1 appears in Table 2, and a complete list of its stimuli in Appendix A.

TABLE 2
DESIGN OF EXPERIMENT ONE

	SENTENCE TYPE				
	<u>Self-embedded</u>		<u>Right-branching</u>		<u>Conjoined</u>
	Subject Relative	Object Relative	Subject Relative	Object Relative	
Coding	Ss	So	Os	Oo	Conj
Number of Sentences	3	3	3	3	3

Experiment 2

Comprehension of Relative Clause

Sentences Preceded by Narratives

The aim of this experiment was to determine for four adult age groups, the effects of differential thematic conditions upon comprehension of four types of sentences containing relative clauses. (See Chapter II for a discussion of thematization.)

For each subject, stimuli consisted of twelve short tape-recorded narratives, each in the form of a newscast, and produced as described in Appendix D. The newscast format was selected for its proven relevance to the lives of adults (Hornstein, LaKind, Frankel, and Mann, 1975; LaKind, in preparation) and for its inherent human interest (Mott, 1962). The final, or target, sentence of each narrative contained a relative clause. Subjects demonstrated the events expressed in the target sentence by manipulating cardboard figures that represented characters in the story. A bell was rung just before the target sentence to signal subjects to prepare for demonstrating it.

Subjects were instructed, "You're going to hear a story. Listen carefully, then act out the end of the story with the cardboard figures. Just before the last sentence of the story you'll hear a bell to signal you to get ready. Act out everything that happens in the last sentence after the bell. Remove the figures from one action before you start the next. Be sure that I can tell WHO is doing WHAT to WHOM ... After you act out the last sentence, I'll ask you to tell me the story."

After acting out the sentence, subjects were instructed, "Tell me the story." This request had a dual purpose:

1. To reveal instances where erroneous responses might be due to misunderstanding of the narrative, rather than of the target sentence.
2. To motivate listeners to attend to the narratives.

To insure that subjects understood the task, two demonstration trials were administered, differing from the experimental task in that both narratives were shorter and unthematized, and targets were conjoined, rather than relative clause, sentences.

To preclude errors based upon misidentification or faulty selection of objects to be manipulated, the precautions taken in Experiment 1 were again employed. Before each narrative was presented, the experimenter selected the three figures to be used, and placed them before the subject. She then identified each figure, e.g., "the lifeguard; the mother; the child." The figures were easily distinguishable by virtue of their apparel or physical attributes.

Stimuli

Target sentences were of the same four types as in Experiment 1 (Ss, So, Oo, Os). To preclude the possibility that results might be determined by idiosyncrasies of the particular stimulus, e.g., sentence length, meaning, or vocabulary, for each of the four sentence types, three target sentences were constructed, for a total of twelve sentences. Twelve different narrative scenarios were also constructed, one to precede each target sentence. Each scenario occurred in three versions: non-thematized narrative (No th), thematized subject of

narrative (Nar-S), and thematized object of narrative (Nar-O). The design of this experiment is presented in Table 3.

The word selected to act as the theme, or "thematized referent," of the narrative was determined by its status in the relative clause of the target sentence. In all cases, the thematized referent was the unrelativized NP of the relative clause, i.e., the NP which was named, and not represented by the pronoun "that." Thus, half the themes were drawn from subjects of the relative clause (in So and Oo sentences) and half were drawn from objects of the relative clause (in Os and Ss sentences). For example, in the So sentence

(3 - 3) The swimmer /that the basketball player tackled/
punched the boxer.

the theme was the relative clause subject, "the basketball player."

In the Nar-S version the central character, or thematized referent, acted as the syntactic subject of sentences in the narrative. In the Nar-O version, the thematized referent acted as the syntactic object of sentences in the narrative. Where a narrative sentence had more than one clause, the theme served those syntactic functions, respectively, in the main clause.

Within the narrative, the central character was referred to in various ways. For example, for the target sentence

(3 - 4) The queen ran from the gunwoman /that the photographer
pushed/.

the thematized referent "the photographer" was also designated by name ("Karen Marcus") and as "the camerawoman." Thus, effects of thematization which may be revealed cannot be due to frequency of specific word occurrence, but probably result from the greater number

TABLE 3

DESIGN OF EXPERIMENT TWO

CONDITIONS OF THEMATIZATION	<u>SENTENCE TYPE</u>			
	<u>Self-embedded</u>		<u>Right-branching</u>	
	Subject Relative (Ss)	Object Relative (So)	Subject Relative (Os)	Object Relative (Oo)
Unthematized (No th)	1	1	1	1
Subject (Nar - S)	1	1	1	1
Object (Nar - O)	1	1	1	1

(One sentence for each combination of theme and sentence type)

of propositions entered into by the referent, regardless of the particular designation used (Perfetti and Goldman, 1974).

The variables of thematization and sentence type were counter-balanced across groups, with each version of a scenario followed by the same target sentence. In summary then, the stimuli for each subject consisted of twelve newscasts, each comprised of a different scenario followed by a different target sentence. Each subject heard each of the four types of target sentence, Ss, Oo, Os, and So, three times -- after a No th narrative, after a Nar-S narrative, and after a Nar-O narrative. In four of the eight thematized narratives, the thematized referent was drawn from the subject of the target sentence's relative clause, whereas in the other four thematized narratives, the thematized referent was drawn from the object of the target sentence's relative clause. Examples of the three narrative versions appear in Table 4 and a complete list of the stimuli for this experiment can be found in Appendix B.

TABLE 4

THREE SCENARIO VERSIONS DIFFERING IN

THEMATIZATION CONDITION

Nar - S: Thematized referent acts as subject of narrative

The New York Times this morning printed a striking series of photographs detailing an attempted assassination.

Luckily, an amateur photographer happened to be part of the crowd that lined the street to welcome the visiting queen.

While Karen Marcus continually rotated her camera to scan the excited faces, she spotted a gun projecting from the crowd.

The horrified camerawoman shouted, causing the gunman to miss her target. Then, as the drama continued ... (signal) ...

*The queen ran from the gunman that the photographer pushed.

Nar - O: Thematized referent acts as object of narrative

The New York Times this morning printed a striking series of photographs detailing an attempted assassination.

Luckily, the crowd that lined the street to welcome the visiting queen contained an amateur photographer.

Her camera's sudden view of a gun projecting from the crowd horrified Karen Marcus, who had been scanning the excited faces.

The gunman noticed the camerawoman and, as a result, missed her target. Then, as the drama continued ... (signal) ...

*The queen ran from the gunman that the photographer pushed.

No th: Non-thematized narrative

The New York Times this morning printed a striking series of photographs detailing an attempted assassination.

Luckily, the crowd which gathered to welcome the visiting queen contained an amateur photographer.

As the camera rotated to scan the excited faces, it focused on a gun projecting from the crowd.

The gunman was startled by a shout from the crowd and, as a result, missed her target. Then, as the drama continued ... (signal) ...

*The queen ran from the gunman that the photographer pushed.

Subjects

This research enlisted 60 volunteer participants in what was described as a "study of how people understand the English language." Subjects were Caucasians ranging in age from 18 years to 80 years, with 15 subjects from each of the following age groups: 18-25 years; 52-58 years; 63-69 years; 74-80 years.

These particular age groups were selected with the view that a comparison of performance across the four groups might reveal a continuum of change in language comprehension abilities. The youngest group served as a control against which to measure age-related changes. Since no significant changes in language comprehension abilities were anticipated until at least the sixth decade, subjects in that age group comprised our youngest experimental group. The seventh decade was selected for study because psychological research reveals performance decrements across a broad spectrum of tasks for members of this age group. Although linguistic research with subjects in their sixties and beyond is virtually nonexistent, it seemed probable that similar decrements might exist for them in comprehending language.

Because of the trend toward increased longevity, it was considered important that the study include subjects through eighty years of age.

All subjects were selected to have the following characteristics:

1. Peripheral hearing adequate for the understanding of average conversational speech

2. No history or indication of neurological deficit
such as stroke, paralysis, or seizures
3. Normal intelligence
4. Residence in their own home settings
5. U.S. residence since three years of age

In addition, as shown in Table 5, age groups were balanced with regard to sex and education, but imperfectly balanced for socioeconomic status. This was unavoidable in the youngest age group because, for most, occupational choices had not yet been made, and in the oldest age group because of inherent difficulties of subject recruitment.

Screening

In order to satisfy the criteria for subject selection, several screening procedures were employed, as described in Appendix C:

Interview

Audiometric Test: 3-frequency pure tone screening

Neurological Test: Motor Impersistence

Intellectual Test: WAIS Vocabulary

Memory Test: WAIS Digit Span

Summary scores for the last two tests are shown in Table 5, where subsequent contrasts by means of t tests revealed no significant age group differences for digit span and a single significant difference between the lowest and highest vocabulary means (Group 1 versus Group 3, $t = 1.86$, $p < .05$, one-tailed).

TABLE 5
CHARACTERISTICS OF SUBJECTS

<u>Group</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
<u>N</u>	15	15	15	15
<u>Age (years)</u>				
Range	18-24	52-58	63-69	74-80
$\bar{x}$	21.13	54.33	66.60	77.00
s.d.	1.95	2.22	2.09	2.42
<u>Sex</u>				
Male	7	7	8	8
Female	8	8	7	7
<u>Education</u>				
College grad.	7	8	8	7
H.S. grad.	8	7	7	8
<u>Socioeconomic Status (SES)^a</u>				
Working	3	5	5	6
Middle	12	3	5	1
Upper middle	-	7	5	8
<u>WAIS Vocab. (raw)</u>				
$\bar{x}$	53.13	60.33	62.66	59.93
s.d.	14.40	14.25	12.58	17.95
<u>Digit Span (raw)</u>				
$\bar{x}$	12.46	10.86	12.33	11.66
s.d.	1.88	1.84	2.35	3.03

^aAccording to Labov (1966). College students were presumed to be geared toward Middle SES, as an intermediate estimate. Retired persons were categorized according to the SES that obtained before retirement.

Administration of Tests

Each subject was seen individually in one session. All screening and test procedures were conducted in a well-lighted, quiet room free from distractions. Subjects who passed the screening immediately embarked upon Experiment 1 followed by Experiment 2.

Performances were not timed and subjects were encouraged to take as much time as they needed. Total testing time ranged from approximately seventy-five to ninety minutes; this period allowed for inter-test pauses in order to avoid subject or experimenter fatigue.

Test stimuli were presented on cassette audiotapes at loudness levels deemed comfortable by each subject.

Subjects' correct performance of the demonstration items before each test indicated that the instructions and tasks were understood. If necessary, additional demonstrations were given. In no case was a test begun before such understanding was demonstrated.

All responses were transcribed on paper forms by the experimenter, with no indication to the subject as to the correctness of the response.

Response Protocol

Every element of an enactment was recorded in the order in which it occurred. Thus, a typical record for the two-clause sentences indicated the subject's selection of S1-V1-01; S2-V2-02. A record was also made of the order in which the two clauses of each sentence were enacted, but order of enactment did not influence judgment as to the correctness of the response.

Finally, an accounting was rendered for three aspects of subjects' verbalizations, two of which occurred adventitiously, and the third of which was a requirement of Experiment 2. A record was made of whether or not each target sentence was verbalized by a subject as it was enacted and whether a verbalization accurately represented the sentence's meaning. Additionally, a record was made of subjects' requests for repetition of the target sentences. In Experiment 2, subjects' recollection and understanding of the narratives were scored according to the number of events recalled.

By evaluating these aspects of performance both quantitatively and qualitatively, it was possible to fulfill all the goals of this research. Frequency of errors could be compared for the four age groups and determination made as to whether any increase that might be observed occurred gradually along a continuum or began abruptly with a particular age group. Sentence types could be compared for order of difficulty and those results related to the sentence processing hypotheses discussed in Chapter II.

By assessing each manipulative act with regard to the grammatical structure of the sentence it demonstrated, rather than merely scoring for errors, it was possible to infer which heuristic strategies subjects employed in attempting comprehension.

The effects of context could be evaluated by comparing the results of Experiment 1, where stimulus sentences appeared in isolation, with those of Experiment 2, where similar sentences appeared as part of a newscast which varied in thematic condition.

Subjects' verbalizations of the stimulus sentences, requests for repetition, and recall of narrative events provided a general index of verbosity, attention, memory, and comprehension of the narratives. The relevance of these verbal expressions to correct performance of the manipulative tasks will be discussed in the following chapters.

CHAPTER IV

RESULTS

The results of this study will be reported in four sections, commencing with an analysis of the subjects' enactments as complete entities, followed by a description of their verbal behavior. Thereafter the enactments will be examined with regard to clause structure and grammatical functions.

Analysis of Total Errors

Each of 60 subjects enacted 27 utterances in the two experiments, for a total of 1620 performances. Of these, there were 278 erroneous enactments, yielding an average error rate of 17.2%.

Errors by Age Group

Table 6 presents the frequency distribution of errors by age group. It will be noted that 10 subjects never made an enactment error, whereas 6 subjects, all from the oldest group, together made 97 errors, more than a third of the total. Indeed, initial group contrasts by means of t tests indicated no discriminability among Groups 1, 2, and 3, whereas Group 4 was just discriminable from the younger groups (t's of 2.14, 2.43, and 2.00, all $p < .05$, one-tailed).¹

Since the weakness of this finding mainly stemmed from a great

¹All hypothesis tests with age groups employed unidirectional significance values since the experimental hypotheses were likewise unidirectional.

TABLE 6
FREQUENCY DISTRIBUTION OF ERRORS
BY AGE GROUP

Number of Errors	Age Group				Total
	1	2	3	4	
0	3	2	3	2	10
1	4	4	4	1	13
2	1	3	1	4	9
3	3	1	1	-	5
4	-	-	2	1	3
5	1	2	1	-	4
7	1	1	-	-	2
8	-	1	-	-	1
9	-	1	1	-	2
12	1	-	1	-	2
13	1	-	1	1	3
14	-	-	-	2	2
15	-	-	-	1	1
16	-	-	-	1	1
18	-	-	-	1	1
20	-	-	-	1	1
Total	52	47	56	123	278
Mean	3.47	3.13	3.73	8.20	4.63
S.D.	4.14	3.05	4.35	7.49	5.32

amount of intragroup variability, we examined the subject variables summarized in Table 5 to determine if they might not account for some of this variance. As shown in Table 7, each of the variables except sex accounted for much of the variance, thus dismissing gender as a source of further concern, but focusing our attention on the other four variables. In particular, we decided to create a new distribution of error scores adjusted for the effects of these demographic factors. To do this we employed the SPSS Regression program (Nie, et al., 1975) in which a set of variables is invited to compete for stepwise entry into an equation which predicts the values of a criterion variable, the sole limitation being that any entering variable must significantly improve the prediction.

In the present situation, when the four significant relations in Table 7 were invited to predict total error scores, the first entering variable was, as is usual, the variable accounting for the greatest amount of variation by itself, namely Vocabulary. Thereafter the computer program examined the partial correlations of the other three variables with the variance not yet accounted for, and found a significant improvement of the prediction from a knowledge of Digit Span. Having done this, the program demonstrated that no significant improvements would accrue from a knowledge of Education or Socioeconomic status (SES), their explanatory power having been absorbed by the two variables already entered.

Table 8 reports the outcome of this analysis where, taken together, Vocabulary and Digit Span achieve a multiple correlation (R) of .735, thus accounting for (R^2) 54 percent of the variation in total error scores. The table likewise indicates the proportional contribution of

TABLE 7
CORRELATIONS OF SUBJECT VARIABLES
WITH TOTAL ERROR

Sex	-.019	~
Education	-.511	***
SES	-.460	***
Vocabulary	-.634	***
Digit Span	-.546	***
*** p < .001		

TABLE 8

MULTIPLE PREDICTION OF TOTAL ERROR

<u>Variable</u>	<u>Beta</u>	<u>Percent of Variance</u>	<u>Percent of Explained Variance</u>
Vocabulary	-.515	30.7	57
Digit Span	-.390	23.3	43
Total	R = .735 ***	54.0	100

*** p < .001

the two variables to the prediction, Vocabulary playing a larger role than Digit Span in the ratio of 57:43.

Upon request of the user, the SPSS Regression program computes the final regression equation for each subject in the analysis, providing a predicted score for each obtained score and producing a distribution of predicted-minus-obtained scores called "residuals." These residuals are exactly equivalent to covariance-adjusted scores except that they are normalized, i.e., a distribution of residuals has a mean of 0 and a standard deviation of 1.

In the present analysis, the program took the Vocabulary and Digit Span score of each subject and produced a personal prediction of total error for that subject, which might have been greater or smaller than his or her actual number of errors but which, averaged over all subjects, yielded no difference between predicted error and obtained error.

Whereas the total distribution of residuals has a mean of 0, when the residuals are partitioned with respect to a relevant variable, the partitioned means may vary substantially around zero, negative values indicating overprediction, positive values indicating underprediction.

Table 9 summarizes the distribution of residuals according to age group, where it is observed that the younger two groups made fewer errors than their Vocabulary and Digit Span would predict, while the older two groups made more errors than the two scores would predict. Indeed, the reader is reminded that the decimal values in Table 9 are in z-score units so that, e.g., the oldest subjects are at the 75th percentile on a normal curve where the 50th percentile

TABLE 9

DISTRIBUTION OF TOTAL ERROR RESIDUALS

BY AGE GROUP

	Age Group			
	1	2	3	4
Mean	-.317	-.396	.039	.674
S.D.	.501	.396	.622	.617

would correspond to perfect prediction.

The outcome of this analysis is presented in Table 10 where residuals for the four age groups are contrasted by means of t tests. It is observed that when the error scores are adjusted for the effects of Vocabulary and Digit Span, there are substantial age group differences. Only the two youngest groups are indiscriminable, all remaining contrasts being significant in varying degree. The goal of variance reduction has been achieved: the oldest group is now sharply discriminated from the two youngest groups and even distinct from Group 3 at the .01 level.

Thematization Effects

In a first examination of stimulus variables, we focused on the primary feature that distinguished Experiment 1 from Experiment 2, namely that the latter test sentences were preceded by narratives. Our first concern was whether there had been any effects of the three counterbalanced test orders, i.e., whether any scenario provoked more errors than any other. Considering the small number of errors after distribution among 3 orders and 12 stimuli, it was not surprising that Kruskal-Wallis tests (Siegel, 1956) revealed no differences among the three test orders. Indeed, of 135 errors of enactment in Experiment 2, there was an almost perfect division among test orders (43, 45 and 47), thereby permitting their merger in further analysis.

Table 11, accordingly, presents the distribution of errors over all 12 test sentences in Experiment 2. Ordinarily one would wish to subject that matrix to a two-way analysis of variance but the small entries in some cells preclude this. Alternatively then,

TABLE 10
AGE GROUP COMPARISONS OF
TOTAL ERROR RESIDUALS

Contrast	t	p
Group 1 vs. Group 2	0.48	~
Group 2 vs. Group 3	2.29	*
Group 3 vs. Group 4	2.81	**

Group 1 vs. Group 3	1.73	*
Group 2 vs. Group 4	5.66	***

Group 1 vs. Group 4	4.83	***

* $p < .05$, one-tailed

** $p < .01$, one-tailed

*** $p < .001$, one-tailed

TABLE 11

EXPERIMENT 2

ERROR SUMS BY THEME AND SENTENCE TYPE

Thematic Condition	Sentence Type				Total
	So	Os	Oo	Ss	
No th	23	11	7	6	47
Nar - S	17	9	10	10	46
Nar - O	15	13	7	7	42
Total	55	33	24	23	135

each of the 12 distributions implied in Table 11 were intercompared by means of McNemar Tests (Siegel, 1956), with the result that none of the three thematic conditions was ever discriminated within a sentence type! When the rows of Table 11 were summed, Wilcoxon T tests again established that the themes were indiscriminable. In a final attempt to find an effect, the Nar-S and Nar-O conditions were summed and compared with the No th condition (after doubling each subject's error score), and yet again no differences emerged. Thus, at the level of complete sentence enactments, no aspect of the narratives had any influence on the likelihood of error.

In contrast to the foregoing, significant differences obtained among the four sentence types. While types Oo and Ss were indiscriminable, both were distinguishable from the Os condition (Oo: $N = 30$, $T = 110$, $p < .05$; Ss: $N = 34$, $T = 156$, $p < .05$) and highly distinguishable from the So condition (Oo: $N = 36$, $T = 72.5$, $p < .001$; Ss: $N = 38$, $T = 73.5$, $p < .001$). Types So and Os were likewise discriminable ($N = 39$, $T = 162.5$, $p < .01$), permitting us to conclude that the four sentence types represent three levels of difficulty, So being the most difficult, Oo and Ss being easiest.

Merger of Experiments 1 and 2

Since there were no effects of thematization, it became possible to compare the outcomes of the two experiments directly. To our surprise the results were nearly identical, both with regard to total errors (143 vs. 135) and to relative difficulty of the four sentence types. In Experiment 1, once again Types Oo and Ss were indistinguishable, but differed from Os (Oo: $N = 24$, $T = 76$, $p < .05$; Ss: $N = 28$, $T = 114$, $p < .05$), and differed greatly from So (Oo: $N = 24$,

$T = 26, p < .001$; Ss: $N = 26, T = 32, p < .001$). As in Experiment 2, So and Os were discriminable ($N = 27, T = 98, p < .05$), albeit somewhat more weakly than in Experiment 2.

The one remaining difference between the two experiments was the occurrence of three conjoined sentences in Experiment 1, introduced, it will be recalled, to provide a baseline for comparison with the relative clause sentences. The three sentences taken together provoked only 15 enactment errors, chiefly by the oldest age group, and thus, as expected, were the easiest sentence type of all. Owing to this small quantity of error made by only 12 subjects, it was not possible to distinguish the conjoined sentences from Oo and Ss, but there was a significant difference from Os ($N = 18, T = 25, p < .01$) and a highly significant difference from So ($N = 28, T = 32, p < .001$). Thus both experiments yielded the same hierarchy of sentence types, with conjoined sentences not discriminably easier than Oo or Os sentences.

Table 12 displays the distribution of sentence type errors across the four age groups. Not surprisingly, the oldest group made the most errors in both experiments in every sentence type. Of greater interest are the remarkable similarities between the cell entries for the two experiments. This being so it seemed reasonable to merge the outcomes of the two experiments, as has been accomplished in the right-most matrix of the Table. This combined matrix can be considered the primary finding of the present study, wherein the most errors are observed for the oldest group enacting the So sentences (40), while the fewest errors are made by the youngest two age groups enacting the Ss sentences (4 and 6 errors). This tenfold to sixfold difference in error

TABLE 12
EXPERIMENTS ONE AND TWO ERROR SUMS
BY AGE GROUP AND SENTENCE TYPE

Age Group	<u>Experiment 1</u>					<u>Experiment 2</u>					<u>Combined</u>				
	1	2	3	4	Σ	1	2	3	4	Σ	1	2	3	4	Σ
Sentence Type															
So	9	10	13	20	52	11	12	12	20	55	20	22	25	40	107
Os	11	3	6	15	35	5	6	7	15	33	16	9	13	30	68
Oo	6	5	2	8	21	3	3	6	12	24	9	8	8	20	45
Ss	2	2	4	12	20	2	4	5	12	23	4	6	9	24	43
Conjoined	3	2	1	9	15	-	-	-	-	-	3	2	1	9	15
Total	31	22	26	64	143	21	25	30	59	135	52	47	56	123	278

rate most aptly summarizes the range of influences exerted by sentence type and age group considered jointly.

Finally, the combined matrix was examined for overall differences among the four sentence types. As was true for both experiments, Oo and Ss remained indistinguishable, but all other differences were sharpened. To emphasize this point, the Wilcoxon T scores have been converted to z scores so that variations in sample size can be ignored (Siegel, 1956). Now it is the case that Ss differs from Os at the .01 level ($z = 2.60$) while Oo differs from Os at the .001 level ($z = 3.17$) while the differences between the two easiest types and So are enormous (Ss: $z = 3.91$, $p < .0001$; Oo $z = 4.09$, $p < .0001$). There is then a definite hierarchy of sentence difficulty with three highly discriminable steps. We shall return to this topic presently.

Verbal Expressions

Before proceeding to a more detailed analysis of the errors made in enacting the test sentences, we shall consider here three types of verbalization which accompanied the enactments. Two of these were unsolicited, the other a requirement of the design for Experiment 2.

Requests for Repetition

Occasionally, following the receipt of a test sentence, a listener would request that it be repeated. When this happened, the experimenter replayed the test sentence and noted this occurrence on the protocol. Altogether, 20 subjects made a single repetition request: 2 from age Group 1, 1 from Group 2, 3 from Group 3, and 14 from Group 4. Two other members of the oldest group made 2 such requests. No relationship could be discerned between these requests and error rate, sentence type, or experiment. The phenomenon seems to indicate a temporary lapse of attention or a lack of confidence on the part of the subjects. In that connection, it is noteworthy that the oldest group accounted for a preponderant majority of these requests.

Verbalizations of Test Sentences

On many occasions, before or during enactment, subjects would verbalize the test sentences. Altogether, 38 subjects verbalized at one time or another, while 22 never did so. We wondered whether verbalization served the function of facilitating a successful performance or, to the contrary, was simply an indicator of a subject's uncertainty. To examine this question the error rates for the two

groups were compared by means of the Kolmogorov-Smirnov test (Siegel, 1956). It was found that 82% of the non-verbalizing group made two or fewer errors, while only 37% of the verbalizing group did so. This dramatic disparity was significant at the .01 level (two-tailed), thus indicating that verbalization did not facilitate correct enactments.

Almost one-third of the time, 24 of the 38 verbalizers repeated their test sentences inaccurately. It seemed reasonable to predict that those subjects would be more likely to err in enacting test sentences accompanied by erroneous verbalizations than in enacting those accompanied by correct verbalizations. Indeed, that was the case, since only four of those subjects made more errors with correct verbalizations than they did with incorrect ones. The distribution of error differences was evaluated by means of the Wilcoxon Test, yielding a T of 31 ($p < .001$). No significant connection could be found between verbalization (correct or not) and sentence type or age group.

Recall of Narrative Events

It will be remembered that, following enactments of the Experiment 2 test sentences, subjects were asked to recall the preceding narratives. These recollections were scored as the number of events correctly recalled. Although subjects differed in the number of events they reported, it was never the case that any subject reported an event inaccurately.

Since the 12 narratives varied somewhat in the number of events which they contained, it was decided to pool subjects' recollections over all 12. Of a possible 67 events which might have been recalled,

the average subject recalled 39.0 (s.d. = 8.60). To account for the great variation around this mean, we examined the influence of several possible variables. These included the significant subject variables of Table 7 as well as the total number of errors made in Experiment 2, since we thought we discerned a regularity whereby erroneous enactments seemed to be accompanied by fewer events recalled. The correlations are shown in Table 13, where it can be seen that our suspicion was correct. Indeed, no subject variable accounts for as much variation as does error rate.

We likewise thought we observed a tendency for the oldest subjects to recall fewer events than the youngest ones, and therefore attempted to create adjusted scores for events recalled following the model which had proven so successful in accounting for total errors (Tables 7 - 10). Accordingly, the variables in Table 13 were entered competitively into a stepwise regression analysis to predict events recalled. As it happened, the analysis took in the Experiment 2 error score on the first step but found no significant improvement from the entry of any subject variable. It appeared then, that whatever the influences of the subject variables, the Experiment 2 error score accounted for them.

Thus, the SPSS Regression program produced predictions of events recalled based only on Experiment 2 errors, calculating residuals adjusted for that factor alone. The resulting partitions of residuals by age group are shown in Table 14, where it can be observed that there is a regular age group effect, in which younger subjects recall more events than their error rates would predict, while older subjects recall fewer such events.

TABLE 13
CORRELATIONS OF SUBJECT VARIABLES AND
EXPERIMENT 2 ERROR
WITH EVENTS RECALLED

Education	.274	*
SES	.336	**
Vocabulary	.353	**
Digit Span	.385	**
Exp. 2 Error	-.632	***

* $p < .05$, two-tailed

** $p < .01$, two-tailed

*** $p < .001$, two-tailed

TABLE 14
 DISTRIBUTION OF EVENTS RECALLED RESIDUALS
 BY AGE GROUP

	Age Group			
	1	2	3	4
Mean	.471	.025	-.186	-.310
S.D.	.599	.670	.881	.754

Examination of the standard deviations in Table 14 reveals much greater variability than was the case in Table 9. Not surprisingly then, when the four means are contrasted in Table 15 we find that only the youngest group can be distinguished from the three older groups. While we had thought the oldest subjects were recalling fewer events, in fact the results require an obverse assertion: it is the youngest subjects who recall more events than their error rates would predict. This is the only finding in our results whereby the youngest age group, introduced to serve as a control, is distinguishable from all older age groups.

In a final examination of events recalled, we attempted to compare our results with those of Perfetti and Goldman (1974), who found that meaning-preserving recall of isolated sentences was poorer than recall of the same sentences appearing at the end of a thematized paragraph. We wondered whether the number of events recalled in our study might likewise vary as a function of thematization. To the contrary, we found that the average of 39 events recalled was almost perfectly divided among the three conditions with means of 12.87, 13.03 and 13.10 for No th, Nar - O and Nar - S respectively. Even the greatest of these differences achieved the t value of only 0.66, thus reemphasizing the equivalency of the three conditions.

TABLE 15
AGE GROUP COMPARISONS OF
EVENTS RECALLED RESIDUALS

Contrast	t	p
Group 1 vs. Group 2	1.92	*
Group 2 vs. Group 3	0.74	~
Group 3 vs. Group 4	0.41	~

Group 1 vs. Group 3	2.39	*
Group 2 vs. Group 4	1.29	~

Group 1 vs. Group 4	3.14	**

* p < .05, one-tailed

** p < .01, one-tailed

Analysis of Performance by Clauses

To this point we have examined performance while considering sentences as complete entities. Each sentence, of course, was composed of two clauses. In this section, we shall consider the order in which the clauses were enacted in the different sentence types, and differential patterns of clause errors.

In the conjoined sentences (Experiment 1) subjects in every case acted out the clauses in the temporal order in which they occurred: the first-heard clause was enacted first, and the final clause enacted second. Of 180 responses, only 15 were incorrect, 12 because of a second clause error, 1 because of a first clause error, and 2 because both clauses were in error; each of the latter were made by members of the oldest age group. Indeed, 9 of the 15 errors were made by just 6 of the oldest subjects.

These findings may serve as a baseline for comparison with the enactments of the relative clause sentences to which we now turn.

Table 16 illustrates performances on all four relative clause sentence types, with respect to both order of enactment and nature of error.

In the self-embedded sentences of both types, So and Ss, the subordinate (embedded) clause was enacted first by the vast majority of subjects (681 of 720 responses). In the right-branching (Oo and Os) sentences, the major clause was enacted first by a somewhat smaller majority (632 of 720 responses). In all instances, most subjects were first enacting the clause whose complete s-v-o relationship was heard first on the tape.

TABLE 16

FREQUENCY OF ERRORS BY ORDER OF CLAUSE ENACTMENT AND AGE GROUP FOR EACH SENTENCE TYPE

Sentence Type		So					Os					Oo					Ss					Combined				
Age Group		1	2	3	4	Σ	1	2	3	4	Σ	1	2	3	4	Σ	1	2	3	4	Σ	1	2	3	4	Σ
Main Clause	Correct	3	2	2	2	9	66	65	72	55	258	64	71	77	60	272	4	3	1	2	10	137	141	152	119	549
First	M Error	-	-	-	-	-	1	1	3	3	8	2	1	1	-	4	-	1	-	-	1	3	3	4	3	13
	S Error	-	-	-	-	-	12	5	7	18	42	7	2	6	10	25	-	-	-	1	1	19	7	13	29	68
	M+S Error	-	-	1	-	1	1	1	-	5	7	-	3	-	2	5	-	-	-	-	-	1	4	1	7	13
	S Omit, M+	-	-	2	4	6	-	-	2	2	4	-	-	-	4	4	-	-	2	6	8	-	-	6	16	22
	S Omit, M-	-	-	-	2	2	-	-	-	1	1	-	-	-	2	2	-	-	-	1	1	-	-	-	6	6
	Total	3	2	5	8	18	80	72	84	84	320	73	79	84	78	312	4	4	3	10	21	160	155	176	180	671
Subordinate	Correct	67	66	63	48	244	8	16	5	5	34	17	11	5	10	43	82	81	80	64	307	174	174	153	127	628
Clause First	M Error	10	10	10	2	32	1	-	1	-	2	-	2	-	1	3	3	4	5	7	19	14	16	16	10	56
	S Error	3	10	4	10	27	1	-	-	-	1	-	-	1	-	1	-	-	2	3	5	4	10	7	13	34
	M+S Error	5	2	8	22	37	-	1	-	1	2	-	-	-	-	-	1	1	-	3	5	6	4	8	26	44
	M Omit, S+	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	-	-	2	3
	M Omit, S-	1	-	-	-	1	-	1	-	-	1	-	-	-	1	1	-	-	-	1	1	1	1	-	2	4
	Total	87	88	85	82	342	10	18	6	6	40	17	13	6	12	48	86	86	87	80	339	200	205	184	180	769
Combined	Correct	70	68	65	50	253	74	81	77	60	292	81	82	82	70	315	86	84	81	66	317	311	315	305	246	1177
	M Error	10	10	10	2	32	2	1	4	3	10	2	3	1	1	7	3	5	5	7	20	17	19	20	13	69
	S Error	3	10	4	10	27	13	5	7	18	43	7	2	7	10	26	-	-	2	4	6	23	17	20	42	102
	M+S Error	5	2	9	22	38	1	2	-	6	9	-	3	-	2	5	1	1	-	3	5	7	8	9	33	57
	Omit, +	1	-	2	4	7	-	-	2	2	4	-	-	-	4	4	-	-	2	8	10	1	-	6	18	25
	Omit, -	1	-	-	2	3	-	1	-	1	2	-	-	-	3	3	-	-	-	2	2	1	1	-	8	10
	Total	90	90	90	90	360	90	90	90	90	360	90	90	90	90	360	90	90	90	90	360	360	360	360	360	1440

The question arises regarding the relevance of the small pool of 127 responses acted out in clause order opposite the majority. On the average, these minority responders were less likely to produce correct enactments than the majority -- 76% versus 82%, respectively. To determine whether the difference was a significant one, it was necessary to examine the performances of each subject separately. It was found that 12 subjects made no "reversed order" responses, and 29 who made such responses made no errors in doing so.

For the 19 subjects who made errors when they opposed the predominant order of clause enactment, we compared their error rates when they did so with their error rates when they did not. In 18 of the 19 cases, the error rate was greater for responses enacted in reversed order ($p < .001$, binomial test). Indeed, in 5 cases the only time a subject opposed the majority order, an error resulted! In comparing the group which made errors in opposing the majority order with the group that made none, there was a tendency for older subjects to be in the former group, but the trend did not achieve statistical significance.

When the combined performances for the two orders of enactment were compared, we observed that the first-enacted clause was less likely to be in error than the second-enacted clause. It will be recalled that this tendency was likewise the case for the conjoined sentences. From appropriate summations of the totals at the right-hand side of Table 16, we note that when the main clause was enacted first it was in error 32 times, while the second-enacted subordinate clause was in error 81 times. Conversely, when the subordinate clause was enacted first, it was in error 82 times, while the second-enacted

main clause was in error 100 times. Thus, the data suggest a memory component to the likelihood of making errors, as well as a tendency for main clauses to be enacted correctly more often than subordinate clauses.

The combined effects of these influences are vividly seen in the distributions of errors for the sentence types taken separately. These data, shown at the bottom of Table 16, have been plotted in Figure 2, where, for the right-branching sentences (Os, Oo) the preponderant majority of errors were in the subordinate clause, and very few errors in the main clause. This asymmetry would be expected from a summation of the two tendencies described above. For the self-embedded sentences (So, Ss), there were more errors in the main clause than the subordinate clause, but here the disparity was not so great as was the case for the right-branching sentences, since now there was a competition between the two tendencies noted above.

The emergent properties of Figure 2 inhere in the observation that errors in both clauses were unlikely in three of the four sentence types, but were conspicuously present in the So type, indeed exceeding the frequency of errors in either clause alone. The other intriguing result was that subjects were far more likely to omit enactments of subordinate clauses than of main clauses in every sentence type; the overall disparity was 28 omitted subordinate clauses versus only 7 omitted major clauses.

Omissions as well as errors in both clauses occurred predominantly in the oldest group. This is seen most clearly in Figure 3, where single clause errors, double clause errors, and omissions are proportionalized for each age group.

Figure 2

Categories of clause errors by sentence type

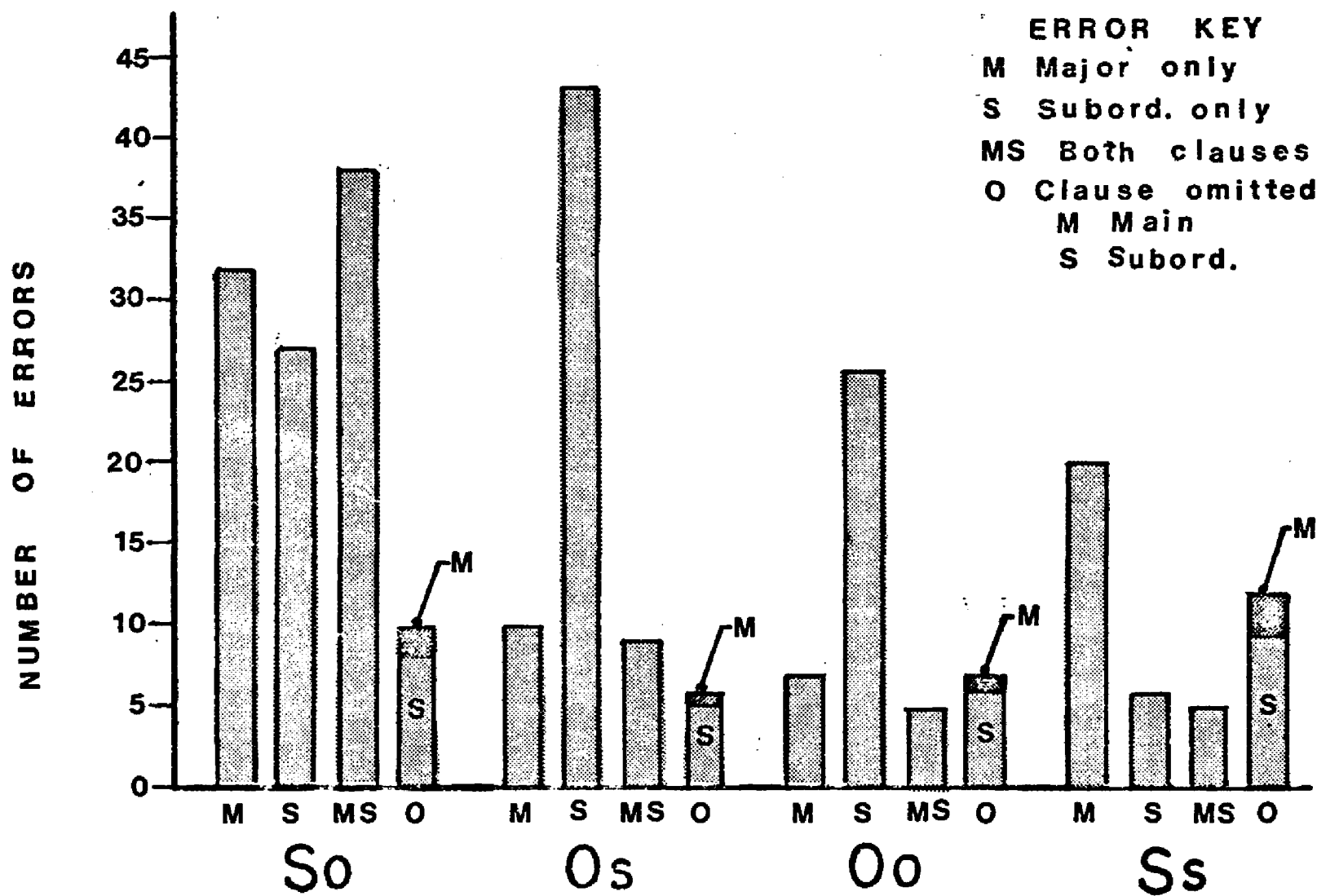
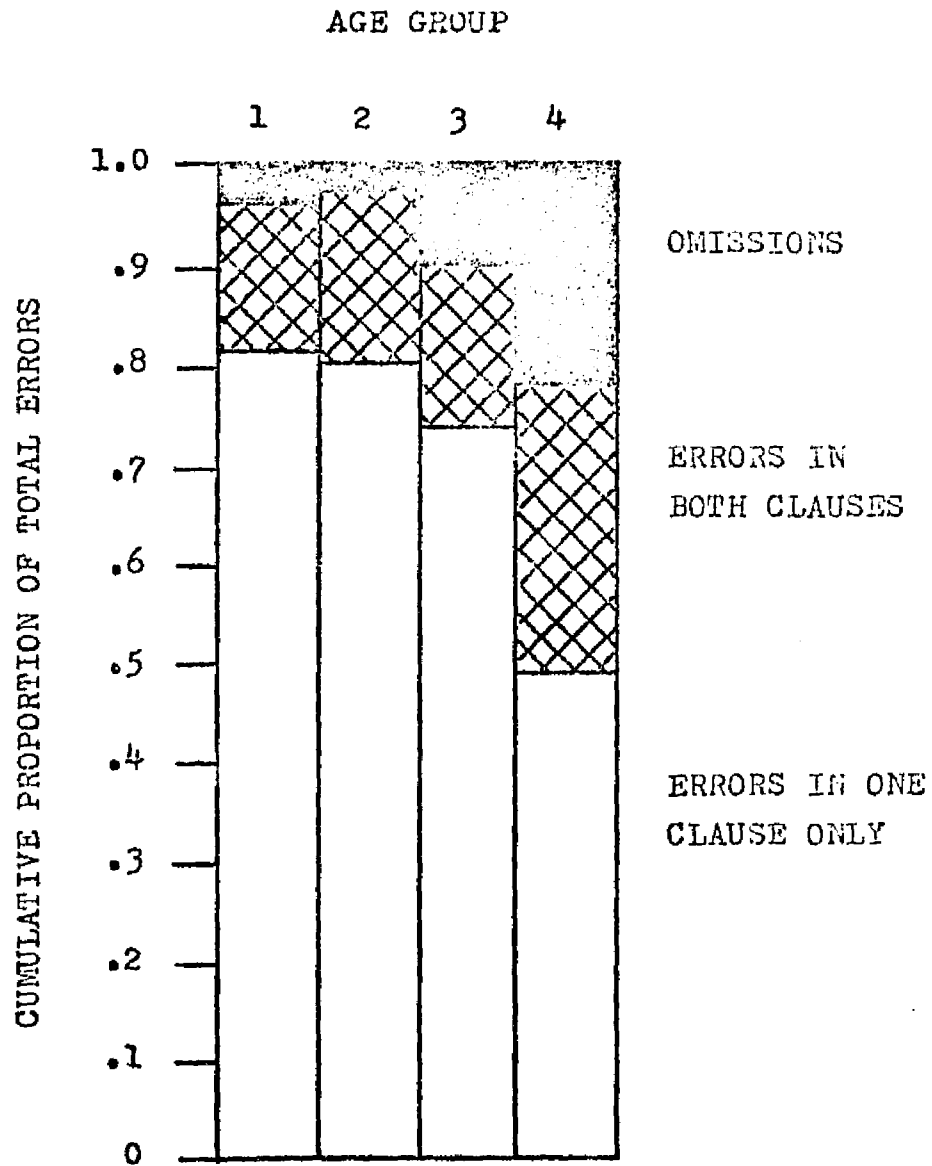


Figure 3**Clause errors proportioned by age group**



Syntactical Analysis of Errors

Classification of Errors

As we have seen in Chapter II, earlier studies predicted certain strategic errors that subjects might make in attempting to comprehend relative clause sentences. Some of those predicted strategies did indeed account for many of the errors made in this investigation, while others did not. Table 17 illustrates for each sentence type the proportion of error accounted for by each predicted strategy, the locus of the error, and a description of its nature. Altogether these predicted strategic errors accounted for 83 of the 263 errors made in enactment of the four sentence types. In addition to the errors that resulted from predicted strategies, several other types of errors were observed.

Omissions. Either clause in its entirety was omitted from enactment, as already discussed. Omissions occurred 35 times, with the majority occurring in the oldest group.

Verb Errors. Verb errors took two forms: the verb from one clause was used in the other as well (let us call this error "verb perserveration") or an entirely new verb was introduced into the sentence and substituted for the appropriate one ("verb intrusion"). These errors occurred in a total of 66 enactments, accompanied by some other kind of error almost half the time. They were especially prominent in the oldest group, as will be detailed later in this section.

Noun Errors. In all, 79 enactments were marred by non-predicted noun errors, a majority of which (42) occurred only in So sentences and took the same form. Although this predominant error occurred

TABLE 17

FREQUENCY OF PREDICTED STRATEGIC ERRORS BY SENTENCE TYPE

Sentence Type	Predicted Strategy	Locus of Error		Nature of Error	Frequency	Percentage of Sentence Type Error
		Clause	Gram. Function			
So	Parallel	main	object	^a N1 replaces N3	2	1.9%
	Parallel	subord.	subject	^b N1 replaces N2	18	16.8
Os	Parallel	main	subject	^b N2 replaces N1	1	1.4
	Parallel	subord.	object	^a N2 replaces N3	3	4.4
	Extrapolation	subord.	subject	N1 replaces N2	32	47.1
Oo	Extrapolation	subord.	object	N1 replaces N2	14	31.1
Ss	SVO	main	subject	N2 replaces N1	13	30.2
Total					83	

^aEntails concomitant subject error in same clause.

^bEntails concomitant object error in same clause.

only in So sentences, it accounted for the greatest proportion of total errors (16%) among all four sentence types! Let us consider the So sentence:

(4 - 1) The lion /that the elephant pushed/ jumped over the giraffe.

In this most prevalent error, which we shall call "subject-borrow," the subject of the subordinate clause is used as the subject of the main clause. Thus, for the above sentence, a subject-borrow error would result in the following enactment:

(4 - 2) The elephant pushes the lion; the elephant jumps over the giraffe.

(It should be remembered that in self-embedded sentences, subjects usually enacted the subordinate clause first).

In 16 cases, more than 1/3 of the responses in which the subject-borrow error occurred, it was accompanied by an error in the subordinate clause that we shall call "s-o transfer," wherein the syntactic functions of the subject and object are reversed. An isolated s-o transfer in the subordinate clause of (4 - 1) above would result in the following enactment:

(4 - 3) The lion pushes the elephant; the lion jumps over the giraffe.

It will be noted that an isolated s-o transfer can also be classified as a parallel function error; that is, the coreferents ("the lion" and "that") are interpreted as serving the same syntactic function (subject in this example) in their respective clauses. However, when s-o transfer is combined with subject borrow, the "parallel function" designation can no longer apply, for the relativized NP is used only

once in the enactment:

(4 - 4) The lion pushes the elephant; the elephant jumps
over the giraffe.

It can be seen that correct enactment of (4 - 1) would employ N2-V1-N1; N1-V2-N3 word order, whereas the combined subject borrow and s-o transfer error (4 - 4) employs N1-V1-N2; N2-V2-N3 word order. The temporal ordering manifested in this error alerted us to a commonality among all the errors: a "temporal strategy" not only accounts for the unpredicted error described above and for errors resulting from SVO strategy (by definition a temporal strategy), but accounts as well for the other literature-predicted strategies that occurred with any frequency. This phenomenon is illustrated in Table 18, which compares, for each sentence type, word order used in correct enactment with word order used when making temporally strategic errors.

Temporal Strategy

The temporal strategy can be explicated in terms of three principles which, taken together, specify the enactment location ($S_1-V_1-O_1$; $S_2-V_2-O_2$) of all five of the nouns and verbs that were heard, but leaves unspecified the noun which must be employed twice. For the So sentences the strategy leaves up to three functions vulnerable to error, whereas in the other sentence types only one function remains ambiguous.

The first principle is that a noun following a verb will be enacted as the object of that verb; the second is that a noun preceding a verb will be enacted as the subject of that verb, and any as yet

TABLE 18

TEMPORAL STRATEGY FOR EACH SENTENCE TYPE

Sentence Type	Order of Presentation	Correct Enactment	Temporal Strategy ^a	Frequency	Name of Strategy
Ss	N1-V1-N2-V2-N3	N1-V1-N2; N1-V2-N3	N1-V1-N2; <u>N2</u> -V2-N3	13	SVO
Oo	N1-V1-N2-N3-V2	N1-V1-N2; N3-V2-N2	N1-V1-N2; N3-V2- <u>N1</u>	14	Extraposition
Os	N1-V1-N2-V2-N3	N1-V1-N2; N2-V2-N3	N1-V1-N2; <u>N1</u> -V2-N3	32	Extraposition
So	N1-N2-V1-V2-N3	N2-V1-N1; N1-V2-N3	<u>N1</u> -V1- <u>N2</u> ; N1-V2-N3	18	Parallel
			N2-V1-N1; <u>N2</u> -V2-N3	26	Subject Borrow
			<u>N1</u> -V1- <u>N2</u> ; <u>N2</u> -V2-N3	16	(S-O Transfer (+ Subject Borrow
			Total		119

126

126

^aUnderlining indicates locus of error.

unspecified noun as its object. The third principle, applicable only in So sentences where it may replace Principle 2, is that the first-heard noun will serve as subject of the first-heard verb, and the second-heard noun as object of the first-heard verb.

The principles operate sequentially in that Principle 1 is applied before Principle 2, or in the case of So sentences, before a choice is made between Principles 2 and 3.

In Ss sentences, the only unspecified function is the subject of the main clause. If the listener elects N1 he will be correct, while if he elects N2 he will be in error. That very error would have been a correct response for an Os sentence.

In the enactment of Oo sentences, only the object of the subordinate clause remains unspecified. If the listener elects N2, he will be correct, while election of N1 leads to error.

In Os sentences, the unspecified function is the subject of the subordinate clause, which will be correct if N2 is enacted, but incorrect if N1 is selected. That error would have been a correct response for an Ss sentence. Thus it will be noted that a trading relation obtains between the error strategies of Os and Ss sentences.

Finally, for So sentences there exists a conflict between Principles 2 and 3. Under Principle 2, the only unspecified function is the subject of the main clause, where if N1 is chosen, the listener will be correct, while the choice of N2 leads to error. Under Principle 3, a parallel function error is unavoidable in the subject and object of the first enactment, a strategy which yields correct enactments of the other three sentence types! The subject of the main

clause remains unspecified as before, so that if the listener chooses N1 as the subject he will be partially correct, while if he chooses N2 he will have enacted both clauses incorrectly.

The terms previously used to describe strategic errors are of value because they are, to some extent, specific to particular sentence types. However, a comparison of the frequencies in Tables 17 and 18 reveals that a unified temporal strategy accounts for a greater proportion of errors than do the predicted strategies alone. The term "temporal strategy" is a more parsimonious description of the general error tendency, subsuming all the predicted strategies and accounting for the newly observed So errors as well.

Weighted Errors

The identification of a temporal strategy permitted the development of a hierarchical approach to the nature of errors observed for any subject. It seemed reasonable to evaluate strategic errors as less severe than any other types of error since such specified behaviors sometimes lead to correct enactments. Likewise it seemed reasonable to consider errors of both nouns and verbs as more severe than errors of either occurring separately. Finally, the failure to enact an entire clause could be construed as the most severe error of all.

With this hierarchy elaborated, the syntactic errors are presented in Table 19, classified according to age group and sentence type. Figure 4 plots the sums for each sentence type, where it is immediately apparent that a temporal strategy accounts for the most errors overall, yet occurred with considerably different frequency in enactments of the four sentence types. It was relatively infrequent

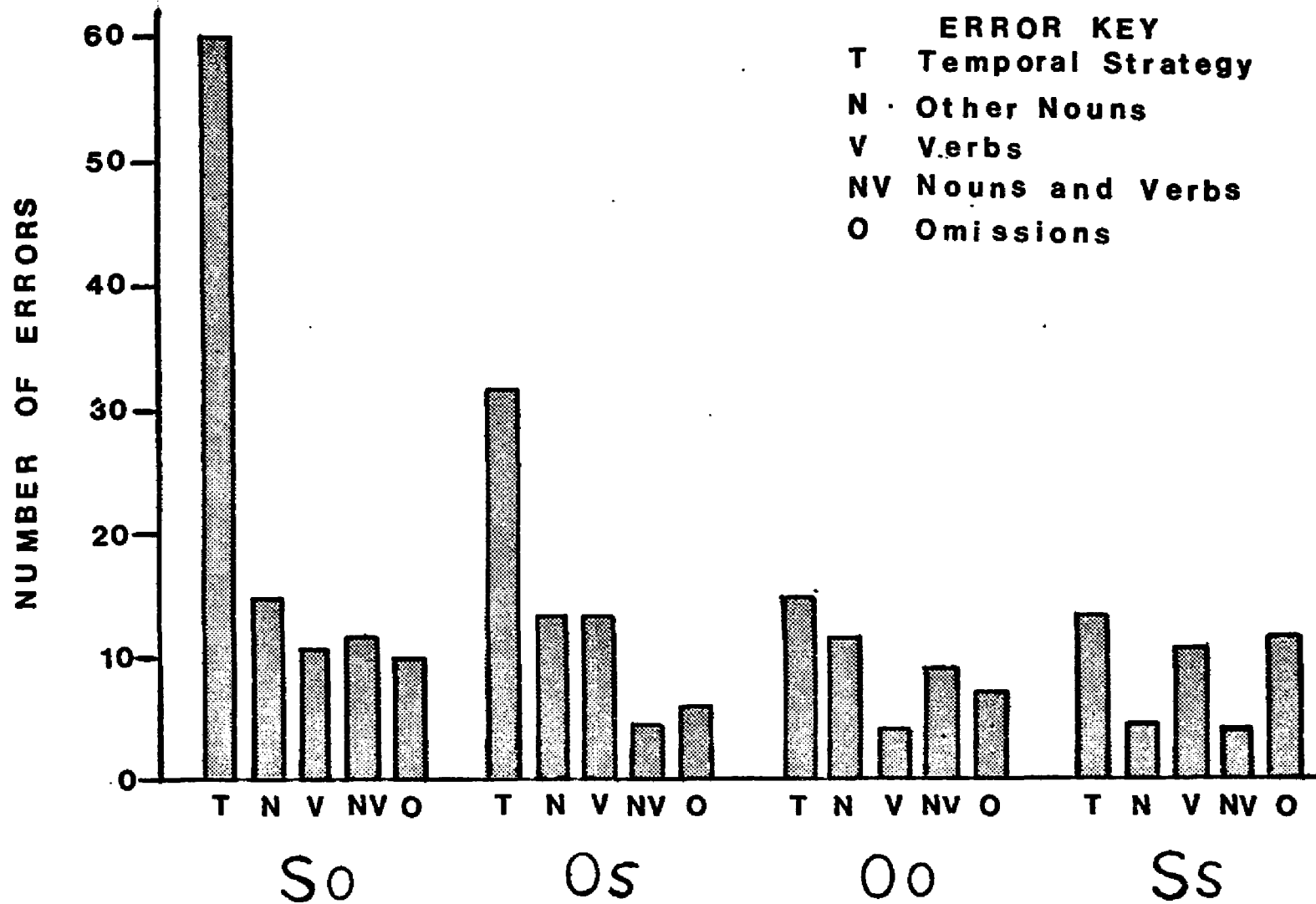
TABLE 19

FREQUENCY OF ERROR TYPES BY AGE GROUP FOR EACH SENTENCE TYPE

Sentence Type	So					Os					Oo					Ss					Combined				
	1	2	3	4	E	1	2	3	4	E	1	2	3	4	E	1	2	3	4	E	1	2	3	4	E
Error Types																									
Temporal Strategy	13	15	19	13	60	8	5	4	15	32	6	2	1	5	14	1	3	4	5	13	28	25	28	38	119
Other Nouns	2	1	1	10	14	5	2	1	5	13	2	1	5	4	12	-	1	2	1	4	9	5	9	20	43
Verbs	3	3	1	4	11	2	-	5	6	13	1	2	-	-	3	2	2	1	6	11	8	7	7	16	38
Nouns and Verbs	-	3	2	7	12	1	1	1	1	4	-	3	2	4	9	1	-	-	2	3	2	7	5	14	28
Omissions	2	-	2	6	10	-	1	2	3	6	-	-	-	7	7	-	-	2	10	12	2	1	6	26	35
Totals	20	22	25	40	107	16	9	13	30	68	9	8	8	20	45	4	6	9	24	43	49	45	55	114	263

Figure 4

Frequency of syntactical errors by sentence type



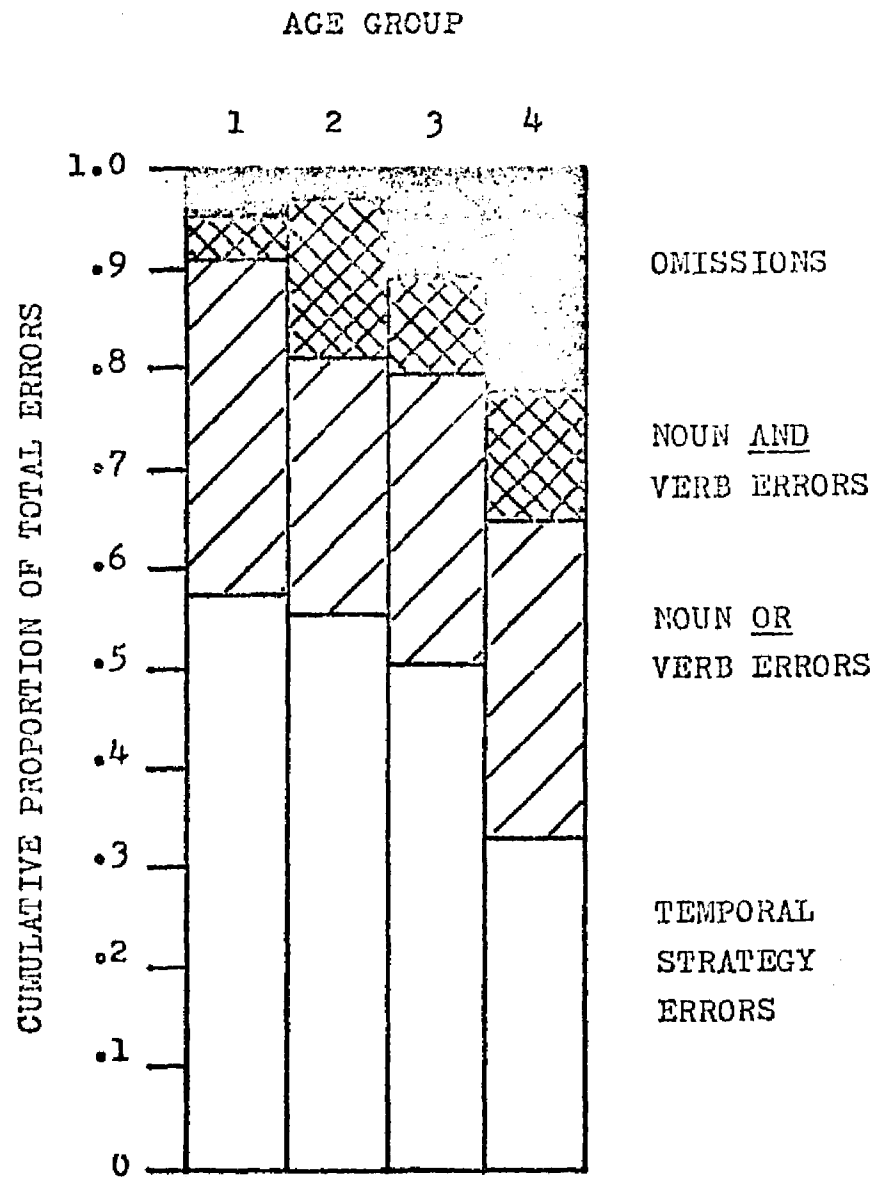
in the parallel function sentences (Oo and Ss), but very common for Os sentences, and outweighed all other types of error combined in So sentences, thus reflecting the overall order of sentence difficulty. Indeed, if temporal strategy errors occurred in the nonparallel So and Os sentences as infrequently as they did in the parallel sentences, there would be almost no differences in error rate among the four sentence types.

Other noun and verb errors were about equally frequent in So and Os sentences, but varied in parallel sentences: noun errors were more likely in Oo sentences, verb errors in Ss sentences. Mixed errors -- joint noun and verb errors -- occurred rarely in subject relatives (Os and Ss), but were more common in object relatives (So and Oo).

Table 19 indicates that the oldest group made more errors in every category than any younger group. Closer examination also reveals that the oldest subjects tended to make more severe errors than younger subjects. This is affirmed in Figure 5, where the different categories of error are proportionalized for each age group. Stepwise regularities are observed, wherein a preponderance of errors made by the younger two groups were temporal strategy errors, whereas they accounted for only a third of the oldest group's failures.

A comparison of Figures 4 and 5 suggested that it might be possible to devise an error score for each subject, weighted according to error severity. To that end, subjects' performances were reevaluated on a clause by clause basis. A correct enactment yielded no error points, while the error hierarchy shown in Figure 5 produced an error score as follows: temporal strategy error (1), other noun

Figure 5**Syntactical errors proportioned by age group**



or verb error (2), joint noun and verb error (3), clause omission (4). Table 20 presents a frequency distribution of weighted errors for each age group which, when compared with Table 6, reveals a much greater range for weighted errors than for unweighted ones.

These new numbers were subjected to the same correlational analysis as was described for total errors at the start of this chapter. As shown in Table 21, Vocabulary and Digit Span are playing approximately the same roles they played in Table 8, with but one interesting disparity. When the variance proportions in the two tables are compared, we observe that Digit Span is somewhat more influential in prediction than it was earlier, thus suggesting that the weighted error score taps slightly more of a memory function than does unweighted error.

Finally, the residuals from this prediction are summarized by age group in Table 22 which, when compared with Table 9, reveals a change in sign for the third age group from positive to negative. Whereas unweighted error approximately balances age Groups 1 and 2 against Groups 3 and 4, weighted error sets the oldest group against all the others. The significance of this change is seen in the contrasts presented in Table 23, where the majority of *t* values are greater than those shown in Table 10. Consequently, adjacent age groups (other than Group 1) are better discriminated than they were before.

Thematization Revisited

Given that a hierarchy of error severity was now established, it was decided to re-examine the disappointing earlier finding that no differences could be discerned between the outcomes of Experiments

TABLE 20
 FREQUENCY DISTRIBUTION OF WEIGHTED ERROR
 BY AGE GROUP

Number of Errors	Age Group				Total
	1	2	3	4	
0	3	2	3	2	10
1	2	2	2	-	6
2	1	2	1	2	6
3	-	-	1	-	1
4	3	2	1	-	6
5	2	2	-	1	5
6	-	-	1	1	2
7	1	1	2	1	5
9	1	-	1	-	2
10	-	1	-	1	2
12	-	1	-	-	1
15	-	1	-	-	1
21	-	1	-	-	1
22	-	-	2	-	2
23	1	-	-	-	1
28	-	-	1	-	1
29	1	-	-	-	1
34	-	-	-	1	1
35	-	-	-	1	1
37	-	-	-	1	1
38	-	-	-	1	1
47	-	-	-	1	1
49	-	-	-	1	1
74	-	-	-	1	1
Mean	6.27	5.93	7.47	23.07	10.68
S.D.	8.51	6.11	9.11	23.17	15.02

TABLE 21
MULTIPLE PREDICTION OF
WEIGHTED ERROR

Variable	Beta	Percent of Variance	Percent of Explained Variance
Vocabulary	-.449	24.2	54
Digit Span	-.372	20.0	46
Total	R = .665***	44.2	100

*** $p < .001$

TABLE 22

DISTRIBUTION OF WEIGHTED ERROR RESIDUALS
BY AGE GROUP

	Age Group			
	1	2	3	4
Mean	-.371	-.429	-.026	.826
S.D.	.455	.344	.506	.834

TABLE 23
AGE GROUP COMPARISONS OF
WEIGHTED ERROR RESIDUALS

Contrast	t	p
Group 1 vs. Group 2	0.40	~
Group 2 vs. Group 3	2.55	**
Group 3 vs. Group 4	3.38	***

Group 1 vs. Group 3	1.96	*
Group 2 vs. Group 4	5.39	***

Group 1 vs. Group 4	4.88	***

* p < .05, one-tailed

** p < .01, one-tailed

*** p < .001, one-tailed

1 and 2, either with regard to sentence type or subject age group. To that end, we examined the occurrence of temporal strategy errors in the two experiments and found to our surprise that they accounted for a far smaller proportion of errors in Experiment 2 than in Experiment 1. Table 24 indicates the sums of temporal strategy errors in Experiments 1 and 2 for the four age groups, where it can be observed that temporal strategy errors occurred almost twice as frequently in Experiment 1 as in Experiment 2.

A pairwise t test for all 60 subjects yielded high significance ($t = 3.10$, $p < .01$), but examination of the table indicates that the effect was created mainly by the behavior of the oldest subjects. Indeed, retrospective Wilcoxon tests on the age groups taken separately indicated that the difference between Experiments 1 and 2 could only be sustained for the oldest group ($N = 10$, $T = 4.5$, $p < .02$). At least for the oldest age group, the additional semantic involvement of the nouns provided by the Experiment 2 narratives appears to have diminished the capacity to apply a temporal strategy to the enactment of the test sentences.

Finally, we noted that the temporal strategy was employed equally often in the three conditions of thematization in Experiment 2 (No th; Nar-S; Nar-O), so that, even under an analysis conditional upon a hierarchy of error severity, the three thematic conditions could not be discriminated.

TABLE 24
FREQUENCY OF TEMPORAL STRATEGY ERRORS
BY AGE GROUP IN EXPERIMENTS 1 AND 2

Age Group	Expt. 1	Expt. 2
1	16	12
2	14	11
3	18	10
4	27	11
Total	75	44

CHAPTER V

DISCUSSION

We will now address our findings to the questions posed in the introductory portions of this thesis. Our first focus will be on the age differences that were observed in the language comprehension tasks of this study. We will then consider the topic of thematization, the order of clause enactments, the order of difficulty among sentence types together with their enactment strategies, and interactions between age group and sentence type. Finally we shall consider the implications of this research for psycholinguistics and gerontology.

Age Differences in Language Comprehension

The results of the two experiments of this investigation clearly demonstrated marked differences in the language comprehension performance of normal persons across the adult age range. The similarity of performance of the youngest experimental group (52 to 58 years) with that of the controls (18 to 25 years) is not surprising in view of the relative simplicity of the task, with only 17.2% of all responses incorrect. Yet despite a task which did not cause much difficulty on the whole, the third age group (63-69 years) made significantly more errors than Groups 1 and 2, and the oldest group (74-80 years) erred to an even greater extent. Although high correlations existed

between subjects' performance and the demographic variables of Vocabulary and Digit Span, when those variables were statistically controlled for, significant age differences remained which discriminated the two oldest groups from each other and from the two younger groups. Thus, as evidenced by this study, language comprehension abilities begin to decline in the sixties and continue to drop rather sharply thereafter. These findings do not preclude the possibility that a more stringent test would unearth deficits in persons in their fifties or even younger.

Not only did older subjects err more frequently in their enactments of the test sentences, but they also made errors of a more serious nature than those made by younger subjects: more of their errors tended to be random, rather than strategic; they made more multiple errors within a single sentence enactment; they tended to make more errors when defying the majority order of clause enactment; they omitted more enactments. Omissions are of particular interest, suggesting a cognitive lapse -- of attention or memory -- rather than a lack of linguistic understanding.

Similarly, a lapse of attention and/or memory in our older subjects is the probable explanation for their inability to recall as many narrative events as did the youngest group. Although their span of immediate rote recall was comparable to that of the youngest subjects, as evidenced by Digit Span scores, they were deficient when the stimulus was meaningful language and the task demanded memory storage for a longer duration. An additional source of difficulty lay in the intervention of the test sentence and the subject's own enactment of it, occurring between presentation and

recall of the narrative. This result conforms to Gilbert and Levee's (1971) finding that memory for meaningful verbal material declined more markedly with age than memory for other types of stimuli, and was especially vulnerable when a delay was imposed before subjects were allowed to respond. Evidently the memories of our older subjects were inordinately affected by the "trace decay" and "interference" so widely discussed in psychological literature (Neisser, 1967; Lindsay and Norman, 1972). On the basis of our research, this deficit occurs at least as early as the fifties, and might have been observed at an even younger age had our experimental groups covered a broader age spectrum.

Another phenomenon, described in the gerontological literature and discussed previously in this paper, was observed in our oldest subjects -- we refer to use of an "unconfident strategy." These subjects were responsible for almost all requests that the test sentences be repeated before enactment. The presence or absence of these repetitions bore no relationship to the quality of the subjects' subsequent enactments. While in some cases these requests may have stemmed from a lapse of attention, it seems likely that in others the cause was a feeling of insecurity on the part of the subject. A lack of security is also seen as the reason that subjects verbalized the test sentence while they enacted it, an event which occurred with far greater frequency in the older groups. Unlike requests that the examiner repeat the test sentences, these verbalizations were a hallmark of being in risk of error, particularly when they were incorrect, i.e., when they did not accurately represent the sentence's meaning.

The tendency to employ a temporal strategy, weaker in older than in younger subjects as they enacted isolated sentences, was reduced even further in the oldest group's enactments of sentences heard after narratives. This reduction, the only influence of context observed in our study, was related to context in general, and not to thematization, since it occurred with equal frequency after narratives in all conditions of thematization -- No th, Nar-S, and Nar-O. Apparently the semantic involvement which the narratives provided for the characters of the test sentences was tantamount to cognitive noise for the oldest group, insufficient to affect their error rate, but sufficient to shake their already weak tendency toward temporally ordered responses. If it were to be argued that the temporal strategy difference between the two experiments inhered in the fact that Experiment 1 nouns were animals while Experiment 2 nouns were humans, one would then be hard put to account for the essentially identical quantity of errors produced by each age group for each sentence type in the two experiments.

Before leaving the topic of age differences, two caveats are in order, one with regard to individual differences and the other concerning cross-sectional studies. Even after adjusting weighted error scores for Vocabulary and Digit Span there remained individual differences within each of the four age groups. The most extreme of these were in the oldest group where, despite a strong tendency for the group to make many more errors than predicted, two subjects actually made fewer errors than predicted and four others were underpredicted to a very mild degree (making 6 or fewer excess errors apiece). Conversely, five of the oldest subjects made 17 or more excess errors apiece. Thus it is apparent that any generali-

zation regarding age differences in language comprehension abilities must be tempered with the recognition that vast individual differences may exist among the members of any age group.

Caution must likewise be observed in interpreting the results of cross-sectional studies such as this, for such studies do not constitute proof that age changes have occurred over time in the particular subjects tested. Cross-sectional age differences may be attributable to differences between cohorts, i.e., between members of different generations. Most notably, there may be generation differences in the amount or type of effort devoted to "intensive acculturation" -- pressure to learn the dominant culture (Horn, 1970). This pressure occurs primarily in school, but is also widespread in other areas of experience. Cross-sectional results, therefore, should be viewed as only suggestive of what might be occurring longitudinally, and possibly as forerunners to longitudinal studies. Thus admonished, let us proceed to our discussion of thematization.

Effects of Thematization

It will be recalled that we not only failed to find a relationship between thematization and error rate or sentence type, but we also found no effects of context whatsoever, apart from the previously discussed reduction of the oldest subjects' tendency to use a temporal strategy. For all sentence types, the error rate in enacting the isolated sentences of Experiment 1 did not differ from the error rate for the sentences heard after narratives in Experiment 2.

In seeking to account for our failure to find any thematization effects, we compared our research with the previously discussed studies that thematized as we did, through repetition of a referent, and that did find such effects. It seemed likely that the discrepancies might be the result of differences in certain parameters of the studies, e.g., subject characteristics or task demands.

Unlike our research which employed adult subjects, Wallach's (1977) study involved children, 2/3 of whom were learning-disabled. Our anticipation of a thematization effect based upon that study may be misguided, for only in one sentence type (So) did such an effect occur for the normally-achieving subjects; it may be that this effect was a statistical artifact of the extremely small number of errors made by those children.

The Perfetti and Goldman studies differed from ours primarily in the demands of their tasks; whereas our subjects were required to manipulate objects in the enactment of sentences, theirs were to recall sentences heard previously (1974) or, after reading

a thematized passage, to select the active or passive sentence which best concluded it (1975). A comparison of those studies with the present one must take cognizance of the fact that certain characteristics of the enactment task distinguish it from such linguistic tasks as sentence recall and sentence selection. The manipulation of three animals or figures in the enactment of the two s-v-o units of each relative clause sentence is ineluctably a serial, rather than a parallel task. Each clause's s-v-o interaction requires time and movement, and the two clauses cannot be enacted concurrently. The two figures required for each s-v-o sequence are picked up in turn and made to interact with each other. One or both are then put down: the one required for enacting the second s-v-o unit as well may be retained in hand to interact with the third figure, or may be put down and then picked up again. In either case the two s-v-o units corresponding to the two clauses are enacted sequentially in whichever order the subject prefers. The strict temporal nature of such a task may reduce its vulnerability to a Gestaltist contextual or thematic effect. Indeed, we have seen some evidence that a contextual environment is incompatible with temporal performance; our oldest subjects, whose tendency to respond temporally was weaker and perhaps more vulnerable to disturbance than that of younger subjects, used a temporal strategy even less frequently when enacting test sentences preceded by narratives than when enacting sentences heard in isolation.

The comparative evidence from these studies and our own suggests the conclusion that, while children may be influenced

by context in their enactments of sentences, and adults likewise may be influenced in other types of linguistic tasks, a contextual antecedent does not influence adults in a sentence enactment task.

Order of Clause Enactment and Patterns of Clause Error

The strong tendency for a listener to respond to the units of a linguistic stimulus in the order in which they arrive at the ear was evidenced in the unanimously temporal order of enactment of the conjoined sentences (wherein the first-heard clause was enacted first). Enactments were temporally ordered by most subjects for the relative clause sentences as well, if we consider order of clause completion rather than order of clause initiation; that is, the clause whose s-v-o relations were first completed on the stimulus tape was enacted first. In self-embedded sentences, although the main clause is initiated first, the subordinate clause is completed first; in right-branching sentences, the main clause is both initiated and completed before the subordinate clause.

As we have seen in Chapter II, a great deal of evidence indicates that during sentence processing, memory storage occurs for each clause as its interpretation is completed. The order of clause enactment used by the overwhelming majority of subjects in this study suggests that the retrieval process used for a post-comprehension response is an orderly one, extracting clauses from memory in the order in which they were stored.

In analyzing the relationship between order of clause enactment and error rate, we sought to determine whether enacting in clause order opposite to the majority increased the likelihood of erring. The answer, we learned, was a complex one. Being a "reverser" (even in just one of the 24 relative clause sentence enactments) placed a subject in a high-risk group, likely to make more errors

over all than her or his majority-order counterparts. However, the penalty paid for reversing the order of response varied among subjects. Most of those who reversed order did so with impunity in each instance, even though they may have erred in some of their majority-order responses. For those who erred at all in their reversed-order responses, the price was high: their reversed-order responses were far more vulnerable to error than were their majority-order responses. Like the curly-haired girl in the nursery rhyme, when reversed-clause-order responses are good they are very very good, but when they are bad, they are horrid.

It will be recalled that for the four relative clause sentence types combined, there were more errors in the subordinate clause than in the main clause. This result obtained overall despite a reverse finding in self-embedded sentences, where more errors occurred in the main clause. As we have noted, these results inhere in two tendencies -- that of being correct more often in the main than in the subordinate clause, and that of being correct more often in the first-enacted than in the second-enacted clause. (The latter tendency was most clearly evidenced in the conjoined sentences which served as our baseline for comparison, with almost all errors occurring in the second-enacted clause).

In Chapter II we pointed out a characteristic of relative clause sentences which would predict our finding of better performance in enacting main clauses than subordinate ones. Because the main clause generally contains the new, or asserted, information of the sentence it should be more salient for the listener than the subordinate clause, which contains the given, or presupposed, information.

If, in self-embedded sentences, there were not a conflict between the two tendencies noted above (that is, if main clauses were enacted first as they are in right-branching sentences), we would expect that the main clause would be enacted correctly more often than the subordinate one. Clearly, this tendency is overwhelmed by the more powerful order effect.

Further evidence of the greater stability of main clauses lies in the hugely disproportionate ratio of main versus subordinate clause omissions. For the most part attributable to the oldest subjects, omissions of subordinate clauses were four times as frequent as omissions of main clauses. Paradoxically, even in self-embedded sentences, where the majority of errors occurred in the main clause, most omissions occurred in the subordinate one.

Order of Difficulty Among Sentence Types

Over all, the sentences used as stimuli in this investigation posed little difficulty for our listeners, with an error rate of just 17.2%. The comprehension and enactment of two easily discriminable, SVO-ordered clauses within a sentence was easily accomplished, as evidenced by the mere handful of errors in the conjoined sentences, for the most part attributable to just six members of the oldest group.

Despite the low error rate for the entire study, the order of difficulty among the relative clause sentence types was readily apparent. The parallel function sentences, Ss and Oo, were not significantly different from each other in error rate, and received the fewest errors. The nonparallel sentences received the most errors. Of these, So sentences proved most difficult and Os sentences held an intermediate position, receiving significantly fewer errors than So and more than the parallel function sentences.

Sheldon's parallel function hypothesis is clearly supported by these data. Conversely, no support was found for either the interruption or the canonical-sentoid hypothesis: listeners had no more difficulty in enacting self-embedded sentences as a group than right-branching ones, and no more difficulty in enacting object relatives than subject relatives.

Upon reflection, the reader will recognize that, of all four sentence types, only So is vulnerable to error under all of the hypotheses previously discussed. Each of those hypotheses, however, would predict that some other sentence type would be as vulnerable as So: the interruption hypothesis would predict equal

difficulty for both interrupted (self-embedded) sentence types, So and Ss; the canonical-sentoid hypothesis would predict equal difficulty for both object relatives, So and Oo; the parallel function hypothesis would predict that both nonparallel sentence types, So and Os, would be equally affected.

In seeking an explanation for the far greater preponderance of errors in the nonparallel So sentences than in their Os counterparts, we need look no further than temporal strategy. In fact, of all four sentence types, So is the only one which requires violation of the sequence N1-V1-N2 as SVO of the first enactment.

In light of our results, it seemed advisable to reexamine the other enactment studies to determine whether they may have overlooked similar unpredicted discrepancies between comprehension of So and other sentence types. It was found that this was indeed the case in both Sheldon's (1974) and Wallach's (1977) studies.

Sheldon noted that her subjects had greater difficulty comprehending nonparallel sentences than parallel ones, but did not note the significantly worse performance for the So type than for its nonparallel counterpart, Os. There is in fact a remarkable concordance between our results and Sheldon's despite her preschoolers' inferior performance overall. Her error rates by sentence type were 83% for So, 71% for Os, 49% for Oo and 47% for Ss. In comparison with our own results, this represents about 52% more errors for So and Os, and 36% more errors for Oo and Ss, but an identical order of difficulty for both studies.

Wallach, in evaluating comprehension of sentences heard after both thematized and nonthematized narratives, found no significant

differences between So and Ss types; however, that finding was for performance averaged across both conditions of thematization. Where thematization was not a factor, i.e., in isolated sentences and in the nonthematized condition, performance for So sentences was overwhelmingly inferior to that for all other sentence types. In both of those investigations as in the present research, subjects' overreliance on a temporal strategy can be indicted as the source of the disproportionately poor performance for So sentences.

Thus far in this discussion we have accounted for the order of difficulty of relative clause sentences by first declaring parallel sentences to be easier than nonparallel ones, and then distinguishing So from Os on the basis of temporal strategy. It is instructive to consider how well we might account for the order of difficulty on the basis of temporal strategy alone. As indicated in Table 18, the temporal strategy predicts up to three points of difficulty in So sentences and only one for the other three sentence types. The question then would be why Os sentences are more difficult than Oo and Ss sentences. An interesting possibility emerges when we examine the options available to a temporal strategy user at the point of choice. In all three sentences, she has already enacted N1-V1-N2, and now must choose between N1 and N2 as the subject (Os, Ss) or object (Oo) of the second enactment. If the enactor chooses the noun that served a parallel role in the previous enactment (N1 for Os, Ss; N2 for Oo) she will be correct for Ss and Oo, but wrong for Os!

If we adopt the temporal strategy as a basic model for the enactment of two-term relative clause sentences, the exact order of sentence difficulty is predicted with the simple addition of a parallel function response bias. From this point of view, the ease of enacting parallel sentences inheres in their supplying the appropriate response bias to a temporal strategy.

Age Group versus Sentence Type

We may ask whether sentence type or age group membership had the greater influence on the likelihood of error. To answer this question Table 25 was constructed by collapsing the 4 x 4 matrix of Table 12 into a 3 x 3 matrix in which the two indistinguishable age groups and sentence types were averaged. Thereafter, the row and column means as well as each cell entry were expressed as deviations from the grand mean of the matrix. We observe that the range of effects attributable to age group and sentence type are almost the same (19% and 18%), and that their combined influences are essentially additive, since no cell entry differs from its row and column sum by more than 1.4%. Thus, the primary stimulus variable and subject variable of this investigation may be said to have had equal and noninteracting power.

TABLE 25
EFFECTS OF SIGNIFICANTLY DIFFERENT AGE GROUP
AND SENTENCE TYPE COMBINATIONS^a

Sentence Type	Age Group			$\bar{x}$
	1-2	3	4	
So	1.3	5.8	22.4	9.8
Os	-8.1	-7.6	11.3	-1.5
Oo - Ss	-14.5	-12.6	2.4	-8.2
$\bar{x}$	-7.1	-4.8	12.0	

^aAll numbers are percentage deviations from the grand mean error rate (= 22.0%)

Implications for Psycholinguistics and Gerontology

From a psycholinguistic point of view the key finding of this study was the identification of a temporal strategy in the enactment of two-term relative clause sentences. This finding commands attention and provokes several questions. One wonders how obligatory the temporal strategy would be in behavioral contexts less demanding of serial processing than is the case with enactment. We also wonder whether a temporal strategy would generalize to the enactment of relative clause sentences containing more than two terms and to other types of sentences. If this were the case, we would wish to determine whether principles other than the three already enumerated would have to be elaborated.

From a developmental point of view we wonder at what age the temporal strategy first emerges and how this emergence may be related to other aspects of language acquisition. One thing remains clear: in the enactment of relative clause sentences a coherent behavioral strategy has been identified which is more parsimonious and elegant than the sentence-specific strategies previously identified in the literature. This construct surely merits the attention of future researchers.

Another psycholinguistic question provoked by this study pertains to the issue of narrative context. We may ask why narratives did not have any effect at all and whether this would always be the case when adults perform an enactment task. Could it be that the enactment demand causes adults to detach the test sentence from its antecedent narrative Gestalt? Some hint of this detachment emerged from the results of our pilot research in preparation for Experiment 2.

After recalling events from the narrative, subjects were requested to recall the test sentence as well. More often than not, subjects who recalled the majority of narrative events were unable to recall the test sentence they had just previously enacted! Rather than serving as a memory reinforcer as would be expected, the enactment appeared to act as a memory "eraser," reassuring subjects that since the enactment was completed, the test sentence could be dismissed.

A third psycholinguistic issue inheres in the tendency toward parallelism. Is this tendency specific to the enactment of two-term relative clause sentences or would it obtain for other sentence structures as well?

A means of addressing several of the issues just raised would be to construct tests of sentence comprehension which entail varying mixes of parallel and serial demand. Such a test might be one which combines a comparison task with an enactment task. If a listener were to hear a relative clause sentence and thereafter see it enacted by the experimenter (sometimes accurately, sometimes not), might she be able to assess the enactment's accuracy on a holistic basis? Would the listener's error rate or response latency be influenced by the experimenter's enacting the sentence in reversed order of clause completion? If children made more errors than adults when seriality was violated, could we establish a developmental timetable for the amelioration of serial demands?

In sum, the value of this research for psycholinguistics is that it has provoked a variety of speculative leads for future investigators.

Turning to gerontological matters, one sees a range of behavior in the oldest age group that might better be handled by an episodic model than by specification of age per se. Six subjects in the oldest age group, even after their scores were adjusted for intelligence and immediate memory, were far inferior to their age mates. It is as if these six were victims of some insult that influenced language processing skills and which had not yet attacked their contemporaries. A likely possibility is that these six had suffered subclinical transient ischemic attacks of which neither they nor the experimenter were aware. Perhaps a test of central auditory impairment (Katz, Basil, and Smith, 1963; Speaks and Jerger, 1965) would have marked these subjects, but in the absence of such information we can only caution that by the seventies, age group membership as such does not predict language functioning.

The foregoing suggests that future research on the language performance of elderly persons should employ longitudinal, rather than cross-sectional designs. If indeed the variability in our oldest group implies a catastrophic model for language impairments, then future designs should sample subjects' performances at least annually.

A second gerontological issue arises from our finding that even by their fifties subjects remembered fewer narrative events than did the youngest subjects, despite no differences in immediate recall. It surely would be worthwhile to define the age at which this deficit first emerges, mindful of course that even in this regard there might be large enough individual differences to

warrant a longitudinal approach. No matter how future gerontological studies of language are conducted, it would seem essential that all subjects be measured with respect to memory capabilities beyond immediate rote recall, e.g., with the Wechsler Memory Test.

Finally, and perhaps most importantly, the findings of this study can serve as a baseline against which to measure the linguistic consequences of brain damage in geriatric persons. Surely a rational description of the language behavior of an elderly aphasic patient should depend on a contrast between that behavior and what would be expected had brain damage not occurred. In this connection our findings regarding variability in the oldest age group loom large. With which age mate should a stroke victim be compared: the one who made no errors in our two experiments or the one who made 47 weighted errors? Obviously, neither is the appropriate control. Assuming that our previously proposed longitudinal study were implemented with annual evaluations, the stroke victim could serve as her own premorbid control. The primary gerontological lesson of this research is its demonstration of the necessity of such a longitudinal approach.

Appendix A

Experiment 1 Stimuli

Experiment 1¹Demonstration sentences (two conjoined sentences):

The alligator crawled under the elephant and the alligator kicked the hippo.

The horse stood on the tiger and the bear ran away from the tiger.

¹It will be observed that the actions which occur in the test sentences are expressed by a verb alone or by a verb in combination with a particle and/or a preposition. In the interest of simplicity, all actions are referred to as "verbs." The justification for this merger was revealed by retrospective analysis, which found no differences in error rates among sentences containing the various verbal forms.

Experiment 1

Test Sentences¹ (twelve relative clause sentences and three conjoined sentences):

<u>Parallel Function</u>	<u>Nonparallel Function</u>
<u>Self-embedded</u>	
<u>Ss</u>	<u>So</u>
The giraffe that bumped into the cow kicked the hippo.	The cow that the hippo stood on ran away from the horse.
The horse that jumped over the bear pushed the camel.	The bear that the camel crawled under faced the alligator.
The alligator that faced the lion crawled under the elephant.	The lion that the elephant pushed jumped over the giraffe.
<u>Oo</u>	<u>Os</u>
The hippo bumped into the horse that the bear jumped over.	The horse crawled under the hippo that stood on the bear.
The camel faced the alligator that the lion ran away from.	The alligator faced the camel that bumped into the lion.
The elephant kicked the giraffe that the cow pushed.	The giraffe crawled under the elephant that jumped over the cow.
<u>Conjoined</u>	
The horse jumped over the bear and the horse pushed the camel.	
The cow pushed the giraffe and the elephant kicked the giraffe.	
The hippo stood on the bear and the horse crawled under the hippo.	

¹Presented in random order with the constraint that sentences of the same type were not presented consecutively.

Appendix B
Experiment 2 Stimuli

Experiment 2 Demonstration Narratives

This morning an attempted robbery was foiled when the revolving door of the Ski and Skate Sport Shop wouldn't budge. A skier holding a pair of heavy skis was trapped in one compartment of the door. In another section, an ice skater struggled to free herself. Clutching a paper bag filled with money, a masked robber frantically tried to rotate the door and make his escape.

To everyone's great relief the door finally turned, so ...

(signal)

the robber pulled the skier and the ice skater jumped on the robber.

Yesterday Springfield High School held its annual Career Day.

A nurse came and made a speech about the advantages of a career in nursing. Immediately afterward, a teacher talked about how much she enjoyed her job.

For a confused student in the audience, it was difficult to decide which career held greater opportunities.

After the speeches were over ...

(signal)

the nurse faced the student and the student approached the teacher.

Experiment 2¹Twelve Scenario Titles and Twelve Target Sentences

<u>No.</u>	<u>Scenario</u>	<u>Sentence Type</u>	<u>Target Sentence</u>
1.	Drowning Child	<u>So</u>	The child that the mother dropped knocked over the lifeguard.
2.	Baseball Game		The doctor that the ballplayer waved to picked up the fan.
3.	Olympics		The swimmer that the basketball player tackled punched the boxer.
4.	Norway	<u>Oo</u>	The general walked away from the king that the president saluted.
5.	Lunch		The daughter wiped the waitress that the mother bumped into.
6.	Assassination		The queen ran from the gunman that the photographer pushed.
7.	Old West	<u>Ss</u>	The sheriff that shook the cowboy picked up the hostess.
8.	Fire		The mother that threw the baby hugged the fireman.
9.	Christmas		The Santa Claus that ran away from the boy jumped on the shoplifter.
10.	Bus	<u>Oo</u>	The bus driver slapped the schoolboy that pulled the sailor.
11.	Country Walk		The bicyclist pointed at the hitchhiker that fell over the old woman.
12.	The Strike		The police chief grabbed the mayor that kicked the hard hat.

¹It will be observed that the actions which occur in the test sentences are expressed by a verb alone or by a verb in combination with a particle and/or a preposition. In the interest of simplicity, all actions are referred to as "verbs." The justification for this merger was revealed by retrospective analysis, which found no differences in error rates among sentences containing the various verbal forms.

Experiment 2

12 Scenarios: 3 Versions of Each^{1, 2}

¹The number preceding each sentence is for the purpose of facilitating comparisons by the reader, and was not heard on the stimulus tape.

²Thematized referent is underlined.

So Scenario 1: Drowning ChildThematized referent acts as Subject of Narrative: Nar - S

1. A strange occurrence in Atlantic City yesterday proved that humans are capable of superhuman accomplishments in times of danger.
 2. Alice O'Connell, who was sunning herself on the beach, suddenly saw that her ten-year-old child had swum out too far in the rough water, and was struggling to keep from drowning.
 3. The mother dashed into the water and swam far out to make a daring rescue.
 4. Back on shore, the exhausted woman surprised the approaching lifeguard by saying, "I can't swim."
 5. As soon as the danger had passed (signal)
 *The child that the mother dropped knocked over the lifeguard.
-

Thematized referent acts as Object of Narrative: Nar - O

1. A strange occurrence in Atlantic City yesterday proved that humans are capable of superhuman accomplishments in times of danger.
 2. The sudden sight of her ten-year-old child struggling to keep from drowning in the deep, rough water frightened Alice O'Connell, who was sunning herself on the beach.
 3. The long stretch of ocean water did not hinder the mother in her swim to make a daring rescue.
 4. Back on shore, a lifeguard ran to meet the exhausted woman who surprisingly said, "I can't swim."
 5. As soon as the danger had passed (signal)
 *The child that the mother dropped knocked over the lifeguard.
-

Non-Thematized Narrative: No th

1. A strange occurrence in Atlantic City yesterday proved that humans are capable of superhuman accomplishments in times of danger.
2. The sudden sight of her ten-year-old child struggling to keep from drowning in the deep, rough water frightened a mother who was sunning herself on the beach.
3. The lifeguard noticed too late to help in the daring rescue that took place.
4. Back on shore, the soaked, exhausted mother carrying her child surprised the approaching lifeguard by saying, "I can't swim."
5. As soon as the danger had passed (signal)
 *The child that the mother dropped knocked over the lifeguard.

So Scenario 2: Baseball GameThematized referent acts as Subject of Narrative: Nar - S

1. Yesterday's drizzle seemed to bring bad luck to the Potomac Skyrockets baseball team.
2. As the skies darkened, first baseman Alec Burger sprained his ankle on the muddy field while he ran for a fly ball.
3. Then he roughly collided with a fan who ran onto the field in an attempt to get the ball.
4. The baseball player was soon relieved to see the team doctor approaching.
5. Some action was taken when (signal)
*The doctor that the ballplayer waved to picked up the fan.

Thematized referent acts as Object of Narrative: Nar - O

1. Yesterday's drizzle seemed to bring bad luck to the Potomac Skyrockets baseball team.
2. As the skies darkened, the muddy field injured first baseman Alec Burger, who sprained his ankle while he ran for a fly ball.
3. Then a fan who ran onto the field in an attempt to get the ball roughly collided with Burger.
4. The team doctor soon approached the relieved ballplayer.
5. Some action was taken when (signal)
*The doctor that the ballplayer waved to picked up the fan.

Non-Thematized Narrative: No th

1. Yesterday's drizzle seemed to bring bad luck to the Potomac Skyrockets baseball team.
2. As the skies darkened, the first baseman sprained his ankle on the muddy field while he ran for a fly ball.
3. Then a rough collision occurred with a fan who ran onto the field in an attempt to get the ball.
4. It was a great relief to see the team doctor approaching the field.
5. Some action was taken when (signal)
*The doctor that the ballplayer waved to picked up the fan.

So Scenario 3: OlympicsThematized referent acts as Subject of Narrative: Nar - S

1. In sports today, friction occurred between member of the re-
turning U. S. Olympic team as they sat in a Montreal bus
terminal.
2. Basketball star "Stretch" Logan boasted that no other sport
requires the precise timing that basketball does.
3. He kept interrupting the boxer who tried to explain the skilled
footwork involved in prizefighting.
4. Logan then became angered at the swimmer's insistence that
swimming is the only sport worth participating in.
5. It almost turned into another Olympic contest when (signal)
*The swimmer that the basketball player tackled punched the
boxer.

Thematized referent acts as Object of Narrative: Nar - O

1. In sports today, friction occurred between members of the re-
turning U. S. Olympic team as they sat in a Montreal bus
terminal.
2. Other members of the team tried to ignore basketball star
"Stretch" Logan as he boasted that no other sport requires the
precise timing that basketball does.
3. The boxer kept interrupting Logan to describe the skilled foot-
work involved in prizefighting.
4. Then the swimmer angered the basketball player by insisting that
swimming is the only sport worth participating in.
5. It almost turned into another Olympic contest when (signal)
*The swimmer that the basketball player tackled punched the
boxer.

Non-thematized Narrative: No th

1. In sports today, friction occurred between members of the re-
turning U. S. Olympic team as they sat in a Montreal bus
terminal.
2. Other members of the team tried to ignore the basketball player
as he boasted that no other sport requires the precise timing
that basketball does.
3. The boxer kept interrupting to describe the skilled footwork
involved in prizefighting.
4. Everyone became increasingly angry when the swimmer insisted that
swimming is the only sport worth participating in.
5. It almost turned into another Olympic contest when (signal)
*The swimmer that the basketball player tackled punched the
boxer.

Thematized referent acts as Subject of Narrative: Nar - S

1. Last week at the White House, a ceremony was held in celebration of our longstanding friendly relationship with Norway.
2. As newspaper and television reporters recorded the historic event, Present Carter welcomed Norway's king with obvious delight.
3. Our leader invited a number of important United States officials to attend, including a four-star general who played a prominent role in the ceremony.
4. The president accepted Norway's gift of a commemorative gold medal showing the sailing of the first Norwegian immigrants to America 150 years ago.
5. After the proceedings (signal)
*The general walked away from the king that the president saluted.

Thematized referent acts as Object of Narrative: Nar - O

1. Last week at the White House, a ceremony was held in celebration of our longstanding friendly relationship with Norway.
2. As newspaper and television reporters recorded the historic event, Norway's king greeted President Carter with obvious delight.
3. A number of other important United States officials joined the President, with a four-star general playing a prominent role in the ceremony.
4. Norway's gift, a commemorative gold medal showing the sailing of the first Norwegian immigrants to America 150 years ago, pleased our leader.
5. After the proceedings (signal)
*The general walked away from the king that the president saluted.

Non-thematized Narrative: No th

1. Last week at the White House, a ceremony was held in celebration of our longstanding friendly relationship with Norway.
2. As newspaper and television reporters recorded the historic event, President Carter welcomed Norway's king with obvious delight.
3. The ceremony was attended by a number of other important United States officials, with a four-star general playing a prominent role.
4. Norway presented the United States with a gift of a commemorative gold medal showing the sailing of the first Norwegian immigrants to America 150 years ago.
5. After the proceedings (signal)
*The general walked away from the king that the president saluted.

Oo Scenario 5: LunchThematized referent acts as Subject of Narrative: Nar - S

1. Your roving reporter witnessed an amusing scene in a busy downtown luncheonette today.
2. Mrs. Angela Venturi was enjoying a pleasant birthday lunch.
3. Because her twelve-year-old daughter was treating, the woman asked the waitress to suggest a meal that was inexpensive.
4. After the festive lunch was over, just as the check arrived --- whoops! --- the mother jumped as a glass of water was spilled.
5. No harm was done, though, because (signal)
*The daughter wiped the waitress that the mother bumped into.

Thematized referent acts as Object of Narrative: Nar - O

1. Your roving reporter witnessed an amusing scene in a busy downtown luncheonette today.
2. Her twelve-year-old daughter was treating Mrs. Angela Venturi to a pleasant lunch as a birthday gift.
3. The waitress helped the woman by suggesting a meal that was inexpensive.
4. After the festive lunch was over, just as the check arrived --- whoops! --- a glass of spilled water upset the mother.
5. No harm was done, though, because (signal)
*The daughter wiped the waitress that the mother bumped into.

Non-thematized Narrative: No th

1. Your roving reporter witnessed an amusing scene in a busy downtown luncheonette today.
2. A twelve-year-old daughter was treating her mother to a pleasant birthday lunch.
3. The waitress helped out by suggesting a meal that wasn't too expensive.
4. After the festive lunch was over, just as the check arrived --- whoops! --- everyone jumped as a glass of water spilled.
5. No harm was done, though, because (signal)
*The daughter wiped the waitress that the mother bumped into.

Oo Scenario 6: AssassinationThematized referent acts as Subject of Narrative: Nar - S

1. The New York Times this morning printed a striking series of photographs detailing an attempted assassination.
2. Luckily, an amateur photographer happened to be part of the crowd that lined the street to welcome the visiting queen.
3. While Karen Marcus continually rotated her camera to scan the excited faces, she spotted a gun projecting from the crowd.
4. The horrified camerawoman shouted, causing the gunman to miss her target.
5. Then, as the drama continued (signal)
 *The queen ran from the gunman that the photographer pushed.

Thematized referent acts as Object of Narrative: Nar - O

1. The New York Times this morning printed a striking series of photographs detailing an attempted assassination.
2. Luckily, the crowd that lined the street to welcome the visiting queen contained an amateur photographer.
3. Her camera's sudden view of a gun projecting from the crowd horrified camerawoman Karen Marcus, who had been scanning the excited faces.
4. The gunman noticed the photographer and, as a result, missed her target.
5. Then, as the drama continued (signal)
 *The queen ran from the gunman that the photographer pushed.

Non-Thematized Narrative: No th

1. The New York Times this morning printed a striking series of photographs detailing an attempted assassination.
2. Luckily, the crowd which gathered to welcome the visiting queen contained an amateur photographer.
3. As the camera rotated to scan the excited faces, it focused on a gun projecting from the crowd.
4. The gunman was startled by a shout from the crowd and, as a result, missed her target.
5. Then, as the drama continued (signal)
 *The queen ran from the gunman that the photographer pushed.

Ss Scenario 7: Old WestThematized referent acts as Subject of Narrative: Nar - S

1. Theater critics gave terrible reviews to a new play that just opened on Broadway, which depicts life as it was in the pioneer days of Texas.
 2. In the opening scene, the new cowboy in town, Bud Farley, drank too much whiskey at the Golden Chance Saloon and passed out.
 3. Farley slept like a baby while the hostess took all the money from his pockets.
 4. He awoke with a start when the sheriff entered noisily.
 5. And, as the scene ended (signal)
*The sheriff that shook the cowboy picked up the hostess.
-

Thematized referent acts as Object of Narrative: Nar - O

1. Theater critics gave terrible reviews to a new play that just opened on Broadway, which depicts life as it was in the pioneer days of Texas.
 2. In the opening scene, too much whiskey at the Golden Chance Saloon knocked out Bud Farley, the new cowboy in town.
 3. Working quickly, the hostess robbed the soundly sleeping cowboy of all the money in his pockets.
 4. The sheriff's noisy entrance work Farley with a start.
 5. And, as the scene ended (signal)
*The sheriff that shook the cowboy picked up the hostess.
-

Non-thematized Narrative: No th

1. Theater critics gave terrible reviews to a new play that just opened on Broadway, which depicts life as it was in the pioneer days of Texas.
2. In the opening scene, many of the patrons in the Golden Chance Saloon were knocked out from drinking too much whiskey.
3. Working quickly, the hostess took all the money from the pockets of a sleeping cowboy who was new in town.
4. Just at that moment, the sheriff noisily entered.
5. And, as the scene ended ... (signal)
*The sheriff that shook the cowboy picked up the hostess.

Ss Scenario 8: FireThematized referent acts as Subject of Narrative: Nar - S

1. Hundreds of Newark residents witnessed a heart-stopping scene as they stood outside a burning building just before dawn today.
2. The drama began when eight-month-old Susan Cohen woke her mother with her loud cries, as their apartment filled with smoke.
3. As the smoke thickened, little Susan began to choke and gasp.
4. The baby became terribly still just as a fireman broke the window.
5. The phenomenal rescue was accomplished as (signal)
*The mother that threw the baby hugged the fireman.

Thematized referent acts as Object of Narrative: Nar - O

1. Hundreds of Newark residents witnessed a heart-stopping scene as they stood outside a burning building just before dawn today.
2. The drama began when smoke pouring into her apartment aroused eight-month-old Susan Cohen before her mother awoke.
3. The thickening smoke choked the gasping baby.
4. When a fireman, struggling against time, broke the window, he saw little Susan, who had become terribly still.
5. The phenomenal rescue was accomplished as (signal)
*The mother that threw the baby hugged the fireman.

Non-Thematized Narrative: No th

1. Hundreds of Newark residents witnessed a heart-stopping scene as they stood outside a burning building just before dawn today.
2. The drama began when a mother and her eight-month-old baby awoke to a smoke-filled apartment.
3. As the smoke thickened throughout the apartment, breathing became extremely difficult.
4. Struggling against time, and afraid of what he might find, a fireman broke the window.
5. The phenomenal rescue was accomplished as (signal)
*The mother that threw the baby hugged the fireman.

Sa Scenario 9: ChristmasThematized referent acts as Subject of Narrative: Nar - S

1. Christmas season in Macy's Department Store may be hectic, but it can never be called dull, as this recent episode illustrates.
 2. Six-year-old Stuart Washington was very excited as he moved toward the beginning of the line, clutching a list of all his Christmas desires.
 3. As he neared his destination, the boy was unaware that the store Santa Claus had his eye on a shoplifter.
 4. Just as it was Stuart's turn to rattle off his list, he had to step aside.
 5. You see, it was business before pleasure, and (signal)
*The Santa Claus that ran away from the boy jumped on the shoplifter.
-

Thematized referent acts as Object of Narrative: Nar - O

1. Christmas season in Macy's Department Store may be hectic, but it can never be called dull, as this recent episode illustrates.
 2. The long line of children ahead of him clutching lists of their Christmas desires didn't discourage excited six-year-old Stuart Washington.
 3. The store Santa Claus ignored Stuart, nearing the front of the line, in order to concentrate on a nearby incident.
 4. Just as it was the boy's turn to rattle off his list, a shoplifter replaced the boy as the object of attention.
 5. You see, it was business before pleasure, and (signal)
*The Santa Claus that ran away from the boy jumped on the shoplifter.
-

Non-thematized Narrative: No th

1. Christmas season in Macy's Department Store may be hectic, but it can never be called dull, as this recent episode illustrates.
2. A six-year-old boy was very excited as he reached the beginning of the line, clutching a list of all his Christmas desires.
3. But no one in the room was aware that the store Santa Claus had his eye on a shoplifter.
4. The reciting of all the Christmas requests had to stop for a moment.
5. You see, it was business before pleasure, and (signal)
*The Santa Claus that ran away from the boy jumped on the shoplifter.

Os Scenario 10: BusThematized referent acts as Subject of Narrative: Nar - S

1. Yesterday evening during rush hour, passengers on a Fifth Avenue bus were treated to a demonstration of both the best and worst of New York manners.
 2. Sailor Tim Andrews, who was visiting the big city from Kansas, smiled pleasantly as he stepped onto the crowded bus.
 3. Andrews was startled to hear the bus driver snarl, "Listen, hick, if you don't have exact change, get off the bus."
 4. The embarrassed seaman stood motionless as a furious schoolboy stormed up the aisle toward him.
 5. And, although it was none of his business (signal)
*The bus driver slapped the schoolboy that pulled the sailor.
-

Thematized referent acts as Object of Narrative: Nar -O

1. Yesterday evening during rush hour, passengers on a Fifth Avenue bus were treated to a demonstration of both the best and worst of New York manners.
 2. The passengers on the crowded bus made way for sailor Tim Andrews, smiling pleasantly on his visit to the big city from Kansas.
 3. The bus driver startled Andrews as he snarled, "Listen, hick, if you don't have the exact change, get off the bus."
 4. Then the shouts of a furious schoolboy storming up the aisle embarrassed the seaman.
 5. And, although it was none of his business (signal)
*The bus driver slapped the schoolboy that pulled the sailor.
-

Non-thematized Narrative: No th

1. Yesterday evening during rush hour, passengers on a Fifth Avenue bus were treated to a demonstration of both the best and worst of New York manners.
2. A sailor who was visiting the big city from Kansas smiled pleasantly as he stepped onto the crowded bus.
3. It was startling to hear the bus driver snarl, "Listen, hick, if you don't have the exact change, get off the bus."
4. Then a furious schoolboy stormed up the aisle to the front of the bus.
5. And, although it was none of his business (signal)
*The bus driver slapped the schoolboy that pulled the sailor.

On Scenario 11: Country WalkThematized referent acts as Subject of Narrative: Nar - S

1. On the local scene is this story of a strange encounter.
2. Yesterday, 80-year-old Agnes Rainey started out on her usual half-mile morning walk along country roads.
3. "Grandma" Rainey, as she is fondly called by her neighbors, stopped and chatted along the way with a young hitchhiker.
4. The old woman then turned to wave at a bicyclist who was coming along the road.
5. Although it wasn't really a pleasant sight (signal)
 *The bicyclist pointed at the hitchhiker that fell over the old woman.

Thematized referent acts as Object of Narrative: Nar - O

1. On the local scene is this story of a strange encounter.
2. Yesterday morning as usual, her daily half-mile walk along country roads invigorated 80-year-old Agnes Rainey.
3. A young hitchhiker who was walking along the same road chatted with "Grandma" Rainey, as she is fondly called by her neighbors.
4. Then a bicyclist on the road approached the old woman, who turned and waved.
5. Although it wasn't really a pleasant sight (signal)
 *The bicyclist pointed at the hitchhiker that fell over the old woman.

Non-thematized Narrative: No th

1. On the local scene is this story of a strange encounter.
2. Yesterday morning an 80-year-old woman took her customary invigorating daily half-mile walk along country roads.
3. A young hitchhiker who was walking along the same route stopped for a chat.
4. Then, strenuously pedaling along the road came a bicyclist.
5. Although it wasn't really a pleasant sight (signal)
 *The bicyclist pointed at the hitchhiker that fell over the old woman.

Os Scenario 12: The StrikeThematized referent acts as Subject of Narrative: Nar - S

1. What started as a peaceful demonstration this morning took an unpleasant turn as the day wore on.
2. Wearing a hardhat, union chief Allen Bleaker led his striking construction workers in a march in front of City Hall to protest the lack of government building contracts.
3. As the mayor and police chief watched, Bleaker aroused the workers' anger in a heated speech that blamed the high unemployment rate on what he called "corrupt city officials."
4. The hardhat cheered his men as they lost control and began overturning cars and throwing rocks at the windows of City Hall.
5. Eventually, after some scuffling (signal)
 *The police chief grabbed the mayor that kicked the hardhat.

Thematized referent acts as Object of Narrative: Nar - O

1. What started as a peaceful demonstration this morning took an unpleasant turn as the day wore on.
2. Striking construction workers followed their union leader, Allen Bleaker, who was wearing a hardhat, as they marched in front of City Hall to protest the lack of government building contracts.
3. The mayor and police chief watched Bleaker as he received applause for his heated speech that blamed the high unemployment rate on allegedly "corrupt city officials."
4. It apparently pleased the hardhat when the angry workers lost control and began overturning cars and throwing rocks at the windows of City Hall.
5. Eventually, after some scuffling (signal)
 *The police chief grabbed the mayor that kicked the hardhat.

Non-thematized narrative: No th

1. What started as a peaceful demonstration this morning took an unpleasant turn as the day wore on.
2. A hardhat led striking construction workers in a march in front of City Hall to protest the lack of government building contracts.
3. The mayor and police chief watched the workers become increasingly angry as they listened to a heated speech that blamed the high unemployment rate on alleged "corrupt city officials."
4. The demonstration became uncontrolled as cars were overturned and rocks were thrown at the windows of City Hall.
5. Eventually, after some scuffling (signal)
 *The police chief grabbed the mayor who kicked the hardhat.

Appendix C
Screening Procedures

Screening Interview

(Adapted from Small, 1973)

Name:

Age:

Address:

Who else lives in your house?

Place of birth:

If foreign born:

How long have you lived in the United States?

What language do you usually speak?

What was the highest grade you finished in school?

Do you ever have difficulty hearing?

Do you ever have difficulty speaking?

Do you ever experience blackouts (inability to hear, respond,
or remember?)

Have you ever had heart surgery?

Did you ever have an accident involving injury to your head?

Did you ever have a stroke?

Audiological Screening

1. Participants' ability to hear conversational speech was subjectively assessed during the initial interview session. Those who evidenced difficulty in hearing or who reported a history of such difficulty were excluded from further testing.
2. Subjects' hearing for pure tones was screened using Maico Audiometer MA 28. 500, 1000, and 2000 Hz were screened at 35 dB hearing threshold level, ISO 1964. Screening was done in a quiet, but not soundproof, environment.

Neurological Screening

The Motor Impersistence Test (Joynt, Benton, and Fogel, 1962) was administered. That test has been found to be a valuable neurological screening device, since "failure in motor persistence is characteristic of many patients with brain damage but occurs with only rare frequency in normal children and adults" (Ben-Yishay, Diller, Gerstman, and Haas, 1968). Each subject was administered the following nine tests for impersistence, according to the procedures suggested by Joynt et al.:

1. keeping eyes closed
2. protruding tongue, blindfolded
3. protruding tongue with eyes open
4. fixating gaze in lateral visual fields
5. keeping mouth open
6. fixating examiner's nose
7. head turning during sensory testing
8. saying "ah"
9. squeezing dynamometer¹

¹Lafayette Instrument Co.

Intellectual Screening

Intelligence was estimated through the WAIS Vocabulary subtest administered according to procedures described in the WAIS manual.¹ This subtest requires that subjects provide definitions for a series of words which progressively decrease in familiarity. Scores vary according to the quality of the response. Performance on the Vocabulary subtest is highly correlated with performance on the entire WAIS battery, with the consequence that this subtest is widely used as an index of general intellect (Zimmerman and Woo-Sam, 1973).

¹Raw, rather than scaled, Vocabulary scores were coded so as to retain the original precision of measurement.

Memory Screening

For this research we used as a screening device the most influential and widely applied measure of immediate recall, the Memory Span for Digits subtest of the WAIS.¹ Beyond minimum levels, there is little correlation between performance on that subtest and general intelligence; in fact, more intelligent subjects may find the task dull or unimportant, and consequently perform poorly. The test seems to be a relatively pure measure of short term memory (Craik, 1968) and is considered an aid in: a). assessing those of low intellect, and b). measuring the nonintellective factor known as attention, concentration, or freedom from distractibility (Zimmerman and Woo-Sam, 1973). The procedure requires that series of auditorily presented digits be recalled in two ways: forward, i.e., in the order presented, and backward, i.e., in reverse order, the latter being a method which creates special problems in transformation (Weinberg, Diller, Gerstman, and Schulman, 1972; Talland, 1968). Span of immediate recall is defined as the number of items which can be consistently recalled. On the average, young adults recall 6 digits forward and 5 backward, with the digit span dropping less than 20% below peak level by the end of the eighth decade (Wechsler, 1955).

¹Raw, rather than scaled, Digit Span scores were coded so as to retain the original precision of measurement.

Appendix D
Recording Apparatus

Recording of stimuli for both experiments

Original Recorder: Ampex 440B
Speed: 7 1/2 i.p.s.
Microphone: AKG D202E
Tape: Scotch 206
In IAC soundproof room; speaker 1 ft.
from microphone.

Duplicate Recorder: Bigston Cassette
Tape: Maxell LN

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