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A PRINCIPAL COMPONENTS ANALYSIS OF THE PROCESS OF ATTENTION.

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A PRINCIPAL COMPONENTS ANALYSIS OF THE PROCESS OF ATTENTION

by

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Hons. B.A., University of Windsor, 1973
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ABSTRACT

A review of the literature reveals that several models of selective attention have been proposed. Traditionally, these models have been distinguished on the basis of two dimensions: their formulations regarding 1) locus of attentional operations and 2) the nature of capacity limitations. In regard to the former, "early" theorists have indicated that attention is a prerequisite for in depth perceptual processing whereas "late" theorists have suggested that attentional activity is confined to postperceptual operations. In regard to the latter, a distinction has been made between "structural" theorists who have implied that attention, which exerts its influence in isolated processing systems, results from the inability of cognitive structures to simultaneously process competitive stimulus inputs and "functional" theorists who have described attention as a diffuse cognitive resource that is limited in a general fashion, however, variable in terms of its restrictions and functions. At the empirical level it is noted that although diverse paradigms have been employed to define and measure attention, researchers from varying theoretical positions have for the most part relied upon a particular means of data collection. On the basis of these observations, it was hypothesized that current controversy may stem from the commonly held assumption that attention is a unitary concept/process. An attempt was made to test this premise.

Specifically, eight experimental tasks, two supporting each of the four theoretical positions that result from the aforementioned

categorization scheme, were administered to 60 subjects. A number of predictions specific to the eight paradigms were tested. Subsequently, the entire data set was submitted to a principal components analysis. The majority of predictions were confirmed suggesting that the diverse methods of assessing attention which currently exist are equally accurate and appropriate. The results of the principal components analysis suggest that attention is a variable process. More specifically, attention appears to operate differently in the visual and the auditory modalities; it appears to manifest both "structural" and "functional" limitations; and it appears to intervene at multiple loci in the perceptual cycle.

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Words of thanks are trite, if not completely inadequate, to express my profound gratitude to my family and friends for their active support and encouragement. Merely to hint that their importance could be neatly presented on paper is a mockery of their very importance. I can only hope that in time they come to realize at least a small part of the significance of their being and presence.

DEDICATION

To my husband Robert, my best friend and teacher, I dedicate this work. During his short life, and even at the time of his death, Robert continuously shared his unselfish love. It is knowing this everlasting love that gave me the courage to complete this work, and that gives me the courage to continue with life after his death.

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CHAPTER I

INTRODUCTION

A fundamental understanding of human behaviour requires an explication of the manner in which persons acquire, assimilate, and utilize information as a means of achieving a meaningful working knowledge of the vast array of stimuli which impinge upon them. Certainly this is neither a novel nor radical idea. With varying degrees of sophistication nearly every major school of psychological thought has sought this objective and has proposed schematic conceptualizations regarding the transformation of sensory energies into cognitive experiences.

A recurrent problematical issue has been the identification and elucidation of a central regulatory process which accounts for the focusing and generally coordinates the organizational, analytical, and integrational activities commonly recognized in perceptual acts. Although other mechanisms have been posited to explain these phenomena, more often than not, an attentional process has been implicated (Blumenthal, 1977). Unfortunately, the ability to obtain a consentient definition of attention and a precise system of measurement of such a process has repeatedly eluded both researchers and theorists alike. That is most clearly illustrated by the fact that the delineation of attention, as evident in present day formulations, has progressed minimally since the exposition put forth by William James (James, 1890). Due to its intangible and elusive nature, moreover, some psychological schools of thought, such as the Gestalt, have minimized the significance of attention while others, such as the early Behaviourist, have rejected the concept completely (Blumenthal, 1977). In modern times the information processing approach[1] provides perhaps the most comprehensive formal system of theorizing, together with a rigorous methodological framework, to be adopted by those researchers who have an interest in investigating the functions and specifying the parameters of attention.

Definition

It only seems appropriate that any investigative effort has as its starting point an elucidation of the subject matter under consideration. In so far as the concept of attention, as discussed in this paper, attains its meaning only within the broader context of cognition, it is necessary to review some suppositions and implications of the information processing approach as they pertain to perceptual/cognitive activities.

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[1]Within a scientific realm an "information processing" approach may be applied to any line of investigation. As such, it connotes a systematic approach, perspective, or conceptual framework to the subject matter under consideration whereby observable or hypothetical phenomena are conceived as being interrelated in a fashion that is analogous to that of computer operations. Within the psychological sphere the term "information processing" has also been used to refer to that specialized field of inquiry which is concerned with the actual conversion of sensory data into meaningful perceptual/cognitive experiences. Throughout this paper the term "information processing" is used exclusively in the former sense, that is, as a computer metaphor. So as to avoid confusion, the act of processing information, including the collection, assimilation, and analysis of sensory data will be subsumed under the broader term of perception.

A central assumption is that perceived events are not necessarily mirror reflections of stimulation but rather, more accurately, are experiences produced by the transformation, analysis, and synthesis of sensory events. Although a complexity of processes describe the assimilation of sensory data, by no means is this achieved in a haphazard or desultory manner. Consequently, stages, processes, or sequences of events, such as encoding, analyzing, and memory have been postulated as a means of accounting for the methodical series of operations which convert sensory phenomena into meaningful and comprehensible cognitive experiences.

In addition, it is assumed that the collection, identification, and integration of sensory data is not an immediate event but rather, is an occurrence which requires time. By extension, moreover, it is generally recognized that the amount of information which can be processed within a given period of time is limited. The assumption of limited capacity, which follows from these governing principles, necessitates the inclusion of a process whereby an organism is able to select from the complex array of stimuli present at any one time that which will be given priority and enjoy access to perceptual analysis, conscious awareness, a response execution mechanism, and representation in long term memory. Within the confines of an information processing approach, then, the concept of attention embodies the selection that occurs in perceptual/cognitive experiences (Haber & Hershenson, 1973).[2]

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[2]Although it is not universally accepted, in so far as objections and criticisms have been raised concerning its inherent redundancy, it should be noted that the term "selective attention" is commonly used in the literature. For the purpose of this study this issue remains immaterial and the terms "attention" and "selective attention" will be employed interchangeably.

Thus, as discussed herein, attention is construed as a central regulatory mechanism or process. As such, it governs consciousness, ultimately sanctions that which will be selected to enter awareness, and insures the temporal as well as contextual continuity of mental events. At a more concrete level, attentional processes may also be defined in terms of the specific phenomena which they must address. A selective attention mechanism must not only account for an organism's ability to focus upon a limited aspect of the sensory field while resisting disrupting influences from competing or irrelevant stimuli, but it must also be sufficiently flexible in scope and direction so as to assure adaptive responses according to demand. In addition, attentional mechanisms must speak to the apparently paradoxical finding that although an organism generally finds it difficult to focus upon two or more competing inputs simultaneously, it is apparently able to react to previously unacknowledged stimuli (Dixon, 1971).[3]

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[3]The focus of the present investigation is concerned with specifying the parameters of attention as they pertain to the selective perception that occurs among well differentiated stimulus events. That is, the main interest is to explicate the process which accounts for an organism's failure to perceive a sensory event in situation "B" that he/she could easily perceive on occasion "A." Selective perception, however, has also been discussed in terms of perceptual unpreparedness. As such, the main interest is to specify the parameters of those conditions in which sensory inputs are not perceived due to a lack of sensory apparatus or skill (perceptual learning) on the part of the organism which precludes a differentiation among the elements comprising a stimulus array. Prominent investigators in this field of inquiry include Gibson (1969) and Tighe and Tighe (1966). The concept of attention itself has also been employed to describe selective processes that occur after the completion of and completely independent from the perceptual act; that is, to explain the phenomenon that perceived and conscious events are not utilized in response selection. Such notions of attention are most often related to discrimination and association learning theory. It is generally maintained that through prior experiences and past reinforcement contingencies, an organism has come to regard those "nonselected," "nonattended" aspects of the stimulus complex as irrelevant. Theorists such as Mackintosh (1975), Fisher and Zeaman (1972), Lovejoy (1968), Trabasso and Bower (1968), and Zeaman and House (1963) have addressed this issue at length within both human and other organisms.

Although the information processing approach to perception and cognition clearly illustrates the need for an attentional mechanism and concomitantly prescribes general guidelines regarding the construction of methodological paradigms for measuring the phenomenon, it does not present an agreed upon definition of the process. The fact of the matter is that, in spite of their sophisticated theoretical and empirical armamentarium, researchers have yet to comprehensively elucidate the concept of attention. That lack justifiably warrants a reassessment of the current selective attention research and theory.

Statement of the Problem

Substantial theoretical dissension pervades the selective attention field as is evident by the numerous models that have been proposed. In spite of the fact that researchers have systematically and comprehensively delineated the role of diverse variables upon the attention process, empirical findings to date have not dispelled theoretical contention. To a certain degree this state of affairs is attributable to the fact that each researcher in attempting to confirm his/her theoretical formulations has demonstrated a decisive preference for a particular means of data collection. For example, Moray (1959, 1960, 1967, 1970) has primarily conducted investigations within the auditory modality, whereas Neisser (1963, 1967, 1973, 1975, 1976) has tended to confine his research efforts to the visual modality. Shiffrin and his colleagues (1972, 1973, 1974, 1976) have generally employed the "simultaneous-sequential" paradigm, while LaBerge (1973, 1983; LaBerge, Petersen & Norden, 1977), has frequently employed an advanced cuing procedure.

Although an unwavering reliance upon a particular methodological approach is not scientifically invalid in itself, the lack of success in resolving theoretical controversy to date suggests that continued pursuits along such segregated lines of inquiry within the selective attention field may be counter productive. A re-examination of the basic issues appears to be needed.

Perhaps the most rudimentary assumption adhered to in the field of selective attention is that attention is a unitary phenomenon, with the proposed models merely reflecting variations in the conceptual framework.[4] A review of the theoretical and experimental literature, however, reveals sufficient justification for questioning that assumption. It is the purpose of this study, therefore, to re-examine this fundamental premise.

Models of Selective Attention

Pioneering Efforts

Broadbent

Donald Broadbent's (1958) Filter Theory was the first formal model of perception that was not only based upon an information processing approach but also postulated in extensive detail the operation of a

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[4] It should be noted that although this state of affairs precludes a unified theory of attention, it is not at variance with sound scientific theory building. That is, the models which have been proposed do not impart an immutable reality nor are they irrevocable. Their value lies in the conceptual framework that they provide and is indirectly measured by the efficacy of each model to parsimoniously explain and predict the empirical data observed. Furthermore, sound scientific theory building predicates that in the absence of any convincing empirical research to the contrary, no one solution or formal means of interpretation is necessarily correct. Thus, at the theoretical level multiple, diverse models of selective attention may, and in fact, do coexist.

selective attention mechanism. Although the model incorporated findings from diverse experimental investigations, most crucial were the observations noted in selective listening situations (Broadbent, 1958).

At the time of his formulation these studies had generally suggested that the inability to comprehend two simultaneously presented messages was due to the involvement of some central process rather than any peripheral operation such as sensory masking; that the rate of stimulus presentation was critical and negatively correlated with comprehension; and that the discarding of information was not random (Moray, 1969b).

Whenever subjects were required to overtly repeat (shadow) one of two simultaneously presented or competing messages, they ignored the nonreported/nonattended message for all practical purposes. Although they detected in the nonattended channel simple physical characteristics, such as the presence of another message, the sex of the speaker, and the general nature of the stimuli (prose, pure tones, etc.), subjects failed to recognize its content (Cherry, 1953).

Split-span studies, in which subjects were required to recall two series of simultaneously and dichotically presented digits (that is, one series of digits was presented to each ear), reconfirmed the finding that stimulus presentation rate was a critical factor affecting perceptual analysis and furthermore, documented the finding that subjects, given a choice, prefer to recall by ear of presentation rather than by order of presentation (Broadbent, 1958).

Based primarily on such data and in accordance with an information processing analysis of perception, Broadbent hypothesized that, from the time external stimulation impinged upon the sensory receptors until it was perceived and responded to by the organism, it was transformed and operated upon by various processes occurring at specified stages in the general schema of information flow. The majority of these activities, it was assumed, occur in a perceptual analyzing system which, being of limited capacity, is susceptible to overload if required to analyze all the external information present.

Schematically, Broadbent conceptualized the movement of sensory information through the perceptual system in the following manner. Incoming stimulus information, arriving over a number of parallel sensory channels, is deposited in a sensory buffer. In addition to briefly storing the material, this facility is capable of conducting an elementary analysis of physical features. Providing that the information is not detained beyond a certain critical period, in which event it will decay, it is relayed in an undisturbed manner to a selective filter. The filter, based upon a sampling of the material held in the sensory buffer, selects one of the many input sources and transmits that information to the central processing channel. It is at this stage that the sensory data is analyzed in detail, perceived, and then transferred to a long term memory store as well as a response execution mechanism. Upon the completion of the perceptual cycle, a resampling of the channels occurs and the entire process is re-engaged.

The resampling procedure or switching of the filter is not an instantaneous process but rather involves a component of dead time during which the remainder of the system is inactive. It should also be noted that the selection of a channel is not random, and the probability of selection may be altered by features of the stimulus such as novelty, salience, intensity, and/or states of the organism such as needs, drives, and arousal. Furthermore, two or more bits of information may move through the system simultaneously or in parallel provided that the maximum capacity of the perceptual analyzing system is not exceeded.[5]

Briefly stated, then, according to Broadbent selective attention refers to that screening process conducted by the filter during the initial phases of the perceptual cycle whereby stimulus events which have been differentiated on the basis of an analysis of their elementary, physical characteristics are identified as relevant and permitted to undergo higher-order perceptual/cognitive processing. Information designated as irrelevant has its perceptual/cognitive processing either temporarily suspended or completely terminated.

Needless to say, Broadbent's formulations and speculations regarding the nature of the attentional mechanism did not go unchallenged. Out of the proliferation of studies which ensued (Gray & Wedderburn, 1960; Treisman, 1960; Yntema & Trask, 1963), those demonstrating

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[5]The reader should bear in mind that the material that has been presented above is merely intended as a brief review of Broadbent's theory of attention/perception. As such it suffers from limitations that are inevitably encountered whenever one attempts to condense highly complex theory into synoptic form. Although specific parameters of the model such as the formulations regarding switching time, are most often blurred by such a rendering of the material, it is felt that the absence of detailed elaboration of such notions does not hinder a fundamental understanding of the model as deemed necessary for purpose of this paper. For this reason, the practice of presenting only the most critical features will be adopted throughout the review of the remaining models.

that the filter did not completely and entirely screen the information arriving on an unattended channel proved to be the most damaging (Moray, 1959; Norman, 1969; Treisman, 1964a). In direct response to these criticisms, Treisman (1964c, 1969) and Deutsch and Deutsch (1963) proposed alternative filtering models of attention. For the most part these models included a relocation of the filtering mechanism and a modification of the process by which selectivity occurs.

Treisman

According to Treisman (1964c, 1969) selection, fundamentally speaking, is the resultant of a binary set of operations; that is, operations occurring at two stages of the perceptual processing sequence. All sensory data impinging upon the organism pass through a complex network of parallel as well as hierarchically arranged specialized feature detectors which are differentially prepared to accept sensory information. Such analyzers independently scan the stimulus inputs for the presence of those critical attributes which collectively establish the criteria for selection. That is, the message which is selected is comprised of the highest possible combination or set of significant features. In addition to isolating the relevant message, these preliminary series of analytical operations also act as filters by attenuating the signal strength of irrelevant messages.

All incoming stimuli, regardless of their signal strength, are then transmitted to a central analyzing structure, the pattern recognition network, where they have the potential of activating their respective memory correlate or dictionary unit. Current perceptual activity and prior learning establish a different and variable activation threshold for each dictionary unit. The first message or pattern of input which is of sufficient signal strength to fire its dictionary unit will enter conscious awareness, and subsequently, gain access to long term memory and a response mechanism. Thus, the information which is ultimately selected has successfully met first filter and then threshold tests. Furthermore, Treisman postulates a reciprocal relationship between dictionary units. Specifically, once a dictionary unit fires it concomitantly lowers the firing thresholds of other dictionary units for all stimuli which are currently anticipated due to prior learning.

In summary, then, Treisman advances the notion that selective attention results from the interaction of operations occurring at two stages of the perceptual processing cycle. Selection initially occurs whenever an analyzer is required to simultaneously conduct operations upon two concurrent sensory inputs. For example, in those situations in which competing stimuli converge upon the same analyzer, only one will be given priority, that is, it will continue the perceptual sequence undisturbed, while further processing of the excluded item will be completed with an attenuated signal strength. The second stage of filtering, which is determined by the activity of the pattern recognition network, involves the selection of the one sensory item that is of sufficient signal strength to surpass the firing threshold for its respective dictionary unit to complete the perceptual/cognitive cycle.

Deutsch and Deutsch

In opposition to Treisman's analysis, Deutsch and Deutsch (1963), contended that the presence of an early filtering mechanism was superfluous. They postulate that all incoming messages proceed undisturbed to a central selection mechanism which is a subcomponent of memory.

Although each stimulus signal fires its respective memory analogue; thereby assuring complete perceptual analysis and recognition for all incoming sensory inputs, it is only that signal whose memory correlate fires with the greatest intensity that will be selected for completion of the perceptual cycle and as such gains access to a response mechanism and permanent storage in memory. The strength of the activation of each memory correlate is in direct accordance with the importance of the stimulus for the organism as determined by momentary intentions and past learning.

Deutsch and Deutsch maintain that each time a signal is selected, it establishes the basal activation level for selection for all other stimuli; and furthermore, in a manner functionally similar to Treisman, it subsequently enhances the importance weightings of related stimuli. Although perceptual analysis through the firing of a memory unit is a necessary condition, it alone does not provide sufficient grounds for conscious awareness which is also dependent upon the organism's state of arousal. In addition to postulating that some degree of general arousal is necessary for attention to operate, Deutsch and Deutsch further distinguish a gradient of responsiveness on the part of the organism which is determined by his/her state of arousal. That is, whereas individuals when aroused will attend to any incoming message provided that it is not concomitant with a more important one, when asleep they will respond to only very important messages, such as a person's own name.

In summary, then, Deutsch and Deutsch postulate that selective attention intervenes in the perceptual cycle at the memory level; after all stimuli have received complete perceptual analysis and activated their respective memory representations. Selection is achieved by a comparison of the firing strengths of the diverse memory correlates. By definition, then, selective attention is that process by which the sensory item whose memory analogue fires with the greatest intensity is selected for completion of the perceptual/cognitive processing sequence.

<u>Norman</u>

Norman (1968) emphasized the need to recognize the qualitative aspects of sensory inputs. He presents a reformulation of the Deutsch and Deutsch model. That is, although all sensory data activate their respective representation in short term or primary storage, thereby undergoing perceptual analysis, they do so in a variable fashion depending upon their physical attributes. The level of sensory activation in conjunction with the pertinence value of the stimulus, as determined by momentary intentions, previous inputs both remote as well as recent in origin, and expectations about future inputs, establishes an aggregate activation level for each stimulus. It is that stimulus which possesses the highest total primary or short term memory activation that is selected for further perceptual processing. Similar to Deutsch and Deutsch, Norman postulates that perceptual analysis and interpretation is merely a precondition for conscious awareness and higher-order perceptual/cognitive functions.

According to Norman, then, selective attention refers to the isolation of that one stimulus event which will be permitted to enter permanent or long term memory, conscious awareness, and have access to a response execution mechanism. Selection, which occurs after all stimuli have activated their respective memory correlates, is determined on the basis of the strongest firing strength of the diverse stimuli represented in primary or short term memory.

Hochberg

Hochberg (1970), stressing the active, dynamic nature of perception, postulated that perceptual acts, as a function of the organism's pre-established, though not unalterable cognitive schemata, are inherently organized and selective. That is, in any perceptual situation an organism generates a set of expectancies which organize his exploration of the stimulus field and concomitantly establishes the order in which sensory information will be encoded into permanent memory. Thus, although an organism may scan all impinging stimuli, only those aspects of the environment which confirm its anticipations, as determined by its schema and established by the context of the situation, will be encoded into more permanent form and subsequently gain access to conscious awareness.

According to Hochberg, then, the employment of cognitive strategies establishes a hierarchical order of encoding for stimulus events or sequences of events. Selective attention refers to the encoding into permanent memory of that limited portion of the stimulus complex which confirms the expectancies generated by the more salient schemata.

With the advent of Hochberg's model, the basic axes for the theoretical orientations to selective attention were established. On the one hand, models of selective attention assumed that perception was a passive activity, the organism merely a conduit of sensory information (Broadbent, 1958; Deutsch & Deutsch, 1963; Norman, 1968; Treisman, 1964c, 1969). Alternative models (Hochberg, 1970), depicted perception as a dynamic, constructive process. The former regarded attention as a necessary but inert facilitator of perception, the latter conceptualized attention as a fluid process which could be appropriately distributed so as to enhance perceptual functioning.

Apart from this distinction, the selective attention field was further divided by questions concerning the exact locus of the attentional mechanism(s). Theorists such as Broadbent (1958) and Treisman (1964c, 1969) postulated that attentional processes operate during the initial phases of the perceptual continuum; that is, prior to the activation of memory correlates. Consequently, not all sensory data attain comparable levels of analysis, and sensory items are differentially processed prior to activating their respective memory analogues. In so far as Deutsch and Deutsch (1963), Norman (1968) and Hochberg (1970) regarded perceptual analysis as an automatic and irrepressible operation, they assert that attentional influences intervene exclusively during the latter stages of cognitive analysis. Corollaries of the postulate that no discriminative functions precede stimulus recognition include that all sensory phenomena receive a uniform degree of feature and semantic analysis, that is, all inputs must unmitigatedly complete their respective perceptual course; and all sensory events attain representation in short term memory.

These initial issues concerning the nature and locus of attentional operations were so pivotal that the various models of selective attention which ensued may be regarded simply as variations on these early themes.

Later Formulations

Broadbent

The various refutations of his original filter model, as were previously noted, coupled with the generation of new data, induced Broadbent (1971) to revise his initial ideas regarding selective attention. The major changes included a reformulation of the assumptions concerning the nature of the filter and the addition of an alternate stage of selection.

Briefly stated, Broadbent postulated that incoming sensory information undergoes initial selection by passing through a filter which attenuates irrelevant messages in a manner analogous to that proposed by Treisman. The resulting "states of evidence" or internal representations generated by this selection process are further processed in accordance with pre-existing categorical structures that are differentially prepared to accept information. Only that sensory input which is of a sufficient signal strength to warrant an interpretation by its corresponding memory structure is selected to complete the perceptual cycle. Since these higher cognitive structures, which are arranged so as to represent more bits of information than the feature analyzers, are typically more encompassing in nature, Broadbent further speculated that synoptic transmission, and inevitably information loss, is to be expected. Thus, in the process of achieving the status of conscious recognition sensory information is initially operated upon by a filtering mechanism, subsequently screened in accordance with an organism's readiness to make an interpretation, and finally condensed via its representation in a higher-order, pre-existing, categorical structure.

In summary, then, Broadbent's reformulated ideas regarding selective attention closely approximate those ideas that were initially advanced by Treisman (1964c, 1969). Selective attention specifically pertains to the operation of filtering mechanisms located at two stages of perceptual analysis. The initial activity, which occurs during the early phases of the perceptual sequence and produces an attenuation of the signal strength of irrelevant stimuli, is the result of the simultaneous convergence of competing stimuli upon the same analyzer. The later activity, which occurs within the memory system and results from the differential firing thresholds of memory units, selects that one item which will be permitted access to memory storage, a response execution mechanism, and entry into conscious awareness. In addition to these two stages of attentional processes, Broadbent further speculated that information loss generally results whenever sensory inputs are represented in pre-established memory structures.

Treisman

Similar to Broadbent, Treisman has within recent years presented a reformulation of her theory regarding selective attention (Treisman, 1982; Treisman & Gelade, 1980; Treisman & Schmidt, 1982; Treisman, Sykes, & Gelade, 1977). The current, feature-integration, model appears to be more an elaboration rather than a fundamental revision of the originally proposed filter attenuation model. That is, although the two processes, signal strength attenuation and variable firing of dictionary units, which Treisman initially postulated as the means accounting for selective attention are not explicitly incorporated, they certainly are not incompatible with her more recent theory. Generally, the filter model focused upon identifying the mechanisms that produced selective cognitive activity, whereas the feature-integration model explains in fuller detail the functions served by attentional processes. A notable difference is that the earlier theory relied heavily upon data gathered from auditory studies for its empirical base; the later model has been tested primarily within the visual modality. Treisman, however, has extended the assumptions of the feature-integration model to interpret findings generated via the employment of diverse paradigms, including dichotic listening.

The feature-integration model postulates that an early stage of perceptual processing results in complete feature registration. At this level all sensory data automatically, independently, and in parallel activate their respective, feature specific maps. This initial analysis is devoid of any integrative/combinational processing. For example, a red circle will activate receptors sensitive to the color red, and simultaneously, but independently, stimulate receptors appropriate to registering a circle. The separate features comprising an object are synthesized into a unitary whole, a red circle, at a succeeding stage of processing. The later process, feature-integration, is demanding of focused attention; and focused attention is directed towards competing stimuli in a serial fashion. Attention, then, is the medium which allows the individual features that define an object or event to be coalesced into a unified percept. Toward this end, it serves a dual purpose: 1) attention selects the features which will be conjoined; and 2) it specifies the manner in which these selected features will be combined.

Treisman proposes that perception, and subsequently conscious awareness, succeed feature-integration and result from the formation of episodic structures. Episodic structures entail the convergence of stored information and current sensory data. The part played by each component is variable and determined by the nature of the information that is being processed. More specifically, the correct synthesis of novel, unexpected, or unpredictable information requires focused attention. Familiar stimuli, on the other hand, which possess a well integrated memory store, may be processed with diminished, and perhaps even independent of attentional capacity. Incoming sensory information, then, may be processed via two perceptual routes. Movement through a "bottom-up" sequence requires the intervention of attention. A "top-down" analysis is successful in those situations in which the properties of expected or primed objects are assimilated into a pre-existing frame independent of attention's selection and coordination functions. More often than not, perception involves a mixture of these two processes.

A central concern is specifying the outcome of stimuli that are not processed via one of these two methods. Illusory conjunctions are formed when focused attention is not directed towards the processing of novel objects. Illusory conjunctions, which involve the interchange of features among competing stimuli, result in the formation of erroneous percepts. For example, if the stimulus field simultaneously contains a red circle and a blue square, an illusory conjunction would be the perception of either a red square or a blue circle. Attention limits, evidenced as illusory conjunctions, will appear under two conditions: if focused attention is directed towards competing stimulus input or if attention is sparsely distributed among numerous features of a complex event. Furthermore, illusory conjunctions are not confined to perceptual operations, that is, the acquisition and integration of information, but may also occur during memory activity.

In summary, then, Treisman regards focused attention as that process which initially selects, and subsequently interrelates the network of features that comprise a stimulus event. In its absence, the features of unattended stimuli will be haphazardly combined into illusory conjunctions.

Moray

Since the influence and theoretical import of Moray's prolific investigations have been so pervasive in the field of selective attention, his more central ideas will be presented here, although his formulations have yet to achieve the status of a formal model.

Consistent with the information processing approach, Moray assumes that, in a very general sense, there is a limit to the amount of information that an organism can effectively process within a given period of time. Unlike the majority of other theorists, however, Moray has stressed the functional rather than the structural limitations of information processing. That is, Moray postulates that all component operations of the perceptual cycle are taxing of a finite "mental resource," and consequently cautions that although limitations of attention may be manifested at specific stages of analysis, it may be erroneous to assume that such stages are the originating sites of limitations. Rather he proposes that selectivity and the distribution of attention be conceptualized as occurring strictly in accordance with functional demands (Moray, 1967, 1969b).

Moray postulates that in each perceptual encounter the deployment of attention is controlled by internal representations of the stimulus field which are being continuously constructed and revised by the organism. An organism samples the source of information available in accordance with this internal model. Sampling a source of information insures the allocation of sufficient attention to perceptually analyze, recognize, and respond to the stimulus material present (Moray, 1975;

Moray & Fitter, 1973; Ostry, Moray & Marks, 1976).

Beyond this general allocation strategy, Moray fails to consistently specify the principles of the distribution of attention. He appears to vacillate between a "time-sharing" model in which attention may only be directed to a single source of sensory information at a time but may be rapidly switched between simultaneously competing inputs (Moray, 1969b; Moray & Fitter, 1973; Ostry, Moray & Marks, 1976); and a "demand-sharing" model in which attention may be simultaneously but proportionately allocated to more than one source of information provided that the total capacity is not exceeded (Moray, 1967, 1969ab, 1975).

Irrespective of his position regarding the divisibility of attention, Moray postulates that selective attention is the strategic allocation of a finite, mental resource to a particular sensory input so as to enable its perceptual processing to occur. Since all component operations of the perceptual cycle are demanding of attention, the intervention of selective processes is variable and pervasive throughout the perceptual/cognitive continuum.

Kahneman

In a manner similar to Moray, Kahneman (1973, 1975) regards attention as "mental effort," the limits of which are imposed by functional rather than structural limitations. Rather than confine or restrict attentional faculties to any specific stage in perceptual processing, Kahneman suggests that attention may exert its selective influences at various points throughout the cycle. Attention operating in the early phases of perceptual processing, for example, may accentuate a stimulus event, and, by so doing, increase the probability that that item will complete the perceptual cycle. In the later phases attention may facilitate response selection by differentially enhancing certain alternatives in the organism's response repertoire.

In so far as attention is not structurally determined, Kahneman is prompted to postulate general principles for allocation. Perhaps the single, most significant factor controlling the dispersion of attention is a preattentive grouping process which segregates the stimulus field into distinct perceptual units. The partitioning of the perceptual field which results from this organizational process is permanent, and thus, the imposed structure is retained throughout the complete analysis of the current perceptual environment. Kahneman indicates that once this parsing has occurred, attention may be distributed among the component groups according to two basic strategies. Attention may be simultaneously divided among the perceptual objects or singularly and linearly allocated to the isolated elements. When the later strategy is employed, the perceptual groups are arranged in a hierarchical order. Following the complete analysis of the information contained in the group of highest priority, residual capacity is directed in a serial and progressively decreasing fashion to the successive groupings. Although attention may be variably distributed between perceptual groups, the grouping process creates relatively indivisible units of perception, and thus, within groups all elements, relevant or irrelevant, exact comparable amounts of attentional capacity (Kahneman & Henik, 1977; 1981).

In addition to this primary allocation policy, Kahneman suggests that the amount of attention apportioned to any one perceptual activity fluctuates in accordance with the general arousal state of the organism, enduring dispositions (for example, natural attraction to novel situations or familiar stimuli such as one's own name), momentary intentions, and demands of other concurrent activities. Furthermore, Kahneman distinguishes between an active and passive mode of attention allocation. In the active mode an organism continuously assesses its performance and adjusts its effort (attention) accordingly. In a passive mode the allocation of attention is predetermined and the organism does not employ any type of regulatory or corrective measures.

Thus according to Kahneman, selective attention is the allocation of a diffuse but limited mental effort to the diverse sequence of stages comprising the perceptual/cognitive processing of specific stimulus events. Related stimulus events are isolated and formed into groups during a preattentive process that structures and organizes the perceptual field. Attention is allocated first to a group as a whole and subsequently to elements within a group.

Keele

Central to Keele's (1973) model of perception and formulations regarding selective attention is the concept of a logogen. Keele conceives of a logogen as a memory engram of a discrete pattern of a stimulus-response behaviour. Specifically, it encompasses the identification, recognition, and/or appropriate response to a stimulus.

In addition, logogens are characterized by variable threshold levels of activation which are determined in accordance with their value to the organism.

During the initial phase of the perceptual sequence all sensory information is automatically shunted to the appropriate site where it is gradually registered by the logogen until sufficient evidence for activation is accumulated. The rate of accumulation of evidence in any logogen is dependent not only upon the actual signal strength, but also upon the strength of the previously established memory trace between the signal and its respective logogen. Only the first logogen to reach its criterion level of activation will be selected for further processing, which includes such mental operations as rehearsal and response initiation, and subsequently will enter awareness.

In summary, then, selective attention may be envisaged as an operation which is specific to the later of two successive stages of perceptual processing, both of which are seated in memory. Specifically, selective attention pertains to the process whereby the first sensory input to surpass its criterion level of logogen activation is chosen to complete the perceptual cycle.

LaBerge

According to LaBerge (1975, 1976), all stimuli impinging upon the organism are automatically transmitted in an undisturbed manner to feature detectors present in the memory system. Further perceptual processing includes the analysis of this information through a complex network of memory structures, or codes, which are hierarchically arranged according to function. Although attention is initially required to establish the connections between the various levels of memory codes, with sufficient repeated exposure attentional activites may be withdrawn and processing will attain a state of automaticity. Since there appears to be no upper limit in regard to the number of codes which may be interconnected, stimuli may be analyzed to a variable degree.

Attention may be deployed either automatically, as in the instances where prior learning dictates that certain codes spontaneously command attention, or directively, as in the establishment of memory traces among memory codes. In regards to the latter function, attention may not only facilitate perceptual analysis in a manner described above, but it may also prepare codes to receive incoming sensory stimulation.

LaBerge postulates that selective attention operates after all stimuli have made their contact with memory. That input which will enjoy selective attention and, subsequently, enter consciousness is that which emits the strongest signal. Although he fails to specify any interpretive guidelines for evaluating the saliency of a stimulus, LaBerge does give some indication of the complex nature of such a task. That is, he presupposes that the importance of a code is mediated by feedback associations with other organizational entities such as the autonomic nervous system.

In summary, then, LaBerge regards attention as a diffuse cognitive resource that may be either utilized automatically in a particular processing sequence or actively allocated as a controlled process. Attention, which intervenes in the perceptual cycle once all stimulus inputs have made contact with their respective memory correlates, serves to initially organize and consolidate higher-order memory traces.

Shiffrin and Schneider

Central to Shiffrin and Schneider's (Schneider & Shiffrin, 1977; Shiffrin, 1976; Shiffrin & Schneider, 1977) position regarding selective attention is the assumption that all perceptual activity is embedded in memory. The basic functional memory unit, the node, depending upon its level of complexity, may contain information regarding the properties of the stimulus, response patterns to a signal, associative connections to other related nodes, and/or directions for further, higher-order perceptual analysis. Its functional unity derives from the fact that whenever one element is activated, all other information stored in the same node will also be activated. Nodes are hierarchically arranged according to their level of operation and follow the principle of undirectional activation towards increasing complexity. That is, at lower levels nodes contain substantial information concerning the physical characteristics of a stimulus event. At higher levels nodes are primarily involved with the storage of semantic information and complex cognitive operations such as comprehension and decision making. Considerable condensation of the information regarding its physical properties occurs as the stimulus input progressively attains representation in higher level nodes. Consequently, as perceptual processing occurs, and nodes are sequentially activated, there is, quantitatively and not qualitatively speaking, a progressive diminution of the information that is being transmitted between levels. The permanent network of inactive, interrelated nodes comprises long term store. Short term store, a labile state that is entrenched in long term store, consists of all currently active nodes. Thus, perceptual processing is confined to the activity occurring in short term store.

Two discrete modes of perceptual analysis or nodal activation, depending upon differential past experience, may occur: automatic or controlled processing. With extensive and consistent practice nodal connections become progressively strengthened so that upon the presentation of a stimulus configuration the activation of an invariable sequence of nodes automatically ensues. In contradistinction to such automatic processing, which is an immutable activity that is resistant to the organism's control and consequently difficult to censor or alter, controlled processing involves the active establishment and consolidation of nodal connections as deemed necessary for the effective execution of the perceptual cycle in novel or ambiguous situations.

Briefly stated, the perceptual cycle may be conceived of as an admixture of these two processes. That is, following the presentation of a stimulus configuration perceptual processing will entail automatic or controlled programming depending upon the nature of the stimulus (including its intensity and duration), its corresponding degree of nodal mapping or representation as determined by past experiences, and overriding directions such as instructional set.

It should be noted that nodal activation in and of itself does not insure conscious awareness. Conscious awareness is a by-product of selective attention. Selective attention may be captured via two alternate means: the inclusion of an attention demanding response in an automatic processing sequence; or the presence of a novel and ambiguous situation which requires controlled processing. Although those stimulus situations which require controlled processing typically enjoy selective attention, automatic sequences may interrupt ongoing controlled processing and momentarily capture attention.

According to Shiffrin and Schneider, then, selective attention is the allocation of a diffuse but limited mental resource which enables the controlled search and processing of the myriad of sensory elements represented in short term memory.

Neisser

Neisser (1967, 1976), similar to Hochberg, regards perception as a constructive process whereby sensory phenomena are actively interpreted in accordance with internal, idiosyncratic cognitive sets.[6] Diametrically opposed to the majority of other theorists presented herein, who imply that perception is externally delimited, though an internally directed process, Neisser and Hochberg propose that perception is internally delimited, but an externally directed activity. Whereas Hochberg, however, postulates that awareness is perception which has been modulated by attention, Neisser considers attention and perception as synonymous, and inseparable from awareness.

[6] Although Ulric Neisser initially proposed a model of perception/cognition in 1967, in so far as he revised his original ideas in 1976, only the latter formulations will be presented.

Neisser suggests that perceptual processing is comprised of two interdependent phases: a preattentive stage where a preliminary and superficial perusal of the stimulus field organizes sensory data; and a more focal stage of analysis which allows for perception and awareness via the superimposition of cognitive schemata upon the sensory field. Schemata through the generation of expectancies direct exploration of the sensory field. That is, in addition to preparing the organism to receive certain kinds of stimulation, schemata, more importantly, focus perceptual activity in a manner consistent with the organism's anticipations. For the most part, events which are not anticipated are not perceived. It should be noted that whatever is encoded reciprocally influences the generation of future expectancies. Thus, perception is an inherently selective, self-regulating process achieved by the implementation of schemata and the verification of expectancies.

According to Neisser, then, selective attention, which is tantamount to perception, refers to the organized and systematic acquisition and analysis of sensory information as determined by the cognitive strategies employed by the organism at any given moment.

Assimilation of Models

Having reviewed the formal models, it is readily apparent that, at the theoretical level, disagreement rather than concensus currently characterizes the selective attention field. This diversity is markedly reduced, however when one classifies these models on various dimensions as depicted in Table 1.

TABLE 1.

Models of Selective Attention

Capacity of Attentional Operations	Locus of Attentional Operations	
	Early	Late
Structural	Broadbent (1958) Treisman (1969, 1982) Broadbent (1971)	Deutsch and Deutsch (1963) Norman (1968) Keele (1973)
Functional	Moray and Fitter (1973) Kahneman (1973) Neisser (1976)	Hochberg (1970) LaBerge (1975) Shiffrin and Schneider (1977)

To the extent that it has generally dominated empirical investigations, perhaps the most salient theoretical issue to have emerged involves the exact locus of selective attention. "Early" theorists subscribe to the notion that selective processes, for example, filtering (Broadbent, 1958), attenuation (Treisman, 1964c; Broadbent, 1971), or effort (Kahneman, 1973) operate during initial phases of perceptual processing, and consequently not all sensory data attain comparable levels of analysis. "Late" theorists, on the other hand, assume that no discriminatory functions precede recognition, and therefore assert that the probability of any stimulus input being eventually selected for awareness is not in any way altered prior to perceptual analysis.

Each of these positions generate their respective corollaries concerning the nature of perceptual processing and selection criteria. That is, the "early" theorists favour the assumption of serial or sequential processing of information, emphasize the efficacy of selecting on the basis of elementary criteria (physical features), and for the most part depict dual sites for selective processes. In contradistinction, "late" theorists advocate parallel processing of coexisting sensory information, regard the nature of selection criteria (physical features or semantic properties) as immaterial, and typically confine selection operations to a single locale: logogens (Keele, 1973), recognition units (Deutsch & Deutsch, 1963), and nodes (Shiffrin & Schneider, 1977).

Another distinction, albeit one that is addressed less frequently in the literature, is one which relates to the nature of attentional limitations. That is, the models of selective attention may be further dichotomized depending upon the extent to which they ascribe processing limitations to structural or functional determinants. "Structuralists" maintain that capacity limitations are due to hypothetical "bottlenecks" such as dictionary units (Treisman, 1969), a filter (Broadbent, 1958), and short term memory units (Norman, 1968), which preclude the simultaneous passage of multiple sources of information. Consistent with this view, moreover, they regard selective attention as a static process which cannot be appreciably altered so as to facilitate perceptual processing, fixed, in that it is relatively impervious to practice and skill, passive, in that it cannot be directly manipulated or distributed, and generally indivisible in that it cannot be shared among the perceptual analysis of two or more concurrent inputs. "Functionalists," on the other hand, attribute capacity limitations to the fact that processing demands exceed the available resources. As such, they contend that attention may be actively deployed, for example, via the implementation of strategies (Moray, 1975), expectancies (Hochberg, 1970), and allocation policy (Kahneman, 1973) as deemed necessary for optimal processing during moments of variable demands.

In summary, then, qualitative differences in theoretical conceptualizations that challenge the unitary status of attention are evident (Table 2). "Structuralists" suggest that attention, as a spontaneous occurrence, is a by-product or inevitable consequence of the perceptual act. "Functionalists," on the other hand, imply that attention, as a process which subserves perception, selectively enhances

TABLE 2

Features Distinguishing the Models of Selective Attention

Capacity of Attentional Operations	Locus of Attentional Operations: Early	Locus of Attentional Operations: Late
Structural	. Competing sensory inputs are processed serially	. Concurrent sensory events are processed independently and in parallel
	. Selective attention is a passive process that filters or attenuates the signal strength of irrelevant stimuli	. Selective attention is a passive process in that the one stimululus event whose memory correlate fires with the greatest intensity is automatically selected
	. Competing sensory inputs are differentially processed prior to activating their respective memory analogues, and memory for nonattended items is confined to echoic/iconic store	. All sensory phenomena receive a comparable degree of feature and semantic analysis; that is, all stimulus inputs unmitigatedly complete their respective perceptual course, including representation in short term memory
	. Perception, including entry into conscious awareness, is a passive process that is determined by the degree to which competing sensory inputs activate their respective memory correlates	. Perception, including entry into conscious awareness, is a passive process that is determined by the degree to which competing sensory inputs activate their respective memory correlates

Continued .....

TABLE 2 CONTINUED

Features Distinguishing the Models of Selective Attention

Capacity of Attentional Operations	Locus of Attentional Operations Early	 Late
Functional	. Sensory phenomena are differentially processed in accordance with attentional demands; that is, the degree of perceptual processing attained by a sensory event is a function of the ratio between the attentional capacity required to effectively analyze the stimulus input and the actual attentional capacity allocated to such operations	. Concurrent sensory events are processed independently and in parallel; whereas controlled processing requires attentional capacity, with repeated and consistent patterning the perceptual/cognitive processing of stimulus events may attain a level of automaticity
	. The allocation of attentional capacity is a function of the immediate stimulus conditions and the currently operative cognitive schema	. The allocation of attentional capacity is a function of the immediate stimulus conditions and the organism's past perceptual/cognitive experiences
	. Selective attention is an active process that enhances the analysis of relevant sensory inputs throughout the perceptual cycle	. Selective attention is an active process that enhances the analysis of relevant sensory inputs at the memory level

Continued .....

TABLE 2 CONTINUED

Features Distinguishing the Models of Selective Attention

Capacity of Attentional Operations	Locus of Attentional Operations: Early	Locus of Attentional Operations: Late
	. Perception is an active process; that is, rather than reflect compromise behaviour that is instigated as a means of attaining cognitive equilibrium among competitive sensory events, perceptual experiences involve the strategic sampling of sensory sources and as such are purposeful, goal-directed activities	. Perception is an active process; that is, rather than reflect compromise behaviour that is instigated as a means of attaining cognitive equilibrium among competitive sensory events, perceptual experiences involve the strategic sampling of sensory sources and as such are purposeful, goal-directed activities

various components of the perceptual act. Superimposed on these diverse theoretical perspectives, the issue concerning the exact focus of attentional activities places the premise that attention is a unitary process in further dispute. On the one hand, attention has been envisaged as a process which arises early in the perceptual cycle, and as such, permits or enhances stimulus information acquisition. Contrarily, attention has also been envisioned as a process occurring after perceptual analysis, and as such, invokes or promotes memory functions as storage, retrieval, organization, and/or consolidation so as to insure that the perceptual cycle is completed.

Empirical Investigations

The skepticism concerning the unitary nature of attention which has been raised at the theoretical level is augmented at the empirical level. That is, although the selective attention field is a prolific area of inquiry, the numerous studies that have been conducted to date have not been instrumental in resolving theoretical controversies. A comprehensive synthesis of the research findings is difficult, if not precluded, by the fact that diverse paradigms have been employed to define and measure attention. Two general observations that do emerge, however, include a) that all the models which have been proposed have received varying amounts of empirical substantiation; and b) more often than not, divergent theoretical positions have been supported by data gathered via differing experimental paradigms. Thus, in light of the fact that methodological differences mirror theoretical controversies, there, correspondingly, appears empirical justification for questioning the assumption that attention is a single, nonvarying process. It is the purpose of the following review to explicitly confirm these speculations. Towards this end, attention will be operationally defined; a review highlighting the diverse methodologies that have been employed to study attention will be presented; and finally an attempt will be made to identify the particular experimental paradigms that have lent support to the various theoretical positions.

Operational Definitions of Attention

In addressing the previously mentioned phenomena, that is, an organism's ability to effectively process a limited aspect of the stimulus field and general inability to process competing inputs simultaneously, selective attention has been operationally defined within the psychological investigative realm as performance on either a focused or divided attention task.[7]

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[7]It should be noted that alternate, perhaps more elaborate, classification schemes of attentional tasks have been proposed within these general designs. Broadbent (1970, 1971), for example, has distinguished between selective decisions made on the basis of a "stimulus set" or a "response set." In the former condition, selection is determined by physical, alterable characteristics of the stimulus as location, size, colour, etc., whereas in the latter, selection relies upon the cognitive categorization of the stimuli, as digits, words, digits or words of a particular class, etc. Treisman (1969) has proposed a four-fold classification schema; selection of inputs, targets, attributes, and outputs. Norman and Bobrow (1975) have discussed the need to differentiate between "data-limited" and/or "resource-limited" tasks. Egeth (1967) identifies four experimental tasks, recognition of tachistoscopically presented materials, listening to one of several simultaneous messages, speeded classification of multidimensional objects, and searching through complex visual displays. Similarly, Moray (1969ab), Posner and Boies (1971), and Keele (1973) have made distinctions between various types of experimental tasks.

Focused attention tasks, involving the presentation of multiple sources of information, require that the organism selectively process one source in the stimulus field while resisting interference, influence, or distraction from simultaneously competing inputs. Performance on a focused attention task may be measured according to two separate but not unrelated criteria: a) the extent to which relevant messages are effectively processed and b) irrelevant messages effectively rejected.

In the auditory mode a focused attention task typically involves presenting the subject with two or more inputs, instructing him or her to restrict processing to one message, and measuring the change in performance resulting from varying multiple parameters of the relevant and irrelevant material. The visual analogue most often involves the presentation of complex tachistoscopic displays where the relevant items are designated by the presentation of either visual or auditory cues arriving prior to or concurrent with the stimulus array. In a manner similar to that of the auditory mode, focused attention is measured by determining the influence of nonrelevant information. Neisser has been most influential in developing two alternative paradigms of focused attention in vision: selective reading (1969) and selective looking (1975). The former situation involves having subjects engage in ordinary reading tasks in which the relevant text is interspersed with or surrounded by intrusions of irrelevant material. Selective looking measures the organism's ability to process one of two competing, optically superimposed images.

The opposite of a focused attention task, whereby attention is assessed by measuring an organism's processing of the information arriving on a predetermined channel, is the divided attention task, whereby attention is assessed by measuring an organism's ability to detect a predetermined target or signal arriving on numerous channels. In a divided attention task, then, the organism is confronted with numerous sources of information, all of which may potentially contain the relevant target(s). Attention is measured in terms of the performance decrements that are evidenced as the number of channels is increased.

In an auditory divided attention task the subject is instructed to respond in some prescribed manner whenever he detects a critical signal. The visual correlate, search and detection tasks, typically employ the presentation of a large array of stimuli with the number and reaction times of correct detections primarily serving as dependent measures. "Split-span" and "whole report," popular variants of a divided attention task in the auditory and visual modalities respectively, utilize the recall of simultaneously presented items as dependent measures.

Dependent and Independent Variables

In employing these basic paradigms, experimenters have also explored the effect of numerous variables, both dependent and independent. Among these have been: stimulus complexity, task demands, and subject variables. Finally the interpretation of the findings has been complicated by the use of different types of response measures.

Stimulus Complexity

Stimulus complexity has been manipulated by altering the method of presentation. That is, competing auditory messages were presented either monaurally (one ear), binaurally (both ears), dichotically (separate to each ear), or stereophonically. The visual correlates of these stimulus presentation modes include monoptic (one eye), binocular (both eyes), dioptic (separate to each eye), and stereoscopic (Norman, 1976).

Stimulus complexity has also been manipulated by varying the type and degree of semantic relatedness of the material. Some of the more commonly used auditory stimuli have included prose passages (Govier & Pitts, 1982; Lawson, 1966; Rinder, 1974; Wilding, 1970), unrelated strings of words (Hede, 1981; Holloway, 1972; Kahneman, 1975; Smith & Burrow, 1971), associated words (Bloomfield, 1972; Lewis, 1970; Treisman, Squire & Green, 1974), statistical approximations to English (Sullivan, 1976), random letters (Mewhort, Thio & Birkenmayer, 1971; Moray & O'Brien, 1967; Underwood, 1972), random digits (Bryden, 1971; Morton & Chamber, 1975; Zelnicker, 1971), and pure tones (Moore & Massaro, 1973; Moray, Fitter, Ostry, Favreau & Nagy, 1976; Zelnicker, Rattok & Medem, 1974). In the visual mode, lights (Tulving & Lindsay, 1967), letters (Butler, 1980; Eriksen & Collegate, 1971; Treisman, 1982), digits (Butler, 1974; Dixon, 1981), dots (Shiffrin, McKay & Shaffer, 1976), words (Rollins & Thibadeau, 1973), patches of colour (Hall & Swane, 1973), curved lines (Humphreys, 1981), geometric as well as nonsense shapes (Kahneman, Treisman & Burkell, 1983; Rock & Gutman, 1981), and prose passages (Willow & Mackinnon, 1973) have been commonly used.

In addition, researchers have also altered the rate of stimulus presentation (Lawrence, 1971; Treisman, 1971; Greenwald, 1973), redundancy (Estes, 1972), the number of irrelevant messages (Treisman, 1964c), as well as the spatial and temporal arrangement of stimuli (Skelton & Eriksen, 1976),[8] and the saliency (Moray, 1959; VonWright, Anderson & Stenman, 1975) and the intensity (Holloway, 1971) of the stimulus.

Task Demands

In terms of task demands, diversity has been produced by varying the level of discrimination and/or decision-making which the subject must employ for successful task-performance. Since the type of discrimination demanded from the subject covaries directly with the complexity of both the relevant and irrelevant stimuli, decision-making has spanned everything from such elementary operations as detecting the presence or absence of an illuminated dot in a prespecified position (Shiffrin, McKay & Shaffer, 1976) to more complex interpretations of semantically and syntactically ambiguous sentences (MacKay, 1973).

Furthermore, it has generally been recognized that such procedural techniques as shadowing and monitoring place differential demands upon the subject (Kahneman, 1973). In the former, the subject is required to repeat, in either verbal or written fashion, one of the

[8] Moray (Moray & O'Brien, 1967; Moray, 1969b, 1970; Moray, Fitter, Ostry et al., 1976) has highlighted the need to recognize the differential performance on divided auditory attention tasks that results from the simultaneous as opposed to the alternating presentation of relevant targets.

messages; whereas in the latter, the subject is merely instructed to attend to stimulus inputs.

Subject Related Variables

With respect to this category the following variables have been manipulated: practice (Moray, 1975; Shiffrin & Schneider, 1977); the type and amount of incentives, that is, the presence or absence of monetary rewards (LaBerge, Tweedy & Ricker, 1967); the level of skill, that is, adeptness at piano playing (Allport, Antonis & Reynolds, 1972) and typing visually as well as auditorily presented information (Shaffer, 1975); and the type of encoding strategies or instructional sets, that is, expectancies concerning the channel of arrival (shadowed or nonshadowed) of the relevant information (Shinar & Jones, 1973; Lyons, 1974) or the bases for discerning the relevant attributes of a complex visual display (Harris & Haber, 1963; Haber, 1964).

Responses Measured

Variations in the types of data collected have also contributed to the difficulty in integrating the various findings. Attentional studies, for example, have utilized such dependent measures as reaction times (Eriksen & Hoffman, 1972a, 1973), galvanic skin responses (Corteen & Dunn, 1974; VonWright, Anderson & Stenman, 1975), number of correct detections (Treisman & Geffen, 1967; Underwood & Moray, 1971), errors of omission and commission (Ostry, Moray & Marks, 1976), recall or recognition of relevant or irrelevant items (Bryden, 1971; Kahneman, 1975), and time delays and intrusions in shadowing

(Lewis, 1970; Sullivan, 1976; Treisman & Riley, 1969).

Assimilation of Empirical Findings

A summary of the relevant studies is presented in Tables A through F (Appendix A). These tables also give a graphic indication of the scope of methodological differences that complicate the interpretation of the findings as well as the lack of consistency in the findings themselves. The studies are classified and discussed according to task (focused or divided) and modality (visual, auditory, or cross modal). Since audition and vision reflect processing within the temporal and spatial fields respectively, they may involve different attentional operations.

Locus of Attentional Operations

In so far as the "early" theorists posit the existence of a filtering mechanism during the initial phases of the perceptual act, they predict minimal interference with the attended message on a focused attention task as evidenced by minimal perceptual processing of irrelevant data. Since the "late" theorists, on the other hand, posit that all stimuli achieve comparable levels of perceptual analysis, they predict greater influence from irrelevant stimuli. Moreover, the interference should increase in direct proportion to the similarity between the relevant and irrelevant stimuli (Table 2).[9]

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[9] Although obvious differences among theoretical perspectives exist, as was previously discussed, to the extent that the formulations of the various models have not been elaborated with any great precision, it is difficult to ascertain what these models would specifically predict on any given attentional task other than in a very global fashion. For this reason exceptions to the predictions as stated herein are to be expected. Overall, this situation is perhaps best exemplified by the fact that <u>a posteriori</u> explanations are more prevalent than <u>a priori</u> predictions.

As Figure 1 illustrates, studies employing a focused attention paradigm have most often generated results favouring the assumptions of the "early" theorists. That is, a large number of focused attention studies (approximately 51%) have reported considerable differences in the perceptual processing of relevant and irrelevant stimuli. Although not to the same degree, a substantial number of studies (approximately 30%) have demonstrated no significant differences between the perceptual processing of relevant and irrelevant stimuli. By so doing these studies have demonstrated that perceptual analysis is an automatic and irrepressible operation, and therefore, favour the propositions of the "late" theorists. Furthermore, approximately 19% of the focused attention studies that have been conducted have generated findings that may be regarded as equivocal in that they either support both positions, support neither position, or in a very few cases, refute one position without necessarily supporting the other. As will become apparent, the observation that a high percentage of studies report results which may be classified as equivocal is characteristic of the findings within this field.

In divided attention tasks, "early" theorists predict only partial success as measured by correct detections of relevant signals, since the initial selection mechanism allows for only the sequential processing of inputs. In contradistinction, "late" theorists predict detection of all relevant signals due to the complete and parallel processing of all incoming stimuli.

As a visual inspection of Figure 1 reveals, the results obtained from studies employing a divided attention paradigm reflect the findings

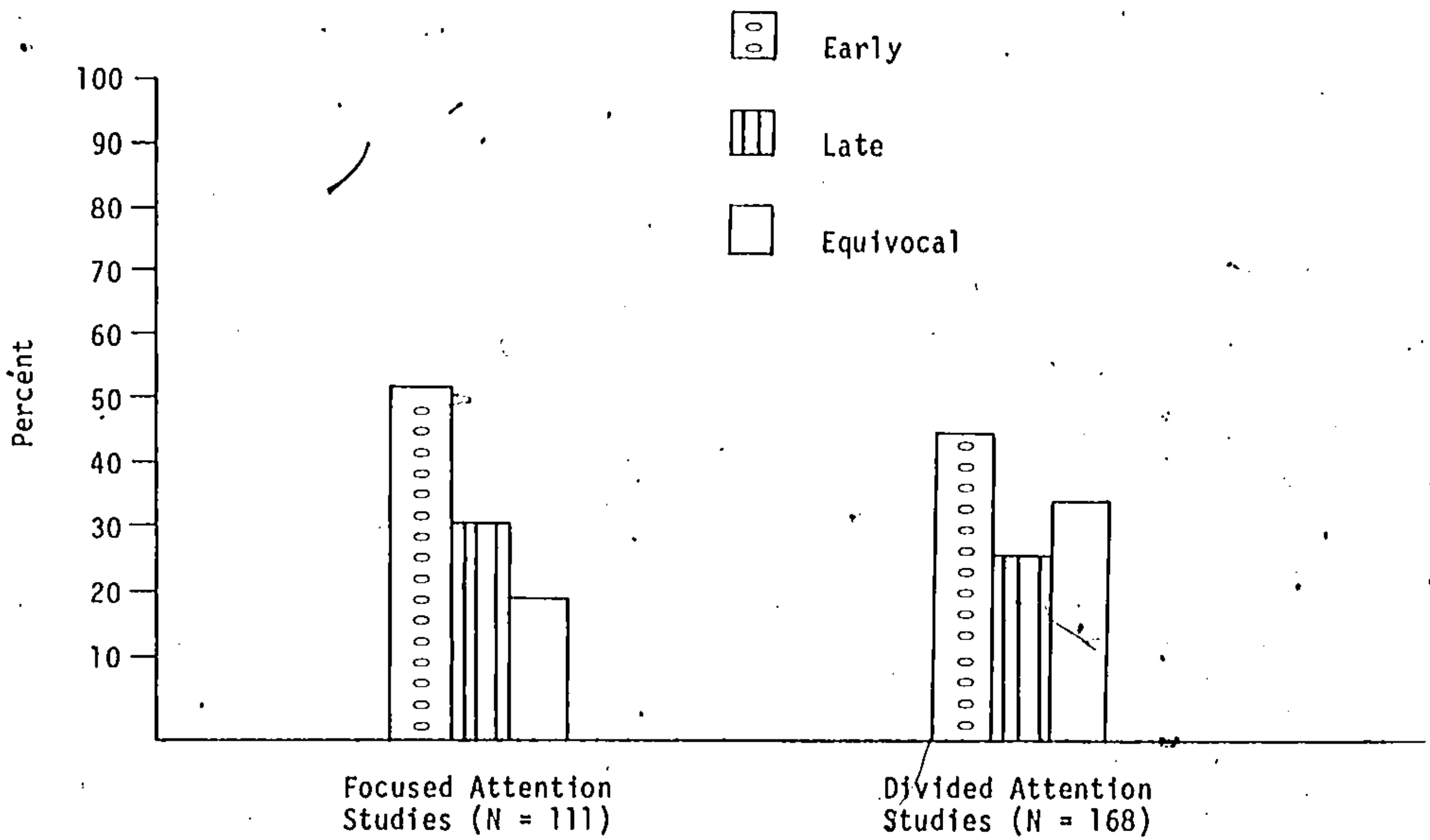

Figure 1. Percentage of focused and divided attention studies supporting "early" and "late" models of attention. (N = the number of studies)

generated by studies employing a focused attention paradigm. That is, although the majority of studies (approximately 44%) report findings in favour of the "early" position, a considerable number of studies (approximately 24%) report data that is consistent with the assumptions of the "late" theorists. Once again, a large number, 32% report equivocal results.

Figure 2 depicts the percentage of auditory, visual, and cross modal studies that have generated support for each of these positions. As can be seen, studies conducted within the auditory mode generate findings decidely favouring the "early" position. The assumptions of the "late" theorists appear to obtain more empirical substantiation from the studies conducted within the visual modality. Specifically, a higher percentage of the visual as opposed to the auditory studies report data consistent with their formulations (36% and 14% respectively). Furthermore, the results appear less ambiguous as reflected by the substantially lower percentage of visual studies that generate equivocal findings. In general cross modal studies, in which stimulus competition is due to the simultaneous arrival of sensory inputs in the auditory and visual modalities, have generated equivocal results.

Capacity of Attentional Operations

In so far as the "structural" theorists regard attention as a passive process which serves to filter or attenuate irrelevant messages, they predict that performance on a focused attention task is determined primarily by the nature of the stimulus situation. Only to the extent that irrelevant stimuli need to be processed for purpose of exclusion will such competing information interfere with the processing

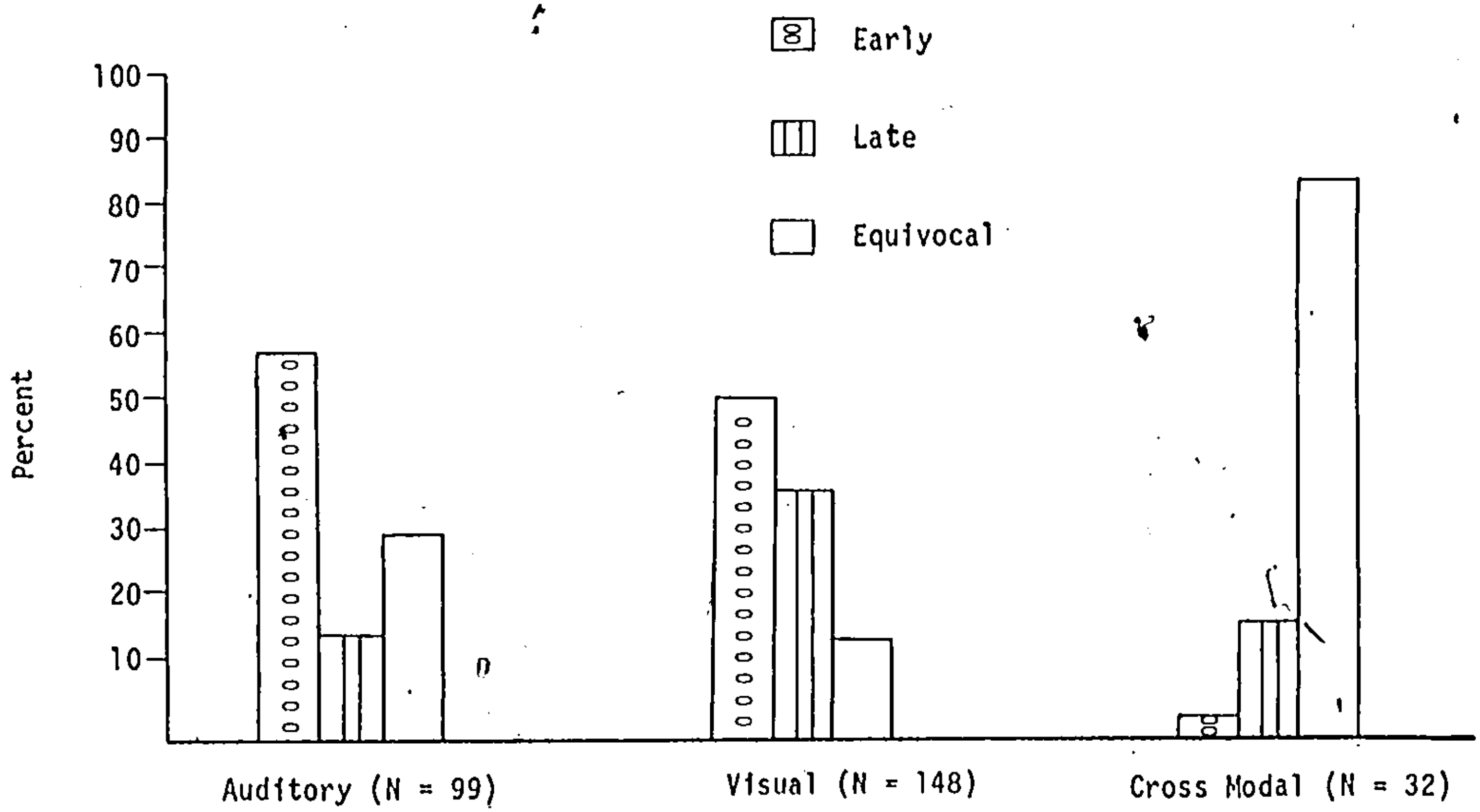

Figure 2. Percentage of auditory, visual, and cross modal studies supporting "early" and "late" models of attention.

of relevant information. Specifically, the interference and intrusions which are evidenced should be inversely related with the degree to which relevant and irrelevant stimuli are perceptually distinguishable (Table 2).

The "functional" theorists postulate that attention, as an active process which serves to enhance those aspects of the stimulus field that are deemed salient by currently operative cognitive strategies, promotes the perceptual processing of relevant information only. For this reason they predict only minimal, if any, intrusions on focused attention tasks from the irrelevant message, regardless of the nature of the stimuli (Table 2).

As Figure 3 illustrates, the results generated from studies relying upon a focused attention paradigm have tended to marginally favour the "structuralist" position.

Since the "structural" theorists regard attention as a unidirectional and invariable process that results from the simultaneous convergence of multiple inputs upon a limited perceptual/cognitive mechanism, they predict successful performance on divided attention tasks only to the extent that the processing demands of concurrent stimuli do not require the simultaneous operation of the same analyzing structure. Furthermore, since they regard attention as a fixed and static process, the "structural" theorists postulate that performance on divided attention tasks should not be appreciably altered by practice, skill, incentives, or cognitive strategies.

Since the "functional" theorists contend that attention is actively deployed in a manner that reflects cognitive strategies, they

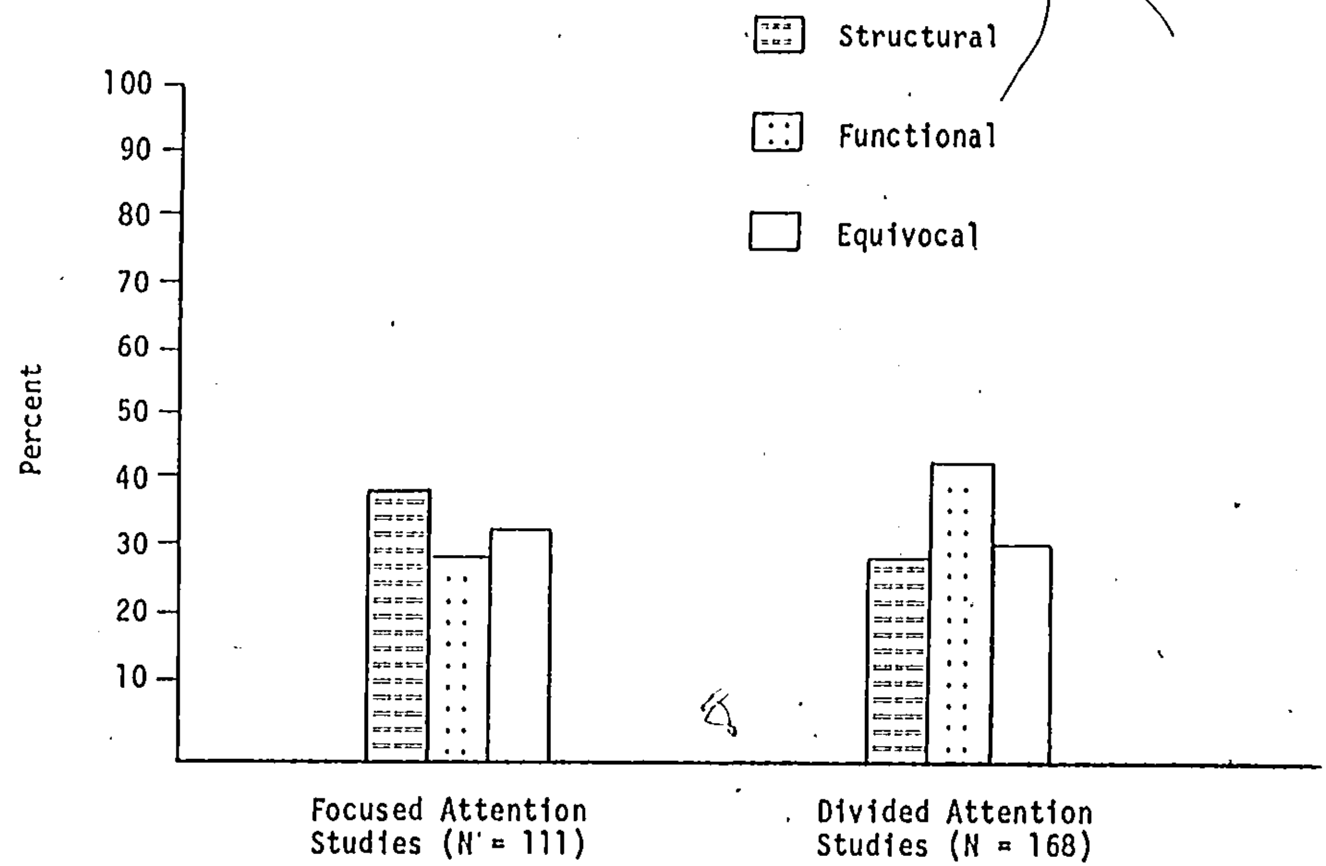

Figure 3. Percentage of focused and divided attention studies supporting "structural" and "functional" models of attention.

postulate that the ability to process concurrent sensory inputs or simultaneously engage in competing perceptual/cognitive activities, such as those required on divided attention tasks, is a function of the cumulative attentional capacity demanded by the total number of diverse operations. For example, perceptually elementary tasks may be successfully performed in unison, whereas the simultaneous execution of perceptually more complex tasks should result in performance decrements due to mutual task demands exceeding the limited attentional capacity. Furthermore, "functional" theorists maintain that cognitive strategies, practice, incentives, and instructional sets may alter the distribution of attention so as to increase target detections on divided attention tasks.

Contrary to the focused attention investigations, studies relying upon divided attention paradigms have tended to favour (41% to 29%) the notions advanced by the "functional" theorists (Figure 3).

Figure 4 depicts the percentage of auditory, visual, and cross modal studies that have generated support for each of these positions. Perhaps the most significant observation is that an equal number of studies in the auditory as well as the visual mode have supported the "structural" and "functional" positions respectively. Although cross modal investigations appear to support the "functional" position, once again, considering the large number (53%) of studies that have reported equivocal findings, the significance of this latter observation is questionable.

The relationship between a particular type of attentional task and the empirical support that it has generated concerning the locus and

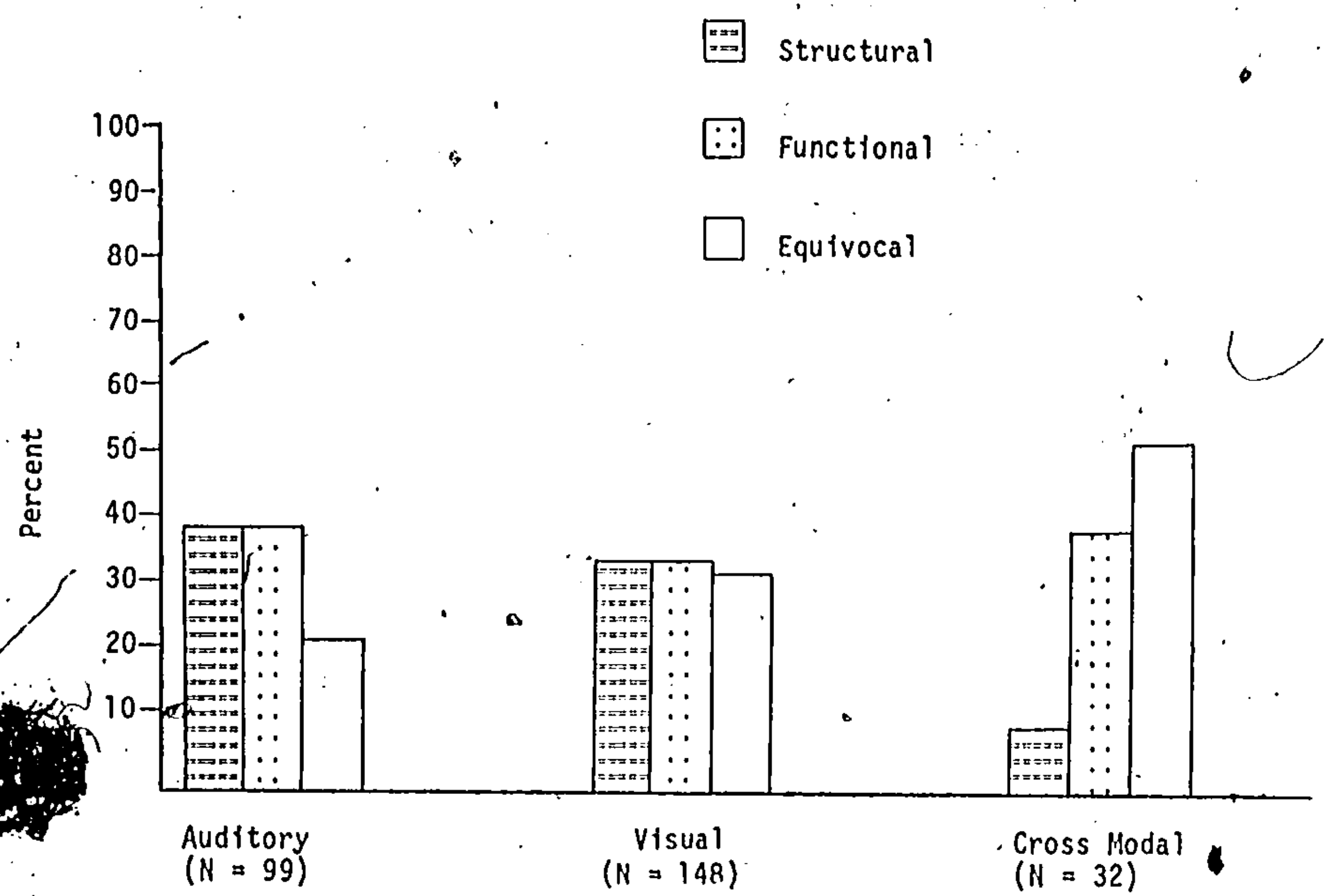

Figure 4. Percentage of auditory, visual, and cross modal studies supporting "structural" and "functional" models of attention.

the capacity of attentional operations is placed in proper perspective by combining the data presented in Figures 1 through 4. Specifically, Figures 5 and 6 depict the percentage of studies, in terms of task and modality, which have generated empirical support for each of the contrasting positions on the early-late and structural-functional dimensions respectively.

Perhaps most apparent from an inspection of Figure 5 is that the formulations of the "early" theorists have been supported by studies employing diverse paradigms whereas assumptions of the "late" theorists have most often been supported by studies conducted within the visual modality. Figure 6 indicates that auditory studies which involve focused attention tasks most often support the position of the "structural" theorists. Those employing divided attention paradigms, however, favour the position of the "functional" theorists.

Figures 5 and 6 also suggest that the utility of employing cross modal investigations, either focused or divided attention paradigms, as a means of elucidating the locus and/or capacity of attentional operations may be questioned in light of the disproportionate percentage of studies reporting equivocal findings as compared with the percentage of studies reporting equivocal findings based upon similar paradigms within the auditory and visual modalities. Whereas 83% of the focused attention and 81% of the divided attention cross modal studies have reported equivocal findings concerning the early-late dimension, the corresponding percentages for these paradigms are 22% and 34% in the auditory mode, and 12% and 15% in the visual mode. In regard to the structural-functional dimension, 83% of the

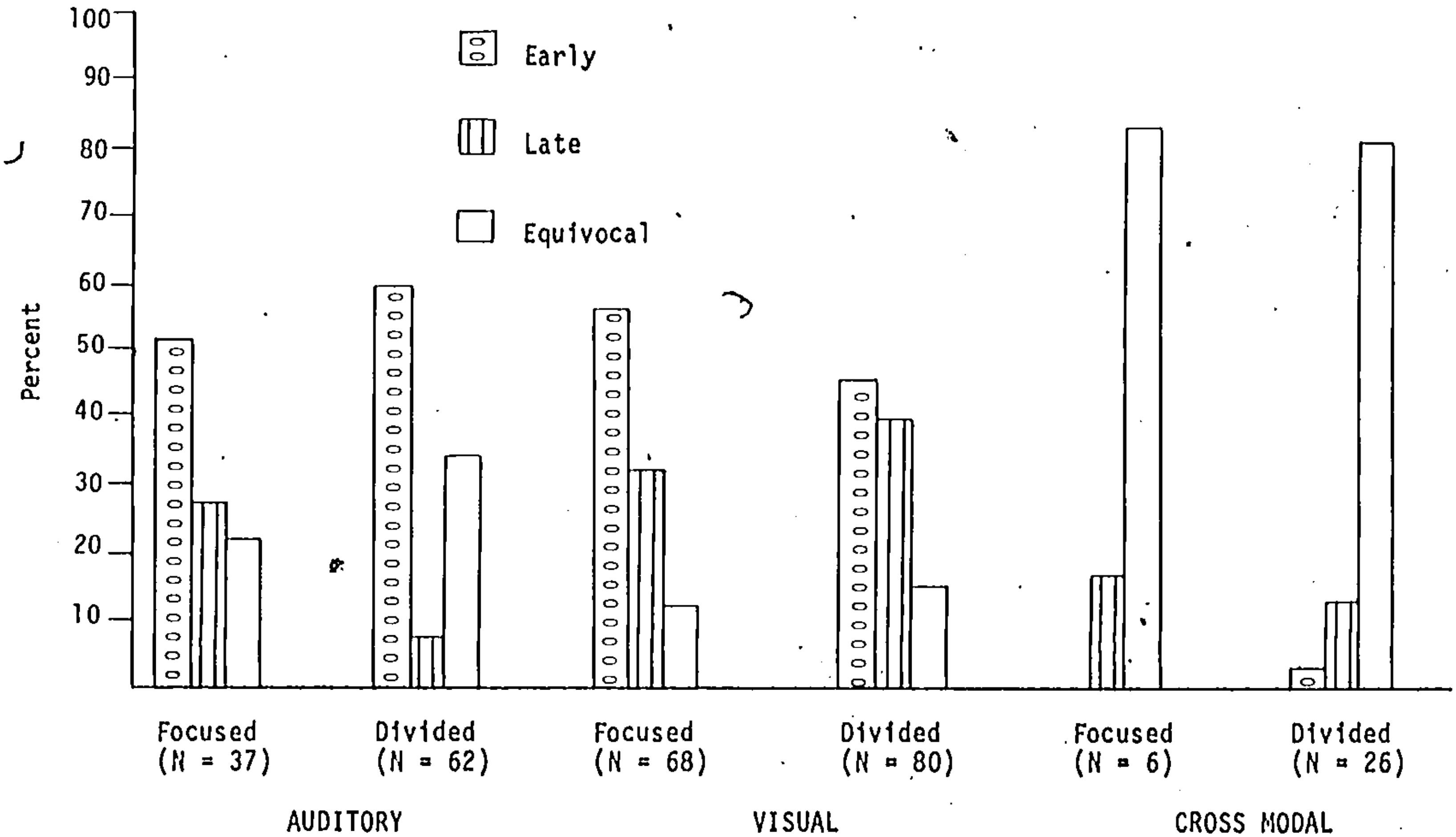

Figure 5. Percentage of studies supporting "early" and "late" models of attention according to task and modality.

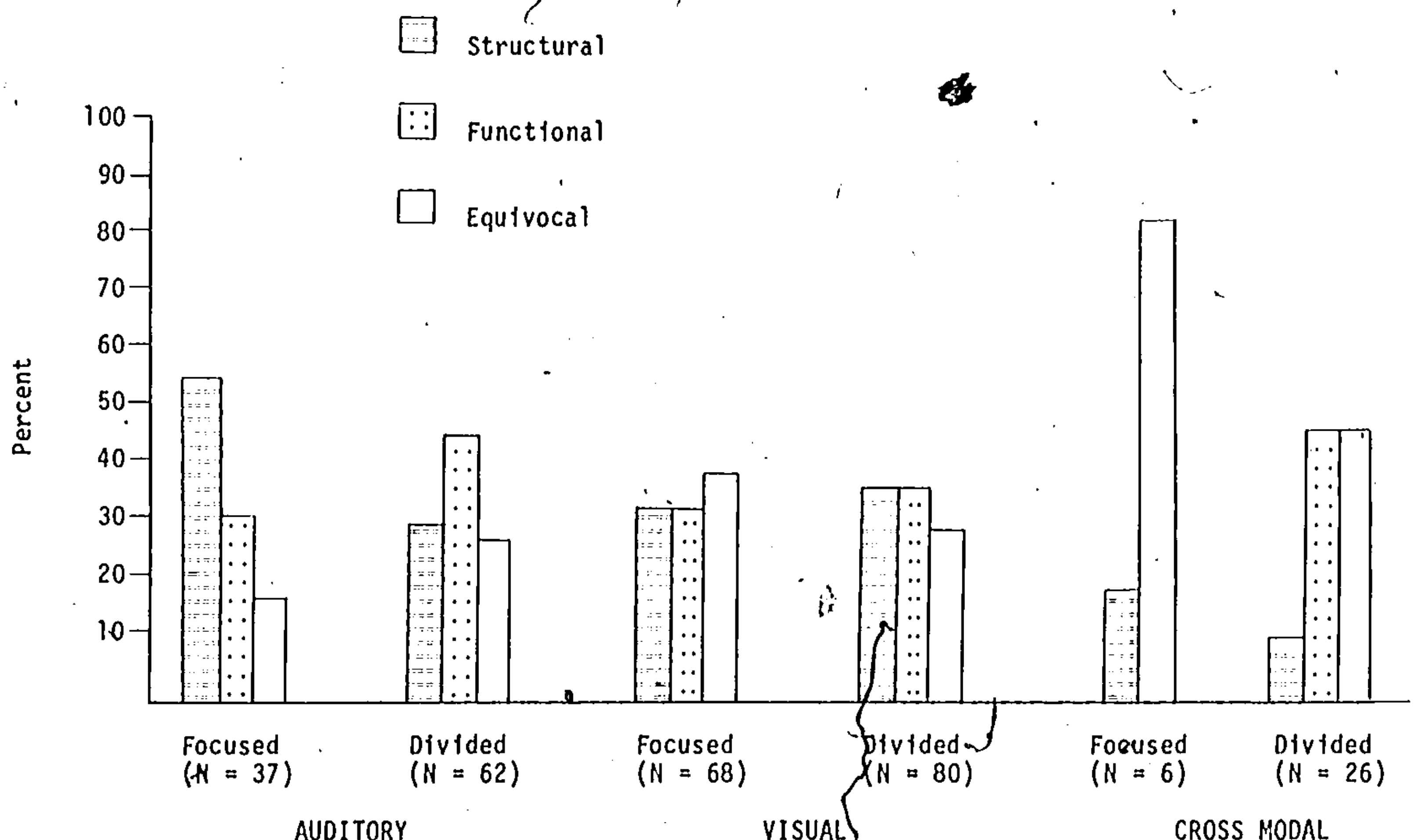

Figure 6. Percentage of studies supporting "structural" and "functional" models of attention according to task and modality.

focused attention and 46% of the divided attention cross modal studies have reported equivocal results. The corresponding percentages for these paradigms are 16% and 26% for the auditory mode, and 38% and 28% for the visual mode. A cautious interpretation of these comparisons is suggested, however, by the relatively small number of cross modal investigations that have been conducted. In summary, Figure 7 illustrates the percentage of studies that have supported each of the four major models of attention. A visual inspection reveals that the "early-structural" position has generally been supported by studies conducted within the auditory modality, employing either a focused or a divided attention paradigm. The "late-structural" position appears to obtain empirical substantiation from focused attention studies conducted with the visual as well as the auditory mode. The "early-functional" position has generally been supported by auditory studies employing divided attention tasks whereas the "late-functional" position has been primarily supported by visual tasks employing divided attention paradigms.

Purpose of the Present Investigation

The controversial status of models of selective attention provided a major impetus for the present investigation. That is, in light of the complexity of the situation at both the theoretical and empirical levels, the present study proposed to examined the fundamental premise that attention is a simple, unitary process.

A brief recapitulation of the principal ideas about the attention process is in order. As Table 1 indicates, the models of attention may

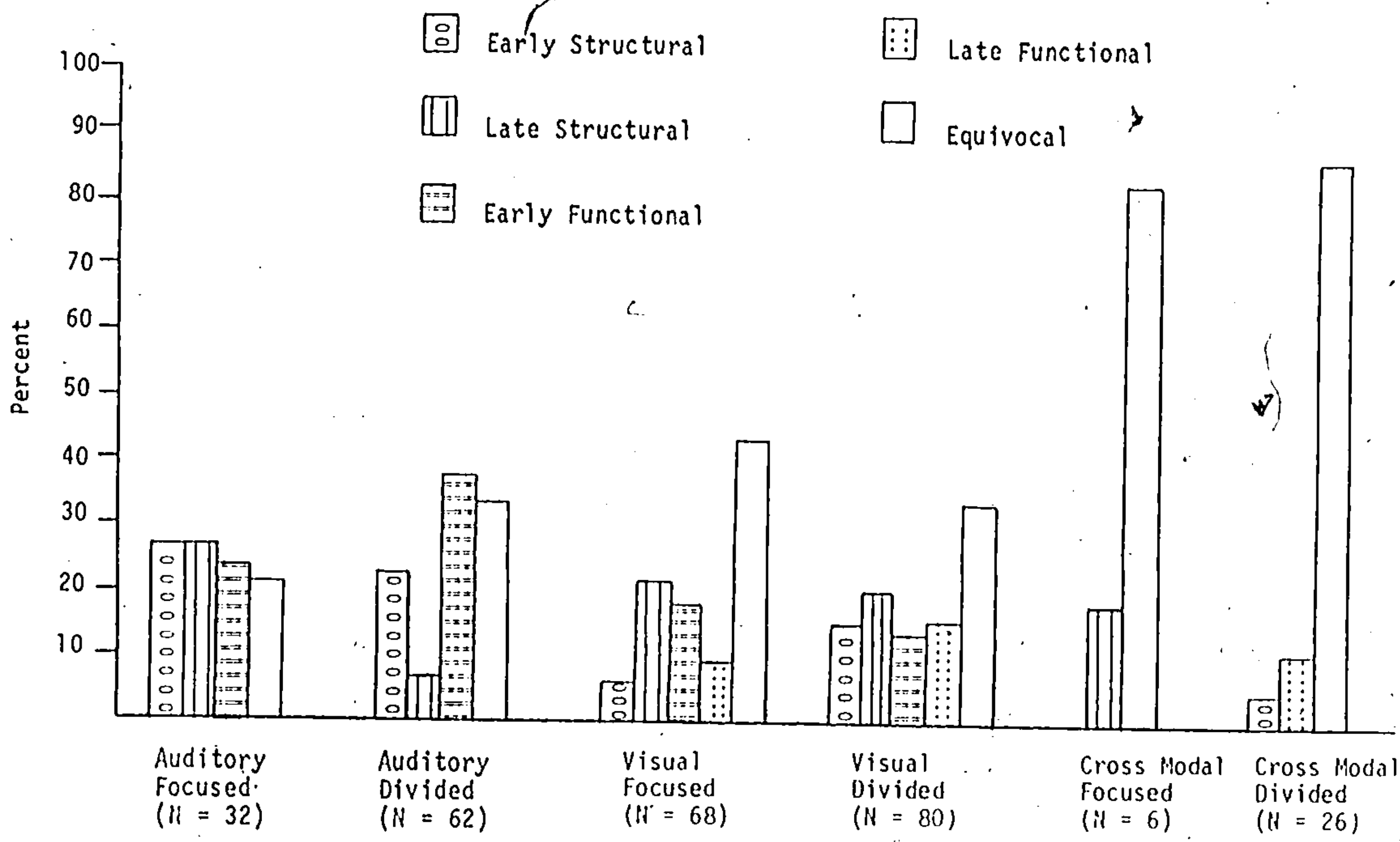

Figure 7. Percentage of studies supporting each of the four major models of attention according to task and modality.

be differentiated in terms of two continua: a) variability in attentional locus; and b) flexibility of attentional capacity. In regard to the former issue, this study addressed the following questions: Is attention, as a selective process, confined to discrete stages (either "early" or "late") in the perceptual cycle, or is attention pervasive throughout the perceptual/cognitive continuum exerting its selective influence at multiple loci? In regard to the latter issue, the question remains: Is attention a fixed, static, and passive process as "structural" theorists maintain, or is attention actively deployed in accordance with functional demands so as to insure the most efficient operation of the perceptual system?

Briefly stated, these questions were addressed by having subjects perform a series of attentional tasks which have tended to support divergent theoretical positions. The data thus obtained was subsequently submitted to a principal components analysis.

Tasks

The tasks were primarily selected so as to insure a representative sample of the currently popular methods of assessing the attentional process. As a second criterion for inclusion in the study, only those tasks which have yielded the most consistent results in favour of one of each of the four major theoretical positions were employed. In summary, the task selection process was based upon a synthesis of the previous research such as the observations that are graphically depicted in Figure 7 and summarized in more detail in Appendix A.

Considering the above criteria and in light of the observations that were previously noted (Figures 5-7), this study employed a variety of focused and divided attention tasks within the auditory as well as the visual modality. Based upon the second criterion, cross modal tasks were excluded from the present investigation.

So as to insure adequate representation of each one of the diverse theoretical positions, eight attentional tasks were administered. That is, for each one of the four major theoretical positions, two experimental paradigms which have generated empirical support for the respective theoretical formulations were employed.

Specifically, the "early-structural" position was assessed by the employment of one auditory divided and one auditory focused attention task; the "late-structural" by one visual focused/divided and one auditory focused/divided; the "early-functional" by two auditory divided; and the "late-functional" by two visual divided attention tasks.

Early-Structural

Task 1: Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Subjects were required to shadow one of two dichotic prose passages and tap whenever they detected a target word in either the primary message (shadowed) or the secondary message (nonshadowed). Two types of target words, distinguishing two experimental conditions were employed: a) in the phonetic condition, target items were capable of being identified on the basis of their physical characteristics; and b) in the semantic condition, target items were capable of being identified on the basis of their semantic properties. The number of targets correctly detected and the number of words correctly shadowed served as the dependent measures.

In accordance with the formulations of the "early-structural" theorists, the following predictions were advanced:

1) the number of targets detected on the shadowed channel would be significantly greater than the number of targets detected on the nonshadowed channel.

Whenever sensory inputs converge upon the same analyzer(s), only one stimulus event may be selected, and consequently be the recipient of attentional activity. In the present task, the experimental instructions insured that the shadowed message was selected. Since attention is a prerequisite for in-depth perceptual processing, only those items arriving on the shadowed channel would be processed to the point of semantic recognition.

2) On the shadowed channel, all target items, regardless of the level of perceptual analysis that was required for their identification, would be detected. On the nonshadowed channel, however, target items which were capable of being identified on the basis of elementary perceptual operations (phonetic analysis) would be detected with a higher frequency than target items which were capable of being identified only on the basis of complex perceptual operations (semantic analysis).

The initial selective operation, attenuation (Broadbent, 1971; Treisman, 1964c) or filtering (Broadbent, 1958) depends upon an analysis of the general physical characteristics of all incoming messages. Since the information resulting from this analysis is available to the subject at the level of conscious awareness, target items, including those on the nonshadowed channel, which were capable of being identified on the basis of their phonetic features would be detected.

3) In the semantic condition, tapping to target items arriving on the nonshadowed channel would interfere with shadowing performance to a significantly greater degree than tapping to target items arriving on the shadowed channel.

Tapping to target items arriving on the nonshadowed channel required semantic analysis and recognition of the stimulus item, and therefore attention. In accordance with "structural" theory that attentional capacity is generally indivisible, such processing of nonshadowed target items necessitated momentary shifts in attention which would be evidenced as decrements in shadowing performance.

Quite different predictions can be derived from the formulations of the "late" theorists. Since the "late" theorists postulate that perceptual processing, including semantic analysis, is an automatic activity that occurs without the intervention of attentional operations, they would predict: 1) complete detection of the target items arriving on the shadowed and nonshadowed channels; 2) complete detection of the phonetic and semantic target items arriving on the nonshadowed channel; and 3) comparable shadowing decrements accompanying semantic and phonetic target detections on the shadowed as well as the nonshadowed channel. This latter prediction is advanced in light of the "late" theorists' proposition that whereas perceptual processing occurs independent of attentional operations, overt responses (shadowing and tapping) are all demanding of attentional capacity.

Similarly, the models advanced by the "functional" theorists would predict the absence of any decrements in shadowing performance on those occasions in which semantic targets are detected on the nonshadowed channel as opposed to those situations in which semantic targets are detected on the shadowed channel. Since "functional" theory maintains that attentional capacity is flexible, that is, divisible, the diversion of only residual capacity to secondary task performance insures that the detection of target items on the nonshadowed channel can occur without expense to the successful execution of the primary task (shadowing). Furthermore, in regard to the phonetic condition, "functional" theorists would predict complete detection of the targets arriving on the shadowed and nonshadowed channels due to the low level of attentional capacity exacted by this task.

Task 2: Auditory Focused: Positional Cue (AF-PC)

Subjects were required to shadow one of three simultaneously presented prose passages. In the dichotic condition, the two irrelevant passages, nonshadowed passage "B" and "C," were presented on either the left or right channel, and the relevant passage, shadowed passage "A," was presented on the alternate channel. In the binaural condition, two passages were presented on each channel; that is channel 1 contained passages "A" and "B," and channel 2 contained passages "B" and "C." Shadowing performance served as the dependent measure.

In accordance with the formulations of the "early-structural" theorists, the following prediction was advanced:

4) Shadowing performance under the dichotic condition would be significantly superior to the shadowing performance under the binaural condition.

"Early" theorists, in assuming that perceptual processing is limited, emphasize that selective perception occurs on the basis of an analysis of the elementary physical characteristics of competing stimuli. Since the dichotic condition enabled the relevant message to be identified on the basis of an obvious physical cue (spatial location), shadowing performance would occur with greater efficiency as compared with shadowing performance under the binaural condition in which no such obvious physical cue existed.

In so far as "structural" or "filter" theory assumes that an organism's ability to focus attention upon a limited aspect of the stimulus field is inversely related to the ability to reject or attenuate irrelevant information, more efficient shadowing performance would also be predicted under the dichotic than under the binaural condition. The former condition provided a cue (spatial location) which permitted more facile discrimination, and therefore rejection, of irrelevant stimuli.

In that "late" theorists assume that all incoming stimuli invariably and automatically attain comparable levels of perceptual analysis, the distinction between the dichotic and the binaural conditions remains immaterial in so far as processing demands, and consequently shadowing performance, is concerned. Thus, they would predict comparable shadowing performance under the dichotic and the binaural conditions.

Similarly, "functional" theorists would also predict comparable shadowing performance under the dichotic and the binaural conditions. Since perceptual processing is confined to the enhancement of relevant information only, "functional" theorists maintain that shadowing performance proceeds undisturbed regardless of the content, number, or spatial arrangement of competing stimuli.

Late-Structural

Task 3: Visual Focused/Divided: Simultaneous-Sequential Paradigm (VF/D-SSP)

Subjects were required to monitor a tachistoscopically presented grid of nine letters for the detection of a relevant character that was capable of being identified on the basis of its position within the display. In the simultaneous condition, subjects were instructed to monitor all nine character position. In the sequential condition, subjects were instructed to monitor only the center grid position. Following each stimulus (grid) presentation, subjects were asked to report the target item that had been presented in a specified position. Correct detections served as the dependent measure.

In accordance with the formulations of the "late-structural" theorists, the following prediction was advanced:

5) Correct target detections would be comparable for the two modes of stimulus presentation, that is, the simultaneous versus the sequential condition.

Since "late" theorists assume that the perceptual analysis of all incoming stimuli occurs in parallel, they maintain that the simultaneous processing of multiple competing inputs results in a level of analysis for each item as if it were processed as a single sensory event. In other words, implicit in the concept of parallel processing is the assumption that the perceptual processing of multiple inputs requires no more time, nor does it result in any more information loss than the processing of a single sensory event. Since "structural" theorists regard attention as a nondirectable process which is not under the subject's control, they would predict that foreknowledge concerning the location of target items, as in the sequential condition, would not enhance or increase target detections.

A different prediction can be derived from the formulations of the "early" theorists. Since they postulate that perceptual processing, excluding the analysis of simple physical characteristics, occurs in a serial fashion, they maintain that performance on a target detection task would be a function of the number of inputs that need to be processed. Specifically, in regards to the present task, they would predict a significantly greater number of target detections under the sequential condition as opposed to the simultaneous condition.

In so far as "functional" theorists postulate that attention is an active and variable process whose allocation is under an organism's control, they would predict that advance knowledge concerning the location of the relevant target item would reduce the demand upon attentional capacity, and consequently enhance target detections. Thus, they would also predict more target detections under the sequential condition as opposed to the simultaneous condition.

Task 4: Auditory Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Subjects were required to monitor a pair of dichotically presented consonant-vowel syllables for the detection of a relevant target item. In the sequential condition, subjects were instructed prior to the stimulus arrival in regards to which one of the two channels would contain the relevant items. In the simultaneous condition, subjects were not informed in advance concerning the channel of arrival of the relevant item, and consequently, they were required to monitor both channels. Following each trial, subjects were required to identify the relevant target item that was presented. Correct target identifications served as the dependent measure.

In accordance with the formulations of the "late-structural" theorists, the following prediction was advanced:

6) Correct target detections would be comparable for the simultaneous and the sequential conditions.

Since "late" theorists assume that attentional operations do not intervene in the perceptual cycle until all stimuli have attained complete feature and semantic analysis, they postulate that perceptual analysis of concurrent stimuli occurs in parallel and to a comparable degree.

Since "structural" theorists regard attention as a passive, nondirectable process, they predict that advance knowledge concerning the location of target items, as in the sequential condition, would not enhance or increase target detections.

Due to the fact that "early" theorists postulate that perceptual processing occurs in a serial fashion, they would predict a significantly greater number of target detections under the sequential condition as opposed to the simultaneous condition. Although attention switching would enable "early" theorists to predict comparable target detections under both conditions, the possibility of this phenomenon occurring in the present task was eliminated by the introduction of a distractor item on the nontarget channel. The processing time invested in identifying the distractor item as a nontarget item precluded the possibility that sufficient processing time would be available to discriminate the relevant target item upon switching attention to the target channel (Shiffrin, Pisoni & Castaneda-Mendez, 1974).

In so far as "functional" theorists postulate that attention is an active, controlled process, they would predict more target detections under the sequential condition than under the simultaneous condition. The former condition provided advance knowledge concerning the location of the relevant target item. Thus, it should have enhanced subjects' attention allocation, and consequently their performance.

Early-Functional

Task 5: Auditory Divided: Primary Task Demands (AD-PTD)

Subjects were required to shadow one of two dichotic prose passages (primary message) and tap whenever they detected a target word in the nonshadowed passage (secondary message). Two types of primary messages, distinguishing two experimental conditions, were employed: a) in the low-attention-demand condition, subjects were required to shadow a familiar prose passage; and b) in the high-attention-demand condition, subjects were required to shadow an unfamiliar prose passage. Target items were capable of being distinguished on the basis of their semantic properties. The number of correct target detections and the number of words correctly shadowed served as the dependent measures.

In accordance with the formulations of the "early-functional" theorists, the following predictions were advanced:

7) Significantly more target detections would be evidenced under the low-attention-demand condition than under the high-attention-demand condition.

"Early" theory postulates that all component operations of the perceptual sequence, excluding the analysis of simple physical characteristics, require attention. "Functional" theory postulates that the interference evidenced among two concurrent activities is a function of the degree to which the individual activities impose upon a common pool of attentional capacity. Thus, tapping scores to relevant target items would increase as the attentional capacity required by the primary task decreased. Specifically, since the amount of attentional capacity allocated to the processing of the secondary message varies inversely with the amount of attentional capacity exacted by the processing of the primary message, secondary message analysis, operationally measured in the present task as the number of correct target detections, would be significantly greater under those conditions in which a familiar prose passage comprised the primary message. That is, it was assumed that shadowing a familiar prose passage would require less attentional capacity than shadowing an unfamiliar prose passage.

8) Comparable shadowing performance would be evidenced under the high-and-low-attention-demand conditions.

Comparable shadowing performance under both experimental conditions was predicted in accordance with the "functional" theorists' formulation that attentional capacity is flexible and divisible in nature. That is, correct target detections would not be due to attention switching between the primary and secondary task, but rather reflected the diversion of residual attentional capacity from the primary (shadowing) task to the secondary (target detection) task.

The above predictions cannot be derived from the formulations of either the "late" or "structural" theorists. Since "late" theorists assume that perceptual processing is an automatic activity that occurs without the intervention of attentional operations, they would predict comparable and complete target detections for the low-and-high-attention-demand conditions. Due to the assumption that attention is a fixed and static process, "structural" theorists would also predict comparable detection rates for both experimental conditions. In contradistinction to the "late" theorists, however, "early-structural" theorists would predict no target detections, regardless of the experimental situation, when the shadowing task was being successfully executed. To the extent that targets on the nonshadowed channel were detected, "early-structural" theorists would predict decrements in shadowing performance due to attention switching. Similarly, "late" theorists would predict shadowing decrements due to response competition.

Task 6: Auditory Divided: Recall Expectancies (AD-RE)

Subjects were required to shadow one of two dichotically presented series of random digits. In addition to the shadowing task, subjects were also required to recall the three digits terminating one of the stimulus lists. Expectancies concerning digit recall were manipulated through experimental instructions. Specifically, prior to each trial subjects were instructed in regard to which channel, shadowed or nonshadowed, would contain the "to-be-recalled" digits. Following stimulus presentation subjects were asked to recall either the expected or the nonexpected digits. The number of digits correctly recalled as well as the number of digits correctly shadowed served as the dependent measures.

In accordance with the formulations of the "early-functional" theorists, the following predictions were advanced:

9) Digit recall from either the shadowed or the nonshadowed message would be significantly greater under those conditions in which subjects were instructed to expect such recall demands.

Since they postulate that all perceptual operations require attention, and attention allocation is a flexible process, "early-functional" theorists maintain that subjects distribute their attention in accordance with their expectancies as generated via instructional set. Consequently, digit recall for those situations in which task requirements, and therefore attentional demands, confirmed subjects' expectancies would be significantly greater than under those conditions in which subjects were not prepared to meet the attentional demands.

In so far as "late" theorists assume that all stimuli attain comparable levels of analysis regardless of instructional set, they would predict complete digit recall under both conditions since all items were equally accessible to subjects via representation in short term memory. On the other hand, due to the assumption that attention is generally indivisible, "early-structural" theorists would predict no digit recall from the nonshadowed message regardless of the expectancies generated by instructional set.

10) Significantly greater shadowing decrements would be evidenced under those conditions in which subjects were instructed to expect to recall digits from the nonshadowed as opposed to the shadowed channel.

In accordance with the assumptions that all component operations of the perceptual sequence are demanding of attention, and attention distribution is a directable process, "early-functional" theorists would predict that under those conditions in which subjects expected to recall digits from the nonshadowed channel, they would have diverted attentional capacity to that channel. This diversion of attentional capacity from the shadowing task would have been evidenced as shadowing decrements.

In so far as "late" theorists maintain that perceptual analysis occurs independent of attentional capacity, they would predict comparable shadowing performance under both expectancy conditions. That is, "late" theorists do not postulate any need for the diversion of attention for the perceptual analysis of nonshadowed digits. "Structural" theorists, due to their assumption that attention is generally indivisible and nondirectable, would similarly predict comparable shadowing performance under both conditions of recall expectancies.

Late-Functional

Task 7: Visual Divided: Consistent versus Varied Mapping (VD-CVM)

Subjects were required to search an array of briefly presented visual characters for the detection of relevant target items. Attentional demands were manipulated by varying: a) the number of characters (1, 2, or 4) comprising the stimulus set (targets); b) the number of characters (1, 2, or 4) comprising the test array (targets and nontargets); and c) the nature of the target items, that is, the target-nontarget relationship. Specifically, two experimental conditions, distinguished on the basis of target-nontarget association, were employed. In the consistent mapping condition, since targets and nontargets were members of different cognitive categories, their experimental relevancy remained constant across trials. Target items were comprised of random digits, whereas nontarget items were comprised of random letters. In the varied mapping condition, target and nontarget items were members of the same class, that is, letters. As such their experimental relevancy was mixed across trials. For example, the letter "C" was significant on one trial, whereas it became irrelevant on a subsequent trial. Reaction times to correct target detections and the number of detection errors served as the dependent measures.

In accordance with the formulations of the "late-functional" theorists, the following predictions were advanced:

11) Significantly shorter response latencies and significantly fewer detection errors would be evidenced in the consistent mapping condition as opposed to the varied mapping condition. Moreover, the response differences observed in comparing the performance yielded by the

> consistent mapping condition with that yielded by the varied mapping condition would increase as the amount of processing required to successfully perform the task (information load) increased. That is, the largest discrepancies would be evidenced in those situations in which the target set and the stimulus array were comprised of four items respectively.

Since the consistent mapping trials were sampling naturally-occurring, well-learned cognitive categories, the perceptual sequences responsible for target item analysis and identification under such conditions would have attained an automated status, and consequently would be actuated independent of attentional capacity. During the varied mapping trials, on the other hand, the perceptual sequences responsible for the comparative analysis of information were neither firmly established nor consolidated, and consequently would require attention for successful execution. The increased reaction times evidenced under the varied mapping condition would reflect the serial comparison of stimulus array items with target set items that occurred during memory search. The increased number of detection errors under the varied mapping condition would reflect the rapid decay of items held in short term memory as they awaited processing via attention which was being allocated in a serial fashion.

12) In the consistent mapping condition, reaction times and detection scores would be comparable across trials varying in information load.

Since perceptual processing is automated, and therefore requires no attentional capacity, all stimulus items would be processed in parallel irrespective of the information load.

13) In the varied mapping condition, reaction times and detection errors would increase as the information load increased.

Each stimulus item would be processed individually and would be serially compared to the items comprising the target set, and thereby would produce longer response latencies. Furthermore, the short term memory representations of items that did not receive attention would decay rapidly. Thus, considerable information loss would result from the sequential allocation of attention.

Since "early" theorists postulate that all perceptual operations, excluding the analysis of simple physical characteristics, require attention, they would predict that as the information load in the consistent mapping condition increased longer reaction times and more detection errors would be evidenced as in the varied mapping condition. Such performance would reflect either the serial processing of each stimulus array item ("early-structural") or the added demands upon attentional capacity ("early-functional").

Due to the assumption that attention is a fixed and static process which remains relatively unaltered in spite of practice, skill, and cognitive strategies, the "structural" theorists, moreover, would predict that comparable response latencies and errors of omission would be evidenced under the varied and the consistent mapping conditions.

Task 8: Visual Focused/Divided: Patterns (VF/D-P)

Subjects were required to indicate when two visual letter patterns, presented either successively or simultaneously, were the same. Each trial presented two signals in a sequential fashion; the first designated as the cue signal, the second designated as the stimulus signal. The cue signal always consisted of a single letter pattern.

The stimulus signal, which contained either one or two letter patterns, distinguished the two experimental conditions, primary and secondary respectively. For the primary trials subjects were required to compare the single cue signal with the single stimulus signal. For the secondary test trials subjects were required to disregard the single cue item and compare the characters simultaneously presented on the stimulus signal. Cue items as well as stimulus items consisted of familiar (letters selected from the standard alphabet) and unfamiliar (angular simulations of standard letters) patterns. The symbols "└," "┘," "┌," and "┐," corresponding to the letters "b," "d," "p," and "q," respectively, comprised the novel character set. Reaction times to correct detections served as the dependent measure.

In accordance with the formulations of the "late-functional" theorists, the following predictions were advanced:

> 14) For the primary trials, mean correct response latencies to unfamiliar letter patterns would not exceed mean correct response latencies to familiar letter patterns.

The differential processing of familiar and unfamiliar letter patterns is a function of the differential amounts of attentional capacity exacted by their respective analyzing sequences. For example, familiar letter patterns, having attained a state of automatic analysis, would be processed without attentional capacity, whereas unfamiliar letter patterns, due to their novelty, would require substantial attentional capacity in order to organize and execute their processing sequences. In so far as attention was already directed towards the proper analyzing sequence when the stimulus signal was to be compared to the cue signal (primary trials), performance scores for unfamiliar letter patterns would reflect reaction times comparable to automatic processing.

15) For the secondary trials, mean correct response latencies for unfamiliar characters would be significantly greater than mean correct response latencies for familiar characters.

Whenever two simultaneously presented target signals were to be compared (secondary trials) automaticity would enable the processing of familiar letter patterns regardless of the direction of immediate attentional concerns. The processing of unfamiliar letter patterns would be delayed until attention was directed towards their analyzing sequences, that is, from the cue signal to the stimulus signal. Consequently, the reaction times for familiar letter patterns would be significantly less than the reaction times for unfamiliar letter patterns.

16) Differences in reaction times between familiar and unfamiliar characters on the secondary trials would significantly diminish as subjects received additional exposure to the unfamiliar letter patterns.

With extended practice the perceptual processing of unfamiliar letter patterns would become automated in a manner similar to that evidenced with the processing of familiar letter patterns.

Since "early" theorists postulate that all perceptual operations, excluding the analysis of simple physical characteristics, require attention, they would predict that reaction times to familiar and unfamiliar letter patterns for the secondary trials would be comparable. More specifically, "early" theorists would predict that regardless of the nature of the stimulus (familiar or unfamiliar) on the secondary trials, the analysis of a nonexpected target signal would require a constant amount of time due to either a need to switch attention ("early-structural") or the demands of additional attentional capacity ("early-functional").

Due to the assumption that attention is a fixed and static process which is not appreciably altered by practice, the "structural" theorists would predict that the reaction times to unfamiliar letter patterns for the secondary trials would not decrease with additional exposure (trials administered over three consecutive days of experimentation), but rather would remain constant.

Hypotheses

The primary objective of the present study was to evaluate the fundamental premise that attention is a single, nonvarying process. Secondary to this, the present study also assessed the validity of conceptualizing attention in terms of two principal attributes: a) locus of attentional operations; and b) capacity of attentional processes. These issues were addressed in terms of the following specific hypotheses.

Hypothesis 1

To the extent that attention is a single process, it was predicted that subjects' performance scores on the various attentional tasks would intercorrelate in such a fashion so as to reflect the operation of a single, underlying factor which would be designated as the general factor of attention.

Hypothesis 2

To the extent that attention may be variable in regard to its locus of operation, it was predicted that a single factor representing this dimension would emerge. Those tasks in which successful performance depends upon the intervention of attention during the initial stages of the perceptual sequence would load highly on a polar extreme of this dimension which would be designated as "early;" whereas those tasks in which successful performance depends upon the intervention of attention following the complete perceptual analysis of all concurrent stimuli would load highly on the opposite polar extreme of this dimension which would be designated as "late." Specifically, it was predicted that tasks 1, 2, 5 and 6 would load more highly on the "early" polar extreme of this dimension than would tasks 3, 4, 7 and 8. Tasks 3, 4, 7 and 8 would load more highly on the "late" polar extreme of this dimension than would tasks 1, 2, 5 and 6.

Hypothesis 3

To the extent that attention may be variable in regard to capacity, it was predicted that a single factor representing this dimension would emerge. Those tasks in which successful performance reflects a fixed and passive mode of attentional operations would load highly on a polar extreme of this dimension which would be designated as "structural;" whereas those tasks in which successful performance reflects a variable and active mode of attentional operations would load highly on the opposite polar extreme of this dimension which would be designated as "functional." Specifically, it was predicted that tasks 1, 2, 3, and 4 would load more highly on the "structural" polar extreme of this dimension than would tasks 5, 6, 7 and 8. Tasks 5, 6, 7, and 8 would load more highly on the "functional" polar extreme of this dimension than would tasks 1, 2, 3 and 4.

Hypothesis 4

To the extent that the dimensions of locus and capacity represent salient attributes of attention (Hypotheses 2 and 3), it was further predicted that subjects' performance scores on the various attentional tasks would cluster in a manner analogous to that suggested by the previously noted classificatory quadrants (Table 1). That is, in so far as the variety of perceptual tasks that were employed tap discrete and measurable distinctions on these dimensions, they should impose different attentional demands for successful performance. Thus, it was predicted that tasks which require comparable attentional operations would intercorrelate more highly among themselves in such a fashion so as to be factorially distinguishable from those tasks which involve alternate attentional functions. Specifically, the following subhypotheses were advanced:

Hypothesis 4a

To the extent that tasks 1 and 2 support the formulations of the "early-structural" theorists, it was predicted that subjects' performance scores on these tasks would intercorrelate in such a fashion so as to reflect higher loadings on the "early" and "structural" factors as compared to the "late" and "functional" factors respectively.

Hypothesis 4b

To the extent that tasks 3 and 4 support the formulations of the "late-structural" theorists, it was predicted that subjects' performance scores on these tasks would intercorrelate in such a fashion so as to reflect higher loadings on the "late" and "structural" factors as compared to the "early" and "functional" factors respectively.

Hypothesis 4c

To the extent that tasks 5 and 6 support the formulations of the "early-functional" theorists, it was predicted that subjects' performance scores on these tasks would intercorrelate in such a fashion so as to reflect higher loadings on the "early" and "functional" factors as compared to the "late" and "structural" factors respectively.

Hypothesis 4d

To the extent that tasks 7 and 8 support the formulations of the "late-functional" theorists, it was predicted that subjects' performance scores on these tasks would intercorrelate in such a fashion so as to reflect higher loadings on the "late" and "functional" factors as compared to the "early" and "structural" factors respectively.

CHAPTER II

METHOD

Subjects

The subject sample consisted of 60 undergraduate students who were enrolled at the University of Windsor. Participation in the study was voluntary, however, the students did obtain extra course credit for their cooperation. There were 17 male subjects and 43 female subjects who ranged in age from 18 to 45 years.

All subjects were initially screened for noncorrected visual and/or auditory impairments and previous experience with the types of tasks that were employed in this study. In addition, only those subjects who met predetermined criterion levels of performance during the preliminary practice session were selected for inclusion in the study.

Procedure

Three practice and eight experimental tasks were administered to each subject individually on five consecutive days. For each subject, Day 1 consisted of approximately 60 minutes of practice involving the shadowing of two binaurally and four dichotically presented prose passages, with each passage containing approximately 285 words, and the recognition of 50 tachistoscopically presented monosyllabic words. This initial practice session served to familiarize subjects with the general nature of the experimental tasks, that is, auditory shadowing and the identification of briefly presented visual material, as well as provided an opportunity to screen subjects who did not meet acceptable criterion levels of performance. On the remaining Days 2-5, each eligible subject performed two new experimental tasks per day and parts of task 8 when appropriate. Elements of task 8 were administered on three consecutive days of experimentation. Each experimental task was immediately preceded by detailed instructions and a practice session approximately two minutes in duration specific to the particular task. To the extent possible the presentation order of the experimental conditions for specific tasks was counter-balanced across subjects. In addition, on Days 2-5 the presentation sequence of the experimental tasks themselves was balanced across subjects as illustrated in Table 3 (Appendix B). The sequence of task administration was firmly adhered to although occasional exceptions were noted.

General Practice and Screening Tasks (Day 1)

Practice Task A
Auditory Shadowing: Binaural (AS-B)

Subjects were required to shadow two consecutively presented, binaural 285 word prose passages. The number of words correctly shadowed served as the dependent measure. The criterion level of acceptance was set at a minimum of 200 correctly shadowed words on at least one trial. That is, subjects were required to demonstrate 70 percent or better shadowing proficiency on at least one passage for inclusion in the study. A complete description of the task, including apparatus, stimulus materials, instructions, and procedure, is presented in Appendices D_1 - D_3.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Subjects were given four trials, each of which involved shadowing one of two 285 word, dichotically presented prose passages. The number of words correctly shadowed served as the dependent measures. The criterion level of acceptance was set at a minimum of 200 correctly shadowed words on at least one trial. That is, subjects were required to demonstrate 70 percent or better shadowing proficiency on at least one passage for inclusion in the study. A complete description of the task, including apparatus, stimulus materials, instructions, and procedure, is presented in Appendices E_1 - E_3.

Practice Task C
Visual Identification: Tachistoscopic (VI-T)

Subjects were required to identify a series of 50 monosyllabic, tachistoscopically presented concrete nouns. The number of words correctly identified served as the dependent measure. The criterion level of acceptance was set at a minimum of 35 correctly identified stimulus words. That is, subjects were required to demonstrate 70 percent or better identification proficiency for inclusion in the study. A complete description of the task, including apparatus, stimulus materials, instructions, and procedure, is presented in Appendices F_1 - F_3.

Experimental Tasks (Days 2-5)

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Subjects were required to shadow one of two dichotically presented 285 word prose passages and tap whenever they detected a target word in either the primary (shadowed) or the secondary (nonshadowed) message. Two types of target words, distinguishing two experimental conditions, were employed. In experimental condition 1 (phonetic) target items consisted of monosyllabic words containing the al phoneme. In experimental condition 2 (semantic) target items consisted of monosyllabic names of body parts. Prior to the presentation of the experimental materials, subjects received a practice trial which served to familiarize them with the nature of the task. Monosyllabic colour names comprised the set of target items for practice purposes. For all conditions, experimental and practice, the primary and secondary passages contained four target items respectively. Dependent measures included the number of correct target detections and the number of words correctly shadowed under each of the experimental (phonetic and semantic) conditions. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure, is presented in Appendices G_1 - G_3.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Subjects were required to shadow one of three simultaneously presented 285 word passages. Two experimental conditions, distinguished on the basis of the spatial arrangement of the primary (shadowed) and secondary (nonshadowed) messages, were employed. In the dichotic condition the relevant passage "A" was presented on one channel, either left or right, of the recorder while the two irrelevant passages, "B" and "C," were simultaneously presented on the alternate channel. In the binaural condition two passages were simultaneously presented on each channel of the recorder. That is, one channel contained the relevant and an irrelevant passage, "A" and "B," while the alternate channel contained two irrelevant passages, "B" and "C." Each experimental condition was introduced by a specific practice trial that served as a means of familiarizing subjects with the requirements of the task. That is, the presentation of the dichotic experimental condition was immediately preceded by the presentation of a dichotic practice trial, whereas the presentation of the binaural experimental condition was immediately preceded by the presentation of a binaural practice trial. The dependent measures included the number of words correctly shadowed under each of the experimental (dichotic and binaural) conditions. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure, is presented in Appendices H_1 - H_3.

Task 3
Visual Focused/Divided: Simultaneous-Sequential Paradigm (VF/D-SSP)

Subjects were required to monitor a tachistoscopically presented grid of nine randomly selected letters for the subsequent identification of a single target character. The target item was capable of being identified only on the basis of its position within the display. Two experimental conditions, differing in regard to the number of channels to be monitored for the identification of target elements, were employed. The simultaneous condition used a post-stimulus cuing technique. Subjects were not informed in advance concerning the position of the target item, and consequently, they were required to monitor nine channels simultaneously for the subsequent recall of a letter that had occupied variable grid positions. In the sequential condition subjects were preinstructed in regard to the position of the target character. Specifically, subjects knew in advance that they would be required to recall the letter that had occupied the center grid position. The simultaneous condition consisted of a block of 73 practice trials and a block of 73 experimental trials. Each block of trials contained six tests of each of the outer eight positions and 25 tests of the center position. The sequential condition was comprised of a block of 25 practice trials and a block of 25 experimental trials. The number of correct target identifications for the two experimental (simultaneous and sequential) conditions served as the dependent measures. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure is presented in Appendices I_1 - I_3.

Task 4
Auditory Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Subjects were required to monitor a pair of dichotically presented consonant-vowel syllables for the detection of a relevant target item. Each stimulus presentation consisted of a target item paired with a standard distractor syllable. Whereas the syllables "ba," "da," "ga," and "pa," comprised the target item set, the syllable "wu" was employed as the standard distractor item. Two experimental conditions, distinguished on the basis of the number of channels to be monitored for the detection of the target items, were employed. In the simultaneous condition since subjects were not informed in advance concerning the channel of arrival of the target syllable, they were required to monitor both channels simultaneously. In the sequential condition subjects were preinstructed in regard to the channel position of the target syllables. Specifically, subjects were informed that target items would be presented in an alternating channel sequence. For both the simultaneous and the sequential condition subjects were asked to identify the target syllable that had been presented. Each condition was presented in blocks of 40 trials, with eight practice trials appropriate to the particular experimental condition immediately preceding the presentation of the testing materials. The dependent measures included the number of correct target identifications under each experimental (simultaneous and sequential) condition. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure is presented in Appendices J_1 - J_3.

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Subjects were required to shadow one of two dichotically presented 285 word prose passages (primary message) and tap whenever they detected a target word in the nonshadowed passage (secondary message). Two experimental conditions, distinguished on the basis of the amount of attentional capacity exacted by the shadowing demands of the primary message, were employed. In the low-attention-demand condition subjects were required to shadow 285 words of the popular nursery rhyme, "This is the House that Jack Built," and to tap to any four-legged animal name. In the high-attention-demand condition subjects were required to shadow a 285 word prose passage concerning the social ecology of coyotes and tap to the names of clothing articles. Prior to the presentation of the experimental materials, so as to familiarize them with the nature of the task, subjects were administered a single practice trial in which they were required to shadow a 285 word historical narrative on the game of checkers and tap to the names of common fish. Eight monosyllabic target items were randomly presented within the nonshadowed passages under each of the experimental conditions and the single practice condition. Dependent measures included the number of correct target detections and the number of words correctly shadowed for the high-and-low-attention conditions respectively. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure is presented in Appendices K_1 - K_3.

Task 6
Auditory Divided: Recall Expectancies (AD-RE)

Subjects were required to shadow one of two dichotically presented series of 10 random monosyllabic digits. In addition to the shadowing task subjects were required to recall the three digits terminating one of the stimulus lists. Four experimental conditions, established on the basis of the relationship between recall expectancies, as generated by experimental instructions, and recall demands, were employed. In the S-S condition subjects were required to recall the three digits terminating the shadowed message in accordance with preshadowing expectancies. In the S-NS condition subjects were asked to recall the three digits terminating the nonshadowed message in contrast to preshadowing expectancies. In the NS-NS condition subjects were required to recall the three digits terminating the non-shadowed message in accordance with preshadowing expectancies. In the NS-S condition subjects were asked to recall the three digits terminating the shadowed list in contrast to preshadowing expectancies. The S-S and NS-NS conditions were each comprised of 15 trials, whereas the S-NS and NS-S conditions each consisted of 10 trials. Each subject received 25 blocked trials of shadowing digits presented on the left channel and 25 blocked trials of shadowing digits presented on the right channel with the order of presentation of trials randomly determined and fixed across subjects. Each set of blocked trials was immediately preceded by four practice trials with the shadowed information arriving on the appropriate channel and each trial representing one of the four experimental conditions. The number of digits correctly recalled and the number of digits correctly shadowed under each of the four experimental conditions served as the dependent measures. A complete description of the task, including apparatus, stimulus materials, instructions, and procedure, is presented in Appendices L_1 - L_3.

Task 7
Visual Divided: Consistent versus Varied Mapping (VD-CVM)

Subjects were required to search an array of briefly presented visual characters for the detection of relevant target items. Attentional demands were manipulated by varying: a) the number of characters (1, 2, or 4) comprising the stimulus set (targets); b) the number of characters (1, 2, or 4) comprising the test array (targets and nontargets); and c) the target-nontarget relationship. Specifically, two experimental conditions, distinguished on the basis of the target-nontarget relationship, were employed. In the consistent mapping condition (CM) target items were comprised of random digits, whereas nontarget items were comprised of random letters. In the varied mapping condition (VM) target as well as nontarget items were comprised of random letters. CM and VM conditions each consisted of 72 experimental trials; that is, eight trials for each of the nine combinations resulting from a representation of all possible stimulus set and target array groupings. In each set of eight trials, targets appeared randomly on one-half of the trials. So as to familiarize subjects with the nature of the task, two blocks of practice trials, one from each of the experimental conditions, was initially administered. Reaction times to correct target detections and the number of detection errors for each of the experimental (consistent and varied) conditions served as the dependent measures. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure, is presented in Appendices M_1 - M_3.

Task 8
Visual Focused/Divided: Patterns (VF/D-P)

Subjects were required to indicate when two letter patterns, presented either successively or simultaneously, were the same. Letter patterns consisted of familiar (letters selected from the standard alphabet) and unfamiliar (symbols that graphically resembled one of four predesignated letters) characters. Specifically, the geometric configurations "⌞," "⌟," "⌜," and "⌝" corresponded to the letters "b," "d," "p," and "q" respectively. Two experimental conditions, distinguished on the basis of the direction of momentary attention states, were employed. Attention allocation was controlled via an advanced cuing technique. In the primary condition the characters to be compared were presented successively. That is, subjects were required to indicate when a stimulus element was the same as the cue item which immediately preceded it. In the secondary condition the characters to be compared were presented simultaneously. That is, subjects were required to disregard the cue item and indicate when the two test patterns which were presented concurrently were the same. The practice condition presented both types of trials. Two blocks of 32 primary trials, each testing a particular letter type, were administered. Practice and secondary test blocks were administered on three consecutive days of experimentation. Secondary blocks were comprised of 56 trials; twelve test trials which presented the targets to be compared simultaneously and 44 catch trials which presented the comparative characters sequentially. On each day of experimentation, one block of secondary trials presented familiar letters on the test trials whereas the other block presented unfamiliar letters. Reaction times to correct responses for each of the letter types (familiar and unfamiliar) served as the dependent measures. Specifically, the primary latency scores and two secondary latency scores for each day of experimentation were computed. A complete description of the task, including apparatus, instructions, stimulus materials, and procedure, is presented in Appendices N_1 - N_3.

CHAPTER III

RESULTS

The presentation of the results is divided into two general sections: the analyses of specific task predictions is followed by a comprehensive analysis that addresses the four major hypotheses. Although the experimental tasks are grouped by theoretical perspective, each of the eight tasks is discussed individually and according to the following sequence: a) a restatement of the prediction(s); b) a tabular outline of the design which includes summary data in the form of cell means as well as standard deviations for each of the experimental conditions; and c) a report of the analyses. The primary objective is to discuss the findings that were expected on the basis of the predictions. In addition to this, however, unexpected findings, both positive and negative, are also discussed. Subsequent to the analysis of the task predictions, are the results of the principal components analysis. The principal components analysis included measurements from all the experimental tasks and tested the hypothesis that attention is a single, unitary process.

Analyses of Task Predictions

Early-Structural

The distinguishing features of the "early-structural" position are that attention is a prerequisite for in depth perceptual processing; and that attention limitations are manifested in isolated processing systems which preclude the simultaneous passage of competing sensory stimuli. Tasks 1 and 2 examined these assumptions.

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Task 1 was intended to assess two parameters of the "early-structural" model: a) attention is serially allocated to competing stimulus inputs; and b) perceptual processing, excluding the analysis of elementary physical characteristics, requires attention. The assumption pertaining to the unidirectional nature of attention was tested via predictions 1 and 3. Predictions 2 and 3 addressed the later assumption; that is, the function subserved by attention during perceptual processing.[10]

<u>Prediction 1</u>
The number of targets detected on the shadowed channel were expected to be greater than the number of targets detected on the nonshadowed channel.

<u>Prediction 2</u>
On the shadowed channel, all target items, regardless of the level of perceptual analysis that was required for their identification, were expected to be detected. On the nonshadowed channel, however, target items which were capable of being identified on the basis of elementary operations (phonetic analysis) were expected to be detected with a higher frequency than target items which were capable of being identified only on the basis of complex perceptual operations.

Table 4 presents a summary of the data which are pertinent to predictions 1 and 2. Further clarification is provided by the subsequent

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[10] The theoretical rationale for the predictions was previously elaborated upon in the Introduction section under "Tasks." Consequently, it will not be repeated in the Results section.

TABLE 4

The Number of Phonetic and Semantic Targets Detected on the Shadowed and Nonshadowed Channels

		Target Type (A)				
		Phonetic (a_1)		Semantic (a_2)		
		Mean	SD	Mean	SD	Mean (B)
Target Channel (B)	Shadowed (b_1)	2.78	1.11	2.40	1.22	2.59
	Nonshadowed (b_2)	.57	.85	.30	.57	.44
	Mean (A)	1.68		1.35		

Prediction 1: $b_1 > b_2$*

Prediction 2: $ab_{11} = ab_{21}$*

$ab_{12} > ab_{22}$

*Observed

equations which state the predictions in terms of the notation that is employed to outline the experimental design in the table.

A 2 x 2 analysis of variance was computed on these data (Table 5). Factor 'A' pertains to Target Type (phonetic/a_1 or semantic/a_2) and Factor 'B" pertains to Target Channel (shadowed/b_1 or nonshadowed/b_2). The number of targets correctly detected, out of the four targets which were presented in each of the experimental conditions, served as the dependent measures.

The ANOVA analysis revealed a significant Target Channel effect, $F(1,59) = 218.33$, $p < .01$.[11] This finding indicates that the number of targets detected on the shadowed channel were significantly greater than the number of targets detected on the nonshadowed channel. As Table 4 shows, the mean detection scores for shadowed and nonshadowed targets were 2.59 and .44 respectively. This result agrees with prediction 1.

The ANOVA analysis also indicated that the Type x Channel interaction was not significant, $F(1,59) = 0.36$, $p > .01$. That is, the detection decrements for targets presented on the nonshadowed channel were comparable for phonetic and semantic targets. Consequently, prediction 2 has not been confirmed. A possible explanation for the substantial detection decrement, that was evidenced when phonetic targets were presented on the nonshadowed channel, concerns the nature of the items

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[11] Considering a) the large number of F ratios which were being tested; and b) the large number of error degrees of freedom, which occurred in many of the F ratios, due to the repeated measures design and large sample size, a rather conservative alpha level (.01) was adopted to guard against spurious confirmation of the predictions.

TABLE 5

Summary of the Analysis of Variance for the Number of Phonetic and Semantic Targets Detected on the Shadowed and Nonshadowed Channels

Source of Variation	SS	df	MS	F
Target Type (A)	6.34	1	6.34	11.53*
Type x Subj.	32.41	59	.55	
Target Channel (B)	279.46	1	279.46	218.33*
Channel x Subj.	75.29	59	1.28	
Type x Channel (AB)	.23	1	.23	.36
Type x Channel x Subj.	37.52	59	.63	

*p < .01

that were selected to comprise the pool of phonetic targets. Specifically, the phonetic targets may not have been completely identifiable on the basis of their acoustical properties.

Furthermore, the ANOVA analysis revealed a significant Target Type effect, $F(1,59) = 11.53$, $p < .01$. As Table 4 shows, this result indicates that phonetic targets were detected to a significantly greater degree than semantic targets. The mean detection scores for phonetic and semantic targets were 1.68 and 1.35 respectively. Although this finding was not predicted, it is nonetheless consistent with the formulations of the "early-structural" position. The model postulates that elementary feature analysis may occur to a large part independent of attentional influence, whereas the meaningful interpretation of stimuli requires the intervention of attentional processes. Thus, the observation that phonetic targets (which were capable of being identified on the basis of their acoustical properties, and consequently, with minimal attention) were detected significantly more often than semantic targets (which required in depth perceptual analysis, and therefore, substantial attention) can easily be accommodated within the theoretical framework.

Prediction 3

In the semantic condition, tapping to target items arriving on the nonshadowed channel was expected to interfere with shadowing performance to a significantly greater degree than tapping to target items arriving on the shadowed channel.

Table 6 presents summary data for those measurements collected on Task 1 which are pertinent to prediction 3. In addition to the number of targets correctly detected, the number of words correctly shadowed, within the five words immediately following the presentation of a target item, served as a dependent measure. The number of words correctly

TABLE 6

Summary Data for the Two Dependent Measures Pertaining to Prediction 3. The Number of Targets Detected and the Number of Words Correctly Shadowed Following the Presentation of Semantic Targets on the Shadowed and Nonshadowed Channels

	Target Channel			
	Shadowed (x_1)		Nonshadowed (x_2)	
	Targets Detected (y_1)	Words Shadowed (y_2)	Targets Detected (y_1)	Words Shadowed (y_2)
Mean	2.40	12.63	.30	16.10
SD	1.22	4.32	.57	3.71

shadowed following the presentation of, rather than the detection of, target items was employed as the dependent measure in light of the fact that so few targets were detected on the nonshadowed channel. As Table 6 shows, the mean detection rate for targets presented on the nonshadowed channel was .30 out of a potential 4.00.

Correlation coefficients computed in order to assess the relationship between the two dependent measures revealed: a) a positive correlation between these measures when targets were presented on the shadowed channel $r = +.26$; and b) a negative relationship between these variables when targets arrived on the nonshadowed channel, $r = -.63$. The difference between the correlation coefficients is statistically significant, $z = 8.57$, $p < .01$. The positive association between detections and shadowing performance, for targets presented on the shadowed channel, indicates that target detections increased as the number of words correctly shadowed increased. The negative correlation for targets presented on the nonshadowed channel, suggests that detections were associated with a shadowing decrement. Specifically, on those occasions that targets were detected, fewer words were correctly shadowed. The direction as well as the magnitude of the correlations then, are consistent with the prediction that the detection of targets arriving on the nonshadowed channel interfered with shadowing performance to a significantly greater degree that the detection of targets arriving on the shadowed channel.

Subsequent to this, a number of analyses of variance were computed (Table 7). A multivariate analysis of variance (MANOVA), that employed target detection scores and shadowing performance scores as the dependent

TABLE 7

Summary of Analyses of Variance Computed for the Number of Targets Detected and the Number of Words Correctly Shadowed Following the Presentation of Semantic Targets on the Shadowed and Nonshadowed Channels

Partitioning		ANALYSES: MANOVA (Targets Detected & Words Shadowed)	ANOVA (Targets Detected)	ANOVA (Words Shadowed)	COVARIATE (Targets Detected/Covariate Words Shadowed/Variate)
Sums of Squares	Treatment		132.3	7223	32.41
	Error		66.70	37,115.50	664.19
Degrees of Freedom	Treatment	2	1	1	1
	Error	234	59	59	58
Mean Square	Treatment		132.3	7223	32.41
	Error		1.13	629.08	11.45
F		26.08*	117.08*	11.48*	2.82

*p < .01

measures, revealed a significant Channel effect, $F(2,234) = 26.08$, $p < .01$. This finding was confirmed and further clarified when the Channel effect was separately assessed for the two dependent variables. A univariate ANOVA showed that a significantly greater number of the targets arriving on the shadowed channel were detected, $F(1,59) = 117.08$, $p < .01$. The mean number of detections for the shadowed and nonshadowed channel were 2.40 and .30 respectively. A second univariate ANOVA revealed, however, that the shadowing increment was in favour of targets presented on the nonshadowed channel, $F(1,59) = 30.12$, $p < .01$. That is, significantly more words were correctly shadowed following the presentation of target items on the nonshadowed rather than the shadowed channel. The mean shadowing scores for nonshadowed and shadowed targets were 16.10 and 12.63 respectively.

In light of the findings obtained from the univariate analyses, a covariate analysis of variance was computed in order to test the hypothesis that the shadowing difference evidenced between the two experimental conditions was related to the difference in target detections. Detection scores served as the covariate and shadowing scores as the variate. The covariate analysis indicated that when shadowing scores were adjusted for differences in target detections, shadowing performance became comparable for the two channel conditions, $F(1,58) = 2.82$, $p > .01$. Specifically, the poorer shadowing performance following the presentation of target items on the shadowed channel was related to the higher incidence of target detections; whereas the superior shadowing performance evidenced following the presentation of target items on the nonshadowed channel was related to the decrement in detections. Thus, the adjustment procedure revealed that the treatment effect was not significant. This finding, that the channel of arrival of the target item did not differentially affect shadowing performance, challenges prediction 3.

Of the diverse analyses that were computed, the correlation coefficients and the covariate analysis most directly address prediction 3. As indicated, the magnitude as well as the direction of the correlation coefficients are consistent with prediction 3; the results of the covariate analysis, however, are not. A plausible explanation for these seemingly discrepant findings is that the covariate analysis was complicated by the experimental design. That is, since target detections were affected by the treatment variable, the channel of arrival of the target items, an interpretation of the covariance results is confounded (Winer, 1971), if not inappropriate (Keppel, 1973). Specifically, the adjustment process may have removed part of the treatment effect, and thus, concealed the Channel effect upon shadowing performance. For this reason, the correlation coefficients are considered the most appropriate test of prediction 3.

The findings of Task 1 then, support the assumption that attention is allocated in a serial manner. Evidence in this regard is obtained via the confirmation of predictions 1 and 3. The failure to confirm prediction 2, specifically, the detection decrement observed for phonetic targets presented on the nonshadowed channel, questions the premise that the processing of physical characteristics occurs without attention.

Task 2
Auditory Focused: Positional Cue

Task 2 examined the "early structural" assumption concerning selection criteria. Specifically, that the efficacy of attention, and subsequently perception, is contingent upon the ability to isolate relevant stimulus information during the initial phases of sensory analyses.

Prediction 4
Shadowing performance under the dichotic condition was expected to be superior to the shadowing performance under the binaural condition.

Table 8 presents summary data for the two experimental conditions as well as a notational statement of the expected outcome. The analysis of the data involved a comparison of the shadowing performance evidenced in the dichotic condition with that measured in the binaural condition. The number of words correctly shadowed, out of the 285 words that were presented in each of the experimental conditions, served as the dependent measures. A correlated groups, Student's 't' revealed a significant Method effect, $t(59) = 3.39$, $p < .01$. As Table 9 shows, this finding indicates that significantly more words were shadowed correctly under the dichotic condition. Mean shadowing scores for the dichotic and binaural conditions were 224.95 and 209.43 respectively. These results agree with prediction 4, and thereby, substantiate the postulate that attentional and perceptual advantages are evidenced under conditions which provide an opportunity to identify competing stimuli as relevant or irrelevant during the early stages of processing.

TABLE 8

The Number of Words Shadowed Correctly Under the Dichotic and Binaural Methods of Stimulus Presentation

Method of Stimulus Presentation			
Dichotic (a_1)		Binaural (a_2)	
Mean	SD	Mean	SD
224.95	34.48	209.43	43.79

Prediction 4: $a_1 > a_2$*

*Observed

Late-Structural

The distinguishing features of the "late-structural" position are that attention limitations are evidenced once all incoming stimulus inputs have attained complete and automatic representation in memory; and that attention, which is superfluous to perceptual analysis, is an essential component of higher-order cognitive activities such as decision-making, comprehension, storage, rehearsal, and retrieval. Employing the same experimental paradigm, Task 3 examined these assumptions concerning the systemic nature of perception in the visual modality whereas Task 4 tested these assumptions in the auditory modality.

Task 3
Visual Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Prediction 5
Correct target detections were expected to be comparable for the two modes of stimulus presentation, that is, the simultaneous versus the sequential condition.

Table 9 presents summary data for the two experimental conditions as well as an equation that expresses the expected outcome. The analysis of the data involved a comparison between the target detections evidenced in the simultaneous and sequential conditions. The number of targets correctly identified, out of the 25 test targets that were presented in each experimental condition, served as the dependent measures. A correlated groups, Student's 't' revealed a significant Method effect, $t(59) = 11.67$, $p < .01$. As Table 10 shows, this finding indicates that significantly more target items were correctly identified in the sequential condition. The mean detection scores for the sequential and simultaneous conditions were 24.97 and 16.95 respectively. Prediction 5 has not been confirmed.

TABLE 9*

The Number of Targets Detected Under the Simultaneous and Sequential Methods of Stimulus Presentation

Method of Stimulus Presentation			
Simultaneous (a_1)		Sequential (a_2)	
Mean	SD	Mean	SD
16.95	5.28	24.97	0.18

Prediction 5: $a_1 = a_2$

*Visual

It appears that two methodological differences may possibly account for the discrepancy between the current findings and those reported by the researchers who originally employed this particular experimental paradigm, Shiffrin, McKay, and Shaffer (1976). Both involve a design change in the present study which may have produced a performance decrement in the simultaneous condition rather than an increment in the sequential condition.

Butler (1980) recognized the importance of distinguishing between two types of test procedures, and consequently, the significance of differentiating between two types of detection errors: mislocation errors which involve the report of an item that was a member of the stimulus array, although not the target item; and intrusion errors which involve the report of a novel item, that is, an item that was not a member of the stimulus array. In the Shiffrin, McKay, and Shaffer (1976) study, the test array presented the stimulus grid of 9 letters intact with the exception that the single target character was deleted. Since the probability of committing a mislocation error was for all practical purposes eliminated, the major error source would have been intrusions. In the present study, however, the test array consisted of a blank grey grid, and the position of the target item was cued by a variation in shading. Consequently, mislocations as well as intrusions were possible sources of error. In fact, a frequency count revealed that 66% of the errors committed were mislocations and 34% of the errors involved intrusions. This difference is statistically significant, $t(59) = 4.68$, $p < .01$. Thus, it appears reasonable to assume that if the probability of making a mislocation error in the simultaneous condition had been substantially reduced, then, target detections may have been comparable for the two modes of stimulus presentation. Specifically, had mislocation errors not occurred, the mean detection rate for the simultaneous condition could have possibly been as high as 22.26. Certainly more similar, if not equal to the mean detection rate measured in the sequential condition (24.97).

A second procedural modification that may have contributed to the noted difference among the results concerns the number of trials that were administered. The Shiffrin, McKay, and Shaffer (1976) study administered a minimum of 10 blocks of test trials for each of the experimental conditions whereas the present study employed one block of test trials for the simultaneous and sequential conditions respectively. The number of trials per block, (73 simultaneous and 25 sequential) were consistent in the two studies. An analysis, computed to test the possibility that additional trials may have increased the number of targets detected in the simultaneous condition, compared performance on the first two and last two test trials, and revealed that more targets were correctly identified at the end of the experimental test block, $t(59) = 1.75$, $.01 < p < .025$. The finding that target detections increased within a single block of trials provides moderate evidence for the hypothesis that additional trials may have raised the detection rate for the simultaneous condition to that correctly observed for the sequential method of stimulus presentation.

Task 4
Auditory Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Prediction 6

Correct target detections were expected to be comparable for the simultaneous and sequential conditions.

Table 10 presents summary data for the two experimental conditions as well as a notational statement of the expected outcome. The analysis of the data involved a comparison between the target detections evidenced in the simultaneous and sequential conditions. The number of targets correctly identified, out of the 40 targets that were presented in each condition, served as the dependent measures. A correlated groups, Student's 't' revealed that there was no significant difference between the two experimental conditions, $t(59) = 1.20$, $p > .01$. The mean detection scores for the sequential and simultaneous conditions were 39.15 and 38.87. This finding agrees with prediction 6, and therefore, substantiates the assumption that the perceptual processing of competing auditory stimuli is complete, automatic, and independent.

Early-Functional

The distinguishing features of the "early-functional" model are that attention operates during the initial phases of perceptual processing; and that attention is a diffuse cognitive resource. Implications of the later formulation include that attention is variable in its influence and actively deployed so as to most suitably accommodate the current processing demands. Tasks 5 and 6 examined these assumptions.

Task 5
Auditory Divided: Primary Task Demands (AD-PDT)

Task 5 was intended to assess the "early functional" position regarding the directable and divisible nature of attention. In addition

TABLE 10**

The Number of Targets Detected Under the

Simultaneous and Sequential Methods of Stimulus Presentation

Method of Stimulus Presentation			
Simultaneous (a_1)		Sequential (a_2)	
Mean	SD	Mean	SD
38.87	1.92	39.15	1.10

Prediction 6: $a_1 = a_2$*

**Auditory

*Observed

to examining the former parameter, prediction 7 also addressed the assumption regarding variable residual capacity. That is, although attention may be allocated to a secondary activity, its quantity will be variable and determined by the capacity exacted by primary processing demands. Prediction 8 tested the premise concerning the directable nature of attention. Specifically, that attention is distributed in such a manner so as to insure the successful completion of high priority activities. Subsequent to this, it is directed towards the analysis of competing stimulus inputs.

<u>Prediction 7</u>
Significantly more target detections were expected under the low-attention-demand condition than under the high-attention-demand condition.

Table 11 presents summary data for those measurements observed on Task 5 which are pertinent to the statistical analysis of prediction 7 as well as a notational statement of the expected outcome. The analysis of the data involved a comparison between the target detections evidenced in the low-attention-demand and high-attention-demand conditions. The number of targets correctly detected, out of the 8 targets that were presented in each condition, served as the dependent measures. A correlated groups, Student's 't' revealed that there was no statistically significant difference between the two conditions, $t(59) = 1.82$, $p > .01$. A visual inspection of Table 11 reveals, however, that targets were generally detected more frequently under the low-attention-demand condition than under the high-attention-demand condition; mean detection scores were 1.60 and 1.22 respectively. Thus, although prediction 7 has not been confirmed, the results suggest a trend in the predicted direction.

TABLE 11

The Number of Targets Detected in the High-and-Low-Attention-Demand Conditions

Attention Demand Condition			
Low (a_1)		High (a_2)	
Mean	SD	Mean	SD
1.60	1.23	1.22	1.48

Prediction 7: $a_1 > a_2$*

*Trend noted in predicted direction

Prediction 8

Comparable shadowing performance was expected to be found under both the high-and-low-attention-demand condition.

Table 12 presents summary data for the two experimental conditions as well.as an equation that specifies the expected outcome. The analysis of the data involved a comparison of the shadowing performance evidenced in the low-attention-demand condition with that measured in the high-attention-demand condition. The number of words, out of the 285 words that were presented in each condition, correctly shadowed, served as the dependent measures. A correlated groups, Student's 't' revealed that there was a significant Demand effect, $t(59) = 10.03$, $p < .01$. As Table 12 shows, this finding indicates that significantly more words were correctly shadowed in the low-attention-demand condition than in the high-attention-demand condition; mean shadowing scores were 234.72 and 180.77 respectively. Prediction 8 has not been confirmed. It should be noted that comparable findings were reported by Rinder (1974), when he employed a similar paradigm.

Although the findings related to predictions 7 and 8 appear to raise questions concerning the divisible and directable aspects of attention, they may also be quite consistent with the theory. That is, the predictions assumed a ranking of the two experimental activities; target detection was regarded as secondary to shadowing. The task instructions, however, may not have made this distinction sufficiently clear. Consequently, the subjects may have considered the activities comparable and proceeded to employ either a time or a demand sharing strategy. Sharing attention between the two activities could have increased the attention given to detecting targets by decreasing the

TABLE 12

The Number of Words Shadowed in the

High-and-Low-Attention-Demand Conditions

Attention Demand Condition			
Low (a_1)		High (a_2)	
Mean	SD	Mean	SD
234.72	35.91	180.77	43.48

Prediction 8: $a_1 = a_2$

amount of capacity directed towards shadowing. The employment of a sharing strategy then, can possibly explain the performance evidenced under the high-attention-demand condition; that is, in comparison to the predictions, more targets were detected but fewer words were shadowed correctly.

Task 6
Auditory Divided: Recall Expectancies (AD-RE)

Task 6, similar to Task 5, was intended to assess the "early-functional" assumptions regarding the directable (prediction 9) and divisible (prediction 10) nature of attention. In addition to this, prediction 9 also examined the premise that stimuli which are processed with reduced attentional focus tend to attain a weakened, and more fragile representation in memory.

Prediction 9
Digit recall from either the shadowed or nonshadowed message was expected to be greater under those conditions in which subjects were instructed to expect such recall demands.

Table 13 presents summary data for those measurements collected on Task 6 which are pertinent to prediction 9. Further clarification is provided by the subsequent equation which restates the prediction in terms of the notation that was employed to outline the experimental design.

Due to the unequal number of trials in the various experimental conditions (NS-NS and S-S were each comprised of 15 trials whereas NS-S and S-NS each contained 10 trials), all statistical analyses were computed on converted data. Specifically, each subject's score in the NS-NS and S-S conditions was multiplied by a factor of two whereas the NS-S and S-NS scores were multiplied by a factor of three.

A 2 x 2 analysis of variance was computed (Table 14). Factor 'A'

TABLE 13

The Number of Digits Recalled According to Expectation and Test Channel

		Test (B)				
		Nonshadowed (b_1)		Shadowed (b_2)		
		Mean	SD	Mean	SD	Mean (A)
Expectation (A)	Nonshadowed (a_1)	39.95	7.00	59.9	5.32	49.7
	Shadowed (a_2)	34.7	5.70	67.8	5.40	51.2
	Mean (B)	37.1		63.8		

Prediction 9: $ab_{11} > ab_{21}$

$ab_{22} > ab_{12}$*

*Observed

TABLE 14

Summary of the Analysis of Variance for the Number of Digits Recalled According to Expectation and Test Channel

Source of Variation	SS	df	MS	F
Expectation Channel (A)	144.15	1	144.15	5.31
Expectation x Subj.	1,602.35	59	27.16	
Test Channel (B)	42,933.75	1	42,933.75	186.58*
Test x Subj.	13,567.75	59	230.11	
Expectation x Test	2,419.35	1	23,419.35	11.68*
Expectation x Test x Subj.	12,222.15	59	207.16	

*$p < .01$

pertains to the expectation channel; that is, the channel (nonshadowed/a_1 or shadowed/a_2) from which subjects expected to recall digits. Factor 'B' pertains to the test channel; specifically, the channel (nonshadowed/b_1 or shadowed/b_2) from which subjects were required to recall digits. The number of digits correctly recalled, irrespective of the order of report, served as the dependent measure. Considering the conversion procedure, a maximum of 90 digits could have possibly been recalled in each of the experimental conditions.

The ANOVA analyses revealed a significant Expectation x Test interaction, $F(1,59) = 11.68$, $p < .01$. The analyses of variance for simple effects for Test according to Expectation indicated that the number of digits correctly recalled from the shadowed channel were significantly greater when subjects expected to recall from the shadowed channel, $F(1,118) = 15.98$, $p < .01$. An Expectation advantage, however, was not evident in the nonshadowed condition. That is, the number of digits correctly recalled on the nonshadowed channel did not significantly increase when subjects expected to recall from the nonshadowed channel, $F(2,118) = 5.90$, $p > .01$ (Table 15, Appendix L_4). An inspection of Table 13 reveals, however, that nonshadowed targets were generally recalled more frequently when subjects expected to recall from the nonshadowed channel. The mean recall scores for the expected nonshadowed and expected shadowed conditions were 39.5 and 34.7 respectively. Thus, although prediction 9 has not been completely confirmed, the results suggest a trend in the predicted direction.

The ANOVA analyses also revealed a significant Test Channel effect, $F(1,59) = 186.58$, $p < .01$. As Table 13 shows, this finding indicates that significantly more digits were correctly recalled from the shadowed channel. The mean recall scores for the shadowed and the nonshadowed channels were 63.8 and 37.1 respectively. Although this result was not predicted, it is nonetheless compatible with the formulations of the "early-functional" theorists. Actually, it may be considered a serendipitous confirmation of their position regarding the function served by attention during perceptual analysis.

> Prediction 10
> Poorer shadowing performance was expected to be evidenced under those conditions in which subjects were instructed to expect to recall digits from the nonshadowed as opposed to the shadowed channel.

Table 16 reports summary data for those measurements collected on Task 6 which are pertinent to prediction 10. It also presents a restatement of the prediction in terms of the notation that was employed to outline the experimental design in the table.

In addition to the transformation procedure that was previously discussed, the statistical testing of prediction 10 required that the raw data be collapsed across the Test Channel variable. Therefore, the analysis of the data involved a comparison of the shadowing performance evidenced in the nonshadowed expectation condition with that measured in the shadowed expectation condition. The number of digits correctly shadowed, out of a possible 600 digits, served as the dependent measures. A correlated groups, Student's 't' revealed that there was no significant difference between the two experimental conditions, $t(59) = 2.00$, $p > .01$. As Table 16 shows, however, digits were more frequently shadowed correctly under the shadowed expectation condition. Mean shadowing scores for the shadowed and nonshadowed conditions were 566.10

TABLE 16

The Number of Digits Correctly Shadowed for the Nonshadowed and Shadowed Expectation Channels

Expectation Channel			
Nonshadowed (a_1)		Shadowed (a_2)	
Mean	SD	Mean	SD
556.88	76.06	566.10	91.34

Prediction 10: $a_1 < a_2$*

*Trend noted in predicted direction

and 556.88 respectively. Thus, although prediction 10 was not confirmed, the results suggest a trend in the appropriate direction. In summary, the findings of task 6, that is, the Test Channel effect evidenced in the analyses of recall scores, and the trends noted in regard to predictions 9 and 10, support the "early-functional" position regarding the active deployment, the divisibility, and the early intervention of attention.

Late-Functional

The distinguishing features of the "late-functional" position are that attention operates upon the retention, but not the perception, of sensory information; and that attention may be differentially required to process different stimulus inputs. Tasks 7 and 8 examined these assumptions.

Task 7
Visual Divided: Consistent versus Varied Mapping (VD-CVM)

Task 7 was intended to assess the formulations concerning automatic and controlled processing. The concept of automatic processing implies that through repeated and consistent mapping, capacity requirements progressively diminish so that sensory stimuli may eventually be processed and responded to without the mediation of attention. Controlled processing, on the other hand, requires that attention be directed towards the memory unit responsible for the analysis of relevant information. That is, although all competing stimuli automatically activate their respective memory units, this activation is temporary and information rapidly decays unless attention maintains the activation. The theory underlying the assumption that these processes are confined to memory systems was previously discussed in the Introduction section under "Tasks." Prediction 12 was concerned with automatic processing; prediction 13 addressed controlled processing; and prediction 11 examined the differences among the two methods.

Prediction 11
Shorter response latencies and fewer detection errors were expected to be evidenced in the consistent mapping condition as opposed to the varied mapping condition. Moreover, the response differences observed in comparing the performance yielded by the consistent mapping condition with that yielded by the varied mapping condition were expected to increase as the amount of processing required to perform the task (information load) increased.

Prediction 12
In the consistent mapping condition, reaction times and detection scores were expected to be comparable across trials varying in information load.

Prediction 13
In the varied mapping condition, reaction times and detection errors were expected to increase as the information load increased.

Considering that so few detection errors were evidenced, approximately .01%, only reaction times to correct target detections served as the dependent measure. Specifically, each of the 18 experimental conditions consisted of 8 trials. Latency scores were computed for each condition by measuring each subject's mean reaction time to the respective group of 8 trials. Table 17 presents summary data in the form of cell means for the various experimental conditions. Restatements of predictions 11, 12, and 13 in terms of the notation that is employed to outline the experimental design in the table is also included. Further clarification of the results is provided by Figure 8 which presents plots of the data reported in Table 17 as well as the slopes for the various regression lines.

TABLE 17

Mean Reaction Times to the Consistent and Varied Mapping Trials at the Various Levels of Information Load

		Mapping (A)					
		Consistent (a_1) Stimulus (C)			Varied (a_2) Stimulus (C)		
		1 Item (C_1)	2 Items (C_2)	4 Items (C_3)	1 Item (C_1)	2 Items (C_2)	4 Items (C_3)
	1 Item (b_1)	.66	.71	.75	.68	.71	.79
Target (B)	2 Items (b_2)	.71	.76	.84	.77	.86	1.05
	4 Items (b_3)	.76	.89	.88	.92	1.17	1.52
	Mean (a_1) = .77		SD a_1 = .08		Mean a_2 = .94		SD a_2 = .27

Prediction 11: A significant Main Effect of A, where $a_1 < a_2$*
A significant A x B x C interaction *

Prediction 12: Analysis of simple effects at a_1:
a) a nonsignificant B effect
b) a nonsignificant C effect
c) a nonsignificant B x C interaction*

Prediction 13: Analysis of simple effects at a_2:
a) a significant B effect*
b) a significant C effect*
c) a significant B x C interaction*

*Observed

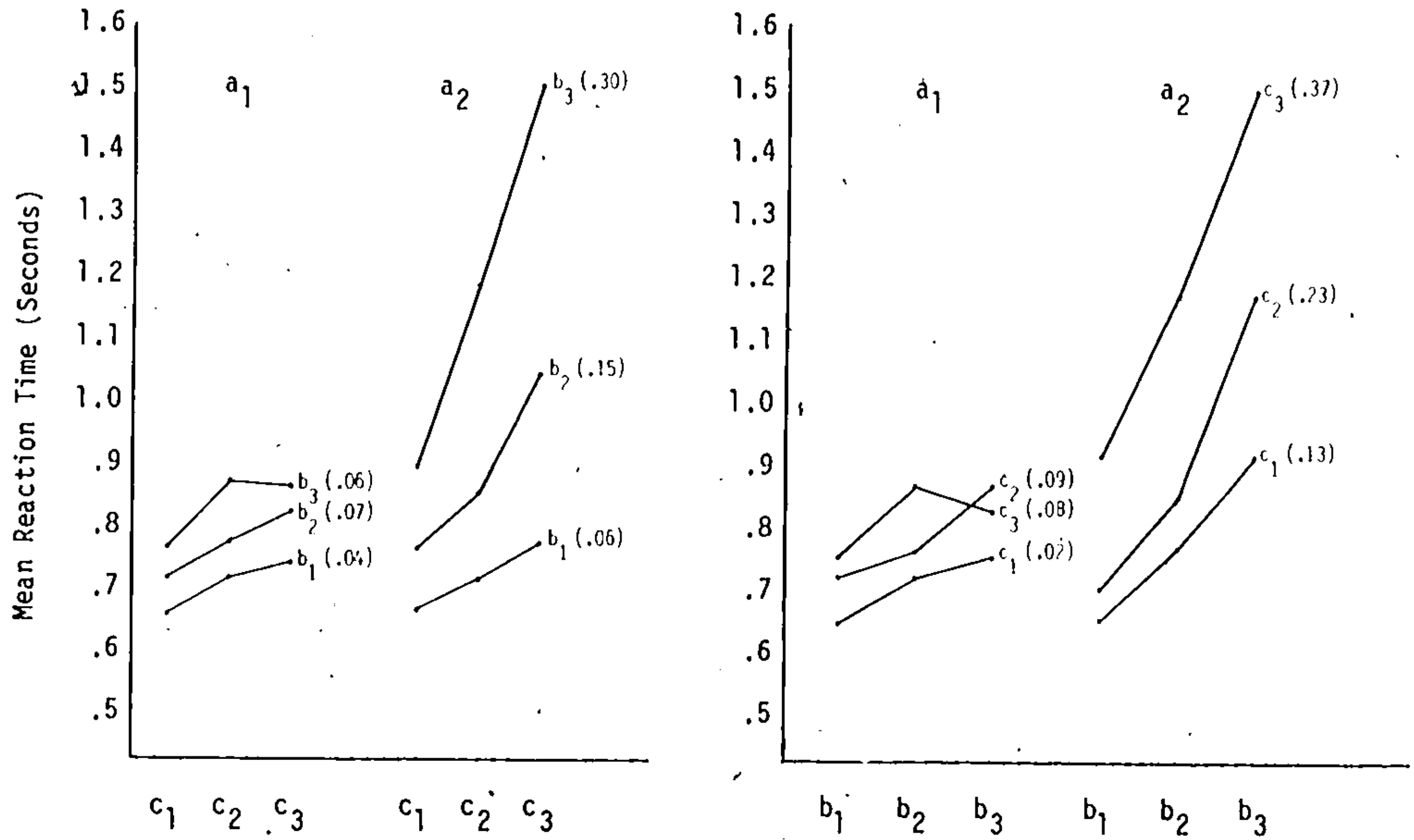


Figure 8. Mean reaction times to the consistent and varied mapping trials (A) at the various levels of Target (B) and Stimulus (C). (Two plots of the data presented in Table 17. Included in the parantheses are the slopes of the regression lines. The representation of factors B and C is reversed in the two plots).

A 2 x 3 x 3 analysis of variance was computed (Table 18). Factor 'A' pertains to the mapping condition (consistent/a_1 or varied/a_2); Factor 'B' pertains to the size of the target/memory set (1/b_1, 2/b_2, or 4/b_3 items); and Factor 'C' pertains to the size of the stimulus/test array (1/c_1, 2/c_2; or 4/c_3 items).

Since the ANOVA revealed that the three main effects and all interaction effects were statistically significant, $p < .01$, a number of secondary analyses were computed. In light of the fact that at the theoretical and empirical (Condition x Target x Stimulus interaction) level alike, the findings of primary interest concern the differences between the consistent and varied mapping trials, subsequent reporting of the results will follow this partitioning.

Analyses of the simple effects for the consistent mapping trials (a_1) revealed that the Target x Stimulus interaction was not significant, $F(4,708) = 1.9$, $p > .01$ (Table 19). The analysis did show, however, that there was a significant Target effect, $F(2,826) = 42.0$, $p < .01$, as well as a significant Stimulus effect, $F(2,826) = 31.2$, $p < .01$. As visual inspections of Figure 8 and Table 17 show, these results indicate that increments in information load, regardless of their origin (Target or Stimulus), produced significant increases in response latencies. These latter findings challenge prediction 12.

In regard to the varied mapping trials, simple effects analyses revealed a significant Target x Stimulus interaction, $F(4,708) = 46.38$, $p < .01$. Furthermore, analyses of the simple, simple main effects indicated that reaction times significantly increased each time the Target and Stimulus were increased in size (Table 20, Appendix M_4).

TABLE 18

Summary of the Analysis of Variance for the Mean Reaction Times to the Consistent and Varied Mapping Trials at the Various Levels of Information Load

Source of Variation	SS	df	MS	F
Mapping (A)	7.44	1	7.44	186*
Mapping x Subj.	2.23	59	.04	
Target (B)	17.32	2	8.66	216.5*
Target x Subj.	5.08	118	.04	
Stimulus (C)	9.20	2	4.60	4600*
Stimulus x Subj.	.13	118	.001	
Mapping x Target	5.55	2	2.78	139*
Mapping x Stimulus	2.53	2	1.27	63.5*
Target x Stimulus	2.15	4	.54	27*
Map x Target x Stimulus	1.72	4	.43	21.5*
ABC x Subj.	15.26	708	.02	

$*p < .01$

TABLE 19

An Analysis of the Simple Effects for the Consistent Mapping Trials (a_1)

Source of Variation	SS	df	MS	F
Target (B)	1.69	2	.84	42*
B x Subj. + ABC x Subj.	20.34	826	.02	
Stimulus (C)	1.25	2	.625	31.2*
C x Subj. + ABC x Subj.	15.39	826	.02	
Target x Stimulus	.15	4	.038	1.9
ABC x Subj.	15.26	708	.02	

*$p < .01$

These results are in agreement with prediction 13.

Various indices, Table 17, the slopes reported in Figure 8, and the results presented thus far, suggest that although the latency increments which accompanied increases in information load were similar in the two mapping conditions, the effects were consistently and significantly more pronounced for the varied mapping trials. That is, the changes in reaction times were in the same direction, but not to the same degree, for the two treatments. Additional statistical evidence in support of this observation includes: 1) a significant Mapping effect, $F(1,59) = 186$, $p < .01$, (Table 18); and 2) F ratios from the analysis of simple effects, that specifically compared performance under the two conditions at the various levels of Target and Stimulus (Table 21). These results are in agreement with prediction 11.

The failure to confirm prediction 12, that is, the discrepancies between the present findings and those reported by Schneider and Shiffrin (1977), requires an examination of procedural differences between the two studies. A notable difference is the number of trials administered. The Schneider and Shiffrin (1977) study employed 14 experimental sessions. Throughout this period, 36 blocks, each comprised of 120 trials, were administered. The current study employed one experimental session, during which time 18 blocks of 8 trials were presented. Performance changes resulting from the exposure to additional trials may reflect either subjects' adjustment to experimental tasks or more basic changes in the processes that these tasks are intended to measure. Although it is difficult to determine at this time which of these two changes may have been operative in the consistent mapping paradigm, an inspection

TABLE 21

An Analysis of the Simple Effects for the Mapping Condition (A)

Source of Variation	SS	df	MS	F
A at b_1	.02	1	.02	1.00
A at b_2	1.40	1	1.40	70*
A at b_3	11.56	1	11.56	578*
A at c_1	.54	1	.54	27*
A at c_2	1.36	1	1.36	68*
A at c_3	6.91	1	6.91	345*
A x Subj. + ABC x Subj.	17.49	767	.02	

*$p < .01$

of Figure 8 suggests the former. Specifically, in the consistent mapping condition reaction times appear to have been stabilizing, even at the higher levels of information load. In the varied mapping condition, however, response latencies continued to increase. On this basis, it appears reasonable to assume that the varying response latencies evidenced in the consistent mapping condition may have been more indicative of subjects' unfamiliarity with the experimental task than changes which occurred in perceptual processes due to the increased information load.

The findings of Task 7 then, support the distinction between two methods of processing information. Evidence in this regard is obtained via the confirmation of prediction 11. The failure to confirm prediction 12 suggests that although the amount of attention which is required to complete a particular cognitive activity may substantially diminish through repeated and consistent performance, there may be a lower limit to this reduction.

Task 8
Visual Focused/Divided: Patterns (VF/D-P)

Task 8 was intended to examine two parameters of the "late-functional" position: a) the active deployment of attention prepares an organism to receive certain information, and by so doing enhances the processing of that information; and b) with practice the amount of attention which is initially required to organize and analyze new information progressively decreases. The assumptions regarding the directional nature of attention were tested via predictions 14 and 15. Prediction 16 addressed the idea of variable and progressively decreasing demand.

Prediction 14
For the primary trials, mean correct response latencies to unfamiliar letter patterns were expected not to exceed mean correct response latencies to familiar letter patterns.

Table 22 presents summary data for those measurements collected on Task 8 which are pertinent to the verification of prediction 14; that is, mean reaction times for correct responses on primary trials. Each primary trial required a comparison between a single cue character and a single stimulus character. Thirty-two primary trials employed familiar letters for cue and stimulus, and 32 trials presented unfamiliar letters. The two dependent measures then, consisted of the mean response latencies observed for the 32 familiar and unfamiliar trials respectively. The analysis of the data involved a comparison of these two measures. A correlated groups, Student's 't' revealed a significant Letter effect, $t(59) = 2.65$, $p < .01$. As Table 22 shows, this finding indicates that the mean response latencies to the familiar letters exceeded the reaction times to the unfamiliar letters. The mean reaction times were .73 and .72 respectively. These results are in agreement with prediction 14.

Prediction 15
For the secondary trials, mean correct response latencies for unfamiliar letters were expected to be greater than mean correct response latencies for familiar letter patterns.

Prediction 16
Differences in reaction times between familiar and unfamiliar letter patterns on the secondary trials were expected to decrease as subjects received additional exposure to the unfamiliar letter patterns.

Table 23 presents summary data for the secondary trials, where subjects were required to disregard the single cue character and instead compare the two simultaneously presented stimulus characters. On each

TABLE 22

Mean Reaction Times to Correct Responses to Familiar and Unfamiliar Letters on Primary Trials

Letter Pattern			
Familiar (a_1)		Unfamiliar (a_2)	
Mean	SD	Mean	SD
.73	.12	.72	.11

Prediction 14: $a_1 \geq a_2$*

*Observed

TABLE 23

Mean Reaction Times to Correct Responses to Familiar and Unfamiliar Letters on Secondary Trials

		Days (B)						
		Day 1 (b_1)		Day 2 (b_2)		Day 3 (b_3)		
		Mean	SD	Mean	SD	Mean	SD	Mean (A)
Letter Patterns (A)	Familiar (a_1)	.87	.11	.83	.13	.80	.11	.83
	Unfamiliar (a_2)	.92	.12	.86	.12	.81	.12	.86
	Mean (B)	.90		.84		.80		

Prediction 15: $a_1 < a_2$*

Prediction 16: $b_1 > b_2 > b_3$*

$ab_{21} - ab_{11} > ab_{22} - ab_{12} > ab_{23} - ab_{13}$*

*Observed

day of experimentation, 24 secondary trials were administered; 12 employed familiar letters whereas 12 employed unfamiliar letters. The mean reaction times, to the 8 positive trials which presented the respective letter patterns, served as the dependent measures.

A 2 x 3 analysis of variance was computed (Table 24). The ANOVA revealed a significant Letter effect, $F(1,59) = 50.0$, $p < .01$, indicating that reaction times to unfamiliar letters were significantly greater than to familiar letters (mean response latencies were 51.91 and 49.99 respectively). Prediction 15 thus was supported.

In regard to prediction 16, the ANOVA revealed a significant Day effect, $F(2,118) = 29.38$, $p < .01$, as well as a significant Letter x Day interaction, $F(2,118) = 5.00$, $p < .01$. A Newman-Keuls test computed for the Day effect showed that reaction times decreased progressively over the three successive days (Table 25, Appendix N_4). In light of the fact that a decrease occurred both for the familiar $F(2,236) = 15.00$, $p < .01$, as well as the unfamiliar letters $F(2,236) = 45.00$, $p < .01$, it was important to determine if the decrease was comparable for the two conditions (Table 26, Appendix N_4). An analysis of simple main effects revealed that although there was a significant difference between the reaction times to familiar and unfamiliar letters on Day 1, $F(1,177) = 55$, $p < .01$, and Day 2, $F(1,177) = 10.00$, $p < .01$; there was no significant difference evidenced on Day 3, $F(1,177) = 5.00$, $p > .01$ (Table 27, Appendix N_4). An ANOVA, comparing the slopes of the regression lines for response latencies over the three days of experimentation, corroborated this latter finding by indicating a significant Letter effect, $F(1,59) = 19.00$, $p < .01$ (Table 28, Appendix N_4).

TABLE 24

Summary of the Analysis of Variance of

Mean Reaction Times to Familiar and Unfamiliar Letters

on Secondary Trials

Source of Variation	SS	df	MS	F
Letters (A)	.10	1	.100	50.00*
Letters x Subj.	.14	59	.002	
Days (B)	.47	2	.235	29.38*
Days x Subj.	.89	118	.008	
Letters x Days	.02	2	.010	5.00*
Letters x Days x Subj.	.23	118	.002	

*$p < .01$

In summary then, these results indicate that the longest reactions times to familiar as well as unfamiliar letters were measured on Day 1. The difference between the groups was also largest at this time. Over the successive days of experimentation, response latencies to both letter types decreased, as did the differences between them. That is, the shortest reaction times for both groups as well as the smallest difference between the groups was observed on Day 3. This pattern of results supports prediction 16.

<u>Summary</u>

As a general summary of the results, Table 29 relates the 8 experimental tasks to the four major models of attention, and also indicates the number of predictions that have been confirmed. An inspection of Table 29 reveals that 12 of the 16 predictions were supported by the statistical analyses or showed trends in the expected direction. The current findings then, appear consistent with, and generally representative of the findings reported in attention research. Beyond this global result, the pattern of the results indicates that the major positions have all, to varying degrees, received empirical support. As Table 29 indicates, the "late-functional" position has had the largest percentage of its predictions substantiated. The "early-functional" position appears the most tenuous in that its support has been obtained exclusively through predicted trends.

Analyses of Major Hypotheses

The primary objective of the present study was to assess the validity of conceptualizing selective attention as a variable process. It was

TABLE 29

Relationship Between Tasks, Predictions

and Models of Attention

Capacity of Attentional Operations	Locus of Attentional Operations: Early	Late
	Early	Late
Structural	Task 1 (Auditory) _1_ 2 _3_	Task 3 (Visual) 5
	Task 2 (Auditory) _4_	Task 4 (Auditory) _6_
Functional	Task 5 (Auditory) 7* 8	Task 7 (Visual) _11_ 12 _13_
	Task 6 (Auditory) 9* 10*	Task 8 (Visual) _14_ _15_ _16_

___ Prediction Confirmed

* Trend Noted in Predicted Direction

hypothesized that attention is comprised of two bipolar dimensions. The Locus dimension indicates flexibility in regard to the point at which attentional processes intervene in the perceptual cycle, that is, "early" or "late." The Capacity dimension indicates variability regarding the source of attentional limitations, that is, "structural" or "functional." The specific experimental tasks which were expected to intercorrelate so as to distinguish these two dimensions are presented in Table 29.

In order to determine if the theoretical distinctions would obtain empirical confirmation through the emergence of two primary factors, A Principal Axes Factor Analysis (Statistical Analysis System (SAS); Helwig & Council, 1979) with Varimax rotation was performed on the dependent measures generated from the eight experimental tasks. The 38 variables that were used to produce the correlation matrix are presented in Table 30. So as to insure that a comparable number of variables were included for each of the experimental tasks, the initial 18 measures which were collected on Task 7 were condensed to an eventual four measures for the principal components analysis. Specifically, the original data was collapsed across the Target and Stimulus variables so that the consistent and varied mapping conditions were represented by their respective means and standard deviations.

The first 12 eigenvalues yielded by the initial principal components analysis are presented in Figure 9. An examination of the eigenvalue plot suggested that five factors be retained for rotation; and furthermore, that the structures resulting from a rotation of three, four, and five factors be evaluated in order to determine the most appropriate factor

TABLE 30

The 38 Variables Producing the Intercorrelation Matrix

Variable Abbreviation	Variable Description
T1___	Task 1
T1PTS	Phonetic condition, number of targets detected on shadowed channel
T1PSS	Phonetic condition, number of words shadowed after the presentation of targets on shadowed channel
T1PTN	Phonetic condition, number of targets detected on nonshadowed channel
T1PSN	Phonetic condition, number of words shadowed after the presentation of targets on the nonshadowed channel
T1STS	Semantic condition, number of targets detected on shadowed channel
T1SSS	Semantic condition, number of words correctly shadowed after the presentation of a target on shadowed channel
T1STN	Semantic condition, number of targets detected on the nonshadowed channel
T1SSN	Semantic condition, number of words shadowed after the presentation of a target on the nonshadowed channel
T2___	Task 2
T2D	Number of words correctly shadowed in the dichotic condition
T2B	Number of words correctly shadowed in the binaural condition
T3___	Task 3
T3SM	Correct target detections in the simultaneous condition

Continued ...

TABLE 30 CONTINUED

Variable Abbreviation	Variable Description
T3SQ	Correct target detections in the sequential condition
T4___	Task 4
T4SM	Correct target detections in the simultaneous condition
T4SQ	Correct target detections in the sequential condition
T5___	Task 5
T5LOT	Low-attention-demand condition, number of targets detected
T5LOS	Low-attention-demand condition, number of words shadowed
T5HIT	High-attention-demand condition, number of targets detected
T5HIS	High-attention-demand condition, number of words shadowed
T6___	Task 6
T6NNR	NN condition, number of digits recalled
T6SSR	SS condition, number of digits recalled
T6NSR	NS condition, number of digits recalled
T6SNR	SN condition, number of digits recalled
T6NNS	NN condition, number of digits shadowed
T6SSS	SS condition, number of digits shadowed
T6NSS	NS condition, number of digits shadowed
T6SNS	SN condition, number of digits shadowed
T7___	Task 7
T7CM	Consistent mapping condition, mean score
T7CS	Consistent mapping condition, standard deviation

Continued ...

TABLE 30 CONTINUED

Variable Abbreivation	Variable Description
T7VM	Varied mapping condition, mean score
T7VS	Varied mapping condition, standard deviation
T8___	Task 8
T8PO	Primary trials, familiar letters, response latencies
T8PN	Primary trials, unfamiliar letters, response latencies
T81SO	Secondary trials, day 1, familiar letters, response latencies
T82SO	Secondary trials, day 2, familiar letters, response latencies
T83SO	Secondary trials, day 3, familiar letters, response latencies
T81SN	Secondary trials, day 1, unfamiliar letters, response latencies
T82SN	Secondary trials, day 2, unfamiliar letters, response latencies
T83SN	Secondary trials, day 3, unfamiliar letters, response latencies

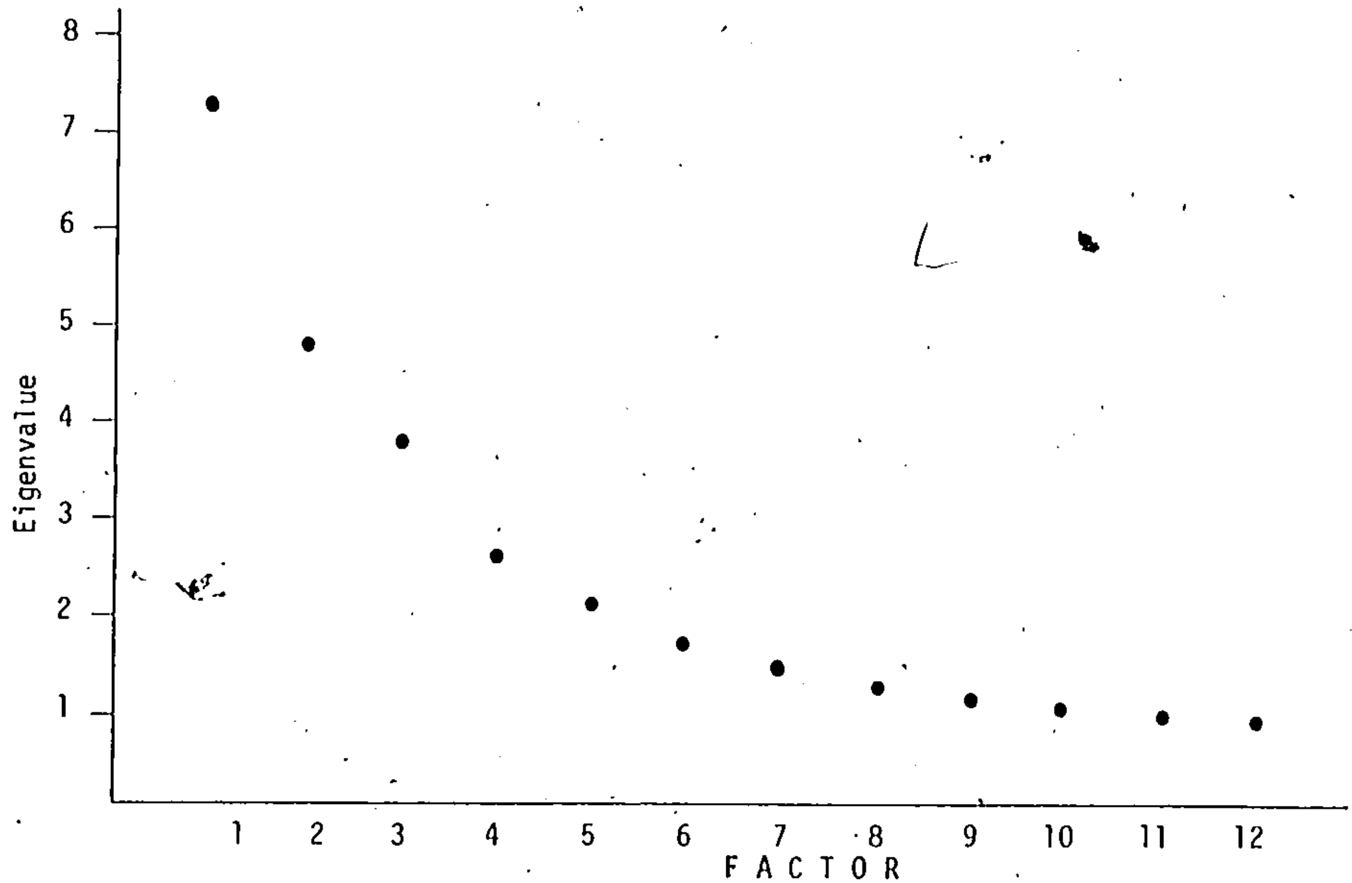


Figure 9. Eigenvalue Distribution of the First Twelve Factors Yielded by the Principal Components Analysis

solution. The pre-rotated factor pattern is presented in Table 31; the rotated factor patterns for the three, four, and five factor solutions are presented in Tables 32, 33, and 34 respectively.

In extracting the most appropriate factor structure, primary consideration was given to: 1) identifying the factor pattern that provided the most discriminability among factor loadings; 2) assessing the value of adding factors to the solution in terms of the amount of additional variance that was explained; and 3) evaluating the meaningfulness of the possible solutions. Generally only those variables whose loadings were greater than .50 were considered to belong to that factor. Loadings ranging from .40 to .49 were examined, however, so as to discover further information that may have contributed to identifying the factor.

Employing these general criteria, the three factor solution was determined to be the most appropriate. Specifically, a comparison of the various factor patterns revealed that the three factor solution yielded the cleanest structure (Tables 32, 33, and 34). The loadings associated with the three factor solution were generally in the vicinity of .70 whereas the four and five factor solutions contained a number of .50 loadings.

Moreover, the three factor solution appeared to be the most discriminating in that the loadings were either quite high ($>.70$) or quite low ($<.20$). There was also a large decrement in the amount of variance that was accounted for by the third and fourth factors. The third factor explained approximately 12% of the variance whereas the fourth and fifth factors accounted for approximately 7% and 8% of the variance.

TABLE 31

Pre-rotated Factor Pattern

Five Factor Solution

Variable	FACTOR 1	2	3	4	5
T1PTS	.20	.25	.08	.42	.02
T1PSS	.40	.28	-.42	-.22	.04
T1PTN	-.26	.04	-.02	.55	.33
TIPSN	.20	.10	-.28	-.43	-.29
T1STS	.24	.42	-.24	.38	.05
T1SS	.23	.29	-.33	.04	.04
T1STN	-.41	-.33	.22	-.19	.34
T1SSN	.27	.42	-.53	.28	-.18
T2D	.19	.38	-.63	-.15	-.19
T2B	.47	.47	-.42	-.02	.12
T3SM	-.31	-.34	-.25	-.16	.18
T3SQ	.12	.11	-.25	.54	-.36
T4SM	.06	-.26	.10	.36	-.07
T4SQ	-.14	.05	.01	-.55	-.01
T5LOT	-.14	.06	-.05	.29	.36
T5LOS	.33	.25	-.40	-.12	.09
T5HIT	-.31	.04	.18	.34	.48
T5HIS	.30	.39	-.52	-.31	-.30
T6NNR	.25	.32	.07	.33	-.24
T6SSR	.23	.31	.36	-.26	-.20
T6SNR	.14	.46	.10	-.12	-.02
T6NSR	.02	.54	-.11	.41	.00
T6NNR	.03	.62	.58	-.02	-.16
T6SSR	.05	.56	.64	-.08	-.08
T6SNR	.01	.59	.46	.02	-.32
T6NSR	-.02	.52	.70	-.10	-.06
T7CS	.55	-.50	.12	.19	-.38
T7CM	.43	-.50	-.14	.22	-.09
T7VS	.47	-.57	.02	.18	-.43
T7VM	.35	-.44	.07	.18	-.44
T8PO	.72	.15	.14	.11	.30
T8PN	.76	.08	.19	.03	.30
T81SO	.82	.02	.15	.01	.37
T82SO	.86	-.23	.18	-.01	.10
T83SO	.79	-.21	.10	-.10	.20

Continued ...

TABLE 31 CONTINUED

Variable	FACTOR 1	2	3	4	5
T81SN	.77	.04	.12	-.08	.22
T82SN	.79	-.27	.27	.03	-.02
T83SN	.78	-.19	.11	-.13	.16
Variance Explained	7.31	4.80	3.80	2.64	2.24
Percentage of Variance Explained	19.2	12.6	10.0	6.9	5.9

TABLE 32

Varimax Rotated Factor Pattern

Three Factor Solution

Variable	FACTOR 1	2	3
T1PTS	.10	.28	.15
T1PSS	.17	.02	.63
T1PTN	-.26	-.03	-.06
T1PSN	.08	-.06	.34
T1STS	.01	.21	.50
T1SSS	.03	.05	.50
T1STN	-.20	-.18	-.50
T1SSN	-.02	.03	.73
T2D	-.10	-.07	.75
T2B	.16	.18	.76
T3SM	-.20	-.47	-.11
T3SQ	.01	-.05	.30
T4SM	.17	-.12	-.19
T4SQ	-.15	.02	-.04
T5LOT	-.16	-.01	.02
T5LOS	.12	-.01	.56
T5HIT	-.26	.09	-.23
T5HIS	.01	.01	.72
T6NNR	.11	.34	.22
T6SSR	.16	.50	-.02
T6SNR	-.03	.43	.22
T6NSR	-.21	.35	.38
T6NNS	-.10	.84	-.09
T6SSS	-.05	.84	-.15
T6SNS	-.12	.73	-.02
T6NSS	-.08	.83	-.25
T7CM	.71	-.20	-.14
T7CS	.55	-.39	.00
T7VM	.65	-.33	-.14
T7VS	.50	-.23	-.15
T8PO	.62	.33	.26
T8PN	.70	.31	.20
T81SO	.77	.25	.22
T82SO	.89	.09	.08
T83SO	.81	.04	.13
T81SN	.70	.25	.23
T82SN	.87	.11	-.04
T83SN	.80	.06	.12

Continued ...

TABLE 32 CONTINUED

Variable	FACTOR 1	2	3
Variance Explained	6.80	4.48	4.62
Percentage of Variance Explained	17.9	11.8	12.2

Note: The underlined factor loadings indicate the variables which were considered to belong to that factor and as such were examined in order to identify the factor.

TABLE 33

Varimax Rotated Factor Pattern

Four Factor Solution

Variable	FACTOR 1	2	3	4
T1PTS	.17	.21	.11	.45
T1PSS	.15	-.01	.65	-.16
T1PTN	-.20	-.08	-.14	.56
T1PSN	.03	-.04	.40	-.40
T1STS	.07	.13	.46	.45
T1SSS	.04	.01	.49	.10
T1STN	-.23	-.12	-.48	-.24
T1SSN	.02	-.04	.69	.37
T2D	-.12	-.09	.76	-.05
T2B	.17	.12	.76	.07
T3SM	-.25	-.43	-.11	-.21
T3SQ	.07	-.14	.22	.56
T4SM	.20	-.17	-.24	.29
T4SQ	-.08	-.04	-.11	.55
T5LOT	-.13	-.04	-.02	.31
T5LOS	.11	-.02	.57	-.07
T5HIT	-.21	.07	-.27	.35
T5HIS	-.02	.01	.75	-.22
T6NNR	.18	.27	.18	.38
T6SSR	.16	.52	.04	-.21
T6SNR	-.01	.44	.25	-.04
T6NSR	-.13	.28	.33	.52
T6NNS	-.04	.84	-.05	.08
T6SSS	.01	.85	-.11	.01
T6SNS	-.07	.73	.00	.12
T6NSS	-.03	.85	-.20	-.02
T7CM	.71	-.26	-.17	.06
T7CS	.54	-.44	-.04	.10
T7VM	.64	-.38	-.17	.04
T7VS	.50	-.27	-.18	.07
T8PO	.65	.26	.26	.10
T8PN	.72	.26	.22	.00
T81SO	.78	.19	.23	-.03
T82SO	.89	.04	.09	-.10
T83SO	.80	.00	.15	-.18
T81SN	.71	.20	.26	-.11
T82SN	.87	.06	-.03	-.07

Continued ...

TABLE 33 CONTINUED

Variable	FACTOR 1	2	3	4
T83SN	.78	.03	.15	-.20
Variance Explained	6.78	4.36	4.66	2.74
Percentage of Variance Explained	17.8	11.5	12.3	7.2

Note: The underlined factor loadings indicate the variables which were considered to belong to that factor and as such were examined in order to identify the factor.

TABLE 34

Varimax Rotated Factor Pattern

Five Factor Solution

Variable	FACTOR 1	2	3	4	5
T1PTS	.14	.25	.22	.16	.36
T1PSS	.24	-.06	.57	-.14	-.26
T1PTN	-.[illegible]	-.10	.01	-.05	.68
T1PSN	.00	-.02	.29	-.01	-.56
T1STS	.09	.15	.56	.06	.31
T1SSS	.09	-.01	.49	-.06	.00
T1STN	-.09	-.23	-.55	-.32	.07
T1SSN	-.05	.03	.78	.17	.08
T2D	.04	-.18	.70	-.31	-.11
T2B	.29	.06	.73	-.15	-.04
T3SM	-.18	-.48	-.17	-.18	-.06
T3SQ	-.17	.05	.41	.51	.24
T4SM	-.06	-.08	-.14	.36	.24
T4SQ	-.17	.04	.05	.22	.49
T5LOT	-.01	-.11	.04	-.17	.45
T5LOS	.20	-.09	.52	-.14	-.14
T5HIT	-.05	-.02	-.20	-.26	.60
T5HIS	-.03	.03	.68	-.03	-.48
T6NNR	.06	.38	.30	.28	.16
T6SSR	.16	.52	-.02	-.03	-.29
T6SNR	.08	.40	.22	-.18	-.08
T6NSR	-.12	.32	.46	.00	.38
T6NNS	.00	.86	-.02	-.12	.02
T6SSS	.08	.83	-.11	-.17	.01
T6SNS	-.11	.80	.05	.02	-.03
T6NSS	.05	.83	-.21	-.20	.02
T7CM	.40	-.09	-.12	.74	-.16
T7CS	.35	-.37	.00	.51	.00
T7VM	.30	-.20	-.12	.76	-.20
T7VS	.18	-.09	-.11	.69	-.17
T8PO	.75	.17	.24	.01	.13
T8PN	.82	.16	.16	.01	.06
T81SO	.90	.07	.16	.00	.05
T82SO	.85	.01	.03	.29	-.12
T83SO	.82	-.07	.06	.14	-.14
T81SN	.78	.11	.18	.03	-.08
T82SN	.77	.07	-.07	.39	-.13

Continued ...

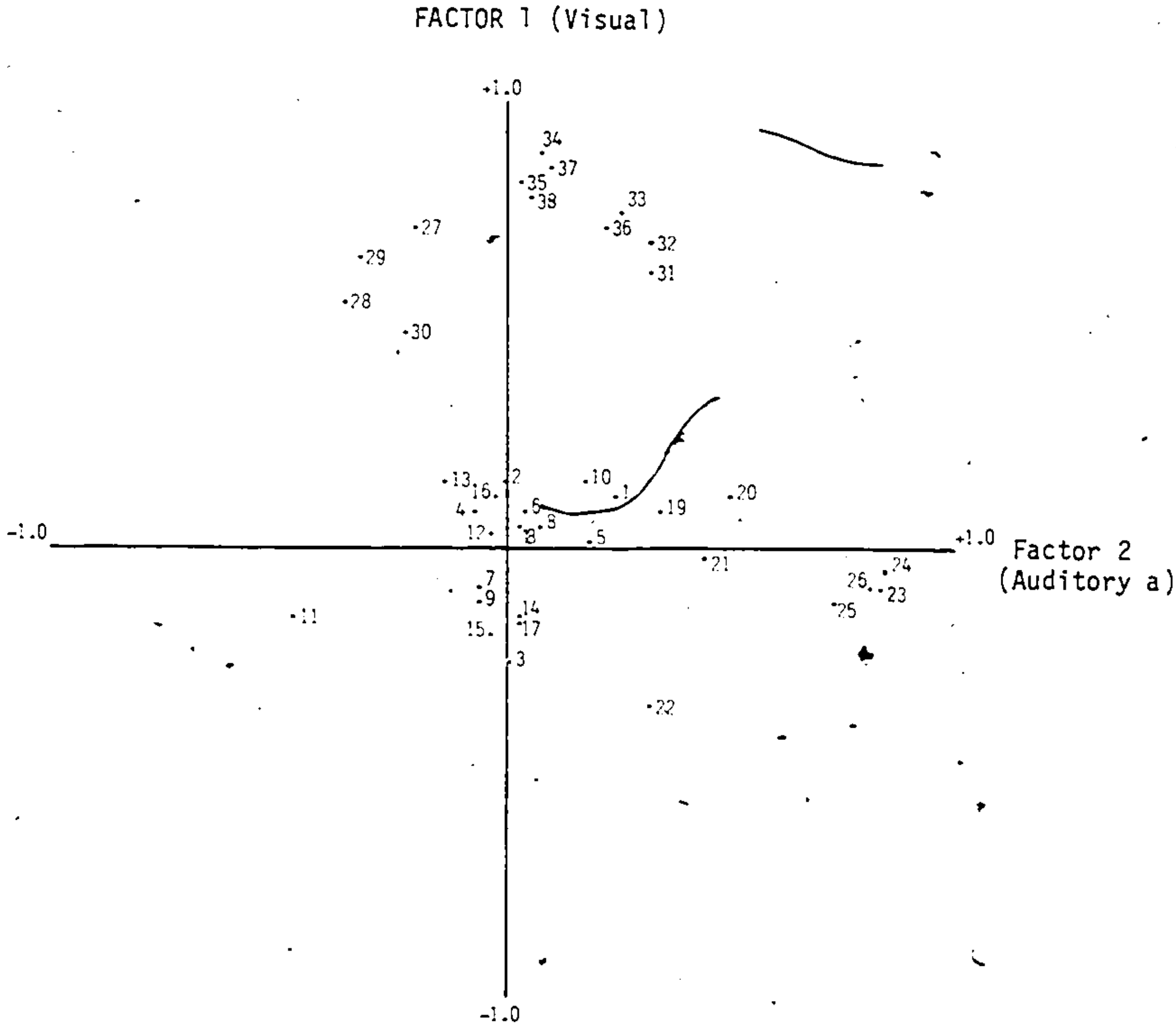
TABLE 34 CONTINUED

Variable	FACTOR 1	2	3	4	5
T83SN	.80	-.04	.05	.14	-.18
Variance Explained	6.10	4.15	4.53	3.24	2.75
Percentage of Variance Explained	16.0	11.2	11.9	8.5	7.2

Note: The underlined factor loadings indicate the variables which were considered to belong to that factor and as such were examined in order to identify the factor.

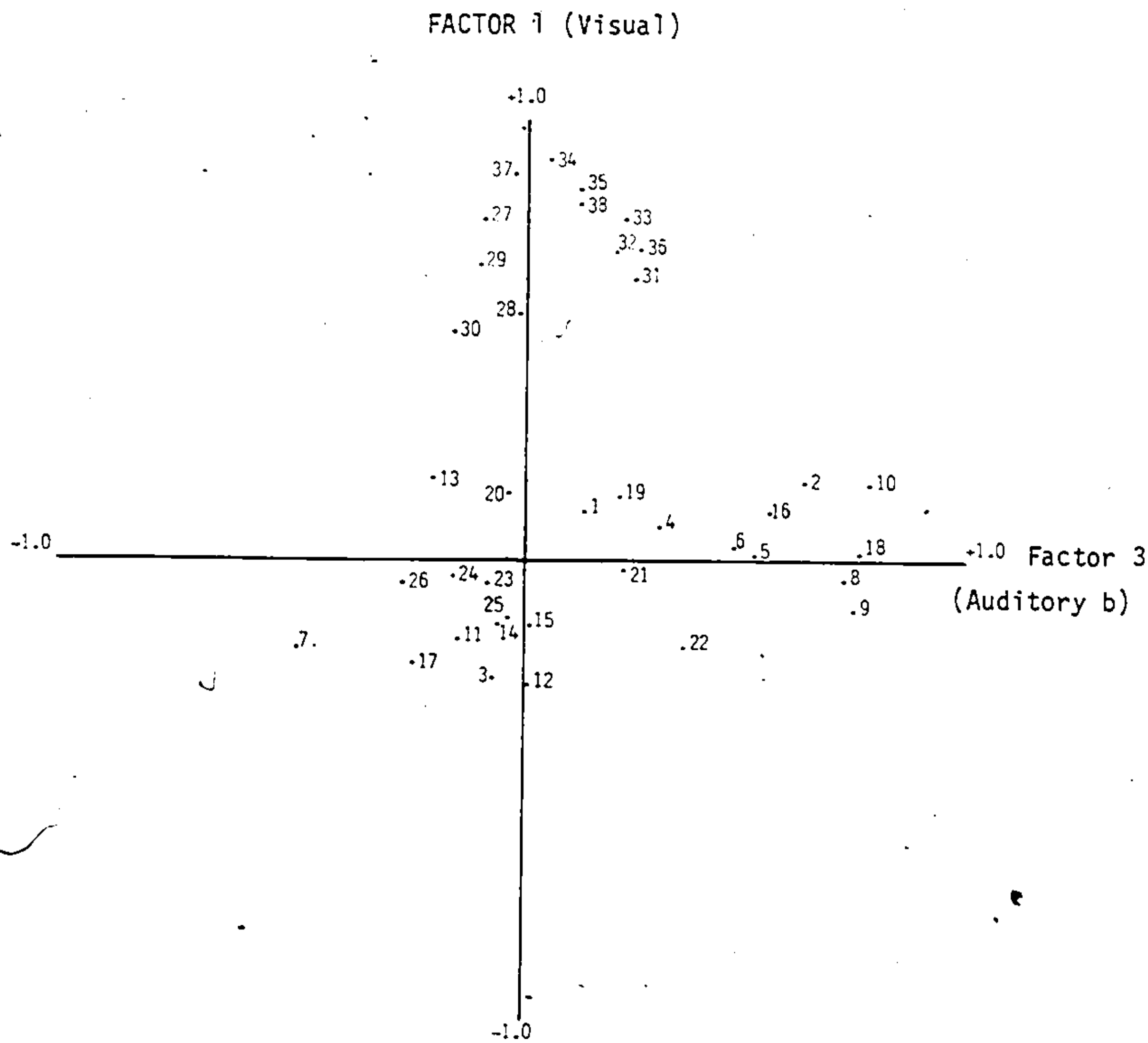
Finally, the three factor solution appeared to be the most meaningful. Factor 1 was clearly a visual factor. It was exclusively associated with Tasks 7 and 8, that is the "late-functional" position. On the other hand, Factor 2, was an auditory factor, herein referred to as Auditory (a). It was primarily associated with Task 6, or the "early-functional" position. Factor 3, labelled Auditory (b), was also an auditory factor. It was highly associated with the Tasks (1, 2, and 5) involving the shadowing of prose passages; that is the "early-structural" and, to a lesser degree, the "early-functional" positions.

The larger solutions were considered not as appropriate since the last factor that emerged contained relatively few significant loadings (>.50), and furthermore, their interpretation did not appear particularly meaningful. For these reasons then, the three factor solution was selected for detailed interpretation. The relationship between Factors 1 (Visual) and 2 (Auditory a), 1 (Visual) and 3 (Auditory b), and 2 (Auditory a) and 3 (Auditory b) are presented in Figures 10, 11, and 12 respectively.



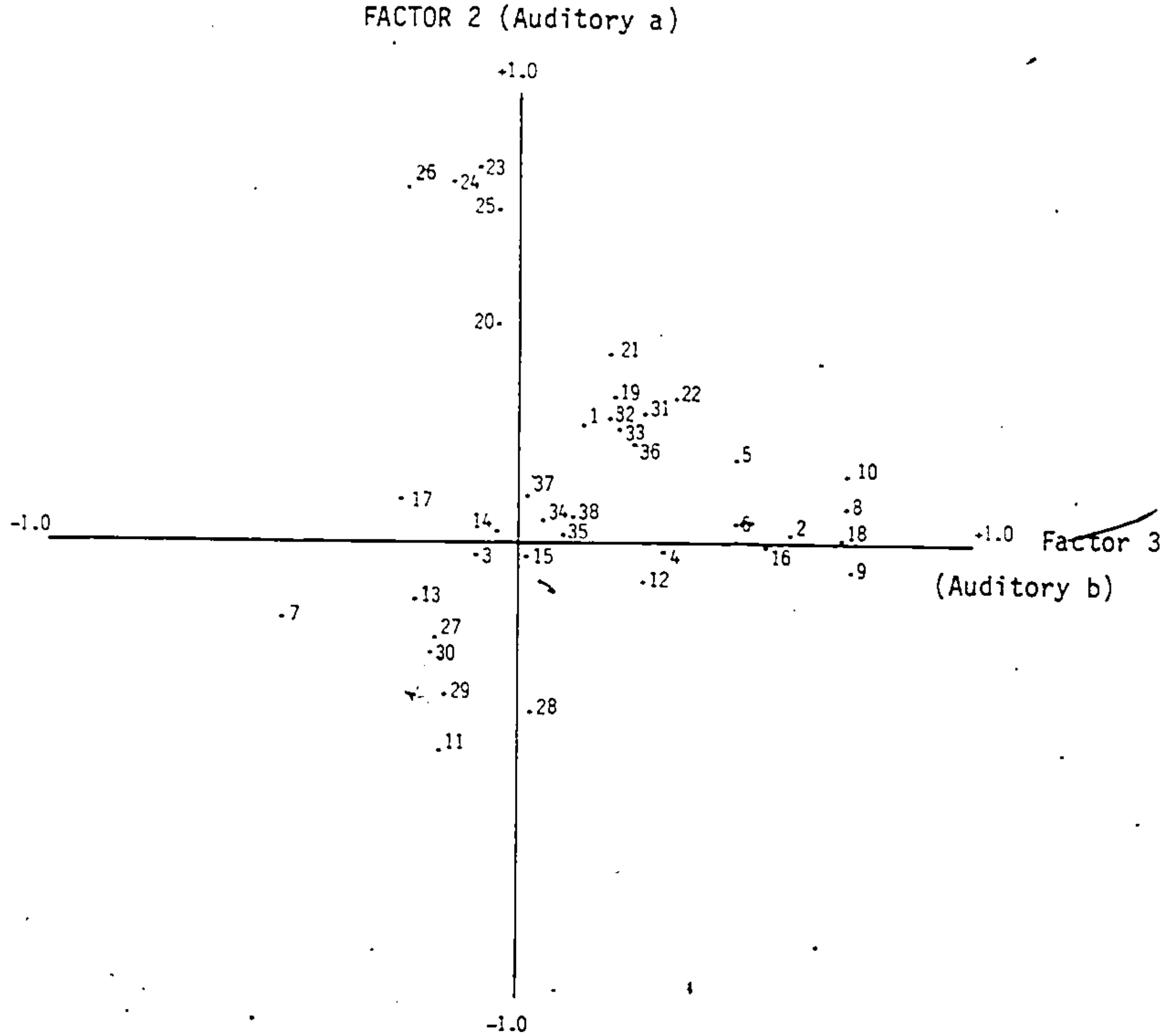
T1PTS = 1	T1PSS = 2	T1PTN = 3	T1PSN = 4	T1STS = 5
T1SSS = 6	T1STN = 7	T1SSN = 8	T2D = 9	T2B = 10
T3SM = 11	T3SQ = 12	T4SM = 13	T4SQ = 14	T5LOT = 15
T5LOS = 16	T5HIT = 17	T5HIS = 18	T6NNR = 19	T6SSR = 20
T6SNR = 21	T6NSR = 22	T6NNS = 23	T6SSS = 24	T6SNS = 25
T6NSS = 26	T7CM = 27	T7CS = 28	T7VM = 29	T7VS = 30
T8PO = 31	T8PN = 32	T81SO = 33	T82SO = 34	T83SO = 35
T81SN = 36	T82SN = 37	T83SN = 38		

Figure 10. Plot of Factor 1 (Visual) with Factor 2 (Auditory a).



T1PTS = 1	T1PSS = 2	T1PTN = 3	T1PSN = 4	T1STS = 5
T1SSS = 6	T1STN = 7	T1SSN = 8	T2D = 9	T2B = 10
T3SM = 11	T3SQ = 12	T4SM = 13	T4SQ = 14	T5LOT = 15
T5LOS = 16	T5HIT = 17	T5HIS = 18	T6NNR = 19	T6SSR = 20
T6SNR = 21	T6NSR = 22	T6NNS = 23	T6SSS = 24	T6SNS = 26
T6NSS = 26	T7CM = 27	T7CS = 28	T7VM = 29	T7VS = 30
T8PO = 31	T8PN = 32	T81SO = 33	T82SO = 34	T83SO = 35
T81SN = 36	T82SN = 37	T83SN = 38		

Figure 11. Plot of Factor 1 (Visual) with Factor 3 (Auditory b).



T1PTS	= 1	T1PSS	= 2	T1PTN	= 3	T1PSN	= 4	T1STS	= 5
T1SSS	= 6	T1STN	= 7	T1SSN	= 8	T2D	= 9	T2B	= 10
T3SM	= 11	T3SQ	= 12	T4SM	= 13	T4SQ	= 14	T5LOT	= 15
T5LOS	= 16	T5HIT	= 17	T5HIS	= 18	T5HIS	= 19	T6SSR	= 20
T6SNR	= 21	T6NSR	= 22	T6NNS	= 23	T6SSS	= 24	T6SNS	= 25
T6NSS	= 26	T7CM	= 27	T7CS	= 28	T7VM	= 29	T7VS	= 30
T8PO	= 31	T8PN	= 32	T81SO	= 33	T82SO	= 34	T83SO	= 35
T81SN	= 36	T82SN	= 37	T83SN	= 38				

Figure 12. Plot of Factor 2 (Auditory a) with Factor 3 (Auditory b).

CHAPTER IV

DISCUSSION

The primary purpose of this chapter is to suggest possible interpretations of the three factors that have been identified by the principal components analysis. In addition, the theoretical as well as the empirical implications of this finding for the process of attention are also discussed.

Factor Interpretation

Within this study, attention has been defined as a component of perceptual/cognitive activity. When identifying the attention factors that emerged, then, consideration was given to the two most fundamental elements that give rise to perceptual/cognitive behaviour. That is, the interpretation of the factors was based upon an analysis of sensory events as well as a description of the demands placed upon the perceiver who is processing these events. The former included an examination of the type of information that was presented on those tasks which contained variables that loaded highly on a particular factor. The latter was inferred subjectively and intuitively. Direction was always provided by the theoretical perspectives that were associated with a particular factor.

Factor 1

As was previously indicated, factor 1 was exclusively associated with the "late-functional" position. In addition to theoretical perspective, the tasks, 7 and 8, which loaded highly on factor 1 shared a number of other elements in common. Included among the most notable similarities were sensory modality, experimental method, the type of information that was presented, and the processing demands that were required.

Both tasks were visual and employed variants of the search and detection paradigm. Each task consisted of a series of short discrete trials and each trial required a comparison of two to eight stimulus characters. The information that was presented was highly redundant in that the stimulus sets for both tasks were comprised of a relatively small collection of familiar characters, and elements from the same stimulus sets were repeatedly displayed over the sequence of trials. The random selection of characters from the item pools, however, made the information presented on each trial highly unpredictable. The requirements of the task as well as the information that was presented appeared to be relatively low in meaningfulness. Specifically, the tasks required that subjects either indicate the presence or absence of a target item (task 7) or indicate when two, simple, stimulus signals were the same (task 8). The stimulus items were either digits, letters, or letter simulations,

Within the information processing approach, perception has been defined as the progressive analysis of sensory information via an increasingly complex and integrative network of cognitive structures (Haber & Hershenson, 1973); and it is commonly assumed that the analysis of physical characteristics precedes the semantic interpretation of stimuli (Broadbent, 1971; Treisman, 1964c). Two additional assumptions are accepted specifically in regards to attention: 1) attention is primarily responsible for the mobilization and co-ordination of perceptual analyzing sequences (Dixon, 1971); and 2) with repeated and consistent patterning perceptual sequences gradually attain levels of permanent consolidation so that attentional demands are progressively diminished (Laberge, 1976; Shiffrin & Schneider, 1977).

Within this conceptual framework then, it would appear that the data presented on these two tasks could have been analyzed by rather elementary subsystems of the perceptual hierarchy; and furthermore, by well-established analyzing sequences. Various indices suggest that higher-order and/or novel analyses were not only unnecessary but could have actually interfered with optimal task performance. For example, the divided attention paradigms that were employed required that attention be dispersed among a number of competitive stimuli rather than be narrowly focused upon the in-depth analysis of a single, stimulus sequence. Although semantic interpretation of the stimuli was not precluded, it was not required. All symbols could have been successfully compared on the basis of their physical characteristics. Considering that speed as well as accuracy was emphasized on both tasks, again, suggests that the deployment of surface attention to a variety of stimuli would have been most efficacious. Finally, in light of the fact that the material, which was highly redundant, familiar, and unpredictable, was presented in a rather experimentally specific context, it appears somewhat unlikely that the tasks would have encouraged higher-order processing. Higher-order processing would have entailed analyzing the information in a manner that was not directly related to the functional requirements of the experimental situation. This type of processing might have included, for example, assimilating the current data into a general cognitive schema that contained past associations to similar stimuli as well as the formation of new associations that may have gained access to long term memory.

In spite of the fact that task 3 was not represented, factor 1 can still be considered a visual attention factor. Possible reasons accounting for the failure of task 3 measures to load highly on factor 1 are discussed in detail at a later point.

Factor 1's association with the "late-functional" position suggests that attention may 1) intervene in memory; and 2) be simultaneously directed towards the analysis of competitive stimuli. An analysis of the information which was presented on tasks 7 and 8 gives an indication of the conditions under which attention may manifest such attributes. Specifically, visual attention may display these two parameters when the sensory situation does not require, due to its familiarity, or encourage, due to its level of meaningfulness, a more in-depth perceptual analysis.

Factor 2

Factor 2 was highly associated with the "early-functional" position. The four variables which loaded highly on factor 2 were all measures pertaining to task 6, an auditory task. Specifically, the measures were shadowing scores that assessed the number of random, dichotically presented digits that were correctly repeated. With the exception of sensory modality, task 6 was very similar to the tasks, 7 and 8, that loaded highly on factor 1. That is, it employed a divided attention paradigm; and it presented a long series of discrete trials. The information which was presented was highly redundant since the entire stimulus set consisted of the primary numbers one to nine; highly uncertain in that the presentation sequence was randomly determined; very familiar; and, for the most part, devoid of meaning independent of the experimental situation.

Once again, it appears that the requirements of the task as well as the type of information that was presented would have curtailed an in-depth or novel perceptual analysis of the sensory data. Successful task performance required the rapid acoustical analysis and repetition of competitive stimuli. Since it is generally assumed that higher-order processes occur over time, pursuing unnecessary operations such as the cognitive manipulation, restructuring, and elaboration of stimuli may have impeded task performance. Furthermore, it seems rather unlikely that the stimuli, random digits, would have encouraged such processing for reasons unrelated to the experimental setting. To the contrary, it seems that optimal task performance would have been obtained through the implementation of well-practiced analyzing sequences; specifically, those responsible for the common analysis of digits.

Factor 2 then, appears to be an auditory attention factor (auditory a). Its association with the "early-functional" position suggests that in hearing attention may 1) exert its selective influence during the initial stages of perceptual analysis; and 2) be divided among the analysis of competitive stimuli. These particular features appear to be manifested in sensory situations which involve the analysis of familiar information in an indifferent or routine context.

Factor 3

The variables which loaded highly on factor 3 were all shadowing scores that were obtained with the presentation of prose passages. Measures from experimental tasks 1, 2, and 5 were included. Tasks 1 and 2 were associated with the "early-structural" position whereas task 5 was associated with the "early-functional" position.

Although factor 3, similar to factor 2, relates to the processing of auditory information, the other interpretative guidelines reveal differences that may have contributed to the emergence of an independent factor. One element of distinction is that prose, unlike the majority of other stimuli employed in this study, presents a coherent, meaningful message. More specifically, the rules of language as well as the unified content of a particular passage provide such messages with a structure, complexity, and meaningfulness that is typically not available with the presentation of random items.

It seems reasonable to assume that the information differences which distinguished the variables that loaded highly on factor 3 were accompanied by perceptual differences. That is, in-depth and novel analyses may both assist and result from shadowing prose. Of the functions which are generally attributed to advanced perceptual processing, semantic interpretation, recognition, restructuring, and elaboration of stimuli would appear to be particularly operative in this activity. For example, hearing has been defined as a complex process of disentangling sounds we need to hear from sounds we need to ignore (Campbell, 1982). One benefit of semantic interpretation, then, is that it provides an opportunity to establish a perceptual set which will help identify information as relevant or irrelevant. Meaningful recognition also allows for the more efficient use of language rules. Specifically, knowledge and utilization of grammar, by making certain arrangements of words and ideas more probable, would appear to additionally assist processing. Finally, meaningfulness, in a somewhat circular manner, both encourages and results from the cognitive manipulation of sensory information. That is, meaningfulness stimulates the retrieval and elaboration of past associations; these activities are accompanied by attention; the availability of attention allows further processing.

Factor 3, then, is a second auditory attention factor (auditory b). Its strong association with the "early-structural" position suggests that in hearing 1) attention may be operative throughout the analysis of sensory information; and 2) selective behaviour may be an inevitable consequence of the simultaneous convergence of competitive stimuli upon a central analyzing structure. More specifically, in those situations that require, due to their novelty, or encourage, due to their significance, an in-depth analysis of sensory data, attention will be singular and fixed.

Summary of Factor Interpretation

It appears that the variables which loaded highly on factors 1 and 2 presented similar information, and thus, required similar perceptual operations in vision and hearing respectively. The items that were highly associated with factors 2 and 3, on the other hand, were all auditory measures. The major distinction between these two factors appears to be in terms of the type of information that they presented. Finally, the three factors differed in regard to theoretical perspectives. Factors 1 and 2 differed with respect to the locus dimension whereas factors 2 and 3 differed with respect to the capacity dimension.

A number of inferences can be derived from these general observations. Perhaps most obvious is the conclusion that attention is not a unitary process. In addition to the evidence provided by this study, a variety of alternate indices suggest this conclusion. Firstly, long-standing theoretical controversies have inherently alluded to the idea that attention is a variable activity. That is, new models have not been advanced in a cavalier or unprompted manner, but rather have been proposed on those occasions that empirical findings, which were difficult to incorporate into the theoretical structures that were currently available, suggested were necessary. Thus, if a variety of models are simultaneously and judiciously proposed to explain a particular phenomenon, a reasonable assumption is that the phenomenon is variable, and that the different models pertain to different elements or reflect 'different points of view.' This form of theory building is not uncommon to science in general. The frequent analogies to the story of the six blind men, who while attempting to discern the shape of an elephant, each described a different part, indicate that a complex, unified theory is often preceded by a series of singular investigations and theories (Hampden-Turner, 1981). Moreover, Posner (1982) arrives at a similar conclusion directly in regards to attention; he states, "the cumulative nature of work on attention is not widely appreciated, in part because ... attention is a concept that can be studied at many levels." (p. 168).

In addition to the historical development of attentional theory, behavioural distinctions, which can be easily conceptualized, defined, and to a lesser degree, measured, similarly imply that attention is variable. For example, situations which require the rapid analysis of a number of competitive and unrelated visual stimuli can be distinguished, at least intuitively, from situations which encourage a detailed analysis of a single, coherent auditory message. Lastly, this study, by demonstrating that attention is comprised of a minimum of three separable components, has provided an empirical/statistical basis for distinguishing different aspects of attention.

That distinctions exist at these three descriptive levels, the theoretical, the behavioural, and the statistical, provides considerable support for the claim that attention is a variable process. That the indices are in agreement with one another further substantiates the claim. That is, the three factors which have been identified by the principal components analysis are associated with very specific and easily distinguished behavioural measures as well as commonly differentiated theoretical perspectives.

Beyond the scientific evidence, the idea that attention is flexible also contains a general cognitive appeal. Specifically, attention has been defined as an essential component of a very complex and variable behaviour, perception/cognition. It has also been assigned a variety of functions. For example, the selection, analysis, organization, and synthesis of sensory information are typically regarded as resultant processes (Blumenthal, 1977). Thus, if attention is considered to be a part of a variable process, and if it serves variable functions, then it seems rather plausible to conclude that attention itself is a variable activity.

Having established the fact that there appears to be sufficient evidence to warrant the conclusion that attention is flexible and non-uniform, direction will now be focused upon elaborating some of the specific attention parameters that have been identified by this study. A salient source of variability appears to be sensory modality. Evidence in this regard is provided by the finding that the variables which loaded highly on a particular factor were all measures from the same sensory mode. Specifically, high factor 1 loadings were all visual measures; high positive factor 2 loadings were all auditory measures whereas the single, reasonably high negative factor 2 loading was a visual item; and finally, all high factor 3 loadings were again auditory measures.

A second source of variability concerns information processing demands. That is, within the same sensory modality attention will manifest variable characteristics depending upon the type of information that is presented. The bifactoring of the auditory measures appears to directly suggest such a conclusion. Specifically, factors 2 and 3 were both comprised of items pertaining to auditory tasks. The major distinction was that factor 2 was associated with very familiar and random stimuli whereas factor 3 was highly associated with novel and well-structured messages. Furthermore, factor 2 variables required that attention be divided among a number of well-practiced analyzing sequences, and factor 3 stimuli required that attention be directed towards developing a single processing sequence. Thus, it appears that attention will also vary depending upon the type of information that is presented. Related to this parameter are such factors as the individual's past experience with that information and the current processing goals of the sensory data.

In light of the fact that distinguishable theoretical perspectives were associated with each of the three factors, they provide a structure for identifying the manner in which attention may vary. Specifically, the relationship between the two auditory factors (2 and 3) and the "early" position suggests that in hearing attention intervenes during the initial stages of perceptual analysis. On the other hand, the visual factor's (1) association with the "late" position implies that in vision attentional operations may be confined to memory; that is, once all stimuli have attained complete feature and semantic analysis. These observations suggest that attentional influence will vary in regard to locus, and specifically, that sensory modality will determine the place at which attention intervenes in the perceptual cycle.

In addition, attention also seems to vary in regards to the origin of capacity limitations. Once again, an inspection of the factor loadings reveals that factors 1 and 2 presented similar information, and likewise, shared the same capacity category; that is, the "functional" perspective. As was previously indicated, factor 3 was the only one associated with meaningful, contiguous stimuli, and also the only factor to reflect the "structural" position. Therefore, there is evidence that attention will vary in terms of capacity limitations. Specifically, "structural" limitations or focused attention will be observed when the sensory data requires or encourages high-order perceptual analysis of novel stimuli. "Functional" or divided attention deployment is operative in those situations that require the rapid analysis of a number of familiar stimuli.

In summary it appears that: 1) attention is a variable process; 2) it will vary depending upon sensory modality; that is, visual attention can be distinguished from auditory attention; 3) it will also vary depending upon processing demands; for example, within the same sensory modality, attention can be further distinguished by considering the type of information that is presented; 4) attention may intervene at multiple loci in the perceptual cycle; specifically, it appears that the formulations of the "early" theorists describe auditory attention and the assumptions of the "late" theorists are more appropriate to visual attention; and 5) it may manifest both "structural" and "functional" limitations; the "structural" position appears to pertain to the type of attention that is operative with the development of new processing sequences whereas the type of attention that is described by "functional" theorists seems to accompany the deployment of well-established analyzing sequences.

Due to a design limitation of this study, that is, the confounding of sensory modality with locus of attention, the proposed factor interpretation must be regarded as tentative. Specifically, since auditory tasks were exclusively employed to test the "early" position whereas visual tasks were primarily used to assess the "late" position, the association between sensory modality and locus of attention requires further confirmation. Future research may correct this bias, and thus, extend the generalizability of the current findings by insuring that each of the theoretical perspectives is represented by both visual and auditory tasks.

A variant of the visual paradigm, which has been recently developed by Treisman (Treisman & Gelade, 1980), might be included among the "early" tasks. The significant part of the paradigm is that the correct identification of a target item is contingent upon the integration of a number of separable features. In a series of experiments, that manipulated such variables as the number, category, spatial distribution, and location of features, Treisman and her associates have consistently demonstrated that attention must be directed serially to each stimulus in a display whenever the integration of features is required to identify an object (Treisman & Gelade, 1980; Treisman & Schmidt, 1982). The "late" position, on the other hand, has often been supported by auditory tasks which have demonstrated that the material presented on an unattended channel is semantically interpreted. Specifically, it has been demonstrated that the meaning of an unattended message can influence the reaction time to stimuli presented on an attended channel (Lewis, 1970), bias the meaning of an attended message (McKay, 1973), and produce a galvanic skin response (Corteen & Wood, 1972). In summary, then, a replication of this study should insure that visual as well as auditory tasks, such as the ones described above, are employed to test the assumptions of each of the theoretical positions.

Late-Structural Position

It is readily apparent that the "late-structural" position has not been represented in the principal components analysis. A number of factors may be relevant to this result. Some are directly related to the outcome of this study, while others are quite independent of my research. Questions concerning the viability of this position are initially raised by an examination of its historical development. The Deutsch and Deutsch (1963) model, for example, was proposed in reaction to the strict single-channel viewpoint that was advanced by Broadbent (1958). Norman (1968) and Keele (1973) developed their respective models in a similar manner; that is, by an analysis of empirical findings which were generally problematic for other popular theories. Beyond this, these theorists have not been particularly active in empirically testing the ideas which they have put forth. Their assumptions have primarily been investigated through the work of Shiffrin and his colleagues (Shiffrin, McKay, & Shaffer, 1976; Shiffrin, Pisoni, & Castaneda-Mendez, 1974); and it should be noted that within recent years, Shiffrin has advanced a model which is classified as "late-functional" (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977).

Directly related to the present study is the fact that of the two tasks, 3 and 4, which were employed to test the assumptions of the "late-structural" position, the results predicted for task 3 were not obtained. Since the anticipated findings were not observed, it is difficult to determine if the task measured what it was intended to measure, in terms of the attentional process. Thus, it is not surprising that the variables pertaining to this particular task were not affiliated with a particular factor.

The interpretation of the principal components analysis suggests yet another possible explanation for the absence of a "late-structural" component. Specifically, the interpretation of the factors indicates that the type of attention which is described by the "late-structural" theorists would perhaps be evidenced on visual ("late") tasks that present meaningful, unified messages and require semantic identification, recognition, and interpretation of stimuli ("structural"). The visual tasks employed in this study were just the opposite. They presented discrete, tachistoscopic information and required a rapid, surface analysis of a number of competitive stimuli. As a result of this observation, it is recommended that future studies include temporal, integrated visual tasks such as the selective reading (Neisser, 1969) and selective looking (Neisser & Becklin, 1975) paradigms that have been developed by Neisser.

Summary and Implications

The purpose of this study was to test the hypothesis that attention is a variable process. The statistical identification of three separable attention components supports this position. The factor interpretation tends to clarify and extend it. Specifically, since an inspection of the factor loadings revealed that the factors could be distinguished on the basis of sensory modality and the processing demands imposed by the stimulus situation, it identified two conditions under which attention may vary. In addition to this, since the classification scheme which was employed to categorize the various attentional models also distinguished the factors, it identified two specific ways in which attention may vary; that is, in terms of locus and capacity.

Integrating the information from these two sources suggests that auditory attention operates "early;" specifically, attention exerts its selective influence throughout the various stages of information acquisition. As a consequence, not all sensory items attain comparable levels of analysis or representation in memory. Visual attention, on the other hand, appears to operate "late;" that is, once all perceptual analyses have been completed. Thus, all items are fully analyzed and represented in memory. In terms of processing demands, it appears that the type as well as the context of sensory information will affect the attentional processes that are employed to analyze that information. Specifically, attention may manifest "structural" properties when the stimulus situation presents novel and meaningful information. Meaningfulness is determined by structure, as well as content. Under such conditions attention will be singular; associated with a central analyzing structure; and encourage the cognitive manipulation of stimuli. When the stimulus situation presents well-known information in a rather familiar context, attention may display "functional" characteristics. Under such conditions attention may be dispersed among the analyzing sequences of competitive stimuli; distributed among various processing systems; and repeat the analyses that were previously performed on the same, or very similar stimuli.

The finding that attention is a variable process suggests that diverse methods exist for conceptualizing and assessing attention. The theoretical models which have been proposed, and the experimental paradigms that have been devised to test their assumptions, are not incompatible, but rather incomplete. Recognizing that attention may manifest a variety of attributes provides a means of integrating seemingly disparate views into a unified and comprehensive theory. An integrated model, then, will incorporate attention parameters that have been identified and systematically investigated by the varying theoretical perspectives.

A skeletal framework for such a theory may currently be derived by considering the parameters of attention which have been identified to date. This study has specifically investigated and supported the "early-structural" assumptions regarding the intervention of attention during perceptual analysis, and the singular nature of attention deployment; the "early-functional" postulations concerning the need for attention during information acquisition, and the divisibility of attentional resources; and the "late-functional" formulations regarding the development of automaticity, and the functioning of attention in memory.

One possible means of integrating these general findings is provided by the following description of perceptual/cognitive behaviour. Consistent with the information processing approach, it is assumed that perceptual analysis is conducted via a hierarchy of cognitive structures. Identifiable subsystems within the hierarchy might include, for example, stages that are responsible for feature registration (Neisser, 1976; Treisman, 1982), semantic recognition (Broadbent, 1971; Hochberg, 1970), elaboration (Kahneman, 1973; Moray & Fitter, 1973), and memory of stimuli (Laberge, 1975; Shiffrin & Schneider, 1977). At each higher level, the systems as well as their operations become increasingly more complex; that is, integrative and general. Although attention is initially required to co-ordinate the activity at each level ("structural"), with repeated and consistent processing of the same material, the need for attention to integrate the activity at that level progressively diminishes ("functional"). In order to move beyond this level of analysis, however, attention will again be required. Thus, excluding very routine operations, perceptual analysis entails a mixture of these two attentional processes. Each has its place and benefits. Attention distributed in a focalized manner will actuate greater depths and novel processing whereas attention distributed in a diffuse fashion will promote greater breadth and familiar processing.

The finding that attentional processes are localized differently for vision and audition is not totally surprising in light of the general perceptual differences that exist between the two senses. That is, hearing generally a) involves the integration of temporal information; and b) presents elementary, physical cues, such as the voice of a speaker, that can be used to distinguish relevant and irrelevant stimuli. Thus, it provides both an opportunity and a method to curtail the analysis of irrelevant stimuli during the initial stages of information acquisition, that is, "early." Vision, on the other hand, due to its spatial nature involves the integration of a variety of simultaneously presented features. Therefore, it may be necessary to initially register all stimuli in memory. Once the entire stimulus field has been represented, then attention may be directed towards the analysis of each item in turn; that is, attention operates "late."

APPENDIX A

REVIEW OF THE EXPERIMENTAL RESEARCH

Each of the following experiments have been classified according to two dimensions of attentional operations. In regards to the locus of attentional operations, studies which have generated findings that support the formulation that attentional processes intervene in the perceptual cycle prior to the level of semantic memory have been classified as <u>early</u>, whereas those studies whose findings are consistent with the postulate that attentional processes are reserved for perceptual/cognitive activities occurring after all sensory inputs have activated their respective categorical memory analogues were classified as <u>late</u>. The category, <u>structural</u>, was employed to designate those studies whose findings have indicated that capacity limitations are due to hypothetical "bottlenecks" within the perceptual/cognitive system that preclude the simultaneous passage of multiple sources of information. The term, <u>functional</u>, was reserved for those studies whose findings have suggested that attention, as a diffuse, finite mental resource, is strategically allocated in accordance with cognitive intentions. Unless otherwise specified, the equivocal category was employed to refer to those studies which have supported both or neither of the contrasting positions on each of the respective dimensions.

TABLE A

Auditory Studies of Focused Attention

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Barr (1981)	1	.Binaural	Prose	Prose	Shadow S_1	Shadowing errors	.Number of irrelevant messages .Spatial localization of irrelevant messages .Nature of irrelevant messages (forward/reversed) speech.	Equivocal
Bloomfield (1972)	1	Dichotic	Lists of high associative word pairs ("you-me" interspersed with word "tap" ("you-tap")	Different pairs of high associative words interspersed with word "tap"	.Shadow S_1 .Shadow S_1 and tap to word "tap"	Intrusions from S_2 .Frequency of tapping	Crossed S_1 & S_2 word pairs	Early Structural
Broadbent (1970)	1	Binaural	.Digits .Letters	Digits	.Monitor S_1 & S_2 .Report cued target items	Items incorrectly reported	Selection criteria (gender of speaker or semantic class)	Early Structural
Corteen & Wood (1972)	1	Dichotic	Prose	Random words interspersed with city names that may have been previously shocked	Shadow S_1	.Shadowing omissions .GSR		Late Structural

Continued ...

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Dawson & Schell (1982)	1	Dichotic	Random words and a critical word (shock associated)	Random words and a critical word (shock associated)	.Shadow S_1 .Detect critical words in S_1 and S_2 .Postexperimental recognition test	.Shadowing performance .Detection of critical words .Electrodermal responses .Postexperimental recognition of critical words	.Channel, response, semantic category (animal/anatomical names) and nature (original/generalization) of critical word .Sex of speaker (S_1 - male; S_2 - female) .S_1 and S_2 ear of arrival .Monetary incentive	Equivocal
Govier & Pitts (1982)	1	Dichotic	Prose and ambiguous target word with one meaning shock associated	Prose and ambiguous target word with one meaning shock associated	.Shadow S_1 .Recall S_2	.Shadowing performance .GSR .Recall of S_2	.Electric shock preconditioning to one meaning of ambiguous target word .Sex of speaker (S_1 - male; S_2 - female)	Late Structural

Continued .....

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Hawkins, Thomas, Presson, Cozic & Brookmire (1974)	1	.Monaural .Binaural	Target (pure tone either 800 or 850 Hz)	Masker (pure tone either 750 or 900 Hz)	Identify pitch of target tone (high or low)	Correct identification	.Channel of masker (ipsilateral, binaural or contralateral to target tone) .Feedback after each trial	Equivocal
	2	.Monaural .Binaural	Target (pure tone either 800 or 850 Hz)	Masker (pure tone either 750 or 900 Hz)	Identify pitch of target tone (high or low)	Correct identifications	.Channel of masker (ipsilateral, binaural or contralateral to target tone) .Feedback after each trial .Foreknowledge of masker channel	Early Functional
Holloway (1972)	1	Dichotic	Words	Words	Shadow S_1	.Shadowing omissions .Intrusions from S_2	Intensity of S_2	Equivocal (refutes Treisman) Functional
Kahneman & Henik (1981)	1	Dichotic through speakers	Digits	Suffix - "bah"	Report S_1	Digits reported	Suffix presentation (single, embedded, interleaved with S_1 or absent)	Early Functional

Continued ...

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Kahneman & Henik (1981)	2	Dichotic through speakers	Consonants	Suffix - consonants	Report S_1	S_1 consonants reported	Suffix presentation (single, embedded, concurrent with S_1 or absent)	Early Functional
Lewis (1970)	1	Dichotic	Words	Words	Shadow S_1	Shadowing latencies	Degree of S_1/S_2 similarity (associative, semantic or unrelated)	Late Structural
	2	Dichotic	Words	One word	Shadow S_1	Shadowing latencies	Degree of S_1/S_2 similarity (associative, semantic or unrelated)	Late Structural
Lyons (1974)	1	Dichotic	Words	Words	.Shadow S_1 .Recall S_1	Recognition of memory probe item	.Strategy .Target/probe relationships (identical, acoustic or semantic)	Early Functional

Continued .....

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Mackay (1973)	1	Dichotic	Ambiguous sentences	Words contextually appropriate to S_1	.Verbally shadow S_1 .Recall S_1 .Ignore S_2	.Shadowing errors .Recall of S_2 .Recognition of S_1 according to S_2 bias shift	Ambiguity of S_1 (lexical, surface or underlying structure)	Late Structural
	2	Dichotic	Ambiguous sentences	Words contextually appropriate to S_1	.Shadow S_1 by writing .Recall S_1 .Ignore S_2	.Shadowing errors .Recall of S_2 .Recognition of S_1 according to S_2 bias shift	Ambiguity of S_1 (surface or underlying structure)	Late Structural
Moore & Massaro (1973)	1	Binaural	Pure tones (target)	Pure tones (masker)	Recognize quality and/or loudness of S_1	Accuracy of recognitions	Varied inter-tone interval	Late Structural
Moray (1970)	1	Dichotic	Pure tones	Pure tones	Detect targets in S_1	.Correct detections .Intrusions from S_2	.Varied frequency & intensity of targets . Simultaneous vs. spaced presentation of targets	Early Functional

Continued .....

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Moray, Fitter, Ostry, Favreau & Nagy (1976)	1	.Dichotic .Binaural	Pure tones	Pure tones	Detect targets in S_1	.Correct detections .Intrusions from S_2	.Practice .Varied frequency & intensity of targets .Simultaneous vs. spaced presentation of targets	Early Functional
	2	Dichotic	Pure tones	Pure tones	Detect targets in S_1	.Correct detections .Intrusions from S_2	.Practice .Varied frequency & intensity of targets .Simultaneous vs. spaced presentation of targets	Early Functional
Moray & O'Brien (1967)	1	Dichotic	Digits & letters	Digits & letters	.Monitor S_1 .Detect letters in S_1	Correct detections	Simultaneous vs. spaced presentation of targets	Early Structural
Morton & Chambers (1975)	1	.Monaural .Binaural	Digits	Auditory suffix (word "nought")	Recall digits	Correct digits recalled	Alternating monaural or binaural presentation of suffix	Equivocal

Continued ......

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Ostry, Moray & Marks (1976)	1	Dichotic	Digits & letters	Digits & letters	.Monitor S_1 .Detect letters in S_1	Correct detections	.Practice .Simultaneous vs. spaced presentation of targets .White noise	Early Functional
	2	Dichotic	Nouns & animal names	Nouns & animal names	.Monitor S_1 .Detect animal names	Correct detections	.Practice .Simultaneous vs. spaced presentation of targets	Early Functional
Salter (1973)	1	Dichotic	.Prose .Words, systematically scrambled	.Prose .Words .Reversed speech	Shadow S_1	Shadowing performance		Equivocal Functional
Shiffrin, Pisoni & Castaneda-Mendez (1974)	1	Monaural	Synthetic consonant vowel syllable (target)		.Identify target .Localize target	.Correct identifications .Correct localizations	Foreknowledge of ear of arrival of target	Late Structural
	2	Dichotic	Synthetic consonant vowel syllable (target)	Synthetic consonant vowel syllable (distractor)	.Identify target .Localize target	.Correct identifications .Correct localizations	Foreknowledge of ear of arrival of target item	Late Structural

Continued .....

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Smith & Burrows (1974)	1	Dichotic	Words	Words	.Monitor S_1 .Ignore S_2 .Forced-choice recognition of memory probe	Correct recognition of memory probes		Equivocal
Treisman (1964a)	1	.Dichotic .Monaural .Binaural	Prose	.Prose .Repeated speech sounds	Shadow S_1	Shadowing performance (correct words & S_2 intrusions)	.Number of irrelevant messages .Number of irrelevant channels .Spatial localization of irrelevant messages .Nature of irrelevant messages	Early Structural
	2	.Dichotic .Binaural	Prose	.Prose .Digits in English .Digits in Czech .Second-order approximations to English	Shadow S_1	Shadowing performance (correct words & S_2 intrusions)	.Spatial localization of irrelevant message .Physical characteristics & content of irrelevant message .Intensity of irrelevant message	Early Structural

Continued ..

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Treisman (1964b)	1	.Dichotic .Binaural	Prose	Prose	Shadow S_1	Shadowing performance (correct words, intrusions, omissions & errors)	Varied S_2 prose according to gender of speaker, content, language, phonetic characteristics, & familiarity to subject	Early Structural
Treisman (1964c)	1	Dichotic	Prose	Prose	.Shadow S_1 .Monitor S_1	.Shadowing performance .Recognition of S_1/S_2 similarity	.Gender of S_2 speaker .Order of onset of S_1 & S_2 .Onset interval of S_1 & S_2 .Language, number & content of S_2 .S_1/S_2 similarity	Early Structural
	2	Dichotic	.Prose .Random words .Digits	.Prose .Digits identical to S_1	Shadow S_1	Recognition of S_1/S_2 similarity		Early Structural

Continued .....

TABLE A CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Treisman, Squire & Green (1974)	1	Dichotic	.Monosyllabic words .Pairs of synonyms	.Monosyllabic words .Pairs of synonyms	Shadow S_1	Shadowing performance (RT, omissions, intrusions from S_2)	Degree of S_1/S_2 similarity	Equivocal
VonWright, Anderson & Stenman (1975)	1	Dichotic	Words & targets	Words & targets	.Shadow S_1 .Detect targets in S_1	.GSR .Correct detections .Shadowing performance .Forced-choice test of target recall	Targets (shocked words, homophones & synonyms)	Late Structural
Zelnicker (1971)	1	Dichotic	Digits	Delayed auditory feedback of S_1 shadowing	.Shadow S_1 .Ignore S_2	.Stuttering frequency .Syllable duration of S_1	Subject sample (adults)	Early Structural
	2	Dichotic	Digits	Delayed auditory feedback of S_1 shadowing	.Shadow S_1 .Ignore S_2	.Stuttering frequency .Syllable duration of S_1	Subject sample (children)	Early Structural

TABLE B

Auditory Studies of Divided Attention

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Beech & McKeating (1980)	1	Dichotic	A play interspersed with random digits	A play interspersed with random digits	.Shadow S_1 or monitor S_1 .Detect digits in S_1 & S_2	.Digits detected .Shadowing performance .Comprehension of S_1	.Presence or absence of irrelevant message .Foreknowledge of comprehension test	Early Functional
Broadbent (1970)	1	Binaural	.Digits .Letters	Digits	.Monitor S_1 & S_2 .Report cued items	Items incorrectly reported	Selection criteria (gender of the speaker or semantic class)	Early Structural
Brown (1970)	1	Dichotic	White noise & nonsense syllable	White noise & nonsense syllable	Recognition of nonsense syllable	Correct recognitions	Absence or presence of visual cue regarding ear of arrival of nonsense syllable	Equivocal
	2	Dichotic	White noise & nonsense syllable		Recognition of nonsense syllable	Correct recognitions	Absence or presence of visual cue regarding ear of arrival of nonsense syllable	Equivocal

Continued .,...

TABLE 8 CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Brown (1970)	3	Dichotic	Nonsense syllable	Nonsense syllable	Recognition of nonsense syllable	Correct recognitions	Absence or presence of visual cue regarding ear of arrival of nonsense syllable	Equivocal
	4	Dichotic	White noise & nonsense syllables	White noise & nonsense syllables	Recognition of nonsense syllables	Correct recognitions	Absence or presence or auditory cue regarding ear of arrival of nonsense syllable	Equivocal
Bryden (1964)	1	Dichotic	.Monosyllabic words .Digits	.Monosyllabic words .Digits	.Monitor S_1 & S_2 .Recall S_1 & S_2	.Items correctly recalled .Order of report	Presentation rate	Early Structural
	2	Dichotic	Words	Words	.Monitor S_1 & S_2 .Recall S_1 & S_2	.Items correctly recalled .Order of report	.Presentation rate .S_1/S_2 relationship .Relationship of S_1 words .Relationship of S_2 words	Equivocal
	3	Dichotic	Digits	Digits	.Monitor S_1 & S_2 .Recall S_1 & S_2	Items correctly recalled		Equivocal Functional

Continued ...

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Bryden (1971)	1	Dichotic	Digits	Digits	.Rehearse S_1 .Recall S_1 & S_2	Correct digits recalled	.Strategy .Order of recall	Equivoçal (refutes Early) Functional
	2	Dichotic	Digits	Digits	.Rehearse S_1 .Recall S_1 & S_2	Correct digits recalled	.Strategy .Order of recall	Equivocal (refutes Early) Functional

Continued ...

TABLE 8 CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Corteen & Dunn (1974)	1	Dichotic	Prose	Random words interspersed with targets (city names that may have been previously shocked)	.Shadow S_1 .Detect targets	.GSR .Target detections		Late Structural
Glucksberg & Cowen (1970)	1	Dichotic	Prose	Prose & Digits	.Shadow S_1 .Detect digits	Digit detections	Immediate or delayed cuing post digit presentation	Early Structural
Hede (1981)	1	Dichotic	Words	Words	.Monitor S_1 & S_2 .Recall cued target items	Targets correctly recalled	.Cuing technique (pre/post) .Partial/whole report .Selection criteria (gender of speaker)	Early Structural
	2	Dichotic	Words	Words	.Monitor S_1 & S_2 .Recall cued target items	Targets correctly recalled	.Cuing technique (pre/post) .Partial whole report .Selection criteria (semantic class)	Early Structural

Continued ...

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Johnston & Dark (1982).	1	Dichotic	Random, target, and priming words	Random, target and priming words	.Monitor S_1 or S_1 and S_2 .Detect targets in S_1 or S_1 and S_2 .Free associate to visual stimulus word	.Targets detected .Free association to visual stimuli	.Target presentation (binaural/monaural) .Presentation of visual stimulus word .Nature of stimulus words (related to nontargets or prime words presented in S_1 or S_2)	Early Structural
Johnston & Wilson (1980)	1	Binaural	Random words and targets	Random words and words varying in relation to S_1 targets	.Monitor S_1 and S_2 .Detect targets	Target detections	.Class of target items (animals or body parts) .Nature of nontarget. items (neutral, appropriate or inappropriate to targets	Equivocal
	2	Dichotic	Random words and targets	Random words and words varying in relation to S_1 targets	.Monitor S_1 and S_2 .Detect targets	Target detections	.Class of target items (animals or body parts) .Nature of nontarget items (neutral, appropriate or inappropriate to targets	Equivocal

Continued ...

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Johnston & Wilson 1980)	3	Dichotic	Random words and targets	Random words, targets, and words varying in relation to S_1 targets	.Monitor S_1 and S_2 .Detect Targets	Target detections	.Class of target items (animals or body parts) .Nature of nontarget items (neutral, appropriate or inappropriate to targets) .Target presentation (S_1 or S_1 and S_2) .Presence or absence of precuing	Equivocal
Kahneman (1975)	1	.Dichotic .Monaural	Words	Words	.Monitor S_1 and S_2 .Recognition of S_1 and/or S_2	Correct recognitions	Presentation rate	Early Functional
	2	Dichotic	Words and targets	Words	.Recall target .Recognize S_2	.Target detections .Correct recognitions .S_1/S_2	Targets (animal names or specific digits)	Early Functional

Continued .....

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Lawson (1966)	1	Dichotic	Prose & pure tones	Prose & pure tones	.Shadow S_1 .Detect pure tones	.Shadowing latencies .Correct detections .RT to tones .Omission errors	Complexity of response (simple choice, complex choice reaction times)	Early Functional
Lyons (1974)	1	Dichotic	Words	Words	Shadow S_1 and recall S_2	Recognition of memory probe item	.Strategy .Target/probe item relationship (identical, acoustic, or semantic)	Early Functional
Mewhort, Thio & Birkenmayer (1971)	1	Dichotic	Letters	Letters	.Shadow S_1 by writing .Recall S_2	Recall of S_2	.Presentation rate .Shifting of S_1 between channels	Early Functional
	2	Dichotic	Digits	Letters	.Shadow S_1 by writing .Recall S_2	Recall of S_2	Shifting of S_1 between channels	Early Functional
	3	Dichotic	Letters	Letters	Recall S_1 and S_2	Recall of S_1 and S_2	.White noise .Presentation rate .Switching between S_1 and S_2	Early Functional

Continued ....

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Mewhort, Thio & Birkenmayer (1971)	4	Dichotic	.Letters .Digits	.Letters .Digits	Recall S_1 and S_2	Recall of S_1 and S_2	Switching between S_1 and S_2	Early Functional
Moore & Massaro (1973)	1	Binaural	Pure tones	Masker (pure tones)	Recognize quality and loudness of S_1	Accuracy of recognition	Varied inter-tone interval	Late Structural
Moray (1959)	1	Dichotic	Prose	Word list repeated 35 times	Shadow S_1	Recognition of S_2		Early Structural
	2	Dichotic	Prose with instructions	Prose with instructions prefixed or not with subject's name	.Shadow S_1 .Follow S_1 and S_2 instructions	Success in following instructions		Early Structural
	3	Dichotic	Prose and digits	Prose and digits	.Shadow S_1 .Recall digits .Recall content of S_1	Digits recalled	Instructions	Early Structural

Continued ...

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Moray (1960)	1	.Dichotic .Binaural	Digits	Digits	Recall digits	Errors in recall	.Order of recall .Presentation rate .S_1/S_2 presentation (successive, simultaneous or overlapping)	Equivocal (refutes Broadbent 1958)
Moray (1967)	1	Dichotic	Digits	Digits	Type digits	Correct digits typed		Early Functional
Moray (1970)	1	Dichotic	Pure tones	Pure tones	Detect targets	Target detections	.Simultaneous vs. spaced target presentations .Varied frequency & intensity of targets .Target presentation (S_1 & S_2, S_1 only, S_2 only)	Early Functional
Moray & Fee (1971)	1	Dichotic	Prose & pure tones	Prose & pure tones	.Shadow S_1 .Detect tones	Correct detections		Early Structural
Moray & Fitter Ostry, Favreau & Nagy (1976)	1	.Dichotic .Binaural	Pure tones	Pure tones	Detect targets.	Correct detections	.Practice .Varied frequency & intensity of targets .Simultaneous vs. spaced presentation of targets	Early Functional

Continued ...

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Moray & O'Brien (1967)	1	Dichotic	Digits & letters	Digits & letters	Detect letters	Correct detections	Simultaneous vs. spaced presentation of targets	Early Structural
Ostry, Moray & Marks (1976)	1	Dichotic	Digits & letters	Digits & letters	Detect letters	Correct detections	.Practice .Simultaneous vs. spaced presentation of targets	Early Functional
	2	Dichotic	Nouns & animal names	Nouns & animal names	Detect animal names	Correct detections	.Practice .Simultaneous vs. spaced presentation of targets .White noise	Early Functional
Rinder (1974)	1	Dichotic	Familiar or unfamiliar prose & pure tones	.Shadow S_1 prose .Detect tones	.Shadowing performance Correct detections			Early Functional
Salter (1973)	1	Dichotic	.Prose .Words systematically scrambled	.Prose .Words .Reversed speech	Shadow S_1 & S_2	Shadowing performance		Equivocal Functional
Shiffrin, Pisoni & Castenada-Mendez (1974)	1	Monaural	Synthetic consonant vowel syllable (target)	.Identify target .Localize target	.Correct identifications .Correct localizations			Late Structural

Continued ....

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Shinar & Jones (1973)	1	Dichotic	Digits with letter terminating the sequence	Digits with letter terminating the sequence	.Shadow S_1 .Shadow S_2 .Recall letter	.Recall of digits .Recall of letter	.Varied precuing of letter .Subject's expectations	Early Functional
Sullivan (1976)	1	Dichotic	Words	Prose & target words	.Shadow S_1 .Detect targets	.Shadowing performance .Correct detections	.Varied S_1 in order of approximations to English .Targets (body parts or specific words)	Early Functional
Treisman (1970)	1	.Dichotic .Binaural	Digits	Digits	Recall digits	.Digits recalled	.Order of recall .Simultaneous vs. alternating digit presentation .Presence of irrelevant items .Nature of irrelevant items	Equivocal
	2	.Binaural .Dichotic	Nonsense syllables	Report one nonsense syllable (subject's choice)	.Letters reported .Channel switching			Equivocal

Continued ....

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Treisman (1970)	3	.Binaural .Dichotic	Digits	Digits	Recall digits	Digits recalled	.Digit duration .Presentation rate .Number of digits	Equivocal
	4	.Binaural .Dichotic	Digits	Digits	Recall digits	Digits recalled	.Order of recall .Irrelevant items (pure tone, letter "B," letters "BR")	Equivocal
	5	.Binaural .Dichotic	.Nonsense syllable .Digit	Nonsense syllable	Recall digit	RT for digit recall	Cuing of digit (visual or auditory)	Equivocal
Treisman (1971)	1	.Binaural .Dichotic	Digits	Digits	Recall digits	Digits recalled	.Presentation rate .Number of digits .Digit duration .Simultaneous vs. alternating digit presentation	Early Structural
Treisman & Geffen (1967)	1	Dichotic	Prose & targets	Prose & targets	.Shadow S_1 .Detect targets	.Interference from S_2 (latencies & omissions in shadowing .Correct detections	Targets (class of words, adjectives, nouns, homonyms, high S-R compatability word, & contextual significance)	Early Structural

Continued ...

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Treisman & Riley (1969)	1	Dichotic	Digits & letters	Digits & letters	.Shadow S_1 .Monitor S_1 & S_2 .Detect letters	.Correct detections .Shadowing performance	.Gender of speaker .Foreknowledge of target letter	Early Structural
Underwood (1972)	1	Dichotic	Letters & digits	Letters & digits	.Monitor S_1 & S_2 .Shadow S_2 .Remember S_1 .Detect digits	.Shadowing performance .Digits detected	Response (immediate upon detection or delayed)	Early Functional
Underwood (1974)	1	Dichotic	Letters & digits	Letters & digits	.Shadow S_1 .Detect digits	.Shadowing performance .Digits detected	.Gender of speaker .Practice	Early Functional
Underwood & Moray (1971)	1	.Dichotic .Monaural	Letters & digits	Letters	.Monitor S_1 & S_2 .Shadow S_1 .Detect digits	Digits detected	.Gender of speaker .White noise	Early Functional
	2	Dichotic	Letters & digits	Letters & digits	.Shadow S_1 .Detect digits	Digits detected	Gender of speaker	Early Functional

Continued ....

TABLE B CONTINUED

Study	Exp.	Method	Stimulus 1 (S_1)	Stimulus 2 (S_2)	Task Demands	Responses Measured	Manipulations	Findings
Underwood & Moray (1971)	3	Dichotic	Letters & digit	Letters & digit	.Monitor S_1 .Shadow S_1 .Detect digits	Digits detected	.Gender of speaker .White noise	Early Functional
	4	Dichotic	Letters & digit	Letters & digit	.Monitor S_1 .Shadow S_1 .Detect digits	Digits detected	Gender of speaker	Early Functional
Wilding & Farrell (1970)	1	Dichotic	Prose	Prose & targets	.Shadow S_1 .Detect targets	Correct detections	Targets (homophones or specific words)	Equivocal
Wilding & Underwood (1968)	1	Dichotic	Prose & targets	Prose & targets	.Shadow S_1 .Detect targets	Correct detections	Targets (vowel sound, word, class of words)	Equivocal Functional
Zelnicker, Rattok & Medem (1974)	1	Dichotic	Words & pure tones	Words & pure tones	.Shadow S_1 .Detect pure tones	Thresholds of detection (method of limits)		Equivocal (refutes Early)

TABLE C

Visual Studies of Focused Attention

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Broadbent (1970)	1	Detection with preinstructions	.Digits varying in colour .Digits & letters	Report target items	Errors in report	Selection criteria (colour or semantic class)	Early Structural
Butler (1974)	1	Detection with cuing	Rows of letters & rows of digits	Report target items	Targets reported	Arrival of cue	Early Functional
	2	Detection with cuing	.Rows of letters .Rows of approximations to English	Report target items	Targets reported	.Post-stimulus mask .Nature of non-reported material	Early Functional
	3	Detection with cuing	Rows of letters, visual noise, white space, nonsense symbols, random letters, letters identical to targets	Report target items	Targets reported	Nature of irrelevant stimuli	Late Functional
Eriksen & Colegate (1971)	1	Identification with cuing	Circular display of letters	Identify targets	Target identifications	.Task demands (1 cue-1 response; 1 cue-2 responses; 2 cues-2 responses) .Spatial arrangement of cues & targets	Early Structural

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Eriksen & Collins (1969)	1	Target identification with cuing	Circular display of letters	Identify cued letters	Target identifications	.Arrival of cue .Nature of cue .Position of cue	Early Structural
	2	Target identification with cuing	Circular display of letters	Identify cued letter & letter opposite cued letter	Correct identifications	.Arrival of cue .Nature of cue .Position of cue	Early Structural
Eriksen & Hoffman (1972a)	1	Target identification with cuing	Circular display of letters	Identify cued letters	.Correct identifications .RT	.Display size .Arrival of cue	Early Functional
Eriksen & Hoffman (1972b)	1	Target identification with cuing	Circular display of letters	Identify cued letters	.Correct identifications .RT	.Spatial arrangement of stimuli .Nature of irrelevant stimuli .Arrival of cue	Late Structural
Eriksen & Hoffman (1973)	1	Target identification with cuing	Circular display of letters	Classify cued letters	.Correct classifications .Classification errors .RT	.Target background similarity .Display size .Arrival of cue	Late Structural

Continued ......

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Eriksen & Hoffman (1974)	1	Target identification with cuing	One letter	Identify letter	.Correct identifications .RT	.Arrival of cue .Nature of cue	Early Functional
Eriksen & Lappin (1967)	1	Target detection with cuing	Nonsense forms	Determine if memory probe was included in the display	Correct discriminations	.Size of display .Arrival of cue .Time interval between display & memory test	Early Structural
Francolini & Egeth (1980)	1	Search	Red letters (targets); black letters and digits (nontargets)	Report number of target items	RT	.Array size .Number of target items .Number and nature of nontarget items .Target/nontarget confusability	Early Equivocal
	2	Search	Red letters and digits (targets); black letters and digits (nontargets)	Report number of target items	RT	.Array size .Number of target items .Number and nature of nontarget items .Target/nontarget confusability .Stimulus duration - 1 second	Early Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Francolini & Egeth (1980)	3	Search	Red letters and digits (targets); black letters & digits (nontargets)	Report number of target items	RT	.Array size .Number of target items .Number and nature of nontarget items .Target/nontarget confusability .Stimulus duration - 200 msec.	Early Equivocal
Humphreys (1981)	1	Target identification with precuing	Pairs of curved lines	Identify curvature of target	.RT to correct identifications .Errors	.Target/nontarget distance .Nature of nontarget (random/constant curvature, straight line, absent) .Target placement (above/below fixation) .Target/nontarget arrangement (position & curvature)	Equivocal Functional

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Humphreys (1981)	2	Target Identification with precuing	Pairs of curved lines	Identify curvature of target	.RT to correct identifications .Errors	.Nature of nontarget (random/constant curvature, straight line, absent) .Target placement (above/below fixation) .Target/nontarget arrangement (position & curvature)	Equivocal Functional
	3	Target Identification	Pairs of curved lines	Identify curvature of target	.RT to correct identifications .Errors	.Nature of nontarget (random/constant curvature, straight line, absent) .Nontarget distance from fixation - target displayed at fixation .Target/nontarget arrangement (position & curvature)	Equivocal Functional
Irwin (1981)	1	Selective Reading	Superimposed word pairs varying in color	Read a list of words printed in a specified color	Reading latencies	Direction of association between word pairs (relevant - irrelevant; irrelevant - relevant)	Late Functional

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Kahneman & Chajczyk (1983)	1	Color naming	Color names, colored bars & words, and neutral words	Name color of bar	.RT .Errors	.Nature and number of distractor items (color/ neutral; single/ double; conflicting/ congruent color)	Early Equivocal
	2	Color naming	Color names, colored bars & words, and neutral words	Name color of bar	RT	.Nature and number of distractor items (color/neutral; single/double; conflicting/ congruent color) .Spatial separation of stimuli	Early Equivocal
	3	Color naming	Color names, colored bars & words, neutral words, and rows of "X"	Name color of bar	RT	Nature and number of distractor items (single/double; neutral/conflicting/ congruent; words and/or "X")	Early Equivocal
	4	Color naming	Color names, colored bars & words, and neutral words	Name color of bar	.RT .Errors	Nature and number of distractor items (single/double; color/ neutral; conflicting/ congruent color)	Early Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Kahneman & Henik (1977)	1	Target identification	Digits and suffix items	Report digits	Digits correctly reported	.Whole or partial report .Number of items .Nature of items (digits or digits & suffix) .Grouping structure of items .Nature of suffix (0, K, A, or vertical strings of 0)	Early Functional
	2	Target identification	Letters varying in color (red or blue)	Report blue letters	Letters correctly reported	.Number of letters .Grouping structure via color	Early Functional
Kahneman & Henik (1981)	1	Color naming	A circle & a square each containing a colored word	Report color of word in circle	RT	.Position of square & circle .Nature of printed words (relevant/irrelevant color) .Color name - response compatability	Early Functional

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Kahneman & Henik (1981)	2	Color naming	A circle and a square, each containing a colored word	Report color of word in circle	RT	.Position of square & circle .Nature of printed words (relevant/irrelevant color) .Color name - response compatability	Early Functional
	3	Color naming	Pairs of words (1 black; 1 colored)	Report the colored word	RT	.Color content (letter; entire word) .Position of colored letter .Color name - response compatability	Early Functional
Kahneman, Treisman & Burkell (1983)	1	Reading	Words & dots	Read target word	.RT .Errors	.Array (1 word; 2 words; 1 word & dots) .Viewing distance .Word length & position	Early Equivocal
	2	Target identification	Colored bars & geometric shapes	Identify target item	RT	.Array (shape; bar; both) .Target item (shape or bar) .Stimulus position	Early Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Kahneman, Treisman & Burkell (1983)	3	Target detection & identification	Words and nonsense shapes	.Detect target .Read target word	.RT .Errors	.Array (target; non-targets; both) .Number of distractor items .Stimulus position	Early Equivocal
	4	Target identification	Words and nonsense shapes	Identify target	.RT .Errors	.Number of distractor items .Precuing	Early Equivocal
	5	Target identification	Words and nonsense shapes	Identify target	.RT .Errors	.Number of distractor items .Temporal pairing of target and distractors	Early Equivocal
LaBerge, Tweedy & Ricker (1967)	1	Speeded classification	Green, red or blue rectangles	Identify colour of rectangle	RT to correct identifications	Colour saliency via instructions	Early Functional
Neisser & Becklen (1975)	1	Target detection	Superimposed prerecorded games (hand game & ball game)	Detect targets in either hand or ball game	Correct detections	.Rate of presentation .Mode of presentation (binocular, dichoptic)	Early Functional

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Rock & Gutman (1981)	1	Recognition	Two overlapping novel figures varying in color	Indicate recognized figures (form)	Recognition of cued and noncued figures	Recognition test (free/forced choice)	Equivocal
	2	Recognition	Novel figures varying in color - presented serially	Indicate recognized figures (form)	Recognition of cued and noncued items	Recognition test (free/forced choice)	Equivocal
	3	Recall & Recognition	Two overlapping figures (novel or familiar)	.Indicate recognized figure (form) .Identify familiar figure	.Recognition of cued and noncued items .Recall of familiar figures	Recognition test (free/forced choice) Delayed recall test	Equivocal
	4	Recall & Recognition	Two overlapping figures (novel of familiar)	.Indicate recognized figure (form) .Identify familiar figure	.Recognition of cued and noncued items .Recall of familiar figures	.Recognition test (free/forced choice) .Immediate recall test	Equivocal
	5	Recognition	Overlapping novel figures	Indicate features of nontarget items	Recognition	.Recognition test (features; size; type of figure - open or closed; mode of contour) .Target/nontarget similarity	Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Schneider & Shiffrin (1977)	1	Target detection	Letters & digits	Detect targets in a prespecified position	Correct detections	.Display size .Target set size .Target background similarity	Late Functional
	2	Target detection	Letters & digits	Detect targets in a prespecified position	Correct detections	.Nature of characters in irrelevant positions .Spatial arrangement of characters	Late Functional
	3	Target detection	Letters & digits	Detect targets in a prespecified position	Correct detections	.Nature of characters in irrelevant positions .Number of irrelevant characters	Late Functional
	4	Target detection	Letters & digits	Detect targets in a prespecified position	Correct detections	.Nature of characters in irrelevant positions .Number of characters in irrelevant positions	Late Functional

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Shiffrin & Gardner (1972)	1	Target recognition	Letters & irrelevant items	Recognize & locate targets	.Correct recognitions .Correct localizations	.Level of background confusability ("Os" or target hybrids) .Post visual mask	Late Structural
	2	Target recognition	Letters & irrelevant items	Recognize & locate targets	.Correct recognitions .Correct localizations	.Level of background confusability ("Os" or target hybrids) .Post visual mask	Late Structural
	3	Target recognition	Letters & irrelevant items	Recognize & locate targets	.Correct recognitions .Correct localizations	.Level of background confusability ("Os" or target hybrids) .Number & arrangement of items	Late Structural
Shiffrin, Gardner & Allmeyer (1973)	1	Target detection	Grid of dots	Detect target dot pattern	Correct detections	Background confusability (number & arrangement of dots)	Late Structural
	2	Target detection	Grid of dots	Detect presence or absence of a dot in a prespecified position	Correct detections	Background confusability (number & arrangement of dots)	Late Structural

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Shiffrin, McKay & Shaffer (1976)	1	Target detection	Grid of 49 dots	Detect presence or absence of a dot in a prespecified position	Correct detections	Display (49 or 48 dots)	Late Structural
	2	Target detection	Grid of 49 dots	Detect presence or absence of a dot in a prespecified position position	Correct detections	Display - 1 dot; Test - 48 dots	Late Structural
	3	Target identification	Grid of 9 letters	Identify letter in specified position	Correct identifications		Late Structural
Skelton & Eriksen (1976)	1	Target detection with cuing	Circular display of letters	Detect if cued items are same or different	.Correct detections .RT	.Spatial arrangement of items .Arrival of cue	Early Functional
Treisman & Gelade (1980)	1	Search	.Target - "T" (green); blue letter; or "S" .Nontarget - "T" (brown) and "X" (green)	Indicate presence or absence of target	.RT .Errors	.Array size .Target presence & placement .Nature of target (conjunctive/feature) .Target/nontarget similarity .RT & error feedback .Error correction .Practice	Early Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Treisman & Gelade (1980)	2	Search	Letters varying in color	Indicate presence or absence of target	.RT .Errors	.Array size .Item arrangement .Target/nontarget similarity	Early Equivocal
	3	Search	Ellipses varying in size	Indicate presence or absence of target	.RT .Errors	.Array size .Target presence and placement .Nature of target (conjunctive/feature) .Target/nontarget similarity .RT & error feedback .Error correction	Early Equivocal
	4	Search	Letters	Indicate presence of target	.RT .Errors	.Array size .Nature of target (conjunctive/feature) .Number of nontargets .Target/nontarget similarity	Early Equivocal
	5	Card sorting	Letters varying in color	Sort cards according to criterion	.RT .Errors	.Spatial arrangement (color; letter; mixed) .Sorting criteria .Presentation (face - up/down)	Early Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Treisman & Gelade (1980)	6	Card sorting	Letters varying in color	Sort cards according to criterion	.RT .Errors	.Spatial arrangement (color; letter; mixed) .Sorting criterion	Early Equivocal
	7	Card sorting	Letters	Indicate card category	.RT .Errors	.Spatial arrangement .Sorting criteria	Early Equivocal
	8	Search	Rows of letters	Report location and identity of target	.Location errors .Identity errors	.Nature of target (conjunctive/feature) .Target/nontarget relationships .Error feedback	Early Equivocal
	9	Search	Rows of letters	Report location and identity of target	.Location errors .Identity errors	.Nature of target (conjunctive/feature) .Target/nontarget relationships .Error feedback .Exposure duration	Early Equivocal

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Underwood (1981)	1	Target categorization	Target word & distractor items	.Indicate target category .Report distractor item	.RT .Correct categorizations .Reported distractor items	.Semantic category of target items .Nature of distractor items (related/unrelated words; nonwords) .Number of related distractor items	Late Structural
	2	Target categorization	Target word & distractor items	.Indicate target category .Report distractor item	.RT .Correct categorizations .Reported distractor items	.Semantic category of target items .Nature of distractor items (related/unrelated words; nonwords) .Number of related distractor items .Instructions to subjects	Late Structural
Willows & MacKinnon (1973)	1	Selective reading	Lines of prose alternating with words	.Read prose .Answer questions	.Reading errors .Reading time .Question response time .Intrusion errors .Recall of irrelevant material	Subject sample (adults)	Late Structural

Continued ...

TABLE C CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Willows & MacKinnon (1973)	2	Selective reading	Lines of prose alternating with words	.Read prose .Answer questions	.Reading errors .Reading time .Question response time .Intrusion errors .Recall of irrelevant material	Subject sample (children)	Late Structural
Wolford & Morrison (1980)	1	Target identification	Digits & words	.Identify if 2 digits are of same parity .Identify length of irrelevant item	.RT .Correct identifications (digits; length) .Recognition of irrelevant items	Presence and nature of irrelevant items (subject's name; "X"; random words)	Late Structural
	2	Target identification	Digits & words	.Identify if 2 digits are of same parity .Identify length of irrelevant items	.RT .Correct identifications (digits; length) .Recognition of irrelevant items .Confidence ratings (recognition test)	Presence and nature of irrelevant items (subject's name; "X"; random words)	Late Structural

TABLE D

Visual Studies of Divided Attention

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Broadbent (1970)	1	Search	.Digits varying in colour .Digits & letters	Report target items	Errors in report	Selection criteria (colour or semantic class)	Early Structural
Butler (1975)	1	Search	Letters & digit	Report digit	Digits correctly reported	Post stimulus visual mask	Equivocal
	2	Search	Digits & letter	Report letter	Letters correctly reported	Post stimulus visual mask	Equivocal
	3	Search	Letters	Indicate absence or presence of target letter	Correct detections	Post stimulus visual mask	Equivocal
	4	Search	Digits & letter	Indicate absence or presence of target letter	Correct detections	Post stimulus visual mask	Equivocal

Continued ....

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Butler (1980)	1	Search	Grid of 9 letters	Identify letter in a specified position	.Correct responses .Errors (intrusion/ mislocation)	.Presence/absence precuing .Presence/absence postdisplay mask	Late Equivocal
	2	Search	Grid of 9 letters	Identify letter in a specified position	.Correct responses .Errors (intrusion/ mislocation) .Subjects comments regarding test trials	.Presence/absence precuing .Presence/absence post display mask .Number of test trials per grid position	Late Equivocal
	3	Search	.Eight letter words .String of 8 letters	Identify letter in a specified position	.Correct responses .Errors (intrusion/ mislocation)	.Presence/absence precuing .Presence/absence postdisplay mask .Exposure duration	Late Equivocal
Davis (1967)	1	Speeded classification with cuing	.Cue signal (visual "+" or "0") .Data signal (red or green digits, 1 or 2) .Warning signal (500 cps tone)	Identify the cued dimension of data signal	RTs to correct identifications	.Arrival of cue signal .Warning interval	Early Structural

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Dixon (1981)	1	Speeded classification (two-choice reaction time)	Letters	Indicate position of target item	.RT to correct responses .Errors .Subjects' cue processing time	Size of target set	Equivocal Functional
	2	Speeded classification (two-choice reaction time)	Letters	Indicate position of target item	.RT to correct responses .Errors .Subjects' cue processing time	.Size of target set .Pairing of target items	Equivocal Functional
Duncan (1979)	1	Search	.Circular display of letters .Circular display of 7 light patches & 1 letter	Detect letter "Q"	.RT .Percentage of errors	.Nontarget letters ("O" & "K," "O" & "C" or "O," "K" & "C") .Target position .Nature of display	Equivocal Functional
Egeth (1966)	1	Speeded classification	Pairs of items varying in colour, form &/or tilt	Indicate whether items are same or different in regards to cued dimension	.RT .Errors	.Dimensions varying per presentation (1, 2, or 3) .Monetary incentives for correct & rapid responses .Feedback after each trial	Equivocal

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Eriksen & Collins (1969)	1	Target identification with cuing	Circular display of letters	Identify cued letter	Correct identifications	.Arrival of cue .Nature of cue .Position of cue	Equivocal
Eriksen & Lappin (1967)	1	Target detection with cuing	Nonsense forms	Determine if memory probe was included in the display	Correct discriminations	.Size of display .Arrival of cue .Time interval between display and memory test	Equivocal
Estes (1972)	1	Search	Letters	Detect presence of predetermined target	.Correct detections .RT	.Display size .Number of targets .Background confusability (letters or dots) .Spatial arrangement of items .Target redundancy	Early Structural
Flowers, Polansky, & Kerl (1981)	1	Target identification with post-display auditory cuing	Trigrams varying in meaning (CVC to words)	Report cued item	Letters correctly reported	.Cue delay (10, 50, 75 msec) .Position of meaningful item/target item .Nature of nontarget item	Late Structural

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Flowers, Polansky, & Kerl (1981)	2	Target identification with postdisplay auditory cuing	Trigrams varying in redundancy	Report cued item	Letters correctly reported	.Cue delay (10, 50, 75 msec) .Position of redundant item/ target item .Nature of non-target items	Late Structural
	3	Target identification with postdisplay visual cuing	Two strings of 4 letters varying in meaning (nonsense to words)	Report cued item	Letters correctly reported	.Position of meaningful item/ target item .Nature of nontarget item	Late Structural
	4	Target identification with postdisplay visual cuing	Two strings of 4 letters varying in redundancy	Report cued item	Letters correctly reported	.Position of redundant item/ target item .Nature of nontarget item	Late Structural
Haber (1964)	1	Speeded classification	Cards differing in number, colour & shape of figures	Report target features	.Errors in reporting .Coding strategy	.Coding strategy .Instructional set .Order of report .Nature of reporting (forced-choice or free)	Early Functional

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Harris & Haber (1963)	1	Speeded classification	Cards differing in number, colour & shape of figures	Report target features	.Errors in reporting .Coding strategy	.Coding strategy .Instructional set .Order of report .Nature of report (forced-choice or free)	Early Functional
Hoffman & Nelson (1981)	1	Search & orientation discrimination	Letters "u" shaped form varying in orientation	.Detect target letters .Discriminate "u" shaped form's discrimination	.Correct detections .Correct discriminations	.Number of tasks (detection; orientation; both) .Task priority .Task presentation (concurrent; serial)	Early Structural
Kahneman & Henik (1977)	1	Recall (whole-report)	.Digits .Letters	Report items	Items correctly reported	.Number of items .Grouping structure of items .Methods of inducing grouping (color; spatial)	Early Functional
Kahneman & Henik (1981)	1	Search	Digits varying in color	Indicate if target pair presented	.Correct detections .Confidence ratings	.Color of targets (same/different) .Grouping structure (by color)	Early Functional

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Kahneman & Henik (1981)	2	Search	Digits & letters	Indicate if target pair presented	.Correct detections .Confidence ratings	.Grouping structure .Item arrangement .Precuing (target relationship)	Early Functional
	3	Search, detection, & recall (whole-report)	Digits	Detect target or report all digits	.Targets detected .Digits recalled	.Grouping structure .Exposure time .Masking .Number of tasks (detection & recall; detection)	Early Functional
LaBerge (1973)	1	Speeded classification with cuing	.Cue signal (familiar or unfamiliar letter patterns) .Target signal (familiar or unfamiliar letter patterns)	.1 character target display (compare cue & target) .2 character target (compare target characters)	RT (latencies for "same" or "different" responses)	.Number of characters per target display .Cue/target arrangements .Target expectancies	Late Functional
LaBerge (1983)	1	Categorization (stimulus & probe)	Stimulus (word/nonword anagram) & probe ("+" & "7," "T," or "Z")	Categorize stimulus word or probe	.RT .Errors	.Probe position .Spatial area (word or single letter) .RT & error feedback	Equivocal Functional

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
LaBerge (1983)	2	Categorization (stimulus & probe)	Stimulus (word/ nonword anagram) & probe ("+" & "7," "T" or "Z")	Indicate if stimulus and probe are both positive	.RT .Errors	Postdisplay/ probe position .Spatial area (word or single letter) .RT & error feedback	Equivocal Functional
LaBerge, Petersen & Norden (1977)	1	Speeded classification with cuing	.Cue (single pair of letters) .Display (2 pairs of letters .Letters pairs familiar (cluster); unfamiliar (letters)	Indicate if display items match	.RT .Errors	.Display - familiar/ unfamiliar .Cue - familiar/ unfamiliar .Cue/display relationship	Late Functional
	2	Speeded classification with cuing	.Cue (single pair of letters) .Display (2 pairs of letters) .Letter pairs familiar (cluster); unfamiliar (letters)	Indicate if display items match	.RT .Errors	.Cue - familiar/ unfamiliar .Display - familiar/ unfamiliar .Cue/display relationship .Blocked trials	Late Functional

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
LaBerge, Peterson & Norden (1977)	3	Speeded classification with cuing	.Cue (single pair of letters) .Display (2 pairs of letters) .Letter pairs - familiar (cluster); unfamiliar (letters)	Indicate if display items match	.RT .Errors	.Cue - familiar/ unfamiliar .Display - familiar/ unfamiliar .Cue/display relationship .Spatial alignment of items (cue & display)	Late Functional
Lawrence (1971)	1	Search	Capitalized & lower case words	Detection & identification of targets	Errors in detection & identification of target words	.Target location .Target background similarity .Presentation rate .Items presented per trial	Early Structural
	2	Search	Animal & nonanimal names	Detection & identification of targets	Errors in detection & identification of target words	.Target location .Target background similarity .Presentation rate .Items presented per trial	Early Structural
Neisser (1963)	1	Search	Horizontally arranged strings of letters	Detect target item(s)	RT for correct detections	.Length of string of letters .Size of target set .Search for absence or presence of target item(s)	Early Structural

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Neisser (1963)	2	Search	Horizontally arranged strings of letters	Detect letter "Z"	RT for correct detections	.Length of string of letters .Spacing of letters	Early Structural
	3	Search	Horizontally arranged strings of letters	Detect target item(s)	RT for correct detections	.Target background similarity .Size of target set	Early Structural
	4	Search	Horizontally arranged strings of letters	Detect target item(s)	RT for correct detections	.Length of string of letters .Practice	Early Functional
	5	Search	Horizontally arranged strings of letters	Detect target items(s)	RT for correct detections	.Size of target set .Practice	Early Functional
Neisser & Becklen (1975)	1	Target detection	Superimposed prerecorded games (hand & ball game)	Detect targets in hand & ball game	Correct detections	.Rate of presentation .Mode of presentation (binocular, dichoptic)	Early Functional
Neisser, Novick & Lazar (1963).	1	Search	.Strings of letters .Strings of digits .Strings of letters & digits	Detect target item	RT for correct detections	.Practice .Size & composition of target set .Monetary incentives	Early Functional

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Rabbitt, Cumming & Vyas (1979)	1	Search & detection	Letters	Detect target items	.RT .Correct detections	.Between trial target arangement (identical targets presented on successive trials)	Late Structural
	2	Search & detection	Letters	Detect target items	.RT .Correct detections	.Between trial nontarget arrangement (nontarget items - character & arrangement - same on successive trials)	Late Structural
	3	Search & detection	Letters	Detect target items	.RT .Correct detections	.Between trial nontarget arrangement (order and item effect)	Late Structural
Schioldborg (1972)	1	Search with precuing	Digits & letters differing in colour & position	Identify targets	.Target identification time .Correct identifications	.Selection criteria (class, position or colour) .Arrival of cue	Early Structural

Continued ...

TABLE D CONTINUED

Study	Exp.*	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Schioldborg (1972)	2	Search with postcuing	Digits & letters differing in colour & position	Identify targets	.Target identification time .Correct identifications	.Selection criteria (class, position or colour) .Arrival of cue	Late Structural
Schneider & Shiffrin (1977)	1	Search	.Letters .Digits .Letters & digits	Identify targets	.Correct detections .RT	.Display size .Number of targets .Target set size .Target background similarity .Spatial arrangement of targets .Selection criteria .Test display (multiple frames)	Late Functional
	2	Search	.Letters .Digits .Letters & digits	Identify targets	.Correct detections .RT	.Display size .Number of targets .Target set size .Target background similarity .Spatial arrangement of targets .Selection criteria .Test display (single frame)	Late Functional

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Schneider & Shiffrin (1977)	3 (a) (b) (c) 4-7	Search	.Letters .Digits .Letters & digits	Identify targets	.Correct detections .RT	.Number of targets .Feedback .Target set size .Spatial arrangement of characters .Display size .Target set size .Target background similarity .Selection criteria	Late Functional
Shiffrin & Gardner (1972)	1	Search	Letters & irrelevant items	Recognize & locate targets	.Correct recognitions .Correct localizations	.Level of background confusability ("Os" or target hybrids) .Pre/Post visual mask	Late Structural
	2	Search	Letters & irrelevant items	Recognize & locate	.Correct recognitions .Correct localizations	.Level of background confusability ("Os" or target hybrids) .Post visual mask	Late Structural
	3	Search	Letters & irrelevant items	Recognize & locate targets	.Correct recognitions .Correct localizations	.Level of background confusability ("Os" or target hybrids) .Number & arrangement of items	Late Structural

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Shiffrin, Gardner & Allmeyer (1973)	1	Search	Grid of dots	Detect target dot pattern	Correct detections	Background confusability (number & arrangement of dots)	Late Structural
	2	Search	Grid of dots	Detect presence or absence of a dot in a prespecified position	Correct detections	Background confusability (number & arrangement of dots)	Late Structural
Shiffrin, McKay & Shaffer (1976)	1	Search	Grid of 49 dots	Detect presence or absence of a dot in a prespecified position	Correct detections	Display (49 or 48 dots)	Late Structural
	2	Search	Grid of 49 dots	Detect presence or absence of a dot in a prespecified position	Correct detections	Display-1 dot; Test-48 dots	Late Structural
	3	Search	Grid of 9 letters	Identify letter in a specified position	Correct identifications	.Cuing Technique Pre/post	Late Structural

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Snyder (1972)	1	Search	.Letters varying in colour & orientation .Fragmented letter patterns	Identify & report position of target item	.Target identifications .Correct localizations	Selection criteria (colour, pattern or orientation)	Early Structural
Sperling (1978)	1	Search & detection	Digits (targets) & letters (nontargets)	.Detect targets .Locate targets .Confidence ratings	.Correct detections .Correct locations .Confidence ratings	.Nature of central stimuli (small; superimposed noise; reversals - letter target & digit nontarget) .Instructions to subjects (focus - outer; center; both)	Early Functional
Treisman (1982)	1	Search	Letters varying in color	Indicate presence/ absence of target	RT	.Display size .Target criteria (conjunctive/feature) .Target/nontarget similarity .Number of nontarget groups .Exposure duration	Early Equivocal

Continued ...

TABLE D CONTINUED

Study	Exp	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Treisman (1982)	2	Search	Letters varying in color	Indicate presence/ absence of target	RT	.Display (number & size of groups) .Target criteria (conjunctive/feature) .Target/nontarget similarity .Trial sequence (random/fixed)	Early Equivocal
	3	Search	Letters varying in color	Indicate presence/ absence of target	RT	.Display (size & spatial arrangement .Target criteria (conjunctive/ feature) .Target/nontarget similarity	Early Equivocal
	4	Search	Rows of colored letters	Indicate presence/ absence of target	.RT .Errors	.Target criteria (conjunctive/ feature) .Target position	Early Equivocal
Treisman & Schmidt (1982)	1	Recall (whole - report)	Black digits & colored letters	.Attend to & report digits .Describe letters (position; color; name)	.Errors .Confidence ratings	.Exposure duration .Item repetition	Early Equivocal

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Treisman & Schmidt (1982)	2	Target identification & probe matching	.Stimulus array (black digits & colored letters) .Probe (colored letters)	.Report digits .Indicate a probe match	.Errors .Confidence rating	.Probe (conjunctive; feature; identical) .Exposure duration	Early Equivocal
	3	Simultaneous matching	.Black digits & colored letters	.Report digits .Indicate if 2 letters are identical	Errors	.Feature similarity among items .Exposure duration	Early Equivocal
	4	Target identification & recall (nontargets)	Black digits & geometric shapes varying in color; size; solidity	.Report digits .Describe shape in cued position	Errors	.Shape variability .Cuing (simultaneous/ post) .Exposure duration	Early Equivocal
	5	Target identification with precuing	Shapes varying in size; color; solidity	Describe cued item	Errors	.Item variability .Exposure duration	Early Equivocal
Treisman, Sykes & Gelade (1977)	1	Search	Letters varying in color	Indicate presence/ absence of target	.RT .Errors	.Target criteria (conjunctive/feature) .Target/nontarget similarity .Display size .Practice	Early Equivocal

Continued ...

TABLE D CONTINUED

Study	Exp.	Method	Stimuli	Task Demands	Responses Measured	Manipulations	Findings
Treisman, Sykes & Gelade (1977)	2	Successive matching	Letters varying in color	Indicate match/ mismatch of target & test	.RT .Errors	.Match criteria (conjunctive/ feature) .Target/test similarity	Early Equivocal
	3	Successive matching	Schematic faces varying in eyes & mouth	Indicate match/ mismatch of target & test	.RT .Errors	.Match criteria (conjunctive/ feature) .Target/test similarity	Early Equivocal
VonWright (1970)	1	Search	.Letters & digits .Vowels & consonants .Letters & mirror images of letters	Report target items	Items correctly reported	Selection criteria (color, location, brightness, size, orientation, or cognitive category)	Early/ Structural
	2	Search	Letters varying in color	.Report cued items .Report noncued items	Number of cued & noncued items correctly reported	Selection criteria (color or shape)	Early Structural

TABLE E

Cross Modal Studies of Focused Attention

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Greenwald (1970)	1	Dichotically presented digits	Digits	.Shadow visual digits .Ignore auditory digits	.Shadowing latencies .Shadowing errors	.Monetary incentives .Shadowing (written or verbal) .Relationship between auditory & visual digits (same or different) .order of presentation & interstimulus interval of auditory & visual digit pairs	Late Structural
Greenwald (1973)	1	Dichotically presented digits	Digits	.Shadow visual digits .Ignore auditory digits	.Shadowing latencies .Shadowing errors	.Presentation rate .Degree of conflict between auditory digits & visual digits	Equivocal
Paap & Ogden (1981)	1	White noise	Letters (prime & target)	.Detect auditory probe .Classify visual stimuli (vowel/consonant)	.RT to auditory probe .RT & correct responses to visual stimuli (primary task)	.Arrival of auditory probe .Predictive value of visual prime (50/90%) .Presence/absence of visual prime	Equivocal

Continued ...

TABLE E CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Paap & Ogden (1981)	2	White noise	Letters & "blots" (prime & target)	.Detect auditory probe .Classify visual stimuli (letter-vowel/consonant)	.RT to auditory probe .RT & correct responses to visual stimuli (primary task)	.Arrival of auditory probe .Nature of visual prime (letter/"blot") .Predictive value of visual prime	Equivocal
Tulving & Lindsay (1967)	1	Pure tones varying in intensity	Patches of white light varying in intensity	Judge intensity of the auditory or visual stimuli	Accuracy of judgments	.Stimulus duration .Stimulus intensity	Equivocal
	2	Pure tones varying in frequency & intensity	Circles varying in size & intensity of illumination	Judge intensity of the auditory or visual stimuli	Accuracy of judgments	.Stimulus duration .Stimulus intensity	Equivocal

TABLE F

Cross Modal Studies of Divided Attention

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Allport, Antonis & Reynolds (1972)	1	.Monaural prose .Words to be remembered	.Words .Complex visual scenes	.Shadow prose .Remember nonshadowed AS & VS	Recognition of nonshadowed AS & VS		Equivocal Functional
	2	Binaurally presented prose	Piano playing from a score	.Shadow AS .Play piano	.Shadowing performance .Errors in piano playing	Difficulty of AS & VS	Equivocal Functional
Hall & Swane (1973)	1	.Noncolor words .Color names	.Patches of color .Color names (same or different from AS)	.Shadow AS .Recall VS	.Shadowing performance .Recall of VS		Equivocal
Johnston & Heinz (1978)	1	.Two binaural prose passages .Monaural prose passage	500 msec. light flash	.Detect VS .Monitor relevant prose passage .Answer questions concerning content of relevant passage	.Correct detections of VS .RTs to VS .Correct answers concerning AS	Selection criteria of relevant AS (gender of speaker or content)	Equivocal Functioning

Continued ...

TABLE F CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Johnston & Heinz (1978)	2	Binaural or monaural prose passages	500 msec. light flash	.Detect VS .Monitor relevant prose passage	.Correct detection of VS .RTs to VS .Correct answers concerning AS	.Number of irrelevant passages (0, 1 or 2) .Selection criteria of AS (gender of speaker or content)	Late Functional
	3	Binaural or monaural prose passages	500 msec. light flash	.Detect VS .Monitor all AS .Answer questions concerning content of all AS	.Correct detections of VS .RTs to VS .Correct answers concerning AS	.Number of prose passages (1 or 2) .Passages differences (gender of speaker or content)	Equivocal Functional
	4	Two binaural lists of nouns	500 msec. light flash	.Shadow relevant list of nouns .Detect VS	.Shadowing errors .Correct detections of VS .RTs to VS	Lists differences (gender of speaker or content)	Equivocal Functional
	5	Two binaural lists of nouns	500 msec. light flash	.Monitor relevant list of nouns .Detect targets in relevant list of nouns .Detect VS	.AS detections .VS detections .RTs to VS	List differences (gender of speaker or content)	Equivocal Functional

Continued ...

TABLE F CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
LaBerge (1971)	1	.Data signal (binaural pure tone)	.Data signal (squares varying in color, or the digit "2") .Cue signal (orange or green square)	Detect relevant data signal (orange or green square)	.VS detections .RTs to VS	.Expectancies of targets .Feedback after each trial	Equivocal
	2	.Data signal (1000 Hz tone, 1200 Hz tone or white noise) .Cue signal (1000 Hz tone)	Data signal (red square)	Detect relevant data signal (1000 Hz tone)	.AS detections .RTs to AS detections	.Expectancies of targets .Practice	Equivocal
Logan (1979)	1	Binaural digits	Letters	.Recall AS in order presented .Indicate manually the VS presented	.Correct AS recalled .RTs to VS	.Size of VS target set .Nature of the trials (AS, VS or AS & VS) .Practice	Equivocal Functional
	2	Binaural digits	Letters	.Recall AS in order presented .Indicate manually the VS presented	.Correct AS recalled .RTs to VS	.Size of VS target set .Nature of the trials (AS, VS or AS & VS) .Practice with varied VS target set across days	Equivocal Functional

Continued ...

TABLE F CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Logan (1979)	3	Binaural digits	Letters	.Recall AS in order presented .Indicate manually the VS presented	.Correct AS recalled .RTs to VS	.Size of VS target set .Nature of the trials (AS, VS or AS & VS) .Practice with same VS target set across days	Equivocal Functional
Long (1976a)	1	Binaural pure tones varying in frequency, intensity & duration	Strips of white light varying in length & intensity	Classify VS & AS according to relevant dimensions	Correct classifications	.Number of varying dimensions per trial .Number of dimensions relevant per trial	Equivocal
Long (1976b)	1	Binaural pure tones varying in frequency	Strips of white light varying in intensity	Classify AS & VS (high, medium or low)	Correct classifications		Equivocal
Martin (1980)	1	Words	Words	Recall cued items	Items recalled	.Word classification & recall criteria (physical-short/long; semantic - plant/ animal) .Presentation (single/ mixed modalities) .Responses (auditory/ spoken; visual/written) .Pre/post cuing	Equivocal

Continued ...

TABLE F CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Martin (1980)	2	Words	Words	Recall cued items	Items recalled	.Word classification & recall criteria (physical - short/long; semantic - plant/animal) .Recall instructions (order of report) .Responses (auditory/spoken; visual/written) .Pre/post cuing	Equivocal
	3	Words	Words	Recall cued items	Items recalled	.Word classification & recall criteria (physical - short/long; semantic - plant/animal) .Recall instructions (order of report) .Responses all spoken .Pre/post cuing	Equivocal
Mulligan & Shaw (1981)	1	Pure tones	White lights	.Detect stimuli .Locate stimuli (left/right) .Identify stimulus modality	.Correct locations .Correct identifications	Unimodal/bimodal presentations	Late Equivocal

Continued ...

TABLE F CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Rollins & Thibadeau (1973)	1	.Prose .Words to be remembered	.Names of common objects .Pictures of common objects .Pictures of fictitious characters	.Shadow prose .Remember non-shadowed stimuli (AS & VS)	Recognition test for non-shadowed items (correct detections & errors of commission)		Equivocal
Shaffer (1975)	1	.Monaural or dichotic prose or letters .Nursery rhymes	.Words or letters .Prose	.Type VS .Recite nursery rhymes .Shadow AS	.Typing accuracy .Accuracy of recitation Shadowing performance		Late Functional
	2	.Dichotic prose & words .Nursery rhymes	.Words .Prose	.Type AS prose .Type AS prose & shadow words .Type VS & shadow AS prose .Type AS & recite nursery rhymes	.Typing accuracy .Accuracy of recitation .Shadowing performance		Late Functional
Treisman & Davies (1973)	1	Dichotic & binaural words or pure tones	.Words .Visual positions	Recall presented AS & VS channel by channel	AS & VS items correctly recalled	AS & VS pairings	Equivocal Structural

Continued ...

TABLE F CONTINUED

Study	Exp.	Auditory Stimuli (AS)	Visual Stimuli (VS)	Task Demands	Responses Measured	Manipulations	Findings
Treisman & Davies (1973)	2	Dichotic words	Words.	.Monitor AS & VS .Detect AS & VS target items	.Correct detections .RTs to correct detections	.Selection criteria (physically or semantically defined targets) .AS & VS pairings .Visual noise (letter "X" terminating words)	Early Structural
Tulving & Lindsay (1967)	1	Pure tones varying in intensity	Patches of white light varying in intensity	Judge intensity of AS & VS	Accuracy of judgments	.AS & VS duration .AS & VS intensity	Equivocal
	2	Pure tones varying in frequency & intensity	Circles varying in size & intensity of illumination	Judge intensity of AS & VS	Accuracy of judgments	.AS & VS duration .AS & VS intensity	Equivocal

APPENDIX B

EXPERIMENTAL TASKS' PRESENTATION SEQUENCE

TABLE 3

Experimental Tasks' Presentation Sequence

Subjects	Days 2	3	4	5	Subjects	Days 2	3	4	5
1	1-2	3-8	4-8-5	8-6-7	21	5-3	8-1	7-8-4	6-2-8
2	2-1	8-4	3-8-6	5-7-8	22	6-4	2-8	3-8-5	8-7-1
3	3-8	4-8-1	8-2-7	5-6	23	7-8	1-8-3	8-5-2	6-4
4	8-4	3-8-2	1-7-8	6-5	24	8-2	8-4-6	1-7-8	5-3
5	5-6	7-8	1-8-2	3-4-8	25	1-8	7-8-2	8-4-5	6-3
6	6-5	8-7	2-8-1	4-3-8	26	2-7	8-1	3-8-6	5-4-8
7	7-8	5-8-6	8-3-4	1-2	27	3-6	8-5	4-8-2	7-1-8
8	8-7	6-8-5	4-3-8	2-1	28	4-8	5-8-6	8-3-1	7-2
9	1-5	8-2	6-8-7	3-4-8	29	8-5	4-8-3	6-1-8	2-7
10	8-2	6-8-1	5-4-8	7-3	30	6-3	4-8	5-8-7	8-2-1
11	3-7	4-8	5-8-1	8-6-2	31	7-2	1-8	6-8-3	8-4-5
12	4-8	3-8-7	8-6-2	5-1	32	8-1	2-8-7	5-4-8	3-6
13	5-1	6-8	2-8-3	8-7-4	33	1-4	8-5	6-8-7	3-2-8
14	6-8	2-8-5	8-1-4	3-7	34	2-8	3-8-7	8-6-5	4-1
15	7-3	8-4	1-8-5	2-6-8	35	8-3	2-8-6	7-5-8	1-4
16	8-4	7-8-3	2-6-8	1-5	36	4-1	5-8	7-8-6	8-2-3
17	8-1	7-8-5	3-2-8	4-6	37	5-8	4-8-1	8-2-3	7-6
18	2-8	6-8-4	8-7-1	3-5	38	6-7	8-3	2-8-1	4-5-8
19	3-5	7-8	1-8-6	4-2-8	39	7-6	2-8	3-8-4	8-1-5
20	4-6	8-2	5-8-3	1-7-8	40	8-5	1-8-4	3-2-8	6-7

Continued

TABLE 3 Continued

	Days					Days			
Subjects	2	3	4	5	Subjects	2	3	4	5
41	1-8	6-8-4	8-7-3	2-5	51	3-1	8-6	4-8-2	7-5-8
42	2-5	3-8	4-8-7	8-1-6	52	4-2	8-7	5-8-3	1-6-8
43	3-8	2-8-5	8-1-6	4-7	53	5-8	7-8-2	8-4-6	1-3
44	4-7	1-8	6-8-2	8-5-3	54	6-8	1-8-3	8-5-7	2-4
45	5-2	8-3	7-8-4	6-1-8	55	8-7	5-8-4	2-6-8	3-1
46	8-6	1-8-7	4-3-8	5-2	56	8-6	3-8-1	7-5-8	4-2
47	7-4	8-6	1-8-5	3-2-8	57	6-8	8-4-2	7-8-1	3-5
48	8-3	5-8-2	6-1-8	7-4	58	7-1	4-8	5-8-2	8-3-6
49	1-3	6-8	2-8-4	8-5-7	59	4-8	7-8-6	8-1-5	2-3
50	2-4	5-8	7-1-8	8-3-6	60	2-3	5-8	4-8-1	8-6-7

APPENDIX C

PREPARATION AND ADMINISTRATION OF AUDITORY STIMULI

Preparation and Administration of Auditory Stimuli

Auditory materials consisted of either prose passages or series of discrete stimulus pairs. Minor differences, as are indicated below, occurred in the preparation and administration of these two types of stimuli.

A Sony two channel, stereophonic tape-recorder, model TC-270, was employed to initially record the prose passages. A Revox reel-to-reel tape-recorder, model A-77, was employed to initially record the sequences of stimulus pairs. The Revox recorder and a McCurdy mixing counsel, custom made for the University of Windsor Media Center, were used in the rerecording and synthesis of all dichotic listening tapes.

The materials, prose passages or stimulus pairs, comprising a dichotic message were individually and simultaneously presented on the two tracks of the Sony recorder, model TC-270. Messages were presented to subjects through a pair of Selfix stereophonic headphones, model 5708. For those tasks requiring dual responses, shadowing and target detection, a metal rod was provided for the purpose of tapping to target items. Subjects responses, shadowing prose passages or shadowing prose passages and tapping to target items, were recorded on a second Sony tape-recorder, model TC-105, with the use of a Sony microphone, model F-25. Subjects' performance was subsequently scored by the experimenter on specially prepared data sheets. Subjects' responses on those tasks that presented discrete stimulus pairs were recorded manually by the experimenter at the time of experimentation.

All stimuli were recorded in the same male voice and prose passages were presented at a rate of approximately 150 words per minute. As an aid to pacing and synchronization, while recording prose passages the speaker monitored metronome clicks played on the Sony recorder, model TC-105 at a rate of 2.5 per second. This procedure insured that the mean error of synchronization did not exceed 25 milliseconds (Lewis, 1970; Lyons, 1974). Messages were read as monotonously as possible so as to avoid long pauses and marked fluctuations in intonations and other parameters of voice quality. Intensity was regulated by means of the tape-recorder's microammeter and its uniformity was subsequently checked and adjusted with the assistance of an independent human editor and a H. H. Scott sound level meter, model 412. The synchronization of stimulus pairs was monitored in a similar manner.

APPENDIX D_1

PRACTICE TASK A

AUDITORY SHADOWING: BINAURAL (AS-B)

APPARATUS AND PROCEDURE

Practice Task A
Auditory Shadowing: Binaural (AS-B)

Apparatus and Stimulus Materials

Two binaural listening tapes (B_1 and B_2) were employed. Each tape was characterized by a warning signal, the spoken word "ready," which preceded the onset of the message by approximately 5 seconds, and a prose passage consisting of a 285 word excerpt taken from either Wallace's (1969), The Word of Van Gogh (B_1) or Armbruster's (1967), Basic Skills in Sports for Men and Women (B_2). All passages are presented in Appendix D_2. The procedures, including the apparatus, employed to prepare and administer the stimuli are discussed in Appendix C.

Procedure

Prior to the presentation of testing materials, subjects were given detailed instructions concerning the nature of the task as listed in Appendix D_3. Briefly stated, subjects were informed that they were required to monitor the binaural message and repeat it immediately upon hearing it. The presentation order of B_1 and B_2 was fixed across subjects, and an interval of approximately two minutes separated the presentation of the two tapes.

The dependent measures included the number of words correctly shadowed. Errors of omission and commission as well as mispronunciations were regarded as shadowing errors. Shadowing scores for each subject were determined by calculating the number of words correctly shadowed for B_1 and B_2 respectively. The criterion level of acceptance was set at a minimum of 200 correctly shadowed words on at least one trial. That is, subjects were required to demonstrate 70% or better shadowing proficiency on either B_1 or B_2 for inclusion in the remainder of the study.

APPENDIX D_2

PRACTICE TASK A

AUDITORY SHADOWING: BINAURAL (AS-B)

STIMULUS MATERIALS

Practice Task A
Auditory Shadowing: Binaural (AS-B)

Binaural Listening Tape (B_1)

"Vincent Van Gogh, who died at 37, in 1890, had one of the briefest careers in art history. It spanned only 10 years - and of these, the first four were devoted almost exclusively to drawing. But the volume of his output was astonishing. Close to 1,700 of his works survive, almost 900 drawings and more than 800 paintings, made in volcanic outbursts of creation that sometimes saw him produce a canvas a day for weeks on end. During his lifetime he sold only one painting for the equivalent of $80.00, and among his last recorded words was the question, 'But what's the use?' The use, of course, became apparent within 25 years after his death. Van Gogh is now ranked as one of the founding fathers of modern art. Van Gogh's work is of an extremely personal sort. With the exception of his countryman Rembrandt, no other great artist has produced more self-portraits. His landscapes, figures, interiors and still lifes are in a sense self-portraits as well. It was his method to fuse what he saw, and what he felt, as quickly as possible into statements that were revelations of himself. His color and his warmth are so powerful that looking at one of his paintings can be like staring into the blue, yellow and orange flames beyond the suddenly opened door of a furnace. It is not that he had an apocalyptic vision of the fires of hell. On the contrary, few men have ever had greater capacity to give love, or greater need to receive it. Sadly, he could express his love only in his art. When he sought to express it directly to other human beings he met only misunderstanding or hostility."[1]

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[1]Wallace, R. The World of Van Gogh. Virginia: Time-Life Books, 1969, pp. 7-8.

Practice Task A
Auditory Shadowing: Binaural (AS-B)

Binaural Listening Tape 2 (B_2)

"The word gymnastics means 'naked art' and comes from the early Greeks. It is believed that the Chinese were the first people to develop activities that resembled gymnastics. The Greeks worked with an apparatus rather than upon it, whereas the Romans used an apparatus in the form of a wooden horse upon which to practice. The word gymnasium is also a Greek word and means 'the ground, or place for gymnastic performances.' When the Roman civilization weakened, the common people were discouraged from particpating in strenuous activities, and through the middle ages, only the knights engaged in much physical activity. Using people as apparatus, human towers were formed during seiges and at public performances. Johann Basedow was the first European to teach organized gymnastic exercises. Then Johann Muths published the first book on gymnastics. Muths is also referred to as the 'great-grandfather of gymnastics.' After the Napoleonic victories over the Germans, a plan for building up the national strength of Germany was formulated by Frederick Jahn during the period from 1810 to 1852. Jahn is credited with introducing the parallel bars, the horizontal bar, the side horse with pommels, and the vaulting buck. He believed that the Germans should be united to protect themselves, so he took the boys of Berlin to nearby woods on hikes and there they invented these different types of apparatus. In 1842, ten years before Jahn's death, gymnastics was introduced into the German public schools in a formal nature. Mats were first used in Copenhagen, Denmark when the Miliary Gymnastic Institute was opened to train teachers in gymnastics. About 1850, a wave of German immigration brought these clubs to America, where they were called Turner Societies. Gymnastics took a thorough hold through these Turner Clubs."[2]

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[2]Armbruster, D., Irwin, L. & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, pp. 130-131.

APPENDIX D_3

PRACTICE TASK A

AUDITORY SHADOWING: BINAURAL (AS-B)

INSTRUCTIONS

Practice Task A
Auditory Shadowing: Binaural (AS-B)

Instructions

This is an attention task that will serve the purpose of familiarizing you with auditory shadowing, a procedure that will be frequently employed throughout the series of attention experiments to be conducted within this study. Auditory shadowing merely means that you overtly repeat stimulus information immediately as you receive it. For example, if you were to repeat what I am saying, you would be shadowing my speech. In all the experiments to be conducted in this study, the auditory stimuli will be tape recorded and presented to you through a pair of headphones. Most often you will be asked to shadow, that is, repeat, prose passages. On occasion, however, you may be asked to repeat other types of verbal stimuli such as random digits. Regardless of the nature of the stimuli, the procedure is the same. You are to listen to the material that is arriving through the headphones and repeat each word or item immediately as you receive it. Do not wait until the end of a sentence or the completion of a passage to repeat the material.

In this task you will be given two trials or attempts at shadowing.

Passage B_1:

On this trial you will be shadowing a two minute passage on the life of the artist, Van Gogh, Remember I would like you to carefully listen to the message and repeat it immediately as you hear it. Since I will be recording your shadowing performance, I would like you to speak as clearly and as loudly as possible. In the event that you feel that you have missed a word, disregard the missed item and continue shadowing the material that you are currently receiving.

Once you have comfortably adjusted the headphones and you are prepared to begin the task, please let me know by saying the word "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the message is about to begin. If you have any problems hearing or understanding the message, please let me know. Remember that you are to continue shadowing for the duration of the entire message. Once the message is completed, you may remove the headphones for a brief rest period.

Do you have any questions?

I would like you to please put on the headphones now.

Passage B_2:

This trial is just like the last one. This time, however, you will be receiving a two minute passage on the history of gymnastics. Remember I would like you to carefully listen to the message and repeat it immediately as you hear it.

Do you have any questions?

I would like you to please put on the headphones now.

APPENDIX E_1

PRACTICE TASK B

AUDITORY SHADOWING: DICHOTIC (AS-D)

APPARATUS AND PROCEDURE

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Apparatus and Stimulus Materials

Four dichotic listening tapes, D_1, D_2, D_3, and D_4, were employed. Each tape was characterized by the following: 1) a dichotic warning signal consisting of the spoken word "ready" which preceded the onset of the dichotic messages by approximately 5 seconds; 2) a message consisting of a 285 word prose passage on the life of a famous artist (D_1: Picasso; D_2: Manet; D_3: Goya; D_4: daVinci); and 3) a messgge consisting of a 285 word prose passage on the history of a well known sport (D_1: field hockey; D_2: tennis; D_3: archery; D_4: soccer). All passages are presented in Appendix E_2. The procedures, including the apparatus, employed to prepare and administer the stimuli are discussed in Appendix C.

Procedure

Prior to the presentation of experimental materials, subjects were given detailed instructions concerning the nature of the task as listed in Appendix E_3. Briefly stated, subjects were informed that they were required to shadow the material arriving on the designated channel and attempt to avoid intrusions or disruption from material presented on the alternate channel.

The passages (passage 1 or passage 2) to be designated as the shadowed or the nonshadowed message, their ear of arrival, and their order of presentation was fixed across subjects. Specifically, for message D_1, subjects were required to shadow the field hockey passage which was presented on the right channel; for message D_2, the Manet passage which was presented on the left channel; for passage D_3, the archery message which was presented on the left channel; and for passage D_4, the daVinci message which was presented on the right channel. An interval of approximately 2 minutes separated each of the four tape presentations.

The dependent measures included the number of words correctly shadowed. Errors of omission and commission, including intrusions from the nonshadowed message as well as mispronunciations were recorded as shadowing errors. Shadowing scores for each subject were determined by calculating the number of words correctly shadowed for D_1, D_2, D_3, and D_4 respectively. The criterion level of acceptance was set at a minimum of 200 correctly shadowed words on at least one trial. That is, subjects were required to demonstrate 70% or better shadowing proficiency on either D_1, D_2, D_3, or D_4 for inclusion in the study.

APPENDIX E_2

PRACTICE TASK B

AUDITORY SHADOWING: DICHOTIC (AS-D)

STIMULUS MATERIALS

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_1 - Passage 1

"Picasso was born on October 25, 1881, in the city of Malaga on the southern coast of Spain. The circumstances of his birth were decidely inauspicious. He failed to breathe and the midwife abandoned him as stillborn. As Picasso tells the story, an uncle who was a doctor happened to be on hand and saved his life by blowing cigar smoke in his nose. Then, Picasso says, 'I made a face and began to cry.' Two weeks later Picasso was baptized under a roster of names that honored various godparents, relatives, and saints. At the end of the list came two more names, Ruiz and Picasso -- the first for his father and the second for his mother, as is Spanish custom. As a young artist Picasso would sign himself P. Ruiz or P. Ruiz Picasso until about 1902, when he settled on Picasso alone -- partly because it was less common than Ruiz, partly out of fondness for his mother. Picasso's family belonged to the professional middle class. His father, whose forebears had been minor aristocrats, was a tall man nicknamed 'the Englishman' because of his reddish hair and his liking for English ways. He was a museum curator, a teacher of art and artist. Picasso once described his father's paintings as 'dining room pictures, the kind with partridges and pigeons, hares and rabbits, fur and feather. Fowl and flowers. Especially pigeons and lilies. Lilies and pigeons.' Picasso's uncle Diego was a diplomat who once served as an envoy to Russia. Another uncle was a doctor of theology. The third, the cigar-smoking doctor who rescued Picasso at birth, was Director of the Health Department of the port of Malaga. Picasso inherited his looks from his mother."[3]

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[3]Wertenbaker, L. The World of Picasso. Virginia: Time-Life Books, 1967, pp. 8-9.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_1 - Passage 2

"Field hockey is undoubtedly the oldest sports game played with a stick and ball. About 2500 years ago, the early Greeks and other ancient nations played a game very similar to our present-day hockey. Some centuries later it was found that the game was being played in France and was called 'hoquet' as we would pronounce hockey. The game became generally known as hockey by its English spelling and pronunciation. However, later when ice hockey, became popular, the game of hockey was called field hockey, and so it remains today. Between 1880 and 1890 field hockey was played exclusively by men in England, France, and other European countries and is still very popular with them. In the United States, men tried the game but it met with little favour. A group of women, who formerly lived in England, formed the Livingston Association on Staten Island about this time, but it was short-lived. Then in 1901, Constance Applebee, demonstrated the game of field hockey during a visit to the Harvard summer school. She recommended it as a health-building form of combative recreation for college women. Miss Applebee was then invited to several women's colleges and on each campus field hockey was accepted with high favour. Women's teams were formed and the first interclass contest was held in 1902. The women enjoyed the game so much and became so vitally interested in it that they adopted it and revised the rules to make them uniform and suitable for women's play. In 1922, the United States Field Hockey Association was formed in Philadelphia to govern the sport for women, and its purpose being to stimulate more enthusiasm for and advance the best interest of hockey for women and girls."[4]

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[4]Armbruster, D., Irwin, L. & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, p. 101.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_2 - Passage 1

"Many artists suffer neglect in their times; few artists have had to suffer the brutal critical attacks and the storms of scorn that haunted Manet during the decade following his exhibition of 'Luncheon on the Grass.' Hooted at by the public, humiliated in print as an 'apostle of the ugly and repulsive,' Manet nevertheless went on painting, and between 1863 and 1873 produced some of his most mature, self-confident and daring pictures. These are paintings of the world at large, of the men and women of Paris, of the news events that shocked the nation, of the city's entertainments and of the private realm of Manet's friends. During this time of trial he paused to say little in his own defense except to note that 'anything containing the spark of humanity, containing the spirit of age, is interesting.' After the storm his 'Luncheon on the Grass' aroused, Manet waited two years before submitting another nude to the Salon. His painting was accepted and hung, but it soon met a cyclone of abuse from both critics and public. Although it was moved to a place high up on a gallery wall, it drew huge crowds of gawkers. His friends and family frequently served Manet as models. One of his most charming pictures, the idea for which he apparently got while vacationing, shows in languid poses a talented artist who would later marry Manet's brother. One of the reasons given for Manet's frequent use of his family and friends as models is that the continuing critical abuse to which he was subjected led him to turn to a congenial group even for his subjects. Oddly enough, however, there are few paintings of Manet's wife, Suzanne."[5]

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[5] Schneider, P. The World of Manet. Virginia: Time-Life Books, 1968, pp. 68-78.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_2 - Passage 2

"There are some historians who trace the game of tennis to the ancient Greeks. Others consider it an outgrowth of the game of handball, which was first played in Ireland and Scotland as early as the tenth century. However, most authorities trace its origins to 'le paume,' the game of the hand, which was first played in France as early as the A.D. 1300. The game at this early time was played either indoors or outdoors. A cork ball or a ball of hair covered with leather was batted with the hand back and forth over a mound of earth on blocks of wood about 3 feet high. Gloves were used to protect the hands. Soon, however, a paddle was used, which later was replaced by a racket with tightly drawn strings. The cork ball was replaced by an inflated ball, and a net replaced the mound of earth. Undoubtedly, the original game of batting the ball with the hand has continued to the present and is known as handball. The game received its present-day name when English visitors heard French officials call 'tenez,' which meant to resume play, an expression similar to 'play ball' used by baseball umpires. The English thought 'tenez' was the correct name for 'le paume:' In times the English word tennis was substituted. It is peculiar that, while the game was widely played during the middle ages, there appears to be no record of any rules governing it. The first known attempt to develop a tennis-type game with standardized rules and regulations was not well liked and was soon replaced by lawn tennis because the game was being played on the lawn. As the game became increasingly popular, hard-surfaced courts became popular."[6]

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[6] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, p. 267.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_3 - Passage 1

"Francisco Goya, with his unique genius, captured the soul of Spain in an amazing range of works. A dazzling versatile artist, he created etchings and lithographs, and painted cartoons for tapestries, incisive portraits, stirring frescoes, and deeply felt scenes of reality and imagination. Born to a poor family that was only barely genteel, he was endowed with a restless amibition that, coupled with his ennobling gift, carried him to the fashionable world of Madrid and its royal court, where Spain's wealthiest aristocrats became his patrons. He had the vigorous, inflammable nature of a rebel, but his deep need for security and affluence taught him to curb his tongue. Material success and personal prudence, however, never dulled the thrust of his art. He remained to his dying day, at the age of 82, a passionate Spaniard who drew and painted with intense veracity those things he saw around him and the emotion he felt for them. Goya's zest for living seldom deserted him, even though it was subjected to brutal tests. He suffered two serious illnesses, one of which denied him his hearing at the age of 46. He watched with horror the barbaric Napoleonic wars as they ravaged Spain, and he was witness to sickening displays of ineptitude exhibited by the Spanish rulers in the royal court. But in his fervent sense of humanity and his passion for reason he revealed the concern he felt for his land and his fellow man. With stunning creative energy he transmitted it all to the canvas. From his position at the center of the turbulent Spanish scene, Goya was acutely aware of history and the people, events and institutions that mold it. Early in his career the office of the Inquisition (and the churchmen who ran it) was the most brutal, powerful and repressive force."[7]

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[7] Schickel, R. The World of Goya. Virginia: Time-Life Books, 1968, pp. 16 & 28.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_3 - Passage 2

"The bow and arrow is one of man's oldest mechanical weapons and remains the weapon of many of our still existing aboriginal races and tribes in many parts of the world. The bow and arrow was first used by primitive man for hunting. It was a chief weapon of the American Indians, both for hunting and war. It was used as a weapon of war by the Egyptians in over throwing Persia and in many other successful wars. With the discovery of powder and the use of firearms in comparatively recent time, the bow has retired to the realm of sport. In this capacity it has sporadically interested groups in various parts of the civilized world, particularly in England and the United States, but has not flourished to the same extent as many other sports. In the United States the recent archery club, known as the United Bowmen of Philadelphia, was organized in 1928. The first tournament was held in Chicago in 1879, and tournaments sponsored by this club are still being continued to the present day. Within recent years there has been a revival of interest in the sport of archery. Along with the revival of interest in all sports of the individual type, it is being enjoyed by an increasing number of men, women, and children. Archery has a carry-over fascination for most people from childhood Indian-playing days. Archery is legendary. One need only be reminded of the adventurous glamor and charm of Robin Hood, William Tell, and Hiawatha. Any bow, except the crossbow, and any arrow are permissible in a contest. Tackle may be changed at any time in the competition. Women may shoot in a men's event or in the junior or senior events."[8]

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[8] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, p. 22.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_L - Passage 1

"Time has dealt gently with the world of Leonardo. Were he now to stand as once he did, looking down across an olive grove at Vinci sleeping in the sun, his view would be essentially the same as it was 500 years ago. In two senses this image suggests flight: the act of soaring above the towers and over the distant hills, and the idea of escaping from a small town that, for all its loveliness, could be only a prison for him. In his childhood the attraction of Florence, less than a day's journey distant, was no doubt overwhelming. In Vinci, Leonardo might see peasants whittling sticks, chipping stones or making such coarse fabrics as they wore -- but the 'City of Flowers' teemed with artists and artisans, daily producing hundreds of shop and studio objects that to a boy must have seemed almost miraculous: tapestries, paintings, illuminated manuscripts, jewelwork, sculpture, decorated chests, cloth of the most exquisite texture and color. The transition -- or the flight -- from Vinci to Florence was a radical one. Leonardo himself, on his thousands of pages of manuscript never made the slightest reference to it, either in terms of melancholy at forsaking his childhood or joy at his liberation. Although Leonardo's undying reputation is rooted in other things as well as his art, it is nonetheless surprising that in his 67 years he produced so few paintings -- little more than a dozen. One of the problems in detecting Leonardo's works lies in his own evolution as an artist: his High Renaissance masterpieces are so overpowering that it is difficult to accept his earlier paintings as coming from the same hand. Another difficulty stems from his influence, which he exerted only through a relatively small number of his paintings."[9]

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[9] Wallace, R. The World of Leonardo. New York: Time-Life Books, 1966, pp. 18 & 27.

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Message D_4 - Passage 2

"The true origin of soccer is difficult to determine. One historian reports that soccer originated in Greece. The Romans obtained the game from the Greeks, and in turn, passed it on to England. The early games were rugged and irregular. Two towns, three to five miles apart, sometimes engaged in a game with no rules being enforced. Occasionally a river had to be crossed. The market place of the town was the goal. Rugby was devised accidentally at Rugby College, England, in 1823 when one of the players on Rugby's team tucked the ball under his arm and ran across the goal line. This act was recognized as unsportsmanlike conduct. The game gained tremendously in popularity through the next forty years, and when the word football was used, some people asked, 'Which kind?' In 1848, the advocates of football met in Cambridge to draw up a list of rules which became known as the Cambridge Rules. This meeting was unsatisfactory since some schools favored carrying the ball as permitted in rugby. The result was a meeting in 1863 of the group that favored the kicking type of game. This group voted to confine play entirely to kicking and later became known as the London Football Association. To distinguish between the two types of football, they called one 'rugby' and the other 'association.' Later this was shortened to its present designation, soccer. Soccer has been played in American colleges since 1830. In 1868, Princeton challenged Rutgers, and the first intercollegiate soccer game was played in New Jersey. Soccer became a national sport in 1913 with the organization of the United States Soccer Association. In 1919 soccer was introduced at a women's college."[10]

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[10] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, pp. 143-147.

APPENDIX E_3

PRACTICE TASK B

AUDITORY SHADOWING: DICHOTIC (AS-D)

INSTRUCTIONS

Practice Task B
Auditory Shadowing: Dichotic (AS-D)

Instructions

This is an auditory attention task that will serve the purpos of familiarizing you with shadowing a dichotic message. Unlike in the last task in which you heard the same message in both the left and right ear, in the present task you will simultaneously receive a differ message in each ear. Although two messages are presented, you are still to repeat one message only. The shadowing procedure remains the same as that employed in the last task. I would like you to listen carefully to the designated message and repeat it immediately as you hear it.

Each message will again be approximately two minutes long. O each trial one message will always be a historical narrative on a well known sport while the other passage will consist of an approximately 300 word excerpt on the life of a famous artist. On some trials you will be asked to repeat the message in your right ear, and on subsequent trials you may be asked to repeat the message that is arriving in your left ear. I will always tell you which message you are to shadow, that is, repeat.

Do you have any questions?

Message D_1:

On this trial I would like you to repeat the message that is presented in your right ear. The passage concerns the sport of field hockey. Try to avoid repeating the message in your left ear. Remember that I would like you to listen carefully to the message about field hockey that will be arriving in your right ear and repeat it immediately as you hear it. Since I will be recording your shadowing performance, I would like you to speak as clearly and as loudly as possible. In the event that you feel that you have missed a word or made another error, do not try to correct your mistake but rather continue shadowing the material that you are currently receiving.

Once you have comfortably adjusted the headphones and you are prepared to begin the task please let me know by saying the word "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the message is about to begin. If you have any problems hearing or understanding the message please let me know.

Remember that you are to continue to shadow the message arriving on your right ear until it is completed. Once the message is completed you may remove the headphones for a brief rest period.

Do you have any questions?

I would like you to please put on the headphones now.

Message D_2:

This trial is the same as the last one, however, different messages will be employed. On this trial I would like you to repeat the passage that you hear in your left ear. The passage will deal with the life of the artist, Manet.

Do you have any questions?

I would like you to please put on the headphones now.

Message D_3:

On this trial I would like you to shadow the message that is presented in your left ear. The passage will deal with the sport of archery.

Do you have any questions?

I would like you to please put on the headphones now.

Message D_4:

On this trial I would like you to shadow the message that is presented in your right ear. The passage concerns the life of the artist, Leonardo da Vinci.

Do you have any questions?

I would like you to please put on the headphones now.

APPENDIX F_1

PRACTICE TASK C

VISUAL IDENTIFICATION: TACHISTOSCOPIC (VI-T)

APPARATUS AND PROCEDURE

Practice Task C
Visual Identification: Tachistoscopic (VI-T)

Apparatus and Stimulus Materials

A 2-field Harvard tachistoscope, model T-2B, was employed to present stimulus materials. The exposure area of the tachistoscope was 19.375° of a visual angle in height and 19.375° of a visual angle in width. The light exposure was set at 1 log unit per field.

Each tachistoscopic presentation consisted of a single, monosyllabic concrete noun. Stimulus words were horizontally printed in lower case type in black ink on a white background. Each word was centrally positioned within the visual field and each character was approximately .156° of a visual angle in height and .156° of a visual angle in width. A gray fixation square, 3.125° x 3.125° of a visual angle, which was centrally positioned on an otherwise blank white screen, served as the adaptation field that was presented immediately preceding and following each tachistoscopic slide.

Fifty stimulus cards were employed. The fifty stimulus words were randomly selected from the 500 most frequently employed words as reported by Thorndike and Lorge (1944). All stimulus materials are presented in Appendix F_2.

Procedure

Prior to the presentation of testing materials, subjects were given detailed instructions concerning the nature of the task as presented in Appendix F_3. Briefly stated, subjects were informed that they were required to identify each stimulus word immediately upon its presentation.

Each trial or tachistoscopic presentation began with the experimenter giving a warning signal, the spoken word "ready." The "ready" signal served as a cue for subjects to fix their gaze upon the fixation square on the center of the adaptation field. Subjects were instructed to manually trigger the apparatus for the presentation of the visual stimulus word whenever ready. Each trial consisted of a 200-millisecond presentation of the stimulus word. The adaptation field was displayed between trials. Immediately following each tachistoscopic presentation, subjects were instructed to report the stimulus word that had been presented on that trial and responses were manually recorded by the experimenter. Inter-trial intervals were determined by each subject's response latency as well as the experimenter's recording time. The order of slide sequence remained constant across subjects.

The number of stimulus words correctly identified served as the dependent measure. Identification scores for each subject were determined by calculating the total number of words correctly reported. The criterion level of acceptance was set at a minimum of 35 correctly identified stimulus words. That is, subjects were required to demonstrate 70% or better identification proficiency for inclusion in the study.

APPENDIX F_2

PRACTICE TASK C

VISUAL IDENTIFICATION: TACHISTOSCOPIC (VI-T)

STIMULUS MATERIALS

Practice Task C
Visual Identification: Tachistoscopic (VI-T)

Stimulus Words[11]

Trial	Stimulus Word	Trial	Stimulus Word
1	wish	26	mile
2	act	27	time
3	horse	28	king
4	lie	29	hope
5	price	30	rest
6	car	31	case
7	age	32	note
8	boy	33	mark
9	school	34	girl
10	fire	35	heart
11	air	36	cut
12	room	37	side
13	state	38	wife
14	eye	39	face
15	day	40	week
16	food	41	war
17	feet	42	book
18	voice	43	tree
19	wind	44	sun
20	part	45	road
21	mind	46	name
22	dress	47	man
23	love	48	fact
24	life	49	hour
25	bank	50	arm

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[11] Thorndike, E. L. & Lorge, I. The Teacher's Word Book of 30,000 Words. New York: Teachers College Press, 1944, pp. 267-268.

APPENDIX F_3

PRACTICE TASK C

VISUAL IDENTIFICATION: TACHISTOSCOPIC (VI-T)

INSTRUCTIONS

Practice Task C
Visual Identification: Tachistoscopic (VI-T)

Instructions

This is a visual attention task that will serve to familiarize you with tachistoscopic presentations, a procedure that will be frequently employed throughout the series of attention experiments to be conducted in this study. Tachistoscopic presentations merely refer to the brief presentation of visual stimuli. For example, you may be asked to recognize a word, letter, or digit that will be exposed for only a few hundred milliseconds. All stimuli are presented via the tachistoscope (experimenter illustrates the tachistoscope).

In this task you will be viewing a series of monosyllabic, concrete nouns, one word at a time. Each trial or tachistoscopic presentation will begin with a warning signal. I will say the word "ready." At that time you should look at the gray square on the center of the screen (experimenter illustrates fixation square), and prepare yourself for the slide presentation. Whenever you are ready to see the slide, I would like you to press this button (experimenter illustrates slide advancer) which will trigger the presentation of the slide that you are to view. Please do not press this button until I have given you the "ready" signal and you have fixated your gaze upon the gray square. As soon as you see the slide I would like you to identify the word that was presented. This experiment will consist of a total of 50 trials with one word presented per trial.

Do you have any questions?

Ready.

APPENDIX G_1

TASK 1

AUDITORY DIVIDED: PHONETIC VERSUS SEMANTIC TARGETS (AD-PST)

APPARATUS AND PROCEDURE

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Apparatus and Stimulus Materials

Three dichotic listening tapes were employed; two experimental tapes (ET_1 and ET_2) which served as actual testing materials, and one practice tape (PT_1) which served the purpose of acquainting subjects with the nature of the task. Each tape was characterized by the following: 1) a dichotic warning signal consisting of the spoken word "ready" which preceded the dichotic message by approximately 5 seconds; 2) a primary message consisting of a 285 word prose passage taken from Knobler's (1966), The Visual Dialogue and four noncontextual target words; and 3) a secondary passage consisting of a 285 word prose excerpt taken from Knobler's (1966), The Visual Dialogue and four noncontextual target words. All messages are presented in Appendix G_2.

Three types of target words, distinguishing the two experimental conditions and the single practice condition, were employed. In experimental condition 1 (phonetic), target words were selected so as to reflect an unique acoustical property. Specifically, target items were randomly selected from a previously generated pool of monosyllabic words containing the āl phoneme. For example, such words as brail, sail, quail, and veil comprised the pool of target items. No word was employed as a target item if its inclusion in the study resulted in the duplication of the initial consonant of a previously selected item. In experimental condition 2 (semantic), target items were selected on the basis of their membership in a particular semantic class. Specifically, monosyllabic target items were randomly selected from the 15 most frequently given associations to the semantic category, body parts, as reported by Marshall and Cofer (1970). The set of target items included, for example, such words as arm, leg, head, and foot. In the practice condition, target items were similarly selected on the basis of their membership in a particular semantic class, specifically, colours. Such monosyllabic colour names as brown, black, green, and red comprised the pool of target items. Target words were inserted in each passage out of context and at random points with the restriction that none occurred in the first or last 10 words, or within less than eight words of another target in either the same or the competing message. Different pairs of passages were employed for each of the three target conditions. The procedures, including the apparatus, employed to prepare and administer the stimuli are discussed in Appendix C.

Procedure

Prior to the presentation of testing materials, subjects were given detailed instructions concerning the nature of the task as presented in Appendix G_3. Briefly stated, subjects were informed that in addition to shadowing the primary message, they were required to monitor both messages and tap the table with the metal rod whenever they detected a target word in either passage. It was emphasized that the shadowing task was of primary importance and that target detection was secondary.

All subjects initially received the practice tape which served as a means of familiarizing subjects with the nature of the task as well as provided an opportunity for minor equipment adjustments. Following a brief interval ET_1 and ET_2 were presented. The experimental conditions (phonetic and semantic) as well as passages (passage 1 or passage 2) to be designated as primary or secondary messages and their ear of arrival were counterbalanced across subjects. An interval of approximately two minutes separated each of the three tape presentations.

The dependent measures included the number of correct target detections and the number of words correctly shadowed. So as to allow for response latency, a tap was recorded as correct if it occurred within five stimulus words following the presentation of the target item. Errors of omission and commission, including intrusions from the nonshadowed message as well as mispronunciations were recorded as shadowing errors. Detections scores for each subject were determined by calculating the number of target items correctly detected on the nonshadowed message and the number of target items correctly detected on the shadowed message for ET_1 and ET_2 respectively. Shadowing scores for each subject were determined by calculating the number of words correctly shadowed for ET_1 and ET_2 respectively.

APPENDIX G_2

TASK 1

AUDITORY DIVIDED: PHONETIC VERSUS SEMANTIC TARGETS (AD-PST)

STIMULUS MATERIALS

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Practice Tape (PT) - Passage 1

.Target words and positions - gold (53), brown (200), white (243), and pink (264)

"Human beings living on the earth in the present have certain basic similarities: the shape and function of their bodies, their primary human drives, and, within the limits of their geographical locations, those aspects of nature which have significance in their lives. The seas, the land, the skies, and the creatures GOLD in them are a large part of the common inheritance; they are physical aspects of the world around us. They can be seen, touched, heard, and smelled. Man has added to the physical world structures demonstrating his ingenuity and industry -- buildings, bridges, roads, and machines -- which seem to increase in numbers by the hour, until in some places they fill the land to exclusion of grass and trees. The physical world is known to each human being through the senses. The retina of the eye reacts to light energy reflected from objects. Vibrations of air on the drums of the ears are received as sound. The skin reacts to changes of temperature and to contacts with other surfaces. Odors are registered and responses are made to them. Coming into the world, the child does not experience ordered sensations. He slowly learns to see as BROWN his forebears saw, so that he can get along in their world. For this he is in their debt. At the same time, by teaching him how to see their world, they have restricted his vision. He is denied the freedom of ordering WHITE his own sensations and seeing the world in his own way. His reactions to stimuli are limited, and since the PINK pattern of sensations to perception is set in a specific mold it is difficult to change. A thousand or even five hundred years ago, men were more isolated from each other."[12]

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[12] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, pp. 50-51.

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Practice Tape (PT) - Passage 2

.Target words and positions - green (39), red (87), blue (139), and black (156)

"In Europe, for four hundred years prior to the nineteenth century, the methods for representing form and space in the visual arts have remained essentially unchanged. Though there were stylistic differences between artists and between national or cultural groups GREEN the similarities between the methods of representation outweighed the differences. Linear perspective, aerial perspective, and shading were the prime methods for indicating natural space and form. These methods had been used so long and so widely that they took on the value of absolutes. That is, RED they were assumed to be a standard by which all methods of representation were to be measured. Late in the eighteenth century photography was invented, and it was subsequently developed in the nineteenth century into a practical and relatively simple method of creating a visual equivalent for the 'real' world. The BLUE introduction of the photograph gave additional importance to perspective as the standard method for producing visual BLACK equivalence to the artists' perceptions of form and space in the physical world. The fact that the camera produced an image in linear perspective by an optical-chemical process seemed to be a scientific confirmation of the validity of the perspective system of representing space. During the same period of time a minority of artists began to experiment with new methods of representation. Stimulated by scientific and technological developments, which were progressing at a startling pace, and influenced by examples of art from the East, from Africa, and from the Americas, these painters and sculptors sought to extend the traditional equivalent forms beyond their representational and expressive limits. These artists had a perception of light and movement which differed from that of their predecessors, and new visual forms were required to communicate this new world."[13]

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[13] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, p. 41.

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Experimental Tape 1 (ET_1) - Passage 1

Target words and positions - pale (58), brail (81), veil (160), and mail (236)

"What is a work of art? In general usage the term 'work of art' may include the products of a wide area of human activity, from the use of the spoken and written word to the use of the body in movement. It includes objects of minute size and delicate craftsmanship and constructions of huge proportions. The PALE definition of 'art object' requires a definition of 'art.' Many definitions of the word 'art' in current use may be found in BRAIL dictionaries and encyclopedias. In addition there are a large number of personal definitions and theories presented by individual writers and philosophers. Dictionary and encyclopedia definitions tend to be neutral in their point of view, with little or no area for argument. On the other hand, estheticians tend to define their own personal concepts of art and its function, often stressing some particular facet of the definition which seems VEIL important to them in the context of their own philosophical preference. The great variety of meanings attributed to the word 'art' emphasizes the desire to explain what appears to be a universal human activity. Social groups throughout time, in every part of the earth, have channeled some of their energies into the production of esthetically satisfying objects. Why do they do this, and what qualities inherent in the objects produced separate them from purely utilitarian products? These questions and others intended to define the nature of MAIL the esthetic object and our response to it have produced no absolute conclusions, but certain concepts do recur in most definitions, so that it may be possible to develop a single definition broad enough to include most of the individual concepts. Differences in the definition of art are concentrated in two major areas."[14]

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[14] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, pp. 20-22.

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Experimental Tape 1 (ET_1) - Passage 2

.Target words and positions - frail (41), whale (91), quail (185), and sale (273)

"The visual arts may be considered as communication, as formal organization, or as a combination of both, but it is impossible to examine the products of the artists as the results of a skilled manipulation of mateirals. Artists find pleasure FRAIL in the act of applying paint or cutting into the resistant surface of a granite rock, and the viewer can also respond to or empathize with the manner in which materials have been manipulated and combined in the process of forming the art object. No art object can exist unless someone has formed WHALE it. The wood or stone which eventually becomes the statue, the paint and canvas which fuse to form the painting, and certainly the many materials which are combined to construct even the simplest building must be worked, manipulated, and controlled to produce the forms that constitute the work of art. As a manipulator of materials, the artist becomes the craftsman. He must know his materials and how to work them. The artisan or craftsman differs from the artist in that the craftsman's concern is almost exclusively the manipulation of the materials. QUAIL He learns to control his materials and to exploit their surfaces, structures, and forms. The artist requires the skills too, but they are only part of his art. They must remain the mean by which he achieves the end of his work, which is communication and/or esthetic organization. How much skill is required? Obviously, enough to do the job. The measure of the skilled use of materials in a work of art is directly related to the intention of the work. When a limited skill in drawing, painting, SALE or carving causes an artist to produce work that is obscure in its intent, then the artist is not the craftsman he should be."[15]

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[15] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, pp. 23-25.

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AS-PST)

Experimental Tape 2 (ET_2) - Passage 1

.Target words and positions - head (64), toe (137), arm (195), and ear (286)[16]

"Nowhere in this definition is the idea of beauty included. This may seem a strange oversight for the word 'beauty' is almost always found in conjunction with art in casual discussion of the subject. The concept of beauty is one of those silent attendants to be expected beside the person who looks at a work of art. For many people a work of art HEAD must be beautiful, but, faced with some contemporary paintings, buildings, or sculpture characterized as works of art, these people feel confused and disturbed, for what they see before them they consider not beautiful, but ugly. There are two basic concepts of the meaning of beauty. In one point of view beauty lies in the subjective response of a person upon contact with an external stimulus: the sense of the beautiful lies within TOE us. Something outside ourselves can make us feel this sense of beauty, but the feeling is not a part of the object that triggered this response; it is solely and completely within the onlooker. In the second point of view beauty is an inherent characteristic of an object or an experience. It is the relationship of the individual ARM parts in their combination that is recognized as beauty by a viewer. These two definitions appear to approach beauty from two opposite poles. Those who think of beauty as existing solely within the responses of the individual are examining the experience from an observer's point of view. Those who think of beauty as inherent in an object or experience are seeing it from the point of view of the creator, the person who must decide how to make his work beautiful. What of the person who is trying to produce a beautiful EAR object, sound, or movement? For him it is not enough to know that beauty is a subjective reaction within the observer."[17]

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[16] Marshall, G. & Cofer, C. Single-word free-association norms for 328 responses from the Connecticut Cultural Norms for items in categories. In L. Postman & G. Keppel (Eds), Norms of Word Association. New York: Academic Press, 1970, pp. 321-360.

[17] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, p. 30.

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Experimental Tape 2 (ET_2) - Passage 2

.Target words and positions - nose (43), leg (93), hand (171), and foot (212)[18]

"Communication between persons of wholly dissimilar backgrounds can occur only on an elementary level; separated by the barriers of language and by the absence of common customs and attitudes the participants in the dialogue may find that their only basis for communication NOSE exists in their common experience of the immediate physical world. Even between individuals who share a common heritage the exchange of ideas, information, and feelings is often difficult. Often the inadequacy of communication is the result of a limited ability to use the available language, but it is also possible LEG that the language itself is incapable of transmitting the information desired. Nevertheless, communication does take place. The complex process of living in social groups requires a continuing interaction among the members of a group. We seem always to be telling someone something or listening to someone. To keep a society functioning, its members must exchange a great deal of practical information, but it is just as important for each member of the group to be able to express HAND those intimate, personal reactions to life which give him a sense of his own humanity. To point or to scream is to communicate, but the need for more complex communication requires a process or method which is itself more complex. Communication FOOT is a transfer of information or ideas from a source to a receiver. Some vehicle or medium is required for this exchange. We usually refer to this vehicle as a 'language.' Two persons, looking at the same object, share the consciousness of it. By a series of manual signals they may refer to that object and exchange a limited amount of information about it. Once these individuals are separated, or the object of their reference is removed, some systematic combination of sounds or marks must be used to span the distance between them."[19]

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[18] Marshall, G., & Cofer, C. Single-word free-association norms for 328 responses from the Connecticut Cultural Norms for items in categories. In L. Postman & G. Keppel (Eds.), Norms of Word Association. New York: Academic Press, 1970, pp. 321-360.

[19] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, pp. 33-34.

APPENDIX G_3

TASK 1

AUDITORY DIVIDED: PHONETIC VERSUS SEMANTIC TARGETS (AD-PST)

INSTRUCTIONS

Task 1
Auditory Divided: Phonetic versus Semantic Targets (AD-PST)

Instructions

This is an auditory attention experiment consisting of two separate parts. In each part of the experiment you will receive a different message in each ear, at the same time. I would like you to listen carefully to one message and shadow, that is, repeat it immediately as you hear it. You should continue to do so for the duration of the entire message.

On some trials you will be asked to repeat the message that is presented in your left ear, and on other trials you will be asked to repeat the message that is presented in your right ear. I will always tell you which message you are to repeat. All the messages are prose excerpts taken from an art history textbook, and therefore, they will all deal with some aspect of the visual arts. Each passage will be approximately two minutes long.

In addition to shadowing the designated message, I would like you to tap the table with the metal rod (experimenter illustrates rod) whenever you detect a target word. Each part of the experiment will have a different set of target words. Again I will tell you what type of words are targets for each part of the experiment. Remember that you are to repeat only the message arriving in the designated ear, but you are to tap whenever you hear a target word regardless of whether it is presented in the left or the right ear.

Before the actual experiment we will have a practice trial.

Practice Condition (PT_1):

In this case I would like you to repeat the message that you hear in your ___________ (left/right) ear. The target words for this trial will be colour names, for example, yellow, grey, purple, etc. Remember repeat the message that is presented in your ___________ (left/right) ear and tap the table with the metal rod whenever you hear a colour name. You need not repeat the colour name. Try not to let your tapping responses interfere with your shadowing performance.

Since I will be recording your responses I would like you to speak into the microphone as clearly and as loudly as possible. Similarly, I would like you to tap the table rather forcefully. In the event that you feel that you have missed a word during shadowing or made another error do not try to correct your mistake but rather continue shadowing the material that you are currently receiving and tap to the next target item.

Once you have comfortably adjusted the headphones and you are prepared to begin the task please let me know by saying the word "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the message is about to begin. If you have any problems hearing or understanding the message please let me know. Remember that you are to continue to shadow the message arriving on your ___________ (left/right) ear and tap to any colour name until the passage is completed. Once the message is completed you may remove the headphones for a brief rest period.

Do you have any questions?

I would like you to please put on the headphones now.

Phonetic Condition (ET_1):

This trial is very similar to the last one. This time, however, I would like you to repeat the message on your ___________ (left/right) ear and tap to any word that rhymes with the word ale; for example, impale, stale, bail, etc.

Do you have any questions?

I would like you to please put on the headphones now.

Semantic Condition (ET_2):

This trial is very similar to the last one. This time, however, I would like you to repeat the message on your ___________ (left/right) ear and tap to any word that is the name of a body part; for example, knee, finger, heart, etc.

Do you have any questions?

I would like you to please put on the headphones now.

APPENDIX H_1

TASK 2

AUDITORY FOCUSED: POSITIONAL CUE (AF-PC)

APPARATUS AND PROCEDURE

Task 2
Auditory Focused: Positional Cue (AF-PC)

Apparatus and Stimulus Materials

Four auditory tapes were employed: one dichotic tape (ED) and one binaural tape (EB) which served as actual testing materials, and two corresponding practice tapes (PD and PB) which served the purpose of acquainting subjects with the nature of the task. Each tape was characterized by the following: 1) a dichotic warning signal consisting of the spoken word "ready" which preceded the onset of the primary (shadowed) message by approximately 5 seconds; 2) a primary (shadowed) message which consisted of a 285 word prose passage concerning the life of a well known artist; and 3) two secondary (nonshadowed) messages which consisted of 270 word excerpts on the history of a common sport and a familiar nursery rhyme. Different primary and secondary passages were employed for ED, EB, PD, and PB respectively. The twelve passages that were employed are presented in Appendix H_2.

In the dichotic condition, the two irrelevant (nonshadowed) passages ("B" and "C") were presented on one track of the recorder with the single relevant (shadowed) passage ("A") simultaneously presented on the alternate channel. In the binaural condition, two passages were simultaneously presented on each channel. That is, one channel contained the relevant and one irrelevant passage ("A" and "B") while the alternate channel contained two irrelevant passages ("B" and "C"). The procedures, including the apparatus, employed to prepare and administer the stimulus materials are discussed in Appendix C.

Procedure

Prior to the presentation of testing materials subjects were given detailed instructions concerning the nature of the task as listed in Appendix H3. Briefly stated, subjects were informed that they were required to shadow the primary message and try to avoid disruptions or intrusions from the two competing secondary messages.

Two experimental conditions, distinguished on the basis of the spatial arrangement of the relevant and irrelevant passages, were employed. In the dichotic condition, the two irrelevant passages were presented on one channel while the relevant passage was simultaneously presented on the alternate channel. In the binaural condition, two passages were simultaneously presented on each channel. That is, one channel contained the relevant and one irrelevant passage while the alternate channel contained the two irrelevant passages. Each experimental tape (ED and EB) was introduced by the appropriate practice tape (PD or PB) which served as a means of familiarizing subjects with the requirements of the task as well as provided an opportunity for minor equipment adjustments. Tape presentations were separated by a brief rest interval of approximately two minutes. The presentation order of the experimental conditions as well as the ear of arrival of the primary passage was counterbalanced across subjects.

The number of words correctly shadowed served as the dependent measures. Errors of omission and commission, including intrusions from the nonshadowed messages, were recorded as shadowing errors. Shadowing scores were individually determined for each subject by calculating the number of words correctly shadowed under the dichotic and binaural conditions respectively.

APPENDIX H_2

TASK 2

AUDITORY FOCUSED: POSITIONAL CUE (AF-PC)

STIMULUS MATERIALS

Task 2
Auditory Focused: Positional Cue (AF-PC)

Dichotic Practice Tape (PD) - Primary Passage

"Although he was often attacked as a revolutionary, Rodin described himself as 'a link in the great chain of artists,' a man whose art was proudly rooted in the past. His education, in the Paris of the 1850s was traditional, and he never deliberately rebelled against it. He learned to sculpt at a school that still taught according to 18th Century percepts. After class he haunted the Louvre, where most often he chose to sketch antique Greek sculpture. Working from museum prints of Michelangelo before he could afford a trip to Italy, he began a lifelong study of the master he called 'this great benefactor of humanity.' Conscious of his role as an inheritor and transmitter of Western artistic tradition, Rodin, as a Frenchman, was also concerned with his own nation's heritage. Examining French sculpture, he traced an unchanging spirit behind the changing styles of succeeding eras -- a spirit that invested the Gothic facades of medieval cathedrals, enlivened the contours of 16th Century nymphs and 17th Century caryatids, and in the 18th Century enhanced mythological groups as well as realistic portrait busts. Rodin's eclectic appreciation contrasted with the academic approach of many of his contemporaries. The quotations that accompany his sculptures are his own writings and reflect what he hoped to instill in his countrymen: the confidence of respond directly to the art of all ages. In Rodin's day a sculptor's chief ambition was to win commissions for large public monuments. The competition was often fierce, but the fees were large, fame was almost certain, and above all the opportunity beckoned to create works on a grand scale. These considerations motivated Rodin to seek such commissions even though he was building a reputation as a skilled producer of portraits."[20]

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[20] Hale, W. H. The World of Rodin. Alexandria, Virginia: Time-Life Books, 1969, pp. 20 & 124.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Dichotic Practice Tape (PD) - Secondary Passage 1

"Through existing records, bowling can be traced back to as far as 7000 years ago. This would easily establish bowling as one of the oldest games of all times known to man. Archeologists trace its origin to the ancient Egyptians, with evidence of crudely shaped implements being used. The game of modern tenpins had its inception in northern Italy, being derived from variations as played by the ancients. This the Italians called 'bowls.' Stones were rounded and used as balls without finger holes and were held in the open hand. Later in the 13th century, the game spread to Germany, Holland, and England and was known as ninepins. It was sometimes known as bowling green, because the game was usually played on grass. In 1623, when the Dutch came to this country with the early settlers, they introduced the game to America as ninepins. It was played on grass, clay, and later on a single wide board. This game attracted considerable interest, causing extensive betting to center about it. Laws were passed in several states in the 1840's banning ninepins. Later, in order to circumvent the existing law and continue the activity, a Dutchman added one more pin and called it tenpins. In 1895, the American Bowling Congress was organized, and it formulated rules, alleys, balls, and pins which have become so popular in America that it can safely be said that bowling has more enthusiasts today than other sports activity. Colleges and universities are building alleys in their student recreation centers, and in many colleges bowling appears on the physical education curriculum as a basic sports skill. Large numbers of students have now enrolled in such bowling courses. Weekly contests on television have done much to increase the popularity of bowling."[21]

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[21] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, p. 52.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Dichotic Practice Tape (PD) - Secondary Passage 2

"Old Mother Hubbard
Went to the cupboard,
To fetch her poor dog a bone;
But when she came there
The cupboard was bare
And so the poor dog had none.

She went to the baker's
To buy him some bread;
But when she came back
The poor dog was dead.

She went to the undertaker's
To buy him a coffin;
But when she came back
The poor dog was laughing.

She took a clean dish
To get him some tripe;
But when she came back
He was smoking a pipe.

She went to the alehouse
To get him some beer;
But when she came back
The dog sat in a chair.

She went to the tavern
For white wine and red;
But when she came back
The dog stood on his head.

She went to the fruiter's
To buy him some fruit;
But when she came back
He was playing the flute.

She went to the tailor's
To buy him a coat;
But when she came back
He was riding a goat.

She went to the hater's
To buy him a hat;
But when she came back
He was feeding a cat.

She went to the barber's
To buy him a wig;
But when she came back
He was dancing a jig.

She went to the cobbler's
To buy him some shoes;
But when she came back
He was reading the news.

She went to the seamstress
To buy him some linen;
But when she came back
The dog was a-spinning.

She went to the hosier's
To buy him some hose;
But when she came back
He was dressed in his clothes.

The dame made a curtsey,
The dog made a bow;
The dame said, Your servent
The dog said, Bow-wow."[22]

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[22] Baring-Gould, W. S., & Baring-Gould, C. The Annotated Mother Goose. New York: The World Publishing Company, 1967, pp. 111-113.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Dichotic Experimental Tape (ED) - Primary Passage

"Rembrandt was one of the greatest draftsmen in the history of art. Because he usually regarded his drawings the way a novelist regards the ideas he jots down in his journal -- as a purely private record of observations and feelings -- they are often deceptively simple. Yet the very spontaneity and economy with which Rembrandt sketched his impressions make them dazzling to connoisseurs. His production of drawings was as prolific as it was brilliant. About 1,400 attributed to him survive, and probably at least an equal number have been lost. The reasons for the loss, aside from fire, flood, and negligence, may be divined from the drawings that remain. Rembrandt made relatively few preparatory studies for his paintings and even fewer highly finished 'presentation' drawings -- gifts for friends and admirers. Usually his drawings were unrelated to his major works and were, moreover, unsigned; only about 25 that bear his signature are known. Thus it is likely that inexperienced collectors, misled by the simplicity of the drawings and ignorant of their authorship, discarded them. Experts estimate the dates of Rembrandt's drawings by studying his style and the way he used his favorite media: red and black chalk, ink and quill or reed pen, brush and washes. Dutchmen of the 17th Century were extremely fond of landscape pictures. Many thousands of these works, sensitive, simple and full of charm, still survive to delight connoisseurs. So great was the vogue for them in their own time that landscape, itself a specialty, was divided into sub-specialties. Some artists dealt only in scenes of canals and dunes; others concentrated on town panoramas, marine views, woods, winter pictures or moonlit ones. Rembrandt's involvement with landscape lasted less than 20 years, from his early 30s to his late 40s."[23]

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[23] Wallace, R. The World of Rembrandt. New York: Time-Life Books, 1968, pp. 48 & 96.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Dichotic Experimental Tape (ED) - Secondary Passage 1

"The royal game of golf as we know it today is one of the most ancient of our modern sports. Historians are not agreed on its origin, but as early as 1457 the Scottish Parliament ordained that golf should not be played by the people because it was distracting from the practice of archery, which was deemed necessary for defensive purposes. It appears certain, therefore, that golf was played in Scotland more than 500 years ago. The Dutch term 'kolf,' meaning a club, is considered by some to have given rise to the name of the present-day game. Regardless of how much Scotland invented on her own and how much she borrowed from others, it appears quite certain that that country was the source from which the game of golf as it is known today spread to all parts of the world. Courses or links of those days differed greatly from those of the present time. Golf was then distinctly a seaside game. It was played over stretches of land that linked the water line of the seashore with tillable lands farther inland. It was this condition which led to calling the scene of play "links,' which in fact means a seaside golf course. Location of holes followed no definite plan. The landscape was partially covered by bushes, trees, and the like. Open areas were chosen as finishing points or putting greens. No official number of holes was adopted as standard for a round of play until 1858, when eighteen holes were designated as a round. Historic documents tell of the organization of golf clubs in the United States in the closing years of the eighteenth century. A few clubs were started in the eastern United States."[24]

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[24] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, p. 113.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Dichotic Experimental Tape (ED) - Secondary Passage 2

"The first day of Christmas,
My true love sent to me
A partridge in a pear tree.

The second day of Christmas,
My true love sent to me
Two turtle doves, and
A partridge in a pear tree.

The third day of Christmas,
My true love sent to me
Three French hens,
Two turtle doves, and
A partridge in a pear tree.

The fourth day of Christmas,
My true love sent to me
Four colly birds,
Three French hens
Two turtle doves, and
A partridge in a pear tree.

The fifth day of Christmas,
My true love sent to me
Five gold rings,
Four colly birds
Three French hens
Two turtle doves, and
A partridge in a pear tree.

The sixth day of Christmas,
My true love sent to me
Six geese a-laying,
Five gold rings
Four colly birds
Three French hens
Two turtle doves, and
A partridge in a pear tree.

The seventh day of Christmas,
My true love sent to me
Seven swans a-swimming,
Six geese a-laying
Five gold rings
Four colly birds
Three French hens
Two turtle doves, and
A partridge in a pear tree.

On the eighth day of Christmas,
My true love sent to me
Eight maids a-milking,
Seven swans a-swimming
Six geese a-laying
Five gold rings
Four colly birds
Three French hens
Two turtle doves, and
A partridge in a pear tree.

On the ninth day of Christmas,
My true love sent to me
Nine drummers drumming
Eight maids a-milking
Seven swans a-swimming
Six geese a-laying
Five gold rings
Four colly birds
Three French hens
Two turtle doves, and
A partridge in a pear tree.

On the tenth day of Christmas,
My true love sent to me"[25]

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[25] Baring-Gould, W. S., & Baring-Gould, C. The Annotated Mother Goose. New York: The World Publishing Company, 1967, pp. 196-198.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Binaural Practice Tape (PB) - Primary Passage

"The visionary genius of Cezanne was nurtured in a childhood of emotional tension. He was the only son of an overbearing father, and he grew up in a quiet, tree-shaded town. His father, a self-made financier, was determined to groom Cezanne for a position in the family bank. He sent him to a proper boarding school for young gentlemen and then on to the local university where he was enrolled in law courses. But Cezanne was torn by passions that warred against the restraints of a provincial business career. Alternately plagued by fits of anger and depression, his imagination fired by morbid fantasies of violence and eroticism he sought expression for his troubled feelings in paintings. At the age of 22, he finally cajoled his reluctant father into letting him give up the law and go to Paris to study art. The young painter's early efforts brought him little personal satisfaction and no acclaim. His work was ridiculed so much by both the public and the critics that he became embittered; once he even referred to painting as 'a dog's profession.' His initial bright enthusiasm turned to frustration and self-doubt -- 'The sky of the future is very black for me,' he lamented. Yet he was driven to continue painting, and as he struggled to express his inner turbulence, he slowly learned to discipline his powerful talent. In their eagerness to acclaim Cezanne as a liberator and revolutionary, many admirers have overlooked the fact that he was also inescapably a man of his own age. It is true that he was by inclination isolated from the public issues of the day, but his art was not isolated. In fact the power with which Cezanne has spoken to the 20th Century is due partially to the sensitivity with which he responded."[26]

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[26] Murphy, R. W. The World of Cezanne. Alexandria, Virginia: Time-Life Books, 1968, pp. 20 & 33.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Binaural Practice Tape (PB) - Secondary Passage 1

"The exploration of the land surface dates from the very beginning of man, and the wanderings of man over the surfaces of the world's water masses date from the beginning of recorded history; but the exploration of the underwater world is a relatively recent adventure. Though Aristotle wrote about diving devices as early as 360 B.C., and the great historian Pliny in A.D. 77 described the use of breathing tubes for underwater activity, man's real opportunity for extended underwater movement and investigation did not occur until the introduction of the scuba regulator in 1943 by Jacques Cousteau. The forerunners of modern methods of underwater exploration and sport are many. Early Greek and Roman strategists, in an effort to perfect the art of warfare, trained and equipped soldiers of strong swimming ability to approach the enemy craft from below the water surface. They were supplied with air through a short length of hollow reed. Soldiers of the fifteenth and sixteenth centuries were fitted with surface-breathing bags connected to the diver by means of a hose and leather hood arrangement. These divers were held to the shallow depths which were necessary because of their crude equipment, by weighted shoes. Benjamin Franklin, in his autobiography described his making of hand and foot fins to facilitate faster swimming. William Forder, in the early 1800's, developed a metal helmet covering one-half of the diver's body and supplied with air from the surface by means of a hand-operated bellows. In the latter part of the 1800's the French developed a rubber diving suit and mask supplied with air from a metal canister carried by the diver. As the diver goes beneath the water surface, he becomes aware of an increase in the pressure that surrounds him."[27]

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[27] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, pp. 189-190.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Binaural Practice Tape (PB) - Secondary Passage 2

"'Will you walk into my parlor?' said the spider to the fly --
'Tis the prettiest little parlor that ever you did spy.
The way into my parlor is up a winding stair;
And I have many curious things to show you when you're there.'
'Oh, no, no,' said the little fly; 'to ask me is in vain;
For who goes up your winding stair can ne'er come down again.'

'I'm sure you must be weary, dear, with soaring up so high;
Will you not rest upon my little bed?' said the spider to the fly.
'There are pretty curtains drawn around; the sheets are fine and thin;
And if you'd like to rest awhile, I'll snugly tuck you in!'
'Oh, no, no,' said the little fly; 'for I've often heard it said,
They never, never, wake again, who sleep upon your bed!'

Said the cunning spider to the fly --
'Dear friend, what can I do
To prove the warm affection I've always felt for you?'
'I thank you, gentle sir,' she said, 'for what you're pleased to say,
And bidding you good-morning now, I'll call another day.'
The spider turned him round about and went into his den,
For well he knew the silly fly would soon come back again;
So he wove a subtle web in a little corner sly,
And set his table ready, to dine upon the fly.
Then he came out of his door again, and merrily did sing --
'Come hither, hither, pretty fly, with the pearl and silver wing;
You're robes are green and purple -- there's a crest upon your head!
Your eyes are like the diamond bright but mine are dull as lead!'" [28]

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[28] Baring-Gould, W. S., & Baring-Gould, C. The Annotated Mother Goose. New York: The World Publishing Company, 1967, pp. 316-317.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Binaural Experimental Tape (EB) - Primary Passage

"What were Michelangelo's working methods? How did he go about freeing the figures he envisioned as lying locked inside their marble prisons? Was his art as effortless as he liked people to believe? One amazed eye witness reported having watched the sculptor, already an old man, knock 'more chips out of the hardest marble in a quarter of an hour than three young masons could have done in an hour ... With one blow he would remove chips as thick as three or four fingers, and his aim was so accurate that had he but chipped off a little more all might have been ruined.' But this was Michelanelo in the fury of execution, the skilled craftsman realizing at last the idea that had tantalized him for so long. Only his intimates could know how much careful preliminary work actually went into his pieces. For almost any project, Michelangelo would produce dozens of sketches, often drawing from live models or turning out little clay or wax figures with which to study poses and proportions. The minutest details of anatomy were subjected to the probing of his 'observing eye' -- veins, wrinkles, fingernails. But, however, accomplished his sketches were, he destroyed all those in his possession before he died, so anxious was he that his work 'give no other appearance than that of perfection.' The relatively few that survived not only have merit of being works of art in themselves but also show Michelangelo seized by an idea and struggling to bring it to the first stages of being. One of the wonders of Michelangelo's long career is that although he saw himself in his last years as being all but broken by his labours, he was nearly as productive as in his youth."[29]

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[29] Coughlan, R. The World of Michelangelo. Alexandria, Virginia: Time-Life Books, 1966, pp. 96 & 180.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Binaural Experimental Tape (EB) - Secondary Passage 1

"The history of the canoe reveals that it was one of the earliest means of traveling via the waterways. Probably one of the first canoes was a hollow log shaped to float on the water. When man discovered that it would support his body and still remain afloat, the idea of the canoe was born. Ancient France, no doubt, gave this crude floating device its name. In French 'canot' means a hollow log. The canoe was known in Europe many centuries before Columbus discovered America. Canoeing, as we think of it in America, is chiefly another sport. However, in isolated parts of the United States, Canada, the Arctic Circle, and other countries, it still serves as a means of transportation. It is no exaggeration to say that the rapid exploration and development in the early pioneer days of America and Canada was undoubtedly due directly to the white man's adoption of the Indian canoe as a mode of travel. Traders, hunters, settlers, and explorers followed the waterways, which were used by the Indians before them, paddling or pulling up the streams to the headwaters, portaging or paddling across a lake, and again following new streams and routes into the great northwest wilderness. It was not until the latter half of the eighteenth century that the canoe began to be used for sport, pleasure, and recreation. There are few sports that offer more invigorating exercise and adventure than does canoeing. It exposes one to the great outdoors, fresh air, and sunshine. As for means of adventurous travel, hunting, and fishing, it has no equal. As a sport it is gaining more and more popularity with Americans. The American Canoe Association is divided into two units."[30]

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[30] Armbruster, D., Irwin, L., & Musker, F. Basic Skills in Sports for Men and Women. Saint Louis: The C. V. Mosby Company, 1967, p. 68.

Task 2
Auditory Focused: Positional Cue (AF-PC)

Binaural Experimental Tape (EB) - Secondary Passage 2

"As I was going to the Derby,
Upon a market day,
I met the finest ram, sir,
That ever was fed on hay.

And if you think that this is not so,
For maybe you'll think I lie,
Oh you go down to Derby town,
And you'll see the same as I.

This ram was fat be ind, sir,
This ram was fat before,
This ram was ten yards high, sir,
Indeed he was no more.

The wool upon his back, sir,
Reached up into the sky,
The eagles built their nests there,
For I heard young ones cry.

The wool on this ram's belly, sir,
It grew down in the ground,
The Devil cut it off, sir,
To make himself a gown.

The horns upon this ram, sir,
They reached up to the moon,
A man went up them in January,
And didn't come down till June.

The space between the horns, sir,
Was as far as a man could reach,
And there they built a pulpit,
But no-one in it preached.

This ram had four legs to walk upon
This ram had four legs to stand,
And every leg he had, sir,
Stood on an acre of land.

And one of this ram's teeth, sir,
Was hollow as a horn,
And when they took its measure, sir
It held a bushel of corn.

Now the man that fed this ram, sir,
He fed him twice a day,
Each time that he fed him, sir,
He ate a rick of hay.

The man that killed this ram, sir,
Was up to his knees in blood,
And the boy that held the pail, sir,
Was carried away in the flood.

The blood it ran for forty miles,
I'm sure it was not more, . . ."[31]

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[31] Baring-Gould, W. S., & Baring-Gould, C. The Annotated Mother Goose. New York: The World Publishing Company, 1967, pp. 298-300.

APPENDIX H_3

TASK 2

AUDITORY FOCUSED: POSITIONAL CUE (AF-PC)

INSTRUCTIONS

Task 2
Auditory Focused: Positional Cue (AF-PC)

Instructions

This is an auditory attention experiment consisting of two separate parts. In each part of the experiment you will receive different messages in each ear at the same time. I would like you to listen carefully to one message and to shadow, that is, repeat it immediately as you hear it. You should continue to do so for the duration of the entire message. On some trials you will be asked to repeat a message that is presented in your right ear, and on other trials you may be required to repeat a message that is presented in your left ear. I will always tell you which message you are to repeat. All the messages that you will be required to shadow will be approximately two minute long narratives concerning the life of a famous artist.

Dichotic Condition

In this part of the experiment you will receive three messages simultaneously; two messages concerning sports and nursery rhymes in your ____________ (left/right) ear, and one message concerning the life of a famous artist in your ____________ (left/right) ear. I would like you to shadow, that is, repeat the message in your ____________ (left/right) ear immediately as you hear it. Try to avoid disruptions or intrusions from the two competing messages in your ____________ (nonshadowed) ear. In the event that you feel that you have missed a word during shadowing or made another error, do not try to correct your mistake but rather continue shadowing the material that you are currently receiving.

Once you have comfortably adjusted the headphones and you are prepared to begin the task, please let me know by saying the word "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the message is about to begin. If you have any problems hearing or understanding the message, please let me know. Since I will be recording your responses, I would like you to speak into the microphone as clearly and as loudly as possible. Once the message is completed, you may remove your headphones for a brief rest period.

Before the actual experiment begins, we will have a practice trial.

Practice Trial (PD):

In this case I would like you to repeat the single message that will be presented in your ___________ ear. The passage that you
(left/right)

will be shadowing will be a narrative on the life of the artist, Rodin.

Do you have any questions?

I would like you to now put on the headphones.

Experimental Trial (ED):

This trial is very similar to the last one. This time I would like you to repeat the message that is presented in your ___________ ear.
(left/right)

This time, however, you will be required to shadow a narrative on the life of the artist, Rembrandt.

Do you have any questions?

Please put on the headphones.

Binaural Condition

In this part of the experiment you will simultaneously receive a different message in each ear. In your ____________ ear you will
(left/right)

receive a message concerning the life of a famous artist, whereas in your ____________ ear you will receive a passage concerning the history of a
(left/right)

well known sport. In addition you will receive the same nursery rhyme in both ears. You are to shadow, that is, repeat back, only the message about the artist which you will hear in your ____________ ear. Try to
(left/right)

avoid disruptions or intrusions from the two competing messages. In the event that you feel that you have missed a word during shadowing or made another error, do not try to correct your mistake but rather continue shadowing the material that you are currently receiving.

Once you have comfortably adjusted the headphones, and you are prepared to begin the task, please let me know by saying the word "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the message is about to begin. So as to enable you to distinguish it from competing messages, the passage to be shadowed will start a few seconds before the other two passages. If you have any problems hearing or understanding the message, please let me know. Since I will be recording your responses, I would like you to speak into the microphone as clearly and as loudly as possible. Once the message is completed, you may remove the headphones for a brief rest period.

Before the actual experiment begins, we will have a practice trial.

Practice Trial (PB):

In this case you will be required to shadow a narrative on the life of the artist, Cezanne. This passage will be presented in your ____________ (left/right) ear, and it will be the first message to start.

Do you have any questions?

I would like you to now put on the headphones.

Experimental Trial (EB):

This trial is very similar to the last one. This time I would like you to repeat the message dealing with the life of the artist, Michelangelo. This passage will be presented in your ____________ (left/right) ear, and it will be the first message to start.

Do you have any questions?

I would like you to now put on the headphones.

APPENDIX I_1

TASK 3

VISUAL FOCUSED/DIVIDED: STIMULTANEOUS-SEQUENTIAL PARADIGM

(VF/D-SSP)

APPARATUS AND PROCEDURE

Task 3
Visual Focused/Divided: Simultaneous-Sequential Paradigm (VF/D-SSP)

Apparatus and Stimulus Materials

A 2-field Harvard tachistoscope, model T-2B was employed to present the stimulus materials. The exposure area of the tachistoscope was 19.375° of a visual angle in height and 19.375° of a visual angle in width. The light exposure was set at 1 log unit per field.

Each trial was comprised of the following sequence: a fixation stimulus, a stimulus slide, and a cue slide. The fixation stimulus consisted of a dark gray square, 9.375° x 9.375° of a visual angle, which was centrally positioned on an otherwise blank white screen. This stimulus served as the adaptation field as well as the inter-trial display.

Each stimulus slide consisted of a centrally positioned 3 x 3 grid of nine letters. All letters were printed in upper case type in black ink on a white background. Each character was approximately 1.875° of a visual angle in height, varied from 0.312° to 1.562° of a visual angle in width, and was separated by a visual angle of approximately 1.875° . A single grid of letters occupied approximately 8.438° x 8.438° of a visual angle with each row of characters separated by a visual angle of approximately 1.25° . Stimulus slides were prepared by randomly selecting nine characters from the standard alphabet, excluding the letter "Q".

Accompanying each stimulus slide was a postdisplay cue slide. A cue slide consisted of a centrally positioned dark gray square which occupied approximately 9.375° x 9.375° of a visual angle. Superimposed on this general cue stimulus was a smaller and lighter gray square that occupied 3.125° x 3.125° of a visual angle and indicated the position of the character which was to be identified.

The SIM condition consisted of a block of 73 practice trials and a block of 73 experimental trials. Each block of trials was comprised of six tests of each of the outer eight positions and 25 tests of the center position. In the SEQ condition, which consisted of a block of 25 practice trials and a block of 25 experimental trials, the subjects knew in advance that the center position would be tested. All stimulus materials are presented in Appendix I_2.

Procedure

Prior to the presentation of actual testing materials, subjects were given detailed instructions and the practice trials appropriate to the experimental condition so as to familiarize them with the nature of the task. Briefly stated, for P-SIM and SIM conditions subjects were instructed to monitor all nine grid positions for later recall of the letter in the cued position. That is, subjects were told to place their attention on the outer eight positions even though there would occasionally be tests of the center position. For P-SEQ and SEQ conditions subjects were instructed to monitor the stimulus card for later recall of the character occupying the center position. Specific instructions are listed in Appendix I_3.

Each trial began with the experimenter giving a warning signal, the spoken word "ready." The "ready" signal served as a cue for subjects to fix their gaze upon the fixation square on the adaptation field. Subjects then manually triggered the apparatus for presentation of the stimulus slide whenever ready. Each stimulus slide was presented for a duration of 20 milliseconds. Immediately following each stimulus presentation the appropriate cue slide was displayed and remained present until the subject responded. Subjects were instructed to view the cue slide for that trial and verbally identify the character that had occupied the cued position, guessing if necessary. Display time for each cue slide was dependent upon subjects' response time. Inter-trial intervals were variable and determined by each subject's response latency and the experimenter's recording time. Subjects' responses were manually recorded by the experimenter on specially prepared data sheets. SIM and SEQ conditions with their respective practice sequences were presented in blocked trials and their order of presentation was counterbalanced across subjects. For both SIM and SEQ the trial sequence was randomly determined and fixed across all subjects.

Correct target letter identifications for SIM and SEQ conditions served as dependent measures. Correct identification scores for each subject were determined by computing the number of cued items correctly identified for SIM and SEQ conditions respectively.

APPENDIX I_2

TASK 3

VISUAL FOCUSED/DIVIDED: STIMULTANEOUS-SEQUENTIAL PARADIGM

(VF/D-SSP)

STIMULUS MATERIALS

Task 3
Visual Focused/Divided: Simultaneous - Sequential Paradigm (VF/D - SSP)

Simultaneous Condition - Stimulus and Cue Set 1

.Practice Trials (P - SIM)

Trial	Stimuli*	Trial	Stimuli	Trial	Stimuli
1	C W E U D N G T I	10	F T S G P I M A L	19	T D A R B O I N E
2	L J N E Y A O K S	11	M E S A O U F I P	20	J I Y V G O B X W
3	U C P I R G E S O	12	E O L R I A W H S	21	T A H N E M Y L R
4	N H K L W T S Y E	13	F O N L P E T W A	22	W R M D V T F L K
5	I P E Z S N R A X	14	R T D M H V S U F	23	R S I A F C O G N
6	R E I S C L T N U	15	O Y T F V S M D R	24	O S N T D I G F Y
7	S L C X Z T K E H	16	O R M Y X F L S U	25	N R U W K L A E O
8	Z E T B N S F C I	17	N R U W K L A E O	26	A I O N U D E R T
9	K N P Z J E I B Y	18	I N F A W O R T L	27	D F A O M V I L T

Trial	Stimuli*	Trial	Stimuli	Trial	Stimuli
28	Y G I T J P A F N	41	S L C X Z T K E H	54	I U F S T R N O L
29	I Y C F R B E J O	42	T A H N E M Y L R	55	V Z R O L E I P Y
30	O Y T F V S M D R	43	S M A H K F Y E R	56	F O N L P E T W A
31	E N A G C B U I T	44	Z E T B N S F C I	57	O R M Y X F L S U
32	T L U I F Z O W S	45	A W O R T U S E J	58	V Z R O L E I P Y
33	E N A G C B U I T	46	R I S M H E W K A	59	E T N L A O P U I
34	H U S I A Y L F J	47	T P Y U E A C S O	60	I U F S T R N O L
35	J E B Y U S L O N	48	A I O N U D E R T	61	N R T C N F A Y S
36	N O R A Z T U I F	49	R S I A F C O G N	62	L F O T M I T Y A
37	E O L R I A W H S	50	R T D M H V S U F	63	Y I D E O N A P H
38	L F O T M I R Y A	51	T D A R B O I N E	64	C W E U D N G T I
39	V U E O S H N R I	52	L A V N X D S O R	65	L J N E Y A D K S
40	M E S A O U F I P	53	S Z L N G R X H E	66	N U O I B X E A G

Trial	Stimuli*	Trial	Stimuli	Trial	Stimuli
67	I P E Z S̲ N R A X	70	M A I E L Y R G T̲	73	U S X W I C T D̲ E
68	U C P I R̲ G E S O	71	J I Y V G̲ O B X W		
69	H U S I A Y L F̲ J	72	Y G I T̲ J P A F N		

*Legend:

_ = Character required to recall

E. G. Stimulus Card # 73

U S X
W I C
T D E

Cue Slide # 73

Simultaneous Condition - Stimulus and Cue Set 2

.Experimental Trials (E - SIM)

Trial	Stimuli*	Trial	Stimuli	Trial	Stimuli
1	S M A H K F Y E R	12	R E I S C L T N U	23	O U S L P E T M R
2	C D U H K U V R E	13	D F A O M V I L T	24	L F O T M I R Y A
3	M A I E L Y R G T	14	I N F A W O R T L	25	S T A F B J W C H
4	E T N L A O P U I	15	J L I P S K E X G	26	Y I D E O N A P H
5	G I U D L F E A N	16	L J N E Y A D K S	27	V Z R O L E I P Y
6	I U F S T R N O L	17	U N T O Z H L F R	28	O R A N H S I T F
7	T D A R B O I N E	18	W R M D V T F L K	29	N R U W K L A E O
8	P Y E S A N J H L	19	D M L U E T R I X	30	A S Z V J R F P N
9	J E B Y U S L O N	20	C W E U D N G T I	31	E O L R I A W H S
10	R I S M H E W K A	21	L A V N X D S O R	32	H I B E M Z G D O
11	F R I L G Y N S U	22	O S N T D I G F Y	33	T L U I F Z O W S

Trial	Stimuli*	Trial	Stimuli	Trial	Stimuli
34	T B G N F S O I Y	47	S L C X Z T K E H	60	E A O I V C Y W T
35	O Y T F V S M D R	48	I F N T W O R L S	61	T A H N E M Y L R
36	N G P R Y L O E A	49	F T S G P I M A L	62	L O E Y I M S A B
37	G C E L Y R F N P	50	U C P I R G E S O	63	J I Y V G O B X W
38	I Y C F R B E J O	51	S Z L N G R X H E	64	R S I A F C O G N
39	Y G I T J P A F N	52	Y T W R N I A O E	65	R C M E O I Y U S
40	S N F O T A I Y L	53	A I O N U D E R T	66	F O N L P E T W A
41	H U S I A Y L F J	54	T P Y U E A C S O	67	E O Y W R U L T C
42	T E R A C N F S D	55	O R M Y X F L S U	68	U S X W I C T D E
43	N H K L W T S Y E	56	K W S Z U E A O I	69	E N A G C B U I T
44	N O R A Z T U I F	57	A W O R T U S E J	70	R T D M H V S U F
45	N U O I B X E A G	58	H R T C N F A Y S	71	K N P Z J E I B Y
46	X A K T D F U N I	59	M E S A O U F I P	72	Z E T B N S F C I

Trial	Stimuli*
73	I V T A X R M E P

*Legend:

_ = Character required to recall

E. G.

Stimulus Card # 73

I V T
A X R
M E P

Cue Slide # 73

Sequential Condition - Stimulus and Cue Set 3

.Practice Trials (P - SEQ)

Trial	Stimuli*	Trial	Stimuli	Trial	Stim
1	V U E O S H N R I	9	K N P Z J E I B Y	17	N O A Z U I
2	I Y C F R B E J O	10	M A I E L Y R G T	18	Y I E O A P
3	W R M D V T F L K	11	D F A O M V I L T	19	O S T D G F
4	R I S M H E W K A	12	R E I S C L T N U	20	L A N X S O
5	E T N L A O P U I	13	I N F A W O R T L	21	T P U E C S
6	F T S G P I M A L	14	N U O I B X E A G	22	S Z N G X H
7	J E B Y U S L O N	15	H R T C N F A Y S	23	A W R T S E
8	T L U I F Z O W S	16	U S X W I C T D E	24	S M H K Y E
				25	G C L Y F N

*Legend:

* Required to recall center character

E. G. Stimulus Card # 25 Cue Slide # 25

G C E
I V D

Sequential Condition - Stimulus Set and Cue Set 4

.Experimental Trials (E - SEQ)

Trial	Stimuli*	Trial	Stimuli	Trial	Stimuli
1	D C A V P O E I F	10	Y U I O V S N F A	19	K D J L G F U N E
2	E J P A H N R L C	11	T S E I Z R D W L	20	I M S E U A T O R
3	S O F W R I Z P G	12	F P B N A I S H U	21	S Y A T C F L V N
4	R I L N S Z C E T	13	E L S Y W N R D T	22	U R M S F T K I O
5	W O Y P I U F X Z	14	N T R F O L A U H	23	J N U H B Y E A I
6	L W K E Y G I R S	15	P R T B X E G N O	24	O F N T K R U L I
7	C E D L N T M Y A	16	R T O I D A S E N	25	I H E R M S O T Y
8	A I G U T E N S R	17	A G I X J W B O F		
9	V Y X M E C L A S	18	M A H D L O Y T E		

*Legend:

Required to recall center character

E. G. Stimulus Card # 25 Cue Slide # 25

I H E
R M S

APPENDIX I_3

TASK 3

VISUAL FOCUSED/DIVIDED: STIMULTANEOUS-SEQUENTIAL PARADIGM

(VF/D-SSP)

INSTRUCTIONS

Task 3
Visual Focused/Divided: Simultaneous-Sequential Paradigm (VF/D-SSP)

Instructions

This is a visual attention experiment consisting of two separate parts. In each part of the experiment you will be briefly presented a 3x3 grid of nine random letters, excluding the letter Q. You are to monitor the grid of letters for the subsequent recall of one of the characters. Immediately following each presentation of letters, a blank dark gray grid with a single cued position will be displayed. The cue will consist of a light gray square. You will be asked to identify the letter that was previously displayed in the cued position. The blank grid will remain on until you respond. You are requested to give a response on each trial, regardless of the degree of confidence that you have in your answer. All materials will be presented to you through the tachistoscope (experimenter illustrates the tachistoscope).

Sequential Condition

In this part of the experiment, the cued character will always occupy the center position of the grid. That is, you are to monitor the grid for later recall of the central letter. I will begin each presentation with the warning signal, the word "ready." At that time you should look at the dark gray square in the center of the screen (experimenter illustrates fixation square) and prepare yourself for the presentation of the letters. Whenever you are ready, I would like you to press this button (experimenter illustrates slide advancer) which will trigger the presentation of the letters. Please do not press this button until I have given you the "ready" signal, and you have focused upon the dark gray square. After each letter presentation continue to monitor the screen for the cue display. The cue display will remain on until you respond. I would like you to give your answer as quickly as possible, guessing if necessary.

Do you have any questions?

We will begin with a few practice trials.

Practice Trials:

Remember that in this part of the experiment the cued character will always occupy the center grid position.

Experimental Trials:

As in the practice trials in this series of 25 trials the cued character will always occupy the center grid position.

Simultaneous Condition

In this part of the experiment the cued character will occupy variable outter grid positions. That is, you are required to place your attention on the outter eight letters for the subsequent recall of the character in the cued position. On occasion, however, you will be asked to recall the letter that was displayed in the center position. I will begin each presentation with the warning signal, the word "ready." At that time you should look at the dark gray square in the center of the screen and prepare yourself for the presentation of the letters. Whenever you are ready, I would like you to press this button (experimenter illustrates slide advancer) which will trigger the presentation of the letters. Please do not press this button until I have given you the "ready" signal, and you have focused upon the dark gray square. After each letter presentation continue to monitor the screen for the cue display. The cue display will remain on until you respond. I would like you to give your answer as quickly as possible, guessing if necessary.

Do you have any questions?

We will begin with a few practice trials.

Practice Trials:

Remember that in this part of the experiment you are required to monitor all nine grid positions, but focus primarily on the outter eight letters. Most often you will be asked to recall letters from the outter eight positions, although there will periodically be tests of the center position.

Experimental Trials:

As in the practice trials in this series of 73 trials the cued letter will occupy variable grid positions. Please let me know if you become tired and would like to take a brief rest period during the sequence of trials.

APPENDIX J_1

TASK 4

AUDITORY FOCUSED/DIVIDED: STIMULTANEOUS-SEQUENTIAL PARADIGM

(AF/D-SSP)

APPARATUS AND PROCEDURE

Task 4
Auditory Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Apparatus and Stimulus Materials

Stimuli consisted of consonant-vowel syllables. Specifically, the syllables "ba," "da," "ga," and "pa" comprised the relevant target item set. The consonant-vowel syllable, "wu," was employed as the distractor item. Each dichotic listening tape consisted of a series of consonant-vowel syllable pairs, with each pair comprised of one member of the target item set and the distractor item. Each stimulus pair was preceded two seconds by a warning signal, a 1000 Hz tone of 250 milliseconds duration. The inter-stimulus-pair interval was 10 seconds.

Two experimental listening tapes, which distinguished two experimental conditions (ET_1 and ET_2), were employed. Each tape consisted of 40 consonant-vowel syllable pairs, to be employed as actual testing materials, and eight corresponding practice pairings, which served the purpose of acquainting subjects with the nature of the task. ET_1 consisted of 48 consonant-vowel syllable pairs, with the target item placement randomly determined and counterbalanced for each channel across trials. That is, each of the four target items occurred five times on each channel in a mixed order for the experimental sequence. ET_2 similarly consisted of 48 consonant-vowel syllable pairs with the order of target presentation randomly determined and the channel position of target items predetermined by alternating between trials. That is, target items were presented on the left channel on odd numbered trials and on the right channel on even numbered trials. Each target item was presented with equal frequency on each channel. All stimulus materials are presented in Appendix J_2. The procedures including the apparatus, employed to prepare and administer the stimuli are discussed in Appendix C.

Procedure

All subjects received ET_1 and ET_2. Prior to the presentation of ET_1 and ET_2, subjects were given detailed instructions concerning the nature of the task as presented in Appendix J_3. Briefly stated, for ET_1, the simultaneous condition (divided attention), subjects were informed that they were required to monitor both channels simultaneously and to correctly identify the target item that was presented by indicating its name. For ET_2, the sequential condition (focused attention), subjects were preinstructed in regard to the channel position of the target items. That is, subjects were informed that they were required to monitor each channel in an alternating sequence for the identification of the target items. The order of presentation of ET_1 and ET_2 as well as the channel arrangement was counterbalanced across subjects.

Subjects' responses were manually recorded by the experimenter as subjects' responded upon the completion of each trial. The dependent measures included the number of correct target identifications for ET_1 and ET_2. Individual scores were computed for each subject for ET_1 and ET_2 respectively.

APPENDIX J_2

TASK 4

AUDITORY FOCUSED/DIVIDED: STIMULTANEOUS-SEQUENTIAL PARADIGM

(AF/D-SSP)

STIMULUS MATERIALS

Task 4
Auditory Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Simultaneous Condition - Experimental Tape 1 (ET_1)

Practice Trials

Trial	Stimuli* L	Stimuli* R	Trial	Stimuli L	Stimuli R	Trial	Stimuli L	Stimuli R
1	ba	wu	4	ga	wu	7	da	wu
2	pa	wu	5	ga	wu	8	wu	pa
3	pa	wu	6	wu	pa			

Experimental Trials

Trial	Stimuli* L	Stimuli* R	Trial	Stimuli L	Stimuli R	Trial	Stimuli L	Stimuli R
1	wu	ba	15	da	wu	29	ba	wu
2	wu	ga	16	wu	pa	30	da	wu
3	ga	wu	17	pa	wu	31	pa	wu
4	pa	wu	18	ga	wu	32	ba	wu
5	ba	wu	19	da	wu	33	wu	pa
6	wu	da	20	da	wu	34	wu	ba
7	ba	wu	21	pa	wu	35	da	wu
8	wu	ga	22	wu	ga	36	ga	wu
9	wu	pa	23	wu	ga	37	ba	wu
10	wu	ga	24	ga	wu	38	wu	da
11	wu	pa	25	wu	ba	39	wu	da
12	wu	pa	26	wu	da	40	wu	da
13	ga	wu	27	wu	ba			
14	wu	pa	28	pa	wu			

*Legend:

L = Left Channel

R = Right Channel

Task 4
Auditory Focused/Divided: Simultaneous Sequential Paradigm (AF/D-SSP)

Sequential Condition - Experimental Tape 2 (ET_2)

.Practice Trials

Trial	Stimuli* L	Stimuli* R	Trial	Stimuli L	Stimuli R	Trial	Stimuli L	Stimuli R
1	ba	wu	4	wu	pa	7	pa	wu
2	wu	da	5	ga	wu	8	wu	pa
3	da	wu	6	wu	ga			

.Experimental Trials

Trial	Stimuli* L	Stimuli* R	Trial	Stimuli L	Stimuli R	Trial	Stimuli L	Stimuli R
1	ba	wu	15	ga	wu	29	ga	wu
2	wu	da	16	wu	pa	30	wu	ba
3	ga	wu	17	ba	wu	31	da	wu
4	wu	pa	18	wu	ga	32	wu	ga
5	ba	wu	19	pa	wu	33	pa	wu
6	wu	ba	20	wu	ba	34	wu	da
7	da	wu	21	da	wu	35	ga	wu
8	wu	ga	22	wu	da	36	wu	ba
9	pa	wu	23	ba	wu	37	pa	wu
10	wu	da	24	wu	da	38	wu	pa
11	pa	wu	25	ga	wu	39	ba	wu
12	wu	ga	26	wu	ga	40	wu	pa
13	da	wu	27	da	wu			
14	wu	ba	28	wu	pa			

*Legend:

L = Left Channel

R = Right Channel

APPENDIX J_3

TASK 4

AUDITORY FOCUSED/DIVIDED: STIMULTANEOUS-SEQUENTIAL PARADIGM

(AF/D-SSP)

INSTRUCTIONS

Task 4
Auditory Focused/Divided: Simultaneous-Sequential Paradigm (AF/D-SSP)

Instructions

This is an auditory attention experiment consisting of two separate parts. In each part of the experiment you will receive a series of simultaneously presented syllable pairs. In one ear you will always hear the syllable, "wu." In the other ear you will hear one of the following syllables: "ba," "pa," "ga," or "da." In each trial you will be required to identify the syllable that is presented with the "wu" sound. Each part of the experiment will consist of 40 trials.

Sequential Condition

In this part of the experiment the syllable to be identified will be presented on alternate ears from one trial to the next. On the first trial it will be presented on the __________ (left/right) ear, whereas on the second trial it will be presented on the __________ (left/right) ear.

Once you have comfortably adjusted the headphones and you are prepared to begin the task, please let me know by saying the word "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the series is about to begin. Each syllable pair will be introduced by a brief tone. You will have approximately 10 seconds to make your response before the next trial begins. In the event that you are unable to respond to a particular trial, do not let it interfere with your subsequent performance but rather prepare yourself to receive the next syllable pair. If you have any problems hearing or understanding the message, please let me know. Since I will be recording your performance I would like you to speak clearly and loudly. Once the series is completed, you may remove the headphones for a brief rest period.

Do you have any questions?

We will begin with a few practice trials.

Practice Trials:

Remember that the syllable to be identified will be presented on alternate ears from trial to trial. On the first trial the syllable to be identified, either "ba," "pa," "ga," or "da," will be presented on the ____________ ear.
(left/right)

I would like you to now put on the headphones.

Experimental Trials:

In this series of trials the first syllable to be identified will be presented on the ____________ ear.
(left/right)

I would like you to please put on the headphones.

Simultaneous Condition

In this part of the experiment you will be required to identify the syllable that is paired with the "wu" sound. For example, if you feel that the syllable "ga" was presented, you should indicate your response by saying "ga."

Once you have comfortably adjusted the headphones and you are prepared to begin the task, please let me know by saying the word, "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the series is about to begin. Each syllable pair will be introduced by a brief tone. You will have approximately 10 seconds to make your response before the next trial begins. In the event that you are unable to respond to a particular trial, do not let it interfere with your subsequent performance but rather prepare yourself to receive the next syllable pair. If you have any problems hearing or understanding the message, please let me know. Since I will be recording your performance, I would like you to speak clearly and loudly. Once the series is completed, you may remove the headphones for a brief rest period.

Do you have any questions?

We will begin with a few practice trials.

Practice Trials:

Remember that in this part of the experiment, you are required to identify the syllable which is paired with the "wu" sound. Again, the target syllables may be either "ba," "pa," "ga," or "da."

I would like you to now put on the headphones.

Experimental Trials:

As in the practice trials, I would like you to identify the syllable that is paired with the "wu" sound.

I would like you to please put on the headphones now.

APPENDIX K_1

TASK 5

AUDITORY DIVIDED: PRIMARY TASK DEMANDS (AD-PTD)

APPARATUS AND PROCEDURE

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Apparatus and Stimulus Materials

Three dichotic listening tapes were employed: two experimental tapes (ET_1 and ET_2) which served as actual testing materials, and one practice tape (PT) which served the purpose of acquainting subjects with the nature of the task. Each tape was characterized by the following: 1) a dichotic warning signal consisting of the spoken word "ready" which preceded the dichotic messages by approximately 5 seconds; 2) a primary message to be shadowed; and 3) a secondary message containing eight noncontextual target words.

In ET_1 the primary message consisted of 285 words of the popular nursery rhyme, "This is the House that Jack Built" (Baring-Gould & Baring-Gould, 1967). The primary message for ET_2 consisted of a 285 word narrative concerning the social ecology of coyotes (Bekoff & Wells, 1980), and the primary message for PT consisted of a 285 word prose passage taken from Gardner's (1980), "Mathematical Games." For each condition (ET_1, ET_2, and PT) a different 285 word prose passage taken from Knobler's (1966), The Visual Dialogue, comprised the secondary message. Target words consisted of the eight most frequently associated monosyllabic names to each of the following semantic categories: fish (PT); four-legged animals (ET_1); clothes (ET_2). For each condition, target positions were randomly determined with the restriction that none occurred within the first or last ten words of the message or, within eight words of another target item. All target items were taken from Marshall and Cofer (1970). All stimulus materials are presented in Appendix K_2. The procedures, including the apparatus, employed to prepare and administer the stimuli are discussed in Appendix C.

Procedure

Prior to the presentation of testing materials, subjects were given detailed instructions concerning the nature of the task as listed in Appendix K_3. Briefly stated, subjects were informed that in addition to shadowing the primary message, they were required to monitor the secondary message and tap the table with the metal rod whenever they detected a target word. It was emphasized that the shadowing task was of primary importance and that target detection was secondary.

Two experimental conditions were employed. In the low-attention-demand condition, subjects were required to shadow the nursery rhyme, "This is the House that Jack Built," and tap to any four-legged animal name that was presented in the nonshadowed channel (ET_1). In the high-attention-demand condition, subjects were required to shadow an unfamiliar prose passage concerning the social ecology of coyotes and tap to the name of any article of clothing that was presented in the nonshadowed channel (ET_2).

All subjects initially received the practice tape (PT) which served as a means of familiarizing them with the nature of the task as well as provided an opportunity for minor equipment adjustments. Following a brief interval ET_1 and ET_2 were presented. The presentation order of the experimental conditions as well as the ear of arrival of the primary message were counterbalanced across subjects. An interval of approximately 2 minutes separated each of the three tape presentations.

The dependent measures included the number of correct target detections and the number of words correctly shadowed. So as to allow for response latency a tap was recorded as correct if it occurred within five stimulus words following the presentation of the target item. Errors of omission and comission were recorded as shadowing errors. Detection scores for each subject were determined by calculating the number of target items correctly detected on the nonshadowed message for ET_1 and ET_2 respectively. Similarly, shadowing scores were determined by calculating the number of words correctly shadowed for ET_1 and ET_2 respectively.

APPENDIX K_2

TASK 5

AUDITORY DIVIDED: PRIMARY TASK DEMANDS (AD-PTD)

STIMULUS MATERIALS

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Practice Tape (PT) - Primary Message

"Nothing is known about the beginnings of checkers, although most game historians now think it originated in southern France sometime in the 12th century. In Britain and the United States it is surely the best-known of all board games when you consider the number of children who learn to play it and never forget its rules, even though checkers is far below chess in the size of its literature, in the number of adults who become top-level players and in the public excitement generated by contests for the world checkers championship. Rules for chess are now standard throughout the Western world, but not so for checkers. Outside of English-speaking countries there are dozens of regional variations. The version most popular in Europe and the U.S.S.R., called Polish checkers, except in Poland, where it is called French checkers, is played on a 10-x-10 board, each side starting with 20 men. It is the standard French form of the game. In French Canada the board is even larger: 12-x-12, with 30 pieces to a side. Rules for checkers differ widely around the world. It is curious to note that in all European countries except Britain the pieces are called ladies; only here and in English-speaking countries are they men. Several consequences follow from the fact that checkers is simpler than chess. One is that a grand-master checkers player is less likely than his chess counterpart to lose to an inferior by making an error. For checkers' buffs this is one of the game's great attractions. They love to quote Edgar Allan Poe's discussion of the two games at the beginning of The Murders in the Rue Morgue."32

[32] Gardner, M. Mathematical games. Scientific American, 1980, 242, 22-30.

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Practice Tape (PT) - Secondary Message

.Target words and positions - pike (23), perch (59), fluke (95), shark (119), carp (150), cod (196), shrimp (230), and trout (267)[33]

"A planographic print is produced from a flat printing surface. The print process utilizing this method is called lithography. Lithography is based PIKE on the natural repulsion of oil and water. In this print method the face of a slab of limestone is specially grained with an abrasive to produce a flat, slightly roughened surface, free of all PERCH dirt and stains. A drawing is then made on the prepared surface with a wax crayon or a special ink. When completed, the drawing is treated chemically so that those areas, including even the most FLUKE minute grains of the stone, which remain untouched by the oil and wax will accept water and repel oil, while those areas touched by SHARK the crayon or ink will accept oil and reject water. The stone is kept damp during the entire printing process. In this manner a microscopic layer of ink is deposited CARP on the stone in the image of the original drawing. At this point, with the stone still damp, a piece of dampened paper is placed on top of it and they are both run through a press. The ink is offset onto the paper and COD the lithographic print results. The process is repeated for each print. Some present-day lithographers use grained metal and paper plates rather than stone. Prints made from paper or metal vary slight in SHRIMP appearance from those drawn on stone, but the drawing and printing process is essentially the same. In lithography, an artist may vary his drawing technique in a great many ways, producing prints which approximate the detail of TROUT a photograph or the boldness of a woodcut. Textures and surfaces unobtainable in any other process are made possible in lithography."[34]

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[33] Marshall, G., & Cofer, C. Single-word free-association norms for 328 responses from the Connecticut Cultural Norms for items in categories. In L. Postman & G. Keppel (Eds.), Norms of Word Association. New York: Academic Press, 1970, 321-360.

[34] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, p. 318.

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Experimental Tape 1 (ET_1) - Primary Message

"This is the house that Jack built.

This is the malt
That lay in the house that Jack built.

This is the rat,
That ate the malt
That lay in the house that Jack built.

This is the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built.

This is the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built.

This is the cow with the crumpled horn
That tossed the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built.

This is the maiden all forlorn
That milked the cow with the crumpled horn
That tossed the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built.

This is the man all tattered and torn
That kissed the maiden all forlon,
That milked the cow with the crumpled horn,
That tossed the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built

This is the priest all shaven and sho
That married the man all tattered and torn,
That kissed the maiden all forlorn,
That milked the cow with the crumpled horn,
That tossed the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built

This is the cock that crowed in the morn,
That waked the priest all shaven and shorn,
That married the man all tattered and torn,
That kissed the maiden all forlorn,
That milked the cow with the crumpled horn..."[35]

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[35] Baring-Gould, W. S., & Baring-Gould, C. The Annotated Mother Goose. New York: The World Publishing Company, 1967, pp. 44-45.

Task 5

Auditory Divided: Primary Task Demands (AD-PTD)

Experimental Tape (ET_1) - Secondary Message

Target words and positions - fox (42), bear (69), goat (88), deer (111), cow (145), horse (190), pig (218), and dog (243)[36].

"A print is an impression of a composition produced by an artist on a master surface. The artist cuts into the surface or draws on it and treats the drawing chemically so that the original design can be transferred from this surface FOX to paper. Many impressions may be taken from one master surface. Prints fall into four major groups: those produced by relief cutting, intaglio prints, planographic prints, BEAR and those produced through a form of stencil process. The relief print is perhaps the best known form GOAT of print making. In this process the artist draws his composition on a block of material that can easily be cut with DEER a knife or gouge. Those areas which he desires to print are left untouched, and the areas to be left white are cut away from the block surface. When the cutting of the COW surface is completed, the resultant block is charged with a viscous ink by a roller, or brayer. As the brayer rolls over the block, it touches only those areas which were left uncut. The areas cut into the block remain free of ink. A HORSE piece of soft, semi-absorbent paper is placed on the charged block, and pressure is applied by a press or, more frequently, by rubbing the back of PIG the paper with a smooth instrument. The ink is offset onto the paper and the print results. When the cutting process is carried out DOG on the flat side of a block of wood, the print is called a woodcut, or wood-block print. Many kinds of wood may be used for this type of print, and the characteristic grain of each type can be integrated into the design."[37]

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[36] Marshall, G., & Cofer, C. Single-word free-association norms for 328 responses from the Connecticut Cultural Norms for items in categories. In L. Postman & G. Keppel (Eds.), Norms of Word Association. New York: Academic Press, 1970, pp. 321-360.

[37] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, p. 315.

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Experimental Tape 2 (ET_2) - Primary Message

"Motion-picture films about the American West almost always depict coyotes in the same way, as solitary animals howling mournfully on the top of a distant hill. In reality coyotes are protean creatures that display a wide range of behavior. They are characterized by highly variable modes of social organization. ranging from solitary and transient individuals to gregarious and stable groups that may live in the same area over a long period of time. Between the two extremes are single individuals and mated pairs that tend to remain in one area. Indeed, a single coyote may in its lifetime experience all the different grades of sociality. This remarkable flexibility in the ways coyotes interact with one another can best be understood by examining their ecology, or the ways they interact with their environment. It is generally accepted that most animal characteristics are the product of an interaction between inherited predispositions and the environment. In other words, although the cumulative passing of genes by successfully reproducing individuals establishes certain tendencies in each animal, many observable traits are subject to modification by proximate, or immediate, factors in the animal's environment. Thus many of an animal's traits, in particular behavioral ones, can be viewed as adaptations to the environments in which the animal has lived or is living. Studies indicate that the social organization of coyotes is indeed a reflection of their food resources and that three variables have a direct and significant impact in this regard: the size of the available prey, the prey's spatial distribution and its temporal, or seasonal, distribution. Coyotes belong to the same family as wolves. There are 19 recognized subspecies of coyotes, but because the animals are currently more mobile than they used to be and crossbreed to a greater extent there seems little reason to retain the more refined classification."[38]

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[38]Bekoff, M., & Wells, M. C. The social ecology of coyotes. Scientific American, 1980, 242, 130-148.

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Experimental Tape 2 (ET_2) - Secondary Message

Target words and positions - tie (33), hat (66), blouse (85), coat (123), shirt (164), dress (209), vest (234), and pants (268)[39]

"Today each artist must isolate that which is important to him, and then he must find the visual equivalent for it. The present-day artist is faced with a situation that never TIE faced his predecessors. He lives in a world for which the visual image is common place. The most inexperienced art student is conversant with visual art forms more varied and more numerous than HAT those known to the master artist of the previous century. Each year the history of art grows larger, BLOUSE and access to the art of the past becomes easier. Museums and galleries in our cities have made possible a first-hand knowledge of major art objects from the very beginning of history to the present, and COAT what the museums have been able to do for their visitors, mass magazines have done for their readers. Color reproductions of works of art seem to find their way to the pages before the paint is dry on the artist's SHIRT canvas. This esthetic bounty has increased the interest in the visual arts, but at the same time it has driven the contemporary artist to a search for new forms of visual communication. As the exposure of paintings and sculpture has grown, the need for DRESS new forms of communication has grown with it. The forms of a painting style which seem to express a sincere and direct sensitivity to VEST human experience at one time in history may become the basis for a stylistic cliche at another. Picasso used the cubist treatment of a head in his paintings of the 1930's as a PANTS vital expressive device. By showing composite views of the head, it was possible for him to intensify the content of his figure symbols."[40]

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[39] Marshall, G., & Cofer, C. Single-word free-association norms for 328 responses from the Connecticut Cultural Norms for items in categories. In L. Postman & G. Keppel (Eds.), Norms for Word Association. New York: Academic Press, 1970, pp. 321-360.

[40] Knobler, N. The Visual Dialogue. New York: Holt, Rinehart & Winston, 1966, p. 307.

APPENDIX K_3

TASK 5

AUDITORY DIVIDED: PRIMARY TASK DEMANDS (AD-PTD)

INSTRUCTIONS

Task 5
Auditory Divided: Primary Task Demands (AD-PTD)

Instructions

This is an auditory attention experiment consisting of two separate parts. In each part of the experiment you will receive a different message in each ear at the same time. I would like you to listen carefully to one message and to shadow, that is, repeat it immediately as you hear it. You should continue to do so for the duration of the entire message. On some trials you will be asked to repeat the message that is presented in your right ear, and on other trials you will be asked to repeat the message that it presented in your left ear. I will always tell you which message you are to repeat. All the messages will be approximately two minutes long.

In addition to shadowing the designated message, I would like you to tap the table with the metal rod (experimenter illustrates rod) whenever you detect a target word in the nonshadowed message; that is, the message that you are not repeating. Each part of the experiment will have a different set of target words. Again, I will tell you what type of words are targets for each part of the experiment. Remember that you are to repeat the message arriving in the designated ear only, and you are to tap to the target words presented in the nonshadowed ear.

Do you have any questions?

Before the actual experiment we will have a practice trial.

Practice Trial:

In this case I would like you to repeat the message that you hear in your ____________ (left/right) ear. You will be shadowing a passage concerning the popular game of checkers. The target words for this trial will consist of names of common fish, for example, lobster, herring, tuna, etc. Remember repeat the message that is presented in your ____________ (left/right) ear and tap the table with the metal rod whenever you hear the name of a fish in your ____________ (left/right) ear. You need not repeat the name of the fish. Try not to let your tapping response interfere with your shadowing performance. Since I will be recording your responses, I would like you to speak clearly and loudly into the microphone. In the event that you feel that you have missed a word during shadowing or made another error, do not try to correct your mistake but rather continue shadowing the material that you are currently receiving and tap to the next target item.

Once you have comfortably adjusted the headphones and you are prepared to begin the task, please let me know by saying the word, "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the message is about to begin. If you have any problems hearing or understanding the message, please let me know. Remember that you are to continue to shadow the message arriving in your ____________ (left/right) ear and tap to the name of any fish until the message is completed. Once the message is completed, you may remove the headphones for a brief rest period.

Do you have any questions?

I would like you to please put on the headphones now.

Low-Attention-Demand Condition

This trial is very similar to the last one. This time, however, I would like you to repeat the message that arrives in your ________ (left/right) ear and tap to any animal name, for example, beaver, camel, donkey, etc., that you hear in your ________ (left/right) ear.

Do you have any questions?

I would like you to please put on the headphones now.

High-Attention-Demand Condition

This trial is very similar to the last one. This time, however, I would like you to repeat the message that arrives in your ________ (left/right) ear and tap to the name of any article of clothing, for example, sweater, jacket, suit, etc., that you hear in your ________ (left/right) ear.

Do you have any questions?

I would like you to please put on the headphones now.

APPENDIX L_1

TASK 6

AUDITORY DIVIDED: RECALL EXPECTANCIES (AD-RE)

APPARATUS AND PROCEDURE

Task 6
Auditory Divided: Recall Expectancies (AD-RE)

Apparatus and Stimulus Materials

Stimulus materials consisted of 58 messages: 50 were employed as actual testing materials and eight were employed for practice purposes. Each dichotic message consisted of a series of 10 monosyllabic digit pairs, with members of each pair simultaneously presented on different channels. Digit pairs and sequences were generated via a table of random numbers. Each dichotic message was comprised of the following: 1) a dichotic warning signal, consisting of the spoken word "ready," which indicated the start of a trial; 2) "expectancy" instructions; 3) a 1000 Hz pure tone of 250 milliseconds duration which signalled the presentation of stimulus pairs; 4) a series of digit pairs; and 5) "recall" instructions. All stimulus materials are presented in Appendix L_2. The procedures, including the apparatus, employed to prepare and administer the stimuli are discussed in Appendix C.

Procedure

Prior to the presentation of the testing materials, subjects were given detailed instructions and practice sessions familiarizing them with the nature of the task. Instructions are presented in Appendix L_3.

Four experimental conditions were employed. For all conditions subjects were instructed to shadow the primary message as designated. In the S-S condition subjects were asked to recall the three digits terminating the shadowed message in accordance with preshadowing expectancies as generated by the experimenter's instructions. In the

S-NS condition subjects were asked to recall the three digits terminating the nonshadowed message in contrast to preshadowing expectancies as generated by the experimenter's instructions. In the NS-NS condition subjects were asked to recall the three digits terminating the nonshadowed message in accordance with the preshadowing expectancies as generated by the experimenter's instructions. In the NS-S condition subjects were asked to recall the three digits terminating the shadowed message in contrast to preshadowing expectancies as generated by the experimenter's instructions.

S-S and NS-NS conditions were each comprised of 15 trials; S-NS and NS-S conditions were each comprised of 10 trials. The order of presentation of trials was randomly determined with the restriction that the number of trials under each condition was counter-balanced across channels. The trials sequence, which was fixed across subjects, is presented in Appendix L_2.

Each subject received 25 blocked trials of shadowing digits presented on the left channel and 25 blocked trials of shadowing digits presented on the right channel. Each block of shadowing trials was counterbalanced for channel presentation across subjects and their administration was separated by a rest interval of approximately two minutes.

Each set of blocked trials began with the experimenter designating the ear of arrival of the primary message to be shadowed. Subjects received four practice trials appropriate to the experimental condition. Following an approximately 60-second interval, the experimental trials began. Each trial began by dichotically designating to subjects the start of a trial and then the message containing the digits which subjects were to expect to recall on that trial. Following the "expectancy" instructions, a dichotic warning signal, a 1000 Hz pure tone preceded the series of digits by approximately five seconds. Immediately upon the completion of the shadowing task, the message containing the to-be-recalled digits was dichotically indicated; and subjects were instructed to immediately report the cued digits to the experimenter. Subjects' responses, both shadowing and digit recall, were manually recorded by the experimenter on specially prepared data sheets.

The number of digits correctly recalled and the number of digits correctly shadowed served as the dependent measures. Recall scores for each subject were determined by computing the number of digits correctly recalled under each of the experimental conditions. Shadowing scores for each subject were determined by computing the number of digits correctly shadowed under each of the four experimental conditions.

APPENDIX L_2

TASK 6

AUDITORY DIVIDED: RECALL EXPECTANCIES (AD-RE)

STIMULUS MATERIALS

Task 6
Auditory Divided: Recall Expectancies (AD-RE)

Stimulus Pairs - Block 1

.Practice Trials

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
1	8 1 6 2 6 9 1 8 2 1 1 8 8 3 1 5 4 8 2 3	NS-NS	3	5 4 8 2 3 8 3 6 6 1 4 6 5 1 4 9 3 1 8 4	S-NS
2	2 8 5 4 3 8 1 6 3 3 3 8 4 2 8 3 5 2 6 9	S-S	4	6 8 8 2 3 3 4 8 9 8 6 9 4 9 2 5 9 6 1 5	NS-S

.Experimental Trials

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
1	9 6 2 4 4 1 5 6 3 2 8 2 5 2 9 5 2 4 2 8	S-S	5	1 3 4 2 1 8 6 3 2 3 5 9 1 5 2 6 8 4 1 9	NS-NS
2	8 4 1 4 5 3 6 6 9 4 8 5 5 2 6 2 3 9 9 2	S-NS	6	8 9 2 3 8 8 9 5 6 9 6 5 5 9 2 4 2 5 2 8	NS-S
3	6 5 4 1 1 4 1 4 5 9 4 2 8 6 1 6 4 3 9 2	NS-NS	7	5 1 9 8 9 9 8 3 6 8 1 2 9 1 1 8 3 8 6 5	S-NS
4	4 3 9 4 5 1 6 8 4 8 4 6 8 5 5 1 9 1 8 2	S-S	8	3 9 4 2 3 8 8 2 2 6 9 3 3 3 4 4 8 2 5 1	NS-S

Continued ...

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
9	4 9 9 3 5 1 8 9 1 2 9 5 9 8 3 8 6 1 9 9	NS-NS	16	1 9 1 8 2 8 3 1 6 6 8 3 3 2 5 9 8 3 1 2	NS-S
10	6 5 9 9 4 5 5 3 2 6 1 6 6 9 3 5 4 9 2 6	S-NS	17	6 6 8 2 1 4 1 5 6 8 2 4 9 1 3 5 9 5 8 9	NS-NS
11	6 9 5 3 4 4 1 6 1 2 1 5 6 6 3 1 1 8 8 4	NS-NS	18	2 4 3 1 6 5 9 4 6 9 3 8 6 2 5 3 2 1 8 4	NS-S
12	2 6 8 4 9 8 4 5 4 6 2 8 9 9 2 6 3 4 6 8	NS-NS	19	1 1 9 1 6 5 3 4 8 1 4 8 9 2 5 2 5 1 9 4	S-S
13	6 8 3 2 9 6 5 4 2 4 3 5 6 4 5 9 3 4 6 8	S-S	20	4 4 2 8 3 2 6 1 9 6 4 1 5 9 2 6 5 9 4 2	S-NS
14	5 8 8 3 8 3 6 1 6 3 4 3 2 5 3 8 4 1 4 5	S-S	21	8 9 2 1 5 3 9 4 1 1 2 3 9 2 8 6 1 6 5 8	NS-S
15	5 9 5 1 3 2 9 4 6 4 3 8 9 9 2 8 1 5 2 4	NS-NS	22	5 1 1 2 3 4 3 4 3 8 3 3 1 5 5 1 1 2 6 2	S-S

Continued ......

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
23	2 9 2 1 5 5 4 1 3 8 4 9 2 4 5 3 5 9 6 1	NS-NS	25	3 3 8 9 8 3 4 6 1 8 5 8 4 1 9 2 3 6 9 5	S-NS
24	1 1 5 8 6 3 2 6 4 1 9 6 3 1 2 1 8 5 1 5	S-S			

*Legend:

Digit pairs are vertically presented.

S-S = Subject expects to recall shadowed digits and is asked to recall shadowed digits.

S-NS = Subject expects to recall shadowed digits and is asked to recall nonshadowed digits.

NS-NS = Subject expects to recall nonshadowed digits and is asked to recall nonshadowed digits.

NS-S = Subject expects to recall nonshadowed digits and is asked to recall shadowed digits.

Task 6
Auditory Divided: Recall Expectancies (AD-RE)

Stimulus Pairs - Block 2

Practice Trials

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
1	2 3 1 5 5 4 8 5 9 1 5 5 4 5 4 3 1 3 4 8	S-NS	3	4 3 5 8 9 6 1 8 3 4 4 4 1 9 6 2 1 3 4 3	NS-NS
2	1 4 8 1 6 3 5 3 2 4 4 3 6 2 2 3 5 5 1 3	S-S	4	5 1 3 2 2 1 1 5 4 3 8 8 3 4 5 9 6 1 8 2	NS-S

Experimental Trials

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
1	5 1 6 2 2 1 6 8 2 2 8 3 2 1 9 6 3 2 5 4	NS-NS	5	5 8 3 3 2 4 8 9 8 5 2 8 4 3 2 4 6 1 3 4	NS-NS
2	2 1 3 9 1 4 9 4 3 4 6 3 5 9 8 6 9 8 3 1	S-NS	6	6 5 5 3 1 2 6 8 9 6 4 6 9 3 2 1 6 9 1 2	NS-S
3	8 9 2 2 1 2 3 6 2 6 5 8 4 3 3 5 1 2 2 3	S-S	7	5 1 3 4 8 9 2 4 2 3 8 6 5 9 3 6 8 5 1 5	NS NS
4	9 8 5 4 6 3 8 6 6 5 8 5 6 5 4 5 4 4 5 2	S-S	8	4 1 2 3 2 1 4 9 4 2 6 9 4 5 8 1 6 8 2 8	S-S

Continued ...

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
9	4 2 9 9 3 1 4 5 8 6 2 8 2 6 4 6 4 3 8 5	NS-S	16	2 1 3 9 2 4 4 1 3 9 3 9 6 5 1 4 5 9 8 1	S-NS
10	2 9 9 3 5 6 9 1 6 3 1 5 2 5 9 1 4 8 9 3	NS-NS	17	4 1 1 9 8 4 4 1 5 9 2 2 6 1 3 1 4 5 4 5	S-S
11	4 5 8 9 1 2 6 9 3 5 1 8 8 1 6 5 9 6 3 2	NS-S	18	6 5 2 1 3 8 3 9 2 6 8 4 2 4 3 9 5 6 1 4	S-NS
12	3 6 1 4 6 8 2 9 2 5 8 2 9 3 5 1 2 8 4 1	S-NS	19	5 6 6 8 6 9 8 3 2 5 4 6 5 8 3 3 2 8 1 4	S-NS
13	2 2 8 1 6 9 4 8 9 8 3 6 3 6 9 8 1 5 4 2	S-S	20	4 1 2 3 4 1 4 9 4 4 9 3 6 9 4 5 8 1 6 8	NS-NS
14	3 5 4 8 1 3 3 9 6 3 1 1 9 3 2 8 9 5 1 2	NS-NS	21	4 3 5 9 8 5 6 2 3 8 1 2 2 4 2 2 6 3 1 6	S-S
15	5 5 6 2 1 5 8 8 4 3 6 1 6 3 4 3 3 9 5 4	NS-S	22	3 1 8 2 4 3 8 4 3 1 6 1 2 5 2 5 1 2 4 6	S-S

Continued .....

Trial	Stimulus Pairs*	Exp. Cond.*	Trial	Stimulus Pairs	Exp. Cond.
23	1 5 1 4 6 5 8 9 8 5 3 1 3 4 2 9 4 8 1 3	NS-S	25	9 3 4 8 9 2 3 6 6 8 2 3 4 5 8 2 5 1 6 5	S-S
24	1 3 4 3 1 8 9 4 9 4 6 4 9 2 8 5 9 8 3 5	NS-NS			

*Legend:

Digit pairs are vertically presented.

S-S = Subject expects to recall shadowed digits and is asked to recall shadowed digits.

S-NS = Subject expects to recall shadowed digits and is asked to recall nonshadowed digits.

NS-NS = Subject expects to recall nonshadowed digits and is asked to recall nonshadowed digits.

NS-S = Subject expects to recall nonshadowed digits and is asked to recall shadowed digits.

APPENDIX L_3

TASK 6

AUDITORY DIVIDED: RECALL EXPECTANCIES (AD-RE)

INSTRUCTIONS

Task 6
Auditory Divided: Recall Expectancies (AD-RE)

Instructions

This is an auditory attention experiment consisting of 50 brief trials. On each trial you will simultaneously receive two series of 10 random digits, that is, a different series of random digits in each ear, at the same time. I would like you to listen carefully to one series of digits and to shadow each digit immediately as you hear it. You should continue to do so for the duration of the entire sequence of digits. On some trials you will be asked to listen to and repeat the digits that you hear in your left ear, and on other trials you may be asked to repeat the digits that are presented in your right ear. Before each set of trials you will be told which digits you are to repeat. You are to continue to repeat the digits presented on the designated channel for the entire sequence of trials.

In addition to shadowing the designated digit series, you will also be required to recall the three digits terminating one of the digit lists. On some occasions you may be asked to recall the last three digits of the series that you shadowed. On other trials you may be asked to recall the three digits terminating the nonshadowed digit list. Immediately prior to each trial you will be informed in regard to which digits you may expect to recall.

Once you have comfortably adjusted the headphones, and you are prepared to begin the task, please let me know by saying the word, "start." I will then start the recorder. A warning signal, the spoken word "ready," will come on telling you that the trial is about to begin. Immediately before each list of digits you will be told which digits you may expect to recall. For example, if you are to recall the digits presented in your right ear, on the recorder you will hear the phrase, "remember right." If you are to recall the digits presented in your left ear, you will hear the instructions, "remember left." These instructions will be followed by a warning signal, a brief tone, informing you that the digit sequence is about to begin.

Following the digit presentation, again, you will be informed which digits you are to recall. For example, if you are to recall the digits that have been presented in your right ear, on the recorder you will hear the phrase, "recall right." At that time you should make your report. You will have approximately 10 seconds to make your response before the next trial begins. There is no need to remove your headphones after each digit list presentation. After approximately 25 trials I will inform you that you may remove the headphones for a brief rest period.

Do you have any questions?

We will begin with a few practice trials.

Practice Trials:

Remember that in addition to reporting the digits presented in your __________ (left/right) ear, you are to recall the last three digits as designated. Again, the recall instructions will immediately precede and follow the presentation of the digits. The instructions that are

presented on the tape-recorder pertain to the digits that you are to recall. For this entire sequence of trials you always shadow the digits presented on the ______________ ear.
(left/right)

Experimental Trials:

We will now begin the experiment. I would like you to continue to shadow the digits that are presented in your ______________ ear
(left/right)
and to recall the digits designated by the instructions.

I would like you to please put on the headphones now.

Experimental Trials (Channel Reversal):

For the remaining trials I would like you to shadow the digits that are arriving in your ______________ ear and to recall the
(left/right)
digits as designated.

I would like you to please put on the headphones now.

APPENDIX L_4

TASK 6

AUDITORY DIVIDED: RECALL EXPECTANCIES (AD-RE)

SUMMARY OF SECONDARY STATISTICAL ANALYSES

TABLE 15

An Analysis of the Simple Main Effects for Expectation Channel (A)

Source of Variation	SS	df	MS	F
A at b_1 Test: Nonshadowed Expectation: Nonshadowed/ Shadowed	691.2	1	691.2	5.90
A at b_2 Test: Shadowed Expectation: Nonshadowed/ Shadowed	1872.3	1	1872.3	15.98*
A x Subj. + AB x Subj.	13,824.5	118	117.15	

*$p < .01$

APPENDIX M_1

TASK 7

VISUAL DIVIDED: CONSISTENT VERSUS VARIED MAPPING (VD-CVM)

APPARATUS AND PROCEDURE

Task 7
Visual Divided: Consistent versus Varied Mapping (VD-CVM)

Apparatus and Stimulus Materials

Each trial was characterized by the administration of the following sequence: a stimulus set which contained target items, a fixation stimulus, and a test array which contained target as well as nontarget items. Two types of stimulus sets, defining two experimental conditions, were employed. For the consistent mapping condition (CM), stimulus sets were generated by randomly selecting items from the single, primary digits, 1 through 9. For the varied mapping condition (VM), stimulus sets were generated by randomly selecting characters from the letter pool comprised of "C, D, F, G, H, J, K, L, and M." For both conditions, stimulus sets varied in size and contained either 1, 2, or 4 elements. Characters were printed in black ink and horizontally arranged on white 3 x 5 inch index cards. Letters were printed in upper case type. Each character was approximately 0.625° of a visual angle in height, 0.625° of a visual angle in width, and separated by a visual angle of approximately 1.875° .

Each stimulus set had a corresponding test set which contained either 1, 2, or 4 elements. For both the CM and VM condition, nontarget test items were randomly selected from the aforementioned letter pool, with the exception that in the VM condition those characters which had been previously chosen as stimulus set items for that trial were excluded from the nontarget array. A 2-field Harvard tachistoscope, model T-2B was employed to present test sets. The exposure field of the tachistoscope was 19.375° of a visual angle in height and 19.375° of a visual angle in width. The light exposure was set at 1 log unit per field. Letters were printed in upper case type and all characters were printed in black ink on a white background. Each character was approximately 0.312° of a visual angle in height, 0.312° of a visual angle in width, and separated by a visual angle of approximately 0.938° . For the test sets containing 4 items, the elements were arranged in a square. For the test arrays consisting of 1 or 2 items, character placement within the 2 x 2 configuration was randomly determined.

The fixation stimulus consisted of a dark gray square, which was centrally positioned and occupied 9.375° of a visual angle. This stimulus served as the adaptation field for tachistoscopic presentations as well as the inter-trial display. An electronic timer was employed to record subjects' response latencies. Subjects' responses and response latencies were manually recorded by the experimenter on specially prepared data sheets. All stimulus materials are presented in Appendix M_2.

Procedure

Two experimental conditions, distinguished on the basis of the target-nontarget relationship, were employed. In the CM condition, since target items were always digits and nontarget items were always letters, the relevancy or irrelevancy of cognitive categories remained constant across trials. In the VM condition, both target and nontarget items were randomly selected elements from a common letter pool, and as such the experimental relevancy or irrelevancy of characters was mixed across trials. That is, whereas the letter "c" was a target item on one trial, it was a nontarget item on a subsequent trial.

CM and VM conditions each consisted of 72 experimental trials; that is, eight trials of each of the nine possible combinations of stimulus-test sets which can be generated. In each block of eight trials, targets appeared randomly on one-half of the trials and the order to presentation was fixed across subjects. The order of presentation of CM and VM blocks, however, was mixed and randomly determined for each subject. A brief rest interval of approximately two minutes separated each block of trials.

Prior to the presentation of actual testing materials, subjects were given detailed instructions and 8 practice trials appropriate to the experimental condition. All practice trials contained two items in the stimulus set and two items in the test set. Briefly stated, subjects were instructed to rapidly search the test arrays for the possibly occurrence of a target item and verbally report to the experimenter as soon as a decision was made concerning whether or not a target had been presented. Specific instructions are presented in Appendix M_3.

Each trial, regardless of the experimental condition, began with the presentation of the stimulus set that was relevant for that trial, and subjects were allowed as much time as necessary to memorize the items contained therein. Upon completion of the memory task, subjects returned the index card containing stimulus items to the experimenter. The experimenter then gave a verbal preparatory signal, the spoken work "ready," which served as a cue for subjects to fix their gaze upon the fixation stimulus on the adaptation field. Subjects manually triggered the apparatus for the tachistoscopic presentation of the test array whenever ready. Each test array was displayed for a 120-millisecond duration. Immediately following each tachistoscopic presentation, subjects verbally reported whether or not a target had been presented on that trial. Subjects' responses and response latencies were manually recorded by the experimenter. Inter-trial intervals were variable and determined by each subject's response latency as well as the experimenter's recording time.

Response latencies to as well as the number of correct detections served as dependent measures. Detection scores for each subject were determined by computing the number of target items correctly detected at each level of CM and VM conditions respectively. Latency scores for each subject were determined by computing the mean reaction time to correct detections recorded at each level of the CM and VM conditions respectively.

APPENDIX M_2

TASK 7

VISUAL DIVIDED: CONSISTENT VERSUS VARIED MAPPING (VD-CVM)

STIMULUS MATERIALS

Task 7
Visual Divided: Consistent versus Varied Mapping
(VD-CVM)

Consistent Mapping Condition (CM)

.Practice Block (2,2)*

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test* Set
1	4 8	J H	5	6 3	M D
2	5 2	L F	6	3 5	D 5
3	1 9	1 K	7	7 1	C K
4	9 2	2 J	8	6 4	4 M

.Experimental Blocks

Block (1,1)*

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	7	G	5	5	F
2	6	6	6	8	C
3	4	H	7	1	1
4	3	3	8	9	9

Block (1,2)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	4	D M	5	8	8 K
2	5	F 5	6	2	F L
3	7	J K	7	1	1 G
4	6	C H	8	3	3 D

Block (1,4)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	7	J 7 H F	5	8	M H F 8
2	9	M D G F	6	1	D H K L
3	3	3 D K M	7	5	L C 5 G
4	2	L M C H	8	6	F G C J

Block (2,1)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	9 7	J	5	6 3	K
2	5 4	M	6	4 6	4
3	2 8	8	7	8 2	C
4	5 7	7	8	1 3	3

Block (2,2)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	5 3	5 F	5	5 3	J D
2	2 9	9 L	6	3 6	3 K
3	6 1	L J	7	4 7	H F
4	9 1	M 9	8	8 2	G D

Block (2,4)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	9 2	2 K M L	4	7 4	H D 4 F
2	3 6	G 3 J C	5	8 5	M L H 8
3	1 2	L H K C	6	5 3	H D G M

Trial	Stimulus Set	Test Set		Trial	Stimulus Set	Test Set	
7	9 4	J M	G D	8	6 8	C K	L J
Block (4,1)							
1	1 6 3 7	H		5	6 2 3 5	D	
2	9 2 4 5	2		6	8 6 3 7		7
3	2 5 8 4		 F	7	9 7 4 8		M
4	3 5 9 4		 9	8	1 6 2 7	 1	
Block (4,2)							
1	3 8 1 7	 L	1	5	2 7 5 3	J	L
2	9 2 4 5	5	 C	6	6 3 4 2	 6	 J
3	2 7 4 1	H M		7	6 9 8 1	 C	 G
4	1 7 8 5		K 7	8	3 5 8 6		F D

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
Block (4,4)					
1	4 2 7 5	G J C H	5	7 8 3 9	M 3 L D
2	8 9 1 3	M D L F	6	8 4 3 2	K J L D
3	2 8 5 9	D K C 8	7	6 4 5 2	2 K C G
4	6 1 5 9	F M H C	8	4 3 1 7	J F 4 H

*Legend:

Block (2,2) = Two items in the stimulus set and two items in the test set.

Block (1,4) = One item in the stimulus set and four items in the test set.

— = Stimulus item present in the test set.

Varied Mapping Condition (VM)

.Practice Block (2,2)*

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	F C	C L	5	G F	H J
2	H M	G C	6	M G	K M
3	J K	K C	7	D J	G L
4	C K	M F	8	D H	D G

.Experimental Blocks
Block (1,1)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	L	L	5	J	J
2	H	C	6	J	D
3	D	D	7	K	F
4	K	K	8	L	G

Block (1,2)

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
1	L	D G	5	G	K G
2	M	M H	6	K	L H
3	C	C	7	J	M K
4	F	F G	8	D	C F

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
Block (1,4)					
1	H	D H L J	5	K	C H L J
2	F	C D J H	6	D	H G D K
3	M	H D F M	7	G	G C F M
4	L	K G M D	8	J	M C H D
Block (2,1)					
1	H D	M	5	G L	H
2	D K	D	6	L H	L
3	C F	F	7	M J	J
4	J K	C	8	C M	F
Block (2,2)					
1	K D	H C	5	C F	L F
2	H D	H K	6	M C	J L
3	M G	F M	7	J G	F C
4	K J	J G	8	F H	M D

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
Block (2,4)					
1	K L	J K / F D	5	D K	L J / G F
2	L G	F K / D M	6	D J	M L / K D
3	F C	L M / D H	7	M F	F G / C H
4	C G	K L / G M	8	H M	F D / J L
Block (4,1)					
1	M J H F	H	5	L K G C	J
2	K F M C	K	6	G C H J	M
3	G H F L	M	7	J F M L	K
4	J L D H	L	8	G C K D	D
Block (4,2)					
1	L F J M	L G	5	F G C K	J M
2	J K D M	D C	6	J G C M	F H
3	G K D L	F K	7	C M L K	D F
4	J M H D	K L	8	H L G F	K F

Trial	Stimulus Set	Test Set	Trial	Stimulus Set	Test Set
Block (4,4)					
1	D G J K	L H F C	5	M H J K	D G L F
2	J D C L	H K G F	6	M G D L	H F K C
3	C D K J	K M L G	7	L J F G	D M C L
4	H F D C	G C L K	8	J G K F	M L G H

*Legend:

Block (2,2) = Two items in the stimulus set and two items in the test set.

Block (1,4) = One item in the stimulus set and four items in the test set.

___ = Stimulus item present in the test set.

APPENDIX M_3

TASK 7

VISUAL DIVIDED: CONSISTENT VERSUS VARIED MAPPING (VD-CVM)

INSTRUCTIONS

Task 7
Visual Divided: Consistent versus Varied Mapping
(VD-CVM)

Instructions

This is a visual attention experiment in which you will be briefly presented via the tachistoscope (experimenter illustrates the tachistoscope) displays of either one, two, or four letters. You will be required to search the displays for the detection of target items. Target items may be either letters or digits and each display will have its own particular target item set. Immediately before each display is presented, you will be given an index card with the target set for that trial. Again, the size of the target sets will vary. That is, they may contain either one, two, or four items. You will have as much time as necessary to memorize the set of target items. Once you have memorized the set of target items you will be shown the display. You will be required to indicate whether or not any item from the memory set appeared in the display.

Once you have memorized the target set I would like you to return the index card to me and repeat out loud the items contained in the target set. At that time I will begin the trial with the warning signal, the word "ready." You should then focus upon the gray square in the center of the screen (experimenter illustrates fixation square) and prepare yourself to view the display. Whenever you are ready, I would like you to press this button (experimenter illustrates slide advancer), which will trigger the presentation of the display. Please do not press this button until I have given you the "ready" signal and you have focused upon the gray square. After each presentation I would like you to indicate as quickly as possible whether or not any member of the target set appeared in the display. If you feel that a target item was presented, I would like you to respond by saying "yes." If you feel that there were no members of the target set presented in the display, indicate your response by saying "no." You need not identify the target item that was presented. Although you are asked to respond as quickly as possible, I would also like you to maintain a high level of accuracy throughout the experiment.

Do you have any questions?

We will begin with a few practice trials.

Practice Trials:

Remember that although the target sets will contain either letters or digits, the display sets will contain letters only.

Experimental Trials:

Remember that although you are asked to respond as quickly as possible, I would also like you to maintain a high level of accuracy. Please let me know if you become tired and you would like to take a brief rest period during the sequence of trials.

APPENDIX M_4

TASK 7

VISUAL DIVIDED: CONSISTENT VERSUS VARIED MAPPING (VD-CVM)

SUMMARY OF SECONDARY STATISTICAL ANALYSES

TABLE 20

An Analysis of the Simple, Simple Main Effects for the Varied Mapping Trials (a_2)

Source of Variation	SS	df	MS	F
B at c_1	1.80	2	.90	39.09*
B at c_2	6.68	2	3.34	145.32*
B at c_3	16.43	2	16.43	357.17*
C at b_1	.45	2	.225	9.78*
C at b_2	1.90	2	.95	41.30*
C at b_3	11.01	2	5.05	219.56*
A x Subj. + ABC x Subj.	17.49	767	.02	

$*p < .01$

APPENDIX N

TASK 8

VISUAL FOCUSED/DIVIDED: PATTERNS (VF/D-P)

APPARATUS AND PROCEDURE

Task 8
Visual Focused/Divided: Patterns (VF/D-P)

Apparatus and Stimulus Materials

A Gaf Anscorama carousel slide projector, model 970, was employed to project stimulus materials. Stimuli were displayed on a Caritel viewing screen (14.5 inches in height and 14 inches in width) which was situated on a table approximately five feet from where the subjects' sat. Subjects' responses were initially recorded with a Superscope cassette recorder, model C-104, and were subsequently scored manually by the experimenter using an electronic timer. A Lafayette Eight Bank Program Timer, model 52021, controlled the slide presentation.

Each trial consisted of the administration of two signals in a sequential fashion; the first designated as the cue signal and the second designated as the stimulus signal. Cue items as well as stimulus items were comprised of familiar, letters selected from the standard alphabet, and unfamiliar, angular simulations of standard letters, patterns. Specifically, the geometric configurations "⌊," "⌋," "⌈," and "⌉," simulating the letters "b," "d," "p," and "q" respectively, constituted the sample of novel letters. Cue displays always contained a single pattern whereas stimulus displays contained either one or two patterns. Letters were printed in lower case type and all characters were printed in black ink on a white background. Single items were centrally positioned; on those trials where double characters were presented, the second element was situated approximately 2.375° of a visual angle to the right of the original item. The familiar letters varied from 1.833° to 2.375° of a visual angle in height and ranged from 1.625° to 1.750° of a visual angle in width. Unfamiliar letters were approximately 2.375° of a visual angle in height and 1° of a visual angle in width. Inter-trial displays consisted of a blank white slide. All stimulus materials, including cue-stimulus contingencies, are presented in Appendix N_2.

Procedure

Two experimental conditions, primary (PC) and secondary (SC), were employed. The cue signal for both conditions consisted of a single letter pattern. The stimulus signal, which contained either one or two characters, distinguished the experimental conditions. PC used only single pattern presentations for the stimulus signal, and as such, required subjects to compare the single cue item with the single stimulus item. SC contained an admixture of single and double character stimulus signals. In the latter situation, subjects were required to disregard the single cue item and compare the simultaneously presented stimulus items. Practice blocks contained both types of trials.

Trials were administered on three consecutive days of experimentation. On Day 1, all subjects received the following sequence: one block of practice trials, two blocks of primary test trials, and two blocks of secondary test trials. Primary test blocks were deleted on the second and third day of experimentation. For the practice block, which consisted of 30 trials, the trial sequence was randomly determined, fixed across subjects, and constant throughout the days of experimentation. Each primary block consisted of 32 trials; one block was comprised of familiar letters and the other contained unfamiliar elements. The within blocks' trial sequence was randomly determined and fixed across subjects. The order of administration of the blocks was counterbalanced; that is, one-half of the subjects initially received the familiar stimuli whereas the other half of the subject sample first received the novel characters. Secondary blocks were comprised of 56 trials, twelve test trials which contained double character stimulus signals and 44 catch trials which contained single character stimulus signals. The two secondary blocks which were administered on each day of experimentation were identical in all manners except for the interchanging of familiar and unfamiliar letter patterns on the double character signals. A different sequence of trials was employed on each day of experimentation. The trial order within each sequence was randomly determined and fixed across subjects. The sequence administration was counterbalanced across subjects across days of experimentation.

Prior to the presentation of actual testing materials, subjects were given detailed instructions and a block of practice trials so as to familiarize them with the nature of the task. Briefly stated, subjects were apprised of the novel configurations and the two types of comparisons to be made. Subjects were instructed to indicate as rapidly as possible when the stimuli to be compared were the same. No response was required when the stimuli differed. Instructions are listed in Appendix N_3.

Each block of trials began with the experimenter giving a verbal preparatory signal, the spoken word "ready," which served as a cue for subjects to fix their gaze upon the adaptation field. Subjects' manually triggered the apparatus for the presentation of the first cue slide and thus initiated a block of trials. Immediately following each cue display, the corresponding stimulus display was presented. Each trial, then, consisted of a 1000 millisecond presentation of the adaptation stimulus, a 1000 millisecond presentation of a cue signal, and a 1000 millisecond presentation of a stimulus signal. A rest interval of approximately 3 minutes was given between blocks of trials.

Mean latencies for correct responses served as the dependent measures. Two primary latency scores were computed for each subject; one for familiar letters and one for unfamiliar letters. Similarly two secondary latency scores were computed for each subject for each day of experimentation. Specifically, mean reaction times for the double item stimulus signals employing familiar patterns and mean reaction times for the double item stimulus signals employing unfamiliar patterns were computed. Each response was scored twice or until two consecutive readings with a difference of less than .05 of a second were recorded.

APPENDIX N_2

TASK 8

VISUAL FOCUSED/DIVIDED: PATTERNS (VF/D-P)

STIMULUS MATERIALS

Task 8
Visual Focused/Divided: Patterns
(VF 1 D-P)

.Practice Trials

Trial	Cue	Stimulus	Trial	Cue	Stimulus
1	a	a	16	n	n
2	n	n	17	a	a
3	a	a	18	a	o
4	a	hh	19	a	kk
5	n	n	20	n	n
6	a	c	21	a	a
7	n	n	22	a	e
8	a	a	23	n	ft
9	n	r	24	n	n
10	n	tf	25	a	a
11	n	m	26	n	ff
12	n	n	27	a	a
13	a	kh	28	n	n
14	a	hk	29	n	tt
15	a	a	30	n	u

.Primary Trials - Familiar Letter Patterns

Trial	Cue	Stimulus	Trial	Cue	Stimulus
1	q	q	6	q	p
2	p	p	7	p	p
3	d	d	8	d	d
4	p	p	9	p	p
5	b	b	10	b	b

Trial	Cue	Stimulus
11	b	b
12	d	b
13	q	q
14	p	p
15	q	q
16	b	d
17	d	d
18	b	p
19	p	b
20	q	q
21	d	d

Trial	Cue	Stimulus
22	d	q
23	p	p
24	d	d
25	b	b
26	p	q
27	d	d
28	q	q
29	b	b
30	b	b
31	q	d
32	q	q

.Primary Trials - Unfamiliar Letter Patterns

Trial	Cue	Stimulus
1	⌊	⌊
2	⌉	⌉
3	⌈	⌈
4	⌋	⌋
5	⌋	⌋
6	⌉	⌉
7	⌋	⌊
8	⌊	⌊
9	⌈	⌊
10	⌈	⌉
11	⌉	⌉
12	⌈	⌈

Trial	Cue	Stimulus
13	⌉	⌉
14	⌈	⌈
15	⌊	⌊
16	⌉	⌋
17	⌊	⌈
18	⌈	⌈
19	⌋	⌉
20	⌊	⌊
21	⌊	⌊
22	⌋	⌋
23	⌊	⌋
24	⌈	⌈

Trial	Cue	Stimulus	Trial	Cue	Stimulus
25	↿	↿	29	⇃	⇃
26	↿	↿	30	⇂	⇂
27	↾	↾	31	⇃	⇃
28	↾	↿	32	⇃	⇃

.Secondary Trials - Sequence 1

Trial	Cue	Stimulus	Trial	Cue	Stimulus
1	n	n	19	a	a
2	a	e	20	a	bb (⇂ ⇂)
3	s	s	21	g	y
4	g	g	22	s	qp (↿ ↾)
5	a	o	23	s	s
6	a	a	24	s	s
7	a	a	25	a	bb (⇂ ⇂)
8	s	c	26	g	g
9	s	qq (↿ ↿)	27	g	db (⇃ ⇂)
10	a	a	28	a	a
11	n	dd (⇃ ⇃)	29	s	s
12	a	a	30	g	g
13	s	s	31	q	a
14	n	pd (↾ ⇃)	32	n	n
15	n	n	33	a	a
16	n	pp (↾ ↾)	34	g	g
17	n	n	35	s	z
18	a	c	36	g	g

Trial	Cue	Stimulus	Trial	Cue	Stimulus
37	a	qq (↿ ↿)	47	a	a
38	s	s	48	s	s
39	g	g	49	n	v
40	s	x	50	n	n
41	s	pp (↾ ↾)	51	n	u
42	n	n	52	g	dd (⇃ ⇃)
43	n	m	53	g	g
44	s	s	54	n	n
45	g	g	55	g	j
46	a	bq (⇂ ↿)	56	n	n

.Secondary Trials - Sequence 2

Trial	Cue	Stimulus	Trial	Cue	Stimulus
1	a	a	15	n	m
2	a	à	16	s	s
3	g	j	17	g	g
4	n	n	18	n	n
5	n	n	19	a	bd (⇂ ⇃)
6	s	s	20	n	v
7	s	s	21	n	n
8	a	c	22	s	z
9	g	g	23	g	g
10	a	a	24	n	pp (↾ ↾)
11	a	a	25	g	g
12	n	dd (⇃ ⇃)	26	s	qq (↿ ↿)
13	a	a	27	s	s
14	s	qp (↿ ↾)	28	s	s

Trial	Cue	Stimulus	Trial	Cue	Stimulus
29	a	a	43	a	bb (⇂ ⇂)
30	n	pd (↾ ⇃)	44	s	s
31	g	db (⇃ ⇂)	45	s	c
32	n	n	46	a	qq (↿ ↿)
33	g	dd (⇃ ⇃)	47	s	s
34	n	n	48	s	s
35	n	u	49	a	a
36	s	pp (↾ ↾)	50	g	g
37	n	n	51	g	bb (⇂ ⇂)
38	a	e	52	a	a
39	a	o	53	n	n
40	g	g	54	g	g
41	g	y	55	g	a
42	g	g	56	s	x

Secondary Trials - Sequence 3

Trial	Cue	Stimulus	Trial	Cue	Stimulus
1	g	g	10	a	bb (⇂ ⇂)
2	a	a	11	s	x
3	a	c	12	s	qq (↿ ↿)
4	s	s	13	g	g
5	n	n	14	s	s
6	n	pp (↾ ↾)	15	g	j
7	s	z	16	g	g
8	g	g	17	g	y
9	n	n	18	g	g

Trial	Cue	Stimulus	Trial	Cue	Stimulus
19	a	bq (⇂ ↿)	38	a	e
20	s	s	39	n	n
21	a	a	40	a	dd (⇃ ⇃)
22	s	pp (↾ ↾)	41	g	g
23	n	u	42	g	bb (⇂ ⇂)
24	a	a	43	n	n
25	g	db (⇃ ⇂)	44	n	n
26	a	a	45	n	pd (↾ ⇃)
27	a	a	46	s	s
28	s	s	47	n	n
29	n	v	48	s	c
30	g	g	49	s	s
31	s	qp (↿ ↾)	50	s	s
32	a	o	51	a	qq (↿ ↿)
33	n	n	52	s	s
34	a	a	53	g	g
35	a	q	54	n	dd (⇃ ⇃)
36	n	m	55	a	a
37	g	a	56	n	n

APPENDIX N_3

TASK 8

VISUAL FOCUSED/DIVIDED: PATTERNS (VF/D-P)

INSTRUCTIONS

Task 8
Visual Focused/Divided: Patterns (VF/D-P)

Instructions

This is a visual attention experiment consisting of a series of brief trials. On each trial you will see letter patterns in rapid succession. I would like you to indicate as quickly as possible whether the letter patterns are the same. If the two patterns are the same, I would like you to indicate your answer by saying, "same." If you think that the two letter patterns are not the same, you need not respond.

The letter patterns will either be familiar to you, that is letters from the standard alphabet printed, such as these for example (experimenter illustrates a sample of familiar letters), or one of these four letter simulations. (experimenter illustrates novel characters).

Each trial will consist of three slides: a blank slide which will introduce the trial, followed by two additional slides. For the most part, the second and the third slides will each contain a single character which you are to compare. That is, you are to say "same" if the character that is presented on the third slide is the same as the character that was presented on the second slide. Occasionally, however the third slide itself will contain a pair of letter patterns. In such cases, you are asked to ignore the pattern presented on the second slide and indicate whether the two patterns presented together on the third slide are the same.

Do you have any questions?

Practice Trials:

I will begin each sequence of trials with the warning signal, the spoken word, "ready." At that time you should look at the screen and prepare yourself for the presentation of the first two patterns. Whenever you are ready, I would like you to press this button (experimenter illustrates slide advancer) which will trigger the start of a sequence of trials. You push this button only at the start of a sequence and not at the start of each trial. Please do not press this button until I have given you the "ready" signal and you have focused upon the screen. After each presentation I would like you to indicate if the two patterns are the same. Remember that you are to give your response as quickly as possible. We will begin with a few practice trials.

Primary Trials:

We will now begin the experiment. This group of trials will contain the following letter patterns (experimenter illustrates the appropriate characters - familiar or unfamiliar letters). Although you are to respond as quickly as possible, I would like you to maintain a high level of accuracy throughout the experiment. Please let me know if you become tired and would like to take a brief rest period during the sequence of trials.

Secondary Trials:

We will continue with the experiment. This particular experiment will be administered on three successive days. The task will remain the same throughout the experimentation period. When the third slide contains a single character, I would like you to compare that item with the one that was presented on the second slide. When the third slide contains two characters, you are to disregard the pattern presented on the second slide and compare the two patterns presented together on the third slide. After each presentation you are to respond as quickly as possible.

APPENDIX N_4

TASK 8

VISUAL FOCUSED/DIVIDED: PATTERNS (VF/D-P)

SUMMARY OF SECONDARY STATISTICAL ANALYSIS

TABLE 25

Summary of Neuman-Keuls Comparisons for Differences in Reaction Times on Three Days of Experimentation

	Day 2	Day 3
Day 1	5.72*	10.50*
Day 2		4.78*

*$p < .01$

TABLE 26

An Analysis of the Simple Main Effects for Days (B)

Source of Variation	SS	df	MS	F
B at a_1 Day differences for familiar letters	.11	2	.06	15.00*
B at a_2 Day differences for unfamiliar letters	.37	2	.18	45*
B x Subj. + AB x Subj.	1.12	236	.004	

*$p < .01$

TABLE 27

Summary of an Analysis of Simple Main Effects

for Familiar and Unfamiliar Letters (A)

for each of the Three Days

Source of Variation	SS	df	MS	F
A at b_1 Letters: Familiar/ Unfamiliar Day 1	.11	1	.11	55*
A at b_2 Letters: Familiar/ Unfamiliar Day 2	.02	1	.02	10*
A at b_3 Letters: Familiar/ Unfamiliar Day 3	.01	1	.01	5
A x Subj. + AB x Subj.	.37	177	.002	

*$p < .01$

TABLE 28

Summary of the Analysis of Variance of the Slopes of the Regression Lines of the Reaction Times to Familiar and Unfamiliar Letters across The Three Days

Source of Variation	SS	df	MS	F
Letters	.019	1	.019	19*
Letters x Subjects	.055	59	.001	

*$p < .01$

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