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ATTENTION AND LEARNING

A Thesis presented in fulfilment
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ABSTRACT

The basic premise of this study, is that although attention is essential for learning, those most closely concerned with the learning/teaching process, teachers and other educational practitioners, have little or no knowledge of the concept of attention, or how it can be applied to learning. The aims of the study are, therefore, twofold: to increase knowledge of the attentional concept; and to suggest ways in which this knowledge can be applied in the design and implementation of learning/teaching sequences.

In order to achieve these aims, the study is undertaken in two parts. Part One investigates, through the literature, the attentional concept. Initially a brief history of the development of attention as a psychological construct is presented, followed by a consideration of the difficulties surrounding the defining of attention. Secondly a review of the existing literature is undertaken. The framework into which the literature is reviewed and classified is a multidimensional framework consisting of three categories:

- (i) activation
- (ii) selective attention
- (iii) vigilance/maintaining attention,

and was suggested and adapted from the work of Moray (1969a, 1969b). Although the review presented is not exhaustive it is felt to be representative of the major theoretical and research concerns surrounding attention.

Part Two is concerned with how knowledge of attention can be transferred into useful teaching principles, and practices. To this end a model of attention to be applied to learning is proposed and is followed by a guidebook of practical teaching procedures that can be utilised in the design and implementation of learning/teaching sequences.

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CHAPTER ONE

INTRODUCTION

The Nature of the Study

Attention is essential for learning. The importance of attention for learning has been widely recognised by educational psychologists, and may be illustrated in the following words:

One category of behaviour that enters into all formal and informal learning of the child - which is a given in the functioning of the other basic behavioural repertoire - involves what is called attention in common sense terms.

(Staats, 1971, 172)

Because attention is essential for learning, those most closely connected with the learning process, teachers and other educational practitioners, could be expected to be thoroughly familiar with the concept, and to utilise it in the designing of teaching sequences. The basic premise upon which this study was undertaken, however, is that teachers generally have little, or no, understanding of attention and, therefore, take no cognisance of it in teaching situations.

Informal questioning of teachers seemed to verify this premise. When asked about attention answers like the following were provided: "Is it something like listening?"; "Attention ... is when they (pupils) look at you and not out the window"; and "Attention, that must have something to do with social behaviour ... if you make them wait to speak, they attend - if they have spoken they are no longer with you."

Indeed, the concept of attention is difficult to define. However, as it plays such an important role in learning some attempt to review the existing status of attention as it appears in the literature should be undertaken so that the knowledge thus gained may then be used to inform decisions made in the designing and implementation of lesson sequences.

The aims of this study are, therefore, twofold. It aims firstly to review and classify the existing literature on attention. Secondly it aims to provide a model of attention that may be applied to learning, and to show the way this model can be used to assist decision-making during the design of learning tasks.

The study is organised into two parts. Part One investigates the concept of attention itself. A brief history is provided and consideration given to the difficulties of defining attention. Current literature is then reviewed. In order that this could be undertaken a framework needed to be adopted. Justification for the adoption of a multidimensional framework is followed by the review of literature in terms of that framework. The categories under which the attentional literature is reviewed are

- (i) Activation
- (ii) Selective attention
- (iii) Vigilance/Maintaining attention

These separate, though not mutually exclusive, approaches to classifying attention were suggested by the work of Moray (1969a, 1969b). Each approach is the subject of a chapter in the later pages of Part One.

Whenever the process of human learning is investigated, as Gagne and Rohwer (1969) point out, it may be assumed that the knowledge so gained may be seen to result in the development of more effective instructional procedures and Part Two, therefore attempts to provide constructive suggestions, in light of the literature reviewed, for the educator in the learning/teaching situation. To this end, Chapter Eight proposes a model of attention to be applied to learning and a guidebook of practical teaching procedures is presented in Chapter Nine.

In sum, the study here presented, intends to

- (i) review, categorise and interpret the literature pertaining to attention and learning; and
- (ii) apply the knowledge gained to suggest instructional guidelines for the teacher in the classroom setting.

Importance of Study

As educators agree that attention is essential for learning, it is important that educators generally, and teachers in particular, employ teaching strategies that take cognisance of the various aspects of attention in the learning situation.

Conflicting and confusing reports on the nature of attention in learning does not make the educators task easy, however, and thus the importance of the study. Because it not only reviews the concept of attention and clarifies the current standing of this concept, but also because it has attempted to propose possible teaching strategies which are informed by such knowledge, the paper may be seen to provide information from which a set of tools, useful in the learning and teaching situation, may be developed.

The study may also be seen as important because a review and classification of recent definitions of attention, such as this, may provide a useful starting point for future researchers in the field of attention and learning. Mostosky (1970) has also recognised this need:

With the increased frequency with which the word (attention) is used, and in the face of the diverse experimental tactics which have been suggested in the name of praising or burying attention research, some elimination of ambiguities of definition would appear to be essential.

(Mostofsky, 1970, 9)

The practical justification for this study rests, therefore, on the assumption that because attention is such an essential element in learning and because, at present, it is an under-utilised step in the teaching process (Allington, 1975) a collation and interpretation of the data on attention in learning may, ultimately, lead to teaching situations where the various aspects of attention are recognised and applied.

PART ONE

ATTENTION : A REVIEW

CHAPTER TWO

Attention: A Brief History

In acknowledging the diversity and confusion which surrounds the term attention today, it appears necessary to look briefly at the history of the concept in order to determine the possible explanation for this situation. In fact the history of the concept is both interesting and informative in light of the present confusion.

Lord Verulum (Francis Bacon), in his observations of animal speech maintained that birds, when compared with other beasts, 'learne to imitate Speech' because they, of all the beasts have learned to attend.

But I conveive, that the Aptnesse of Birds,
is not so much in the Conformite of the
Organs of Speech, as in their Attention.

He goes on to say that

... those that teach Birds to sing, doe
keepe them Waking, to increase their
Attention.

(Bacon, 1627, 65)

Bacon, thus, provides one of the earliest recorded statements linking attention with learning. Concerning human learning, Helvetius (1758), some years later, suggested that inequality in minds between individuals was caused by an unequal capacity for attention. He believed that

Since it is more or less attention which
engraves objects more or less deeply into
memory, and makes us more or less perceptive
of the relationships which form the greater
part of our true and false judgements; and
since we owe almost all our ideas to
attention, it is plain that the unequal
strength of men's minds depends on their
unequal capacity for attention ...

(Helvetius, 1758, Ch.4.)

The importance of the role of attention in learning has long been recognised in psychology although it has been subjected to many shifts in popularity, with some recognising it as an absolutely essential construct, and others ignoring it as an ill-defined irrelevant construct.

The period from 1750 through 1920 (approximate dates) was of particular significance for this period and marks the origin of modern

psychology within science - and consequently the origins of the attentional construct may also be found. The development of the concept of attention is closely linked with the founding of experimental psychology, and those associated with this development particularly Helmholtz, Muller, Wundt and the work carried out at the Leipzig laboratory, Kulpe and the Wurzburg school and Titchener. Similarly, soon after the turn of the century a demise in popularity of the construct was observed and this may be linked with the development of Gestalt psychology and Behaviourism.

What did the early psychologists discover about attention and how did they define the concept? In answering this question, it is important to note that, when reviewing the literature, it is possible, in retrospect, to identify the discoveries that have come to be recognised as part of the construct - psychologists at the time did not necessarily recognise these constituent parts. In fact Boring (1970) believes that the history of the phenomenon of attention involves 'at least ten overlapping little histories'. Indeed a number of overlapping little histories are identifiable in the literature and will be discussed in the following pages of this chapter.

One of the most enduring notions of attention was linked to the belief that in order to attend to something, an individual must withdraw from surrounding stimuli, and was proposed by Bonnet in 1760. He formulated what has commonly been labeled the drainage theory of attention and this theory remained popular for some 150 years. Bonnet wrote that when an individual turns his attention to some object then:

He turns his eye away from surrounding objects;
thus he weakens the impression that those
Objects make. He fixes his view on the Object of
his Attention; he concentrates it on that Object;
he tenses the organ for that Object ...

(Bonnet, 1760, 136)

Because the attention is focussed on the Object, neighbouring objects fail to make an impression on the soul. This view became associated with the Functionalist view of attention as a "selective" process. William James (1890) is recognised as the chief representative of this school. He wrote

My experience is what I agree to attend to. Only
those items which I notice shape my mind - without
selective interest experience is an utter chaos ...

(James, 1890, 402)

Initial impetus for the study of attention, experimentally, is regarded to be the study of personal differences between individual astronomers in their observations of the movements of stellar events. Maskelyne, observer royal at Greenwich Observatory recorded such differences in 1795 but Bessel, recognising the significance of the differences is responsible for the 'personal equation'. His study of the differences, and his comparisons of his own observations with those of fellow astronomers, showed that individual differences in the speed of reaction existed. Although an astronomy problem, Bessel had the foresight to realise how importantly personal variability entered into these differences, and the problem became a psychological one. In so doing, two more of the overlapping histories of the attentional construct became definite lines of research in the new experimental psychology. These lines of research are summarised by

- (i) the complication experiment
- (ii) the reaction experiment.

Herbart in 1816 proposed the term "complication" as meaning a mental complex which includes processes from more than one sense department (Boring, 1957, 142). The complication experiment showed that the results obtained in the classical astronomic setting of the experiment depended on the disposition of attention, in the sense that the stimuli to which the attention was principally directed enjoy the prior entry into consciousness.

The reaction time experiment was developed in 1850 by Helmholtz. It was based on a subject indicating as quickly as possible when he felt an electric shock which was used to stimulate the skin away from the brain and then near the brain. Helmholtz was, however, only able to gain a rough estimate of individual reaction times. A significant advance in the ability to measure individual reaction times was made by Hirsch when he adopted the newly developed Hipp chronoscope for that purpose.

F.C. Donders further advanced knowledge of reaction times when, in 1868, he 'attempted to measure the physiological time of mental processes such as discrimination and choice' (Woodworth and Schlosberg, 1954, 10). In so doing he was able to study compound reactions.

Lange (1888) in Wundt's laboratory continued to study reaction times and seemed to confirm the general validity of the Donders' procedure when he discovered that the differences between sensorial and muscular reactions

depended on the subject's attention before he reads. Kulpe at Wurzburg, achieved similar results postulating attention as predisposition or preparation.

This was followed by the contributions of Watt and Ach (1904-05) who introduced the notion of the "Einstellung" or attentional set and finally the concept of the determining tendency to explain a directing force in thought processes.

Another line of investigation on attention stemmed from comments made by Sir William Hamilton (1859) to students in a lecture on metaphysics. He stated that if you were to throw some marbles on the floor, you would

find it difficult to view at once more than six, or seven at the most, without confusion; but if you group them into twos, or threes or fives you can comprehend as many groups as you can units because the mind considers these groups only as units.

(Hamilton, 1859, lect. x/v)

and thus initiated work on the span of attention or the span of apprehension as it was more commonly called. Jevons (1891) carried out systematic experiments on the span of apprehension, and found that the span may vary from moment to moment.

Wundt, and his associates, continued their study of attention in two major ways:

- (i) its range or span, and
- (ii) its fluctuations.

Cattell, concerning himself with the first of these, carried out experiments on the span of attention. He found that on a single exposure, too short to allow any movement of attention, that four, five or six units (words, lines or letters) could be apprehended. At the same time Dietze examined the range of attention for successive stimuli.

As a result of these investigations, Wundt saw attention as existing in two dimensions, embracing not only simultaneous but successive events

... with very keen attention both stimuli can enter the focus of consciousness simultaneously: all that is required for this to happen is that attention shall be divided as evenly as possible over both stimuli

(Wundt, 1784, 753)

The 'conditions of attention', the final line of study discussed here, were first outlined by G.E. Muller in 1873. In his doctorate thesis, Zur Theorie der Sinnlichen Aufmerksamkeit, he pointed out that such things as familiarity, novelty and intensity of stimuli play a definite role in determining what may enter the focus of attention. His views have had a great deal of influence on all subsequent treatments of attention.

As stated at the outset of this discussion the historical foundation of attention is very closely linked with the development of experimental psychology and thus with Wundt and his colleagues. The death of Wundt in 1920, saw Titchener rise to become the champion of the Wundtian tradition until his own death in 1927.

Titchener had little doubt about the centrality of the concept of attention in psychology.

The doctrine of attention is the nerve of the whole psychological system, and that as men judge of it, so shall they be judged before the general tribunal of psychology

(Titchener, 1908, 173)

However, because he believed attention to be observable, he 'tried to deal with attention as an extra attribute of sensation, an attribute of clearness of vividness which all sensations have and which occurs in high degree when a sensation is attended to' (Boring, 1970, 6).

Although unsuccessful in convincing psychologists generally of the validity of his views, Boring (1970) suggests none-the-less that this view impeded the development of the experimental psychology for three decades.

The same period saw the establishment of the Gestalt and Behaviourist schools. Attention did not conform to the SR rules formulated by the Behaviourists and rapidly lost approval. Similarly the Gestalt school preferred to study 'perception' in place of attention. Work on the construct thus became concealed in research on perception and motivation and in attitude studies.

The early history of attention in psychology is both confusing and often contradictory with the same construct labelled differently by many who studied it. Overlapping histories characterise the development of the attentional concept and the more important of these have been outlined. Woodworth and Schlosberg (1954) effectively summarise the history of attention up till the 1950's.

In spite of the practical reality of attending, the status of attention in systematic psychology has been uncertain and dubious for a long time. Early psychologists thought of it as a faculty or power, akin to the Will ... Not very different has been the view of many functional psychologists ... Any such view was strongly opposed by the associationists who wished to recognise as forces only sensory stimulation and association. The Gestalt psychologists also have regarded any force of attention as extraneous to the field forces which in their view are the dynamic factors in human activity. The behaviourists have rejected attention as a mere traditional mentalistic concept.

(Woodworth and Scholsberg, 1954,
72-73)

Since 1950 attention has again returned as a subject of psychological and physiological research. There may be many reasons for this rise in popularity but probably the most important of these is that the human was recognised as somewhat more than a stimulus response machine. He was again seen as capable of actively searching for and selecting stimuli that are important for him and ignoring those judged to be unimportant.

Renewed interest in the concept has led to research work in many experimental domains. The most important of these domains are:

- (i) selective attention
- (ii) sustained attention or vigilance, and
- (iii) neurophysiological correlates of attention.

Interest in selective attention may be seen as a 'picking up the threads' of the earlier work of theorists for selective attention is what the functionalists believed attention was all about. The major impetus for research in this area was given by Cherry (1953) who investigated human information processing using dichotic listening experiments, and was continued by Broadbent (1958), Moray (1959) and, more recently by Treisman (1969).

Sustained attention or vigilance experiments are also linked, though more indirectly, with historical interpretations of attention. In this work researchers are concerned with the 'result of the attentive process, or the "sensory clearness", that was stressed by the Structuralists' (Swets and Kristofferson, 1970). The major research question in this line of study is why does a subject's performance become less efficient when he is engaged in a monotonous task? The "vigilance task" was developed in an attempt to answer this question (N.H. Mackworth, 1950). Vigilance tasks usually require subjects to detect 'infrequent, irregular and barely discriminable signals when presented against a background of monotonous and repetitive stimulation' (Gale and Lynn, 1972).

Theories of performance decrement have been proposed to account for this drop in performance. Major contributors are; N.H. Mackworth (1950), J.F. Mackworth (1969, 1970), Egan, Greenberg and Schulman (1961), and Hatfield and Loeb (1968).

An active area of research during the last decades has concerned itself with analysing the physiological bases of attention. This analysis was initially linked with work on the reticular activating system and also with work conducted on arousal and habituation. Pavlov (1927) introduced the notion of the orienting reflex and much work has since been undertaken studying activation and the orienting reflex in the classical conditioning tradition (Zaparozhets, 1961; Voronin *et al.*, 1965). The orienting response is 'a complicated series of neural, sensory, circulatory, and motor components which is elicited by certain stimuli' (Harris, 1976, 49). Research on the neurophysiological correlates of attention is, of necessity, concerned more with internal biological changes rather than overt behaviour. Because of this emphasis, work on activation has limited application in the educational setting and has tended to be less widely reported in educational psychology journals when compared with the other two major attentional research domains.

This chapter is presented not because it suggests answers to the diversity and confusion which surrounds the attentional construct today, but rather because it shows that the history of the concept was fraught with many of the same difficulties present researchers face when trying to adequately define attention.

Attention has not been well defined historically, it has developed through a wide number of differentiated research domains, and the work conducted since 1950 has strengthened rather than diffused the complexity which surrounds the concept.

An important question which has been raised during this discussion is why attention is so difficult to define - Chapter Three attempts to answer this question.

CHAPTER THREEATTENTION: THE "VERBAL PHANTOM"

Attention, upon first reflection, appears comparatively easy to define - most people believe they know what attention is. In psychology, as was seen in the previous chapter, this is certainly not the case. Why has attention come to be recognised as the 'verbal phantom'? (James, 1890).

Three reasons immediately present themselves. Firstly the nature of the history of attention, with its consequent decline in favour during the central part of this century must be seen as a major difficulty and set-back for those who now study the concept. Because the behaviourists refused to provide an explanation for the fact that an individual is constantly being exposed to a huge number of stimuli at any one moment and that the individual somehow deals with these competing stimuli, the study of attention has been badly hindered. Only recently has there been some recognition of a need to define the process by which the individual attends to one rather than the multitude of competing stimuli.

The second major reason why attention is such a problem for the students of psychology is because attention, the concept, has been described and defined in numerous numbers of ways. Terms such as arousal, vigilance, selective attention, abstraction, plus many others, have been used frequently as synonymous with attention. Consequently, research on each different aspect has been undertaken with little knowledge of the inter-relatedness, or otherwise, of the research findings.

Berlyne (1970) suggests that the third factor hindering the investigation of attention has been that until recently we have had no way of measuring the number of stimuli an individual can attend to at any given moment. Clearly researchers have found it necessary to measure the attributes of attention in order to prove experimentally the existence of the phenomenon. With the development of the human information processing models over recent years this problem appears now to be largely overcome.

In addition to the problems mentioned above, Mostofsky (1970, 10) suggests that there may also be 'three major categories of recurring criticism to the concept of attention' which can be recognised.

In some fields of attention research, researchers, as yet, have not been able to identify or agree upon a 'dependent variable as the external referent for ascertaining the presence of attention' (Mostofsky, 1970, 10). Thus attention is an inferred process - for only after a subject has made a response to presented stimuli can it be said that the individual has attended.

Responses may be made in a number of ways:- learned responses such as answering a question correctly have been used to indicate attention; body orientation in the direction of the presented stimulus has also been used to indicate that the subject has attended, as have measures of physiological changes in the body.

Clearly definitions of the concept which rely on describing attention after the subject has attended appear circular and as such open to criticism. Here attention is measured in tasks requiring responses and then inferred from those responses. Mostofsky (1970) identifies this problem in the logic of many definitions of attention as the first area of criticism surrounding the attentional concept, for in presenting such definitions researchers suggest that attention and response to stimuli are one and the same - whereas, more correctly, responses to stimuli enable the identification of attention.

'The failure to select a dependent variable as the external referent for ascertaining the presence of attention, independent of that which is to be measured, has been serious' (Mostofsky, 1970, 10) and has raised the interesting research question of whether an individual learns because he attends or whether he attends because he has learned. The classical Zeaman and House findings (1963) have been strongly criticised for they imply that 'retardates are deficient in acquiring "attention" responses because they already have an attention deficit' (Wischner, 1967, 213). Although circular in meaning this piece of research has led to a multitude of studies all of which have failed to select a dependent variable and, therefore, all suffer from the criticism that their results are circular with responses being both cause and effect.

The second criticism hindering the study of attention as a concept, is the attempt being made to physiologise attention - bringing with it views of attention in physiological terms when in fact no substantive

physiological data exists to warrant such views. Interpretations of attention in these physiological terms has produced fears, and thus criticisms, by some, of a revival of mentalism.

Evidence of a possible physiological mechanisms for attention has been suggested by the research findings of Hernandez-Peon et al., (1956). When one sensory channel is employed, other channels may be gated out. Results indicate that the focus of attention is brought about by sensory input which reaches the sensory parts of the central nervous system; correspondingly the sensory input in the margin of attention is inhibited.

Although evidence for this mechanism comes from experiments in which recordings are actually made from the sensory channels, (Hernandez-Peon et al., 1956) more recent experiments have cast doubt on this conception, finding a lessening of responding in the nervous system for all stimuli, even those involved in the focus of attention (Thompson, 1967).

Worden (1966) has been a strong critic of this view of attention and maintains that there has been no evidence, of any substance, of attentive states at the cochlear nucleus. He goes on to assert that any observations of such attentive states "can be better explained in terms of inadequate control of relevant variables and inadequate sampling procedures" (Worden, 1966, 45).

The third, and final, criticism of attention contends that the whole concept of attention - and the study of that concept - is pleonastic: that the information gained and analysed by researchers in this field of study is 'adequately analysable in other contexts, and nothing is to be gained by attributing additional connotative frills' (Mostofsky, 1970, 12). Those that hold this view believe the elements which are said to make up the attentional concept may, in fact, be found in many existing research structures such as orienting responses, cognitive-perceptual descriptions and stimulus control theory.

Rightly, Mostofsky (1970) asks whether attention is merely part of other psychological frameworks or whether there is justification for treating it as a concept in its own right. In each case, Mostofsky cogently argues that attention is still a useful framework and can offer something more than existing structures.

Mostofsky (1970) clearly shows that the difficulties surrounding the study of attention are indeed enormous, and discusses in some detail the criticisms that have been levelled against the study of the concept. None-the-less he concludes that attention should not be rejected rather that instead of viewing it as a single entity, attention must be recognised, researched and studied as a multidimensional concept so that conceptual clarity may result in the future (Mostofsky, 1970).

This also, is one of the major theses of this paper. To view attention as a global concept breeds confusion - but by studying the individual dimensions that make up attention, some important insights into the concept and its usefulness, particularly in the educational field, can be made.

The next section, therefore, discusses: the various multidimensional conceptualisations of attention; provides justification for the choice of dimensions chosen here for study and investigates individually, through the literature, each dimension.

CHAPTER FOUR

ATTENTION: A MULTIDIMENSIONAL CONCEPT?

Like James (1870), many classroom teachers maintain that 'everyone knows what attention is'. Thus, so long as a pupil is seen to be attending: that is, if the pupil is looking at the right place at the right time; if the pupil sits or stands still when the stimulus is presented; and if the correct reply follows a question regarding that stimulus, then the teacher assumes that the child is attending. The resulting lack of cognisance, on the part of the majority of teachers, that there may be something more to attention may account for the failure to fully utilise knowledge of attention in the classroom setting.

There has been little or no recognition by educational practitioners that it is reasonable '... for educational purposes at least, that attention is made up of a number of different, partially independent components, and that these components may have different influences on learning' (Keogh and Margolis, 1976, 20). Considering the number of conceptions of attention which have been posited proposing inter-related functions, this lack of recognition is somewhat surprising.

Mostofsky proposes that attention is a multivariate concept because it implies considerations of 'process (attentional), subject (attentive), and stimulus (attention-getting)' (Mostofsky, 1970, 22). Dyknan *et al.* (1971) treat attention as a unitary trait but propound the existence of four inter-related functions: alertness, stimulus selection, focussing and vigilance.

S. Jay Samuels (1977) proposes that attention consists of two components - an external component and an internal component. The external component of attention is that set of behaviours outlined above, that teachers use to monitor a child's attention to the task at hand. These observable behaviours are, without doubt, important cues for the classroom teacher. Not only can they indicate learning, through correct responses to task-relevant stimulus questions, but they can also indicate the degree to which a pupil can adapt to the classroom environment for 'paying attention' is a prerequisite for all educational activities in the classroom situation.

Although these external displays are important in learning, Samuels (1977) believes the internal manifestations of attention, while being particularly difficult to describe, are even more crucial. Three characteristics of internal attention are proposed: alertness, selectivity, and limited capacity.

Alertness is described in two ways. In one sense alertness refers to nothing more than 'the active attempt to come in contact with sources of information' (Samuels, 1977, 17). Alertness can also be used in terms of an individual's ability to sustain attention over a long task - and this aspect of alertness is commonly labelled 'vigilance'.

Selective attention, the second characteristic of internal attention, means that an individual is able to attend to one source of information selected from the many of which he is constantly being bombarded. Having selected the source of information an individual is also able to select one kind of information, present in that source, rather than another. For example, a subject, having attended to the class 'circles' from a set of triangles, squares and circles, is then able to distinguish or attend to the red, as opposed to the yellow circles.

The final characteristic of internal attention, limited capacity, implies simply that we can, at any one time, attend to only one event. Samuels (1977) provides convincing proof of this. He shows that while we may perform two tasks simultaneously - for example, typing a report and answering questions - this is only possible when one of these tasks, in this case typing, is performed without attention. Tasks may be performed without attention when skill has been developed at those tasks, (Samuels, 1977).

A second discussion of attention and its inter-related functions to be outlined here comes from the work of Keogh and Margolis (1976). Although the study provided by these writers is directed at professionals working with children with learning problems in particular, the three dimensional approach to the study of attention has much wider application.

The three separate, although probably interactive, aspects of attention are: coming to attention; decision making; and ability to sustain attention over time (Keogh and Magolis, 1976, 21). 'Coming to attention' denotes that a pupil focusses his attention on the task at hand and is able to understand the task and what action he is required to perform. This

means a pupil must exhibit attending behaviour in an appropriate direction and secondly he must be able to select and organise the salient and critical attributes of the task (Keogh and Margolis, 1976). Coming to attention is similar to Samuels' (1977) external component of attention and the internal, selective, characteristic.

The second aspect of attention, 'decision-making', is significant in that never before has it been included as a component of the attentional concept. Impulsive decision making by pupils in problem solving can be linked, argue Keogh and Margolis, with problems in coming to and maintaining attention.

The final aspect of attention, the ability to sustain attention over time, is synonymous with Samuels' (1977) alertness characteristic. Clearly the ability of a pupil to maintain attention, so that a task may be completed, is of the utmost importance in learning.

Thus far, a number of studies positing the existence of separate aspects have been outlined. No evidence, however, has been provided to suggest the validity of employing such frameworks and it is important to convince the reader of a need to study attention as a multidimensional concept since it is the stance adopted in the present review. A look at some studies which suggest a need to study attention in this way, does, therefore, follow.

Recent physiological studies concerned with investigating changes in subjects during attending behaviour provide support for a differentiated analysis of attention. Lacey, Kagen, Lacey and Moss (1963), for example, found that situations where subjects were required to attend to external environment, decreases in cardiac rates resulted. On the other hand, situations requiring the subjects to ignore the environment and employ cognitive processing skills resulted in accelerated cardiac rates. Further studies by Lacey and Lacey and associates have confirmed these results, as have a series of studies by Obrist and colleagues (Lacey, 1967; Lacey and Lacey, 1970; Obrist, Webb, Sutterer and Howard, 1970; Obrist, Sutterer and Howard, 1971.)

Whilst the above-mentioned laboratory investigations of attention support a differentiated classification of the concept, the Hallahan,

Kauffman and Ball (1974) research, although not concerned with physiological changes but rather observations of children's behaviour, also supported this view.

Hallahan, Kauffman and Ball (1974) investigated the effects of stimulus attenuation on selective attention performances of children in first, fifth and seventh grades. The investigation 'found no relationship between measures of percent of time attending to task and shifts in attention, leading to the suggestion that these aspects of attention must be treated separately' (Keogh and Margolis, 1976, 20).

In studying the development of activity levels in children, Routh, Schroeder and O'Tuama (1974) concluded that activity levels differed markedly according to the setting in which the child was placed and according to the activity to be performed, and that, therefore, activity levels are multidimensional.

The important implications of this, and other, studies, is that when an individual attends, the way he attends is not always the same - rather attention modes are dependent on the task, its setting, and its requirements.

While arguing that the most useful method of investigating attention is on a multivariate basis, this paper does not suggest that the separate components are, or should be seen as, independent of one another. Research to date favours a conclusion that the individual components are inter-related (Campbell and Douglas, 1972; Douglas, 1972; Cohen, Weiss and Minde, 1972). However, in certain situations or when performing particular tasks, one component may play a more dominant role than another.

In accordance with the information presented above, a multivariate framework has been adopted in this section of the paper as a classification system for reviewing the literature pertaining to attention and learning. Moray (1969a, 1969b) suggested that some seven subcategories of attention could be identified. These be labelled and described as:

1. Mental concentration

The person concentrates on some particular task, such as mental arithmetic, and tries to exclude all incoming stimuli which might interfere with the performance of the specified task.

2. Vigilance

A situation where nothing much is happening, but the observer is paying attention in the hope of detecting some event whenever it does happen (watch-keeping).

3. Selective attention

'The Cocktail Party Problem' faced by a person who is receiving several messages at once and is trying to select only one of them to accept and respond to.

4. Search

A set of signals is presented and the observer hunts among them for some subset or single signal.

5. Activation

'Sit up and pay attention'. In other words, get ready to deal with whatever happens next. This is an everyday version of the 'orientation reflex'.

6. Set

A preparation to respond in a certain way, either cognitively ... or by overt motor responses.

7. Neisser (1967) has recently argued strongly that attention refers to a process which seems identical with what is usually called 'analysis-by-synthesis'.

(Moray, 1960a, 6)

From the seven subcategories proposed by Moray, three have been adopted to provide the framework for reviewing the literature on attention. They are

- (i) Activation
- (ii) Selective Attention
- (iii) Vigilance

Activation allows the review of the literature pertaining to the Orienting Reflex and Neisser's (1967) notion of pre-attentive mechanisms. Selective Attention, the second category, encompasses a wide range of literature on attention per se and discusses analysis-by-synthesis as a model of selective attention; search, set; and mental concentration. It was considered that these subcategories as identified by Moray could most usefully be discussed under the general topic of selective attention as they imply differing degrees of selectivity and do not warrant separate category analysis. The vigilance category allows for the review of the classical studies of vigilance and also the more recent research into an individual's ability to maintain attention to a task.

Although a complex system, this framework was chosen for a number of reasons. First, the framework does not posit a generalised or global view

of attention. It suggests rather, a number of aspects, readily recognisable in the classroom situation, which may influence learning at any given time. Teachers may find pupils that adequately function at each phase of attention. At the same time, the nature of the subdivisions provides a useful tool which may be employed to identify and assist the pupils who exhibit attentional difficulties in one or other phase. Instead of developing a programme to improve or overcome a child's attentional problems in a general sense, this framework suggest a more specific and, therefore, more useful identification of attentional problems and specific programmes may be developed and initiated.

The second reason that the Moray framework has been adapted, rests on the nature of this paper itself. The task was to undertake a review of the literature on attention and learning. In so doing a meaningful classification of the studies reviewed was essential - the Moray framework provided just such a classification system.

Each subcategory will be discussed separately in the following chapters. The reader, however, will arrive at the end of the discussion realising that in the attentional field there is ' ... a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities in detail ...'

(Wittgenstein, 1953).

CHAPTER FIVE

ACTIVATION

Attention has, quite frequently, been used synonymously with 'activation', 'arousal' and the 'orienting reaction' (orienting response or orienting reflex). In this paper, however, 'activation' is seen as a component of attention - not as a replacement for the term (Mostofsky, 1970; Berlyne, 1960). Here, 'activation', 'arousal' and the 'orienting reaction' are used interchangeably, although the major emphasis of the review is on the 'orienting reaction' (OR), and studies involving this concept.

The study of the OR was initiated in Russia where psychologists were interested in the immediate reactions of individuals to stimuli carrying information of importance to them. It was Pavlov (1927) who recognised that when an animal is presented with a novel stimulus the animal is likely to: look at the stimulus, prick up its ears, and prepare itself to deal with the stimulus. This reflex Pavlov described as follows:

It is the reflex which brings about the immediate response in man and animals to the slightest changes in the world around them, so that they immediately orientate their appropriate receptor organ in accordance with the perceptible quality in the agent bringing about the change, making a full investigation of it.

(Pavlov, 1927).

The overt components of the OR specified by Pavlov, have been summarised by Barham and Boersma (1975) and include:

- (a) momentary arrest of ongoing motor activity,
- (b) turning of the head and eyes towards and about the source of stimulation, and
- (c) other overt receptor adjustments such as turning (in some animals, pricking up) the ears towards the source of a sound stimulus.

Apart from these overt responses, increased sophistication in measuring instrumentation, and interest in the OR has, in recent years, led to the knowledge that, in most cases, the following physiological changes also occur:

- (1) the pupils dilate,
- (2) photochemical changes occur in the retina which lower thresholds for light intensity,
- (3) auditory thresholds are lowered four to ten decibels,
- (4) general muscle tonus rises,
- (5) respiration is delayed, thereby increasing olfactory sensitivity, and
- (6) blood vessels constrict in the limbs and dilate in the head.

(Lynn, 1966, 2).

The major function of the OR is a preparatory one, in that it prepares the individual to deal with the possible events the stimulus may initiate, or to receive information. Travers (1972) suggests that one function of the response is a clearing away of whatever information is being held in the trace system. This clearing process being necessary so that confusion between the existing information in the trace system and the new information is not created. Sokolov (1960) has also reported that the changes brought about by the OR, if not extreme, are a basic requirement for learning, and that learning is unlikely in the absence of the response.

The Status of the Orienting Reaction in Attentional Theory

A number of researchers (for example, Zaporozhets, 1965), have tended to link the OR very closely with attentional processes in some cases calling it attention, producing a great deal of criticism for this viewpoint in the literature.

The confusion has probably arisen because three reactions: orienting, adaptive, and defensive, can be made to a novel stimulus. Each reaction is quite different. Most frequently the OR occurs first. In the case of a weak or moderate stimulus the OR, after a number of exposures, is replaced by an adaptive reaction. When an intense stimulus is presented a defensive reaction follows the OR.

The adaptive reaction can be distinguished from the OR in that '(a) it is local rather than generalised and confined to the sense organ stimulated and the specific sensory tracts from the sense organ to the cortex; (b) it has a homeostatic negative feedback rather than a positive

feedback effect; and (c) it does not habituate with repeated stimulation' (Lynn, 1966, 7).

Similarly the defensive reaction can be distinguished from the OR although the task is made more difficult through the many terms which have appeared naming this reaction: the defensive reaction (Sokolov, 1960); the startle reaction (Strauss, 1929; Landis and Hunt, 1939); and the orientation reflex (Konorski, 1960).

However some distinctions may be made between the OR and the defensive reaction. According to Sokolov (1966a), the defensive reaction may produce overt responses including freezing, running away from the stimulus, and, in some cases, aggressive reactions. Quite a different set of responses when compared with body movement towards the stimulus which characterises the OR. Differences in terms of physiological reactions also accompany these reactions (Sokolov, 1960; Gastaut and Roger, 1960), as do differences in affective reactions. OR are typically moderate, increasing excitement while reactions accompanying defensive reactions tend to be unpleasant. The rates of habituation differ, with the defensive reaction habituating very much more slowly than the OR (Sokolov, 1963).

Mostofsky (1970) suggests that there has been too great a tendency to equate the OR with attention per se, and praises those writers who distinguish the OR from other reactions (Veronin et al., 1965; Lynn, 1966; Sokolov, et al., 1966b; Maltzman, 1967). Berlyne (1960) also argues against the equating of the OR with attention.

Perhaps the more useful, and moderate, view is presented by Barham and Boersma (1975) who maintain that the OR has a place in a discussion of the attentional concept. In any event, the characteristics of stimuli that elicit the OR have been studied extensively and this knowledge is summarised below.

Stimuli Eliciting the Orienting Reaction

Berlyne (1960) has researched most comprehensively in this area and concludes that the characteristics of stimuli eliciting the OR are as follows:

1. Novelty

Novel stimuli are those not normally encountered or expected. In the experimental situation they may be such things as a loud noise or flash of light (Pavlov, 1927).

In the everyday environment, the appearance of a horse and buggy on a city street is an example of a novel stimulus because of the unexpected nature of the event (Travers, 1972, 237).

That novel stimuli elicit the OR has been investigated experimentally using both animal and human subjects. Animal studies that illustrate effectively the function of novelty have been conducted by Berlyne (1955) and Thompson and Solomon (1954) with rats, and by Welker (1956) with chimpanzees.

Berlyne's (1958) experiment with human subjects also verified the OR eliciting characteristics of novel stimuli. Pairs of animal pictures were projected side by side on a screen for ten seconds. During ten trials one animal constantly reappeared on one side of the screen. On the other side of the screen a different animal appeared every time. Results showed that subjects spent more and more of the ten seconds fixating the novel pictures on the varying side and less and less fixating the recurring picture (Berlyne, 1960).

2. Intensity and Colour

Intense stimuli elicit the OR, although very intense stimuli are more likely to elicit the defensive reaction. In human infants Valentine (1914) and Staples (1932) found that colour preferences were identified by about four months with coloured stimuli more likely to produce the OR than grey. Similarly in adults, Brandt (1944) found subjects spend more time looking at red and white designs than at black and white ones.

3. Complexity, Uncertainty, Incongruity

Two stimuli may be equally familiar, or novel, but one may still be more attractive than the other. Of the possible variables, besides novelty, one in particular has been identified as a major determinant of attention and exploration in both animals and man. This variable has been labelled stimulus complexity.

The exact definition of complexity has been the subject of controversy among psychologists. Attempts at providing abstract definitions have made use of the concepts of information theory (Glanzer, 1958), of conflict theory (Berlyne, 1957), and of Combs' scaling theory (Dember and Earl, 1957). All these definitions seem to share the assumption that the more complex stimulus is the one the individual can do more with. It affords more opportunities for responding than does the less complex stimulus.

Human infants, at very early ages, show a preference for viewing materials that exhibit a degree of complexity. Thomas (1965) for example, showed that when diagrams are displayed above the head of an infant a different amount of time is spent fixating on the different diagrams with the least complex diagrams receiving the least attention.

Yarbus (1967) has found evidence showing that during visual scanning of a complex display, more time is spent looking at those parts which are not complex. Wohlwill (1968), experimenting with college students using two sets of slides, one showing scenes from geographic environments and the other showing pieces of modern art, concluded that subjects choose to view slides not just in terms of what they like or do not like, but in terms of the amount of information present (Travers, 1972).

4. Indicating Stimuli

The OR may be elicited by stimuli through learning. Obvious examples says Berlyne (1960) are verbal formulas like "Look at what he is doing!" and "Listen to this!"

Russian psychologists working with animals have demonstrated these conditioning effects in experiments where 'a neutral stimulus comes to evoke an OR through association with another stimulus' (Lynn, 1966,11). Narbutovich and Podkopaev (1936) presented a tone and a flash of light to dogs and found that the stimulus presented first came to evoke OR towards the source of the second (Lynn, 1966) and Kasatkin, Mirzoiants and Khokhitva (1953) have demonstrated the same phenomenon in two and a half month old human infants.

5. Surprise

Because we tend to become used to the stimulation around us - surprising changes in experimental conditions have been found to elicit OR. For example, OR were displayed by monkeys when they found a lettuce instead of an expected banana under the cup they lifted in an experiment conducted by Tunklepaugh (1928).

Lynn (1966) points out, however, that it is difficult to distinguish surprise as a variable from novelty, because the two frequently occur together.

6. Conflict

The term 'conflict' Berlyne (1954, 1960, 1965) uses to denote the degree to which mutually incompatible responses are being instigated at any time (Berlyne, 1970). In an experiment where associations were established in dogs between various stimuli and various incompatible activities (e.g. avoidance of pain, feeding, vomiting, postural reflexes), Polezhaev (1959) found that the appearance simultaneously of stimuli associated with two of these activities gave rise generally, to orienting behaviour directed at both stimuli in turn (Berlyne, 1960). Bykov (1958) suggests that in differentiation situations an animal makes OR to both the positive and negative stimuli producing a conflict situation. Further training establishes the predominance of one or other stimuli, conflict is reduced, and the OR dies down.

Berlyne (1960) lists four factors influencing the degree of conflict: '(a) the nearness to equality in strength of the competing response tendencies, (b) the absolute strength of the competing response tendencies .. (c) the number of competing response tendencies ..., (d) the degree of incompatibility between competing response tendencies' (Berlyne, 1960, 32-33)

As the OR is a preparatory response the identification of the characteristics of the stimuli that elicit the OR is very important to teachers. If these characteristics are able to be identified and Berlyne has demonstrated that this is indeed possible, then this information may be used to gain pupils' attention in the classroom setting. Barham and Boersma's (1975) work indicates that the OR may have some direct implications in the learning/teaching situation.

The Orienting Reaction and Learning

Barham and Boersma suggest that the views of activation postulating an unidimensional interpretation of the arousal construct are not entirely adequate (e.g. Sokolov, 1963). These researchers conclude that activation and arousal might, more effectively, be seen to employ a number of dimensions with complex relations among them, and this view supports the propositions of Berlyne (1967), Lacey (1967) and Taylor and Epstein (1967).

If this multidimensionality of orienting behaviour as opposed to unidimensionality is accepted as a valid conceptualisation then generalisations concerning the OR must, state Barham and Boersman, be strictly governed, particularly generalisations concerning different stimulus conditions, response domains and age differences. Further, if it is possible to view the OR as a modifiable, rather than a purely reflexive response as Barham and Boersma suggest, then this has important implications for teaching in that modification and adaptation of the reaction may be achieved through regular learning processes. 'If such learning is the case then almost certainly the school is unwittingly conditioning orienting responses to particular stimulus classes and maybe even contributing to dissociation between, say, autonomic and behavioural response classes' (Barham and Boersma, 1975, 130).

The modifiability of OR would suggest that even at this initial stage of attention, learning is possible, and teachers may employ behaviours that reinforce desired OR and eliminate undesirable reactions.

The Orienting Reaction: Summary

After Pavlov (1927) many researchers have equated attention with an orienting response. This OR is a complex series of neural, sensory, circulatory, and motor components which is elicited by certain stimuli.

The OR is a preparatory response with the net effect being increased sensitivity and a readiness reaction in the musculo-skeletal system. There is a demonstrable (although largely covert) biological change in the attending organism which makes it more receptive to less intense stimulation and better prepared to react to the stimulus generating the OR.

The characteristics of the stimuli likely to elicit the OR are: novelty, intensity and colour; complexity, uncertainty and incongruity; indicating stimuli; surprise; and conflict. There is also a suggestion that the OR is something more than a reflex reaction with the possibility that it may be modified through regular learning processes.

The OR is therefore, a response to stimuli. Recently the suggestion has arisen that in order for this response to occur there must be some preliminary processing of the sensory data. Neisser (1967) has labelled this initial processing 'pre-attention', and if learning does intervene, as the above discussion would suggest, at this fundamental level a discussion of this pre-attentional concept is warranted. The implications of these pre-attentional controls and their links with theories of selective attention will become clear in Chapter Six.

Pre- Attention

Neisser (1967) posits a theory which states that attention takes place in two successive stages: (1) the pre-attentive stage; and (2) the analysis-by-synthesis stage. Attention cannot, he suggests, be paid to the whole visual field simultaneously, therefore, some preliminary operations, namely 'pre-attentive processes', segregate the figural units involved enabling the second stage focal attention to come into play. Pre-attentive processes 'produce the objects which later mechanisms are to flesh out and interpret' (Neisser, 1967, 89). Pre-attentive processing involves detection of physical features, grouping and localising the whole percept and monitoring for critical features which may require the later, more sophisticated level of processing, Neisser calls focal attention (Keren, 1976).

Neisser believes that there are two classes of movements which are most often under pre-attentive control. The first class of movements are re-orientation movements where changes occurring in the field almost always capture our attention producing a redirection of attention itself. These movements, which include re-orientation of the head and eyes, are similar to the orienting reaction. The second class of movements often under pre-attentive control are guided movements, for example, walking and driving which can be made without the use of focal attention.

A further distinction made by Neisser is that pre-attentive processes appear to be limited to the immediate present and that more permanent storage of information requires an act of attention. Although, he suggests, this issue should be left open for the present (Neisser, 1967).

Increasing support is being given to Neisser's notion of pre-attention, through research studies conducted to ascertain its distinguishing features. For example, Neisser's theory (1967) suggests that pre-attentive processes and focal processes may follow different rules. Work supporting this viewpoint has been conducted by Beck (1972), and Beck and Ambler (1972), who show that the relative difficulty of discrimination problems may change in different states of attention (Kahneman, 1973).

Keren (1975) was concerned to identify the conditions under which the pre-attentive and focal processes operate, and suggested that the two processes were related to the 'response set' and 'stimulus set' distinctions proposed by Broadbent (1970).

'Stimulus set', according to Broadbent, permits selection among its elements on the basis of physical features which are inherent in the stimulus. Elements within the other type of stimulus material, 'response set', cannot be distinguished solely on the basis of meaning that is conveyed by the stimulus (Keren, 1976).

Utilising these distinctions, Keren (1975) stated that response-set materials require focal attention but that stimulus set materials may be handled by pre-attentive mechanisms. He did point out, however, that it is impossible to make an absolute distinction between stimulus and response set, and therefore, a decision, in most real life situations, as to whether a situation is of stimulus or response set nature, and accordingly whether pre-attentive or focal attention is the dominant process, should be made on a relative scale (Keren, 1976).

In Keren's (1976) work strong support was found for the notion that stimulus and response set material require different levels of processing as suggested by Broadbent (1970). Secondly, support was also provided for

Neisser's (1967) notion that pre-attentive processes operate in parallel, while focal attentional processes are serial in nature.

Broadbent (1977) supporting Neisser's assumptions finds evidence for at least two stages of perceptual selection. The first is an early global, or low frequency stage that packages information from the environment into different segments, each of which can then be attended or rejected. It also acts, largely passively, to suggest percepts biased to probability. The later inquiry, or verification, stage works with more detailed information from the original packages or segments, and is, suggests Broadbent, more affected by semantic context, by the pleasantness of a word, and by the co-occurrence probability of letters in words (Broadbent, 1977).

Finally, Pachella (1975) differentiates between the analytic or the information extraction processes of perception, and the synthetic or the interpretive processes of perception. The analytic processes concern the extraction of cues and features from the stimulus or its immediate sensory storage and are similar to Neisser's pre-attentional processes. On the other hand the synthetic processes concern the nature of the representation with which the subject cognitively deals and may be likened to Neisser's focal attentional processes (Pachella, 1975). Interestingly, Pachella also believes that the analytic and synthetic processes follow different rules providing further support for the similar views held by Beck (1972) and Keren (1975; 1976), and Neisser (1967).

Attention, as it is most commonly used, implies that there is a selective process for taking information into the perceptual system. There is also, however, an initial phase which occurs before selection which has been described here as the orienting reaction. The evidence presented above suggests that there is a further pre-attentive mechanism operating which follows somewhat different rules from attentional processes. The links between the OR and pre-attentive mechanisms and the selective nature of attention form the basis for discussion in Chapter Six.

CHAPTER SIX

SELECTIVE ATTENTION

Although not backed by experimental evidence, William James (1890) recognised intuitively many of the features of selective attention. Attention, he wrote, '... is the taking possession by the mind, in clear and vivid form, of one out of what seems several simultaneously possible objects or trains of thought ... it implies withdrawal from some things in order to deal more effectively with others.' (James, 1890, 402 - 403).

The revival of interest in attention since the 1950's has seen a great deal of research based on the notion of the selective nature of attention. Impetus was given, most significantly, by Broadbent (1954, 1958) and a situation has now been reached where many of the self-evident truths proposed by James are on a much firmer footing. However, '... this work has also disclosed effects which are by no means self-evident,' (Horn, 1965).

Selective attention is particularly important in the educational setting as a pupil's ability to both organise and select the prominent and critical attributes of the task has far-reaching implications for success in learning. This chapter reviews firstly, modern theories of selective attention, and reviews the literature pertaining to the distinguishable components of selective attention: search, mental concentration and attentional set.

Theories of Selective Attention:

Two major types of models of selective attention are found in the literature: bottleneck models of attention; and capacity models of attention. The bottleneck models attempt to account for the structural limitations of the mental system, while capacity models attempt to account for the capacity limitations of the mental system. The models have been devised to provide an answer to the problem of how an individual deals with the myriad of stimuli to which he is constantly exposed, and why he responds to one stimuli, ignoring others.

Bottleneck Models of Attention

The study of attention, in recent times, has been dominated by theories which assume a bottleneck stage somewhere in the central nervous system, although the actual location of the bottleneck is still hotly debated.

If two stimuli are presented at the same time two outcomes may result. Either one stimulus will elicit a response and the other will be ignored, or both stimuli will elicit a response, but in succession.

Queuing and/or suppression occur frequently in the organisation of behaviour suggesting 'the image of a bottleneck, a stage of internal processing which can only operate on one stimulus or one response at a time' (Kahneman, 1973, 5).

Because man is constrained during sensory and motor performance by some bottlenecks in his biological constitution, attentional theorists believe that in the central nervous system similar limited stages are present which enable man to do only one thing at a time. These theorists include Broadbent, Triesman, Deutsch and Deutsch, and Neisser - the theories are discussed in the following pages.

Broadbent: The Filter Theory

In Perception and Communication (1958), Broadbent proposed the Filter Theory - the first modern model for attention. The filter model attempted to deal with the problem of competing stimuli - and provided an explanation of the mechanism which allows the individual to deal with one input while rejecting all other inputs.

Broadbent's filter theory proposes "that the human operator is a limited-capacity information channel" (Moray, 1969a, 34). As a consequence the human perceptual system is incapable of simultaneously analysing the information received through the many sensory, parallel pathways. Although a great deal of information constantly impinges upon the human operator, only some of this stimulation elicits response. Broadbent stated that '... adequate response to one part of the stimulus situation is incompatible with adequate response to another part' (1958). In order to deal with the inputs a selective operation is performed. The inputs from the sensory pathways pass through a filter in the nervous system which selects part of the information and ultimately passes this

on to the perceptual system.

The filter usually selects information relating to the task being undertaken although 'the filter is biased toward input channels in which novel or intense events occur and toward the ear more than the eye,' (Swets and Kristofferson, 1970, 34). Broadbent also suggested that 'Certain properties of a stimulus will make it more likely to be selected from among its competitors, and to retain its dominance if selected by chance,' (Broadbent, 1958). The properties of a stimulus which make it more likely to be selected are its novelty, intensity (physical), and importance biologically. The physical characteristics of the information determine whether a particular input will be selected. Broadbent also proposes a short-term memory system which prevents the loss of information about the past history of the unselected channels. Broadbent (1958) published a flow diagram model to summarise his views of the filter theory. This diagram was later adopted by Moray (1969b) and is presented below to enable more complete understanding of Broadbent's theory.

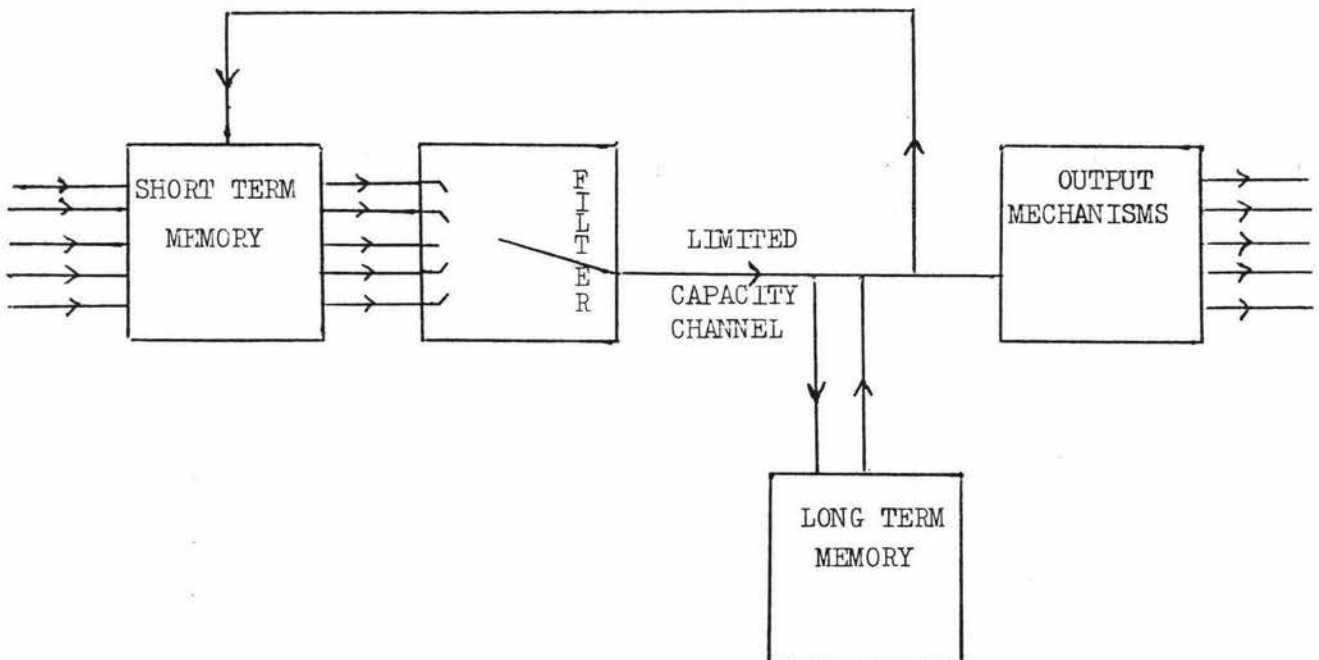


Fig. 6.1: Broadbent's filter theory (after Broadbent, 1958)
from Moray, 1969b, 29.

Broadbent's theory as originally proposed was an "all-or-none" process. In the light of further research work (Triesman, 1960, 1966, 1969; Moray, 1959; Grey and Wedderburn, 1960), however, this view has been somewhat modified.

Grey and Wedderburn's (1960) experimental work clearly showed that the filter theory of Broadbent was not entirely adequate in accounting for the selective process of attention. They suggested that psychological attributes and not merely the physical characteristics of sensory channels, played a significant role in the selection of information. Moray (1959) also argued the need for alternatives to the filter theory, but Anne Triesman was first to propose a valid alternative system.

Triesman: The Filter-Attenuation Theory

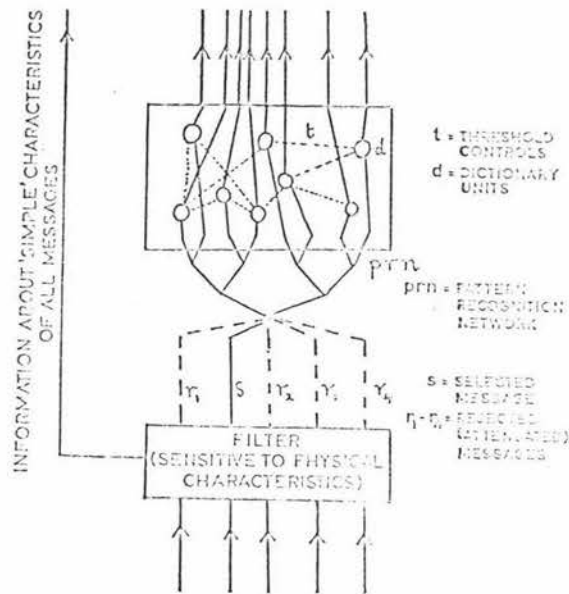
The experiments upon which Triesman developed the attenuation theory are a series of 'shadowing' experiments (Cherry, 1953; Moray, 1959; Triesman, 1960, 1964a, 1964b, 1964c). Recognising that a listener can normally separate two streams of speech when they are presented simultaneously, one to each ear, by following one stream and ignoring the other, Cherry (1953) introduced the shadowing technique which asked the listener to follow one of the messages, repeating it as it is received. Moray and Triesman developed these experiments leading to Triesman's proposal of the selective nature of attention.

Although similar in outline to the Broadbent model, Triesman's formulation '... can be thought of as making more explicit the selection rules governing the action of the filter, and also the problem of identifying particular signals when they occur' (Moray, 1969b, 30).

Once again information is seen to enter the organism through a number of parallel pathways. Upon reaching the receptors, the information inputs are analysed. Analysis occurs for crude physical characteristics, such as loudness, pitch, position, colour and brightness. 'The information resulting from this analysis is available to conscious perception and for reporting by the subject regardless of what happens to the message beyond this point' (Moray, 1969b, 31). Messages selected for further analysis continue into the nervous system where recognition occurs.

Thus, Triesman argues that the filter is not an all-or-none block. Instead filtering is seen as a 'matter of attenuating signals rather than cutting them off entirely and that filtering is accomplished during, rather than before or after, recognition of the stimulus. Recognition occurs when a stimulus leads to activation of an internal representation, referred to as a "dictionary unit" in early papers and as a "perceptual analyser" more recently' (Swets and Kristofferson, 1970, 347).

Fig. 6.2. Triesman's Filter-attenuation Model



Although Triesman outlines two important attributes of the dictionary units - namely that their thresholds differ and that their thresholds are variable - implying that in order for a process to occur then the thresholds of the dictionary units for that process must be exceeded, her theory does not make clear why a dictionary unit is fired. However, her work would suggest such a firing would occur when the listener makes a conscious recognition of the stimulus.

Attention, according to this model, takes place in two stages. The first stage of the process takes place when filtering, on the basis of channel characteristics, occurs and the next stage when dictionary unit thresholds are set. Selection is an active process and is achieved by the

rejection of all irrelevant messages, however, every irrelevant message requires some analysis.

Triesman's model raises some difficulties. Firstly, the theory would seem to suggest that if thresholds of dictionary units match appropriately incoming signals along several channels then firing of these units could occur simultaneously. The result being that several things should be heard by the listener at once. Secondly, 'no predictions can be made as to what will happen if the listener is asked to handle two simultaneous inputs, accepting them both' (Moray, 1969a, 38).

Because of these difficulties, and theoretical differences, Deutsch and Deutsch (1963) proposed a further theory of selective attention.

Deutsch and Deutsch: The 'Response-selection' Theory

Using the same experimental data as was used by Triesman, Deutsch and Deutsch (1963) argued, on the basis of behavioural and neurophysiological experiments, that 'the selection of wanted from unwanted messages requires discriminatory mechanisms of as great a complexity as those in normal perception' (Deutsch and Deutsch, 1963, 362), and that this supposition presents difficulties for filter theory.

In order to deal with this difficulty a theory was proposed in which one message is selected and all other messages are ignored. A stimulus, before being accepted or ignored, must however be fully analysed to the point of recognition, because 'the most important stimulus is the one selected of all those present, and "importance to the organism" is a property of the internal representation of a stimulus' (Swets and Kristofferson, 1970, 348). Consequently every stimulus is recognised through exciting its internal representation.

Deutsch and Deutsch maintain that each recognition response has a weighting for importance. The recognition response with the highest importance weighting, at any given time, is the response selected for awareness, motor output, and memory storage (Swets and Kristofferson, 1970).

Although this model has been referred to as the response selection model, the authors regard it as selecting incoming signals - and in so doing link their model with that of Triesman. An experiment designed to

differentiate between the two models was conducted by Triesman and Geffen (1967) although this was not accomplished. A significant, but inconclusive struggle continues between the Triesman and Deutsch groups, and Moray (1969a) suggests that both models are likely to be deficient in attempting to account for selective attention on three basic counts.

Both models concentrate entirely upon competition between inputs, where sufficient evidence is now coming forward suggesting the need to take into account not only competition among outputs, but also competition between inputs and outputs (e.g. Moray and Taylor, 1958). Neither model could be easily modified to cover these contingencies.

The second deficiency is that both models employ shadowing as the method of presenting stimuli. Moray (1969a) suggests that shadowing, with running speech as stimulus and response, makes a study of the fine structure of stimulus-response relationships extremely difficult, and that any attempt to measure the effect of slight timing differences, a factor crucial for a complete understanding of attention, is all but impossible.

Finally, neither Triesman nor the Deutsch group, have presented their models described sufficiently accurately or in sufficient detail. This has led to a situation where detailed prediction of responses is impossible. Differences between the two groups appear likely to continue.

Neisser/Hochberg: Analysis-by-Synthesis

An alternative to the filter-attenuation theory was proposed by Neisser (1967). As already indicated (Chapter Five), Neisser sees attention taking place in two successive stages. It is the second of these, the analysis-by-synthesis stage - with which this discussion is now concerned.

Perception is, according to Neisser, an active process of analysis by synthesis. Thus 'perception is an act of construction, and the role of attention is to select the percepts that will be constructed or synthesised' (Kahneman, 1973, 126). 'On this hypothesis, to "follow" one conversation in preference to others is to synthesise a series of linguistic units which match it successfully. Irrelevant, unattended streams of speech are neither filtered out nor attenuated; they fail to enjoy the benefits of analysis by synthesis' (Neisser, 1967, 213).

Neisser believes this analysis by synthesis process is the mechanism of attention itself and as stated above, he discounts the validity of the mechanisms posited by other theorists, namely 'channels', 'filters', or 'attenuators'. Kahneman (1973) however presents an adequate argument which shows that the selection of messages for synthesis is indistinguishable from the operation of a filter. Because Neisser attributes the effects of significance and context to the role of expectations in the process of synthesis, and because the theory assumes a crude and global analysis of the rejected message, Kahneman (1973) suggests there is no way to separate Neisser's view from Triesman's attenuation theory (Kahneman, 1973, 126-127).

Neisser himself has begun to question the validity of his analysis by synthesis model as the following quote indicates:

The mistake in question is my own. In 1967 I suggested, following Halle and Steven (1964), that speech is perceived by "analysis-by-synthesis", meaning that the listener formulates a series of specific hypotheses about the message and then tests them on the sound wave. I no longer believe that this can be literally true; it would require that an implausibly large number of false hypotheses be generated all the time. The listener's active constructions must be more or less specific, so that they are rarely disconfirmed.

(Neisser, 1976, 384).

Hochberg (1970), presented a similar view of selective attention which overcomes some of the difficulties of the Neisser model. For example, Neisser, identified detailed perceptual analysis with focal attention and focal attention with awareness but as Kahneman (1973) points out, this is implausible, since some complex motor skills, such as driving, are often performed with little awareness, although they require detailed perceptual analysis (Kahneman, 1973, 125). Hochberg's approach on the other hand, implies a separation of detailed perceptual analysis from awareness.

Hochberg described perception as a confirmation of a changing set of expectations - and he assumed that only sets of expectations that have been confirmed are stored in memory by the perceiver. 'An intention to focus attention on one message causes detailed expectations to be produced for that message alone. Irrelevant messages are not expected in detail, and are forgotten almost as soon as they are heard' (Kahneman, 1973,

128). Obvious similarities exist between Neisser's active synthesis and Hochberg's production of expectations.

Although the models of Neisser and Hochberg represent a major advance in theories of selective attention as proposed fifteen or twenty years earlier a great deal of scientific enquiry still needs to take place before it can be stated with any degree of confidence why some stimuli elicit responses and are thus attended to while other stimuli are ignored. Theorists, continue to posit answers to this question.

Other Models of Selective Attention

Unlike the models reviewed thus far, Reynolds (1964), drew on both visual and auditory work when formulating his response selection theory. The previous theories of selective attention Reynolds divides into three classes: stimulus orientated (filter theory); organismic (expectancy theory); and response theory. He concentrated on the last of these but failed to present a useful theory.

Reynolds sought to explain what takes place when two stimuli are presented simultaneously, or nearly simultaneously, to a subject. He concluded that, in such a situation, rivalry occurs and a delay in response to one of the stimuli takes place. This phenomenon was labelled 'temporary inhibition of response' and is, in fact, Reynolds' theory. Using a somewhat sophisticated method, Reynolds posits, quite simply, that one stimulus will be responded to before the second stimulus and response selection will be made according to the potency of the stimuli. Although this is generally accepted Reynolds' theory has little explanatory or predictive value, and adds little to the existing, knowledge of selective attention.

Egeth's paper (1967) reviews the data available on selective attention and does not postulate a model of attention. He does imply, however, that in order to understand attention, the coding and decoding rules which are being applied from moment to moment by the observer who is being bombarded with information, need to be discovered (Moray, 1969b). Attention, according to Egeth, is the application of these coding rules. The rules are arranged hierarchically and data is transferred and transformed through the codes until recognition and response are obtained.

Moray (1962b) suggests that Egeth's ideas are intuitively rather important being convergent to the problems more usually attacked in attentional research. Elaboration of this view is required to enable a more adequate assessment and to establish the possible relations between it and other theories of selective attention.

Capacity Models of Attention: Kahneman- Attention as Effort

Capacity models of attention explain man's limitations in ability to pay attention to all incoming stimuli, by positing a general limit on man's capacity to perform mental work (Kahneman, 1973, 8). This limited capacity can, according to the theory, be allocated among concurrent activities with considerable freedom.

In order for recognition to occur activation of a cognitive structure corresponding to the stimuli, takes place. Two types of inputs are required to activate this corresponding structure: an information input specific to that structure and a nonspecific input which Kahneman (1973) suggests may be labelled "effort", "capacity", or "attention". Thus, in explaining why man can carry out a number of activities in only a limited way, capacity models assume that at any given time the total amount of attention which can be deployed is limited.

A central notion of Kahneman's theory is that the degree to which concurrent activities are mutually interfering can often be predicted by considering the "effort" which these activities require, that is, the load which they impose on a common pool of limited capacity.

In contrast to filter theory, this view admits the possibility that the processing of concurrent stimuli may occur in parallel, if this processing demands little effort (Kahneman, 1975).

A capacity model of attention (Figure 3) attempts to deal with three central questions according to Kahneman.

- (i) What makes an activity more or less demanding?
- (ii) What factors control the total amount of capacity available at any time?
- (iii) What are the rules of the allocation policy?

(Kahneman, 1973, 10).

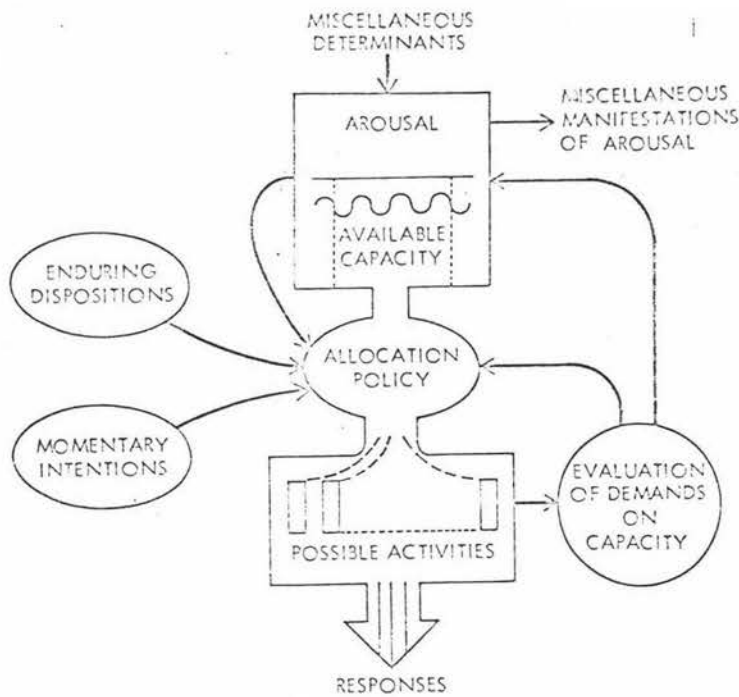


Figure 6.3: A Capacity Model of Attention. Kahneman, 1973, 10.

Kahneman (1975) in a series of experiments, showed that while subjects who focus attention on one of two long lists of words can refrain from storing the content of the other list in memory, subjects, participating in search task experiments, involuntarily store irrelevant items to which they paid attention in the task. Thus showing that attention does not operate directly on the storing of information, but presumably affects relatively early stages in the sequence of information processing - an idea that is adapted from filter theory.

Kahneman found also that the recognition of simultaneous words in long lists, when attention was divided, showed no trace of competitive interference, even at a fast rate of presentation - but the general level of performance was lower. This, he suggested, is the pattern expected for a passive mode of allocation of attention to two tasks. Although the task of listening to two long dichotic lists is difficult, it does not appear to elicit much effort - and, therefore, the dimensions should not be identified with the dimensions of task difficulty (Kahneman, 1975).

Kahneman (1976) concludes that his results present difficulties for theories that view attention as a post-perceptual selective process - namely the theory of Deutsch and Deutsch (1963) - because the experiments showed that the allocation of attention is not as flexible as the theory of post-perceptual selection would imply.

Also the Kahneman experiments (1975) provide evidence that selective

attention is more effectively controlled by perceptual factors, such as spatial orientation or voice, than by the designation of a class of items as irrelevant. Or, in Broadbent's (1970) terms, stimulus set is more effective than response set.

Kahneman (1973) suggests that capacity models such as that shown in Figure 6.3 should not be seen to replace bottleneck models but merely to complement them. They are in fact two different types. Bottleneck models are schematic flow-charts that attempt to describe the sequence of operations that are applied to a set of simultaneous stimuli, while Figure 6.3, as an example of a capacity model is a control diagram that describes the relations of influence and control between components of a system (Kahneman, 1973, 11).

Models of Selective Attention: Summary

Two major types of models have been proposed to account for the selective nature of attention. These models - bottleneck and capacity - both predict that concurrent activities are likely to be mutually interfering (Kahneman, 1973). Interference, in bottleneck models, is caused when one mechanism is required to carry out two incompatible operations at the same time. Whereas interference, in capacity models, occurs when the demands of the two tasks exceed available capacity. Interference between tasks in structural models is specific depending on the degree to which the tasks require the same mechanism. Interference is nonspecific in capacity models and depends on the demands of both tasks (Kahneman, 1973).

The most prominent bottleneck theories of attention have been proposed by Broadbent, Triesman, Deutsch and Deutsch, and Neisser and Hochberg. Some similarities exist between these views, namely they all suggest the existence of some kind of pre-attentive mechanism, which operates crudely to classify incoming sensory data into classes of events which are considered pertinent for further analysis (Norman, 1969). The major difference between the theories tends to be in terms of the siting of the bottleneck in the analysis of incoming sensory data.

The most influential capacity model of attention has been proposed by Kahneman who suggests that attention requires effort, and that there is in effect a limited capacity within the individual to perform cognitive tasks. Although numerous studies have been conducted on selective attention, as reviewed here and in countless numbers of books and journals Egeth's (1967, 56) view is still valid:

... unfortunately, it is not obvious what distinguished those situations in which subjects can filter readily from those which cannot. This is clearly going to be fruitful subject for further study.

Today, some ten years after the publication of Egeth's paper this question still lacks an answer.

Components of Selective Attention

Moray (1969a, 1969b) identified seven components of attention. Three of these; search, set, and mental concentration have been included in a discussion of selective attention in this review as at times it is impossible to differentiate between selective attention and search; search and set; and set and mental concentration.

The discussion of each component which follows identifies the reasons why these concepts are discussed as subcomponents of selective attention.

Search

One of the chief types of experimental tasks used in the study of selectivity are the visual search tasks. The results of which have been used to formulate a search theory of selective attention.

An array of stimuli is presented to the subject in a visual search task. Subjects are then required to locate a specific stimulus or set of stimuli contained the array. The array of stimuli is generally labelled the "field", while the object of the search is called the "target".

Subjects may be required to make one of three responses. They may have to indicate whether an array does or does not contain the target; they may be directed to indicate by pointing, the actual location of the target; or they may have to remember the identity of the targets if

several are presented in the array. 'The dependent variable in a search paradigm is usually the latency between the onset of the array and the response indicating that the subject has located the target' (Egeth, 1967, 52). Accuracy of recall is frequently used as a response measure when a number of targets are present in the stimulus.

The question to which most researchers address themselves in search tasks, is whether perception of field items differs in any way from the perception of target items. Or, more specifically, whether field items are perceived at all by the subject as attention is directed towards selecting the target items.

Neisser (1963) and Neisser, Novick and Lazar (1963) have studied this question extensively. In an experiment where subjects searched through vertical lists, each consisting of fifty lines of items, Neisser reported the following behaviour characteristics of subjects who had had several days of practice and reached a stable level of performance.

Subjects reported that targets seemed to jump out at them, and that they passed over irrelevant items in a blur without really "seeing" them.

After subjects searched through a list of fifty items they were then presented with another set of words - half of which had been used as field items and half had not. Recognition was, according to Neisser (1964), at a chance level. Thus no retention of the field items was exhibited by the subjects.

Neisser also found that subjects' search for a target item was faster than search for its absence. Egeth (1967) commenting on this finding expected search for absence to be faster than search for presence because, on the average, examination of a line can be terminated half way through, while every letter of all lines preceding the target line must be examined when searching for the presence of a particular letter.

The search rate was, according to Neisser, influenced by the similarity of the target to the field. Search rate decreased as similarity increased. Thus a round shaped letter was easy to find among a field of sharp angular letters but more difficult to find among other round shaped letters.

Finally, in a range of one to ten items, the speed at which subjects search for targets is independent of the number of targets. Using these results, Neisser postulated that recognition during visual search tasks is a hierarchical system of decision processes. His system works in the following way. When subjects are directed to search for the letter B, a number of elementary tests (for roundness, angularity) are made on all the visual inputs. Characters failing this testing are then passed over, subjected to no further analysis. This model suggests, therefore, that perception of target items does differ from perception of field items. 'The latter are rejected as non-targets, but since they fail low-level tests, they are not given any positive classification, they are not identified'(Egeth, 1967, 53).

Through this work, and further research, Neisser has argued that 'it is implausible to suppose that special "filters" or "gates", ... block the irrelevant material from penetrating deeply into the "processing system" ' (Neisser and Becklen, 1975, 482). Instead, because subjects report that they hardly "see" the irrelevant letters or words in the field array, their responses depend not on visual synthesis - but are directly under preattentive control (Chapter Five). This pattern-recognition model of Neisser is almost identical to the model Triesman has developed to explain the results of selective listening experiments.

Egeth reports that one class of hierarchical models has received some support from neurophysiological research. 'Hubel and Wiesel (1962) found cortical neurons in cats which responded to special patterns of retinal stimulation. Thus, some units responded to lines that formed a specific angle with the horizontal; these units responded to lines at that particular angle regardless of the position of the lines on the retina, and they did not respond to any other pattern of excitation. Other units were found that responded to spots of light, still others to moving edges' (Egeth, 1967, 54).

Simple patterns were responded to in this experiment - they were so simple, in fact, that they bear a suggestive similarity to the rudimentary tests that Neisser and others presume to be present at the base of a hierarchical pattern - recognition process (Egeth, 1967). To

date, however, it has not been verified that human subjects have these elementary pattern detectors so the suggestive nature of the above data is emphasised.

Set

The phenomenon of perceptual set has received a great deal of attention even from the beginning of experimental psychology. A large number of studies have been conducted to investigate this aspect of attention, and a surprisingly large number of reviews have been presented summarising and critically analysing this research. Dashiell (1940) and Gibson (1941) reviewed much of the early work, with more recent research reviewed by Egeth (1967), Egeth and Bevan (1973), Gibson (1969), Haber (1966) and Steinfeld (1967).

The phenomenon of set concerns the advanced preparations that an organism makes for dealing with the probabilities or contingencies which characterise a particular stimulus or task (Fitts, 1964). Thus, stimulation does not fall on a passive receiver. The individual is "prepared", implicitly or explicitly, for certain kinds of input; the input is actively dealt with on the basis of this preparation. The fate of any input is at least partly dependent on the nature of the preparation, or set.

Set has been found to influence recognition thresholds. Chapman (1932) is considered to have conducted the classic experiment in this area. The stimulus materials consisted of a group of cards on which were printed several capital letters. The cards varied in three ways: number of letters, identity of letters and spatial arrangement of letters. The cards were presented tachistoscopically, under conditions of illumination and exposure-duration that yielded less-than-perfect recognition of any of the three attributes.

Set was manipulated through instructing the subject to report on one of the three characteristics of a card on each exposure. The instructions about which of the three attributes to report on were given either before the exposure or after it.

When the instructions were provided before the exposure, the subject presumably was specifically set for the appropriate attribute. Instructions

given after the presentation of the stimulus could not influence the subject's set.

As expected, there were fewer errors under the before condition than under the after condition. In the before condition the subject had a single, specific set. Even in the after condition, however, set must have been operative to some extent, because the subject knew he would be asked to report on one of three attributes. The difference conditions may, therefore, have been not so much a difference between set and no-set as a difference between single and multiple set.

An experiment by Lawrence and Coles (1954) cast doubt on the original interpretation of Chapman's results. Lawrence and Coles argued that Chapman's set-inducing instructions had their effect not directly on the perceptual process itself, but rather on the memory trace of the stimulus, which is tapped at the time the subject responds. The procedural differences between the two studies, however, makes a definitive stance, for one or other finding difficult and probably invalid.

A further study investigating the before-after technique was undertaken by Lawrence and La Berge (1956). Cards, differing in colour, form and numerosity, presented tachistoscopically were used as stimuli. Four types of instructions were given to subjects, two of which are important here. Subjects, before exposure to the stimulus, were asked to pay primary attention to one dimension, but to report all three. This was labelled the Emphasis condition. In the Ordered condition equal attention was to be paid to, and report on, all three dimensions. The order in which the dimensions were to be reported was specified immediately after the exposure of the stimulus. Imagined cash bonuses were to be given for correct reports. In the Emphasis condition \$100 was to be given for the emphasised dimension and \$1 for each of the two unemphasised dimensions. \$34 per dimension was to be given for the Ordered condition.

In the Emphasis condition results indicated that accuracy of report was significantly higher for an emphasised dimension than for an unemphasised dimensions. In the Ordered condition 'the difference in accuracy between the first recorded dimension and the average of the other two was as large as the difference between the emphasised and unemphasised dimensions' (Egeth, 1967, 43). These results would appear to suggest that Emphasis instructions will determine the order in which dimensions are reported and this order is likely to determine the accuracy of report.

Although the authors concluded that the effect of instructional set was on memory rather than perception, this view was not wholly supported by the statistical data, and further analysis is required in order to justify this stance.

Brown (1960) criticised the use of the before-after technique because, he suggested, the technique allows differential effects during retention. He proposed, therefore, a before-during design in an attempt to answer 'whether a selective process can operate during perception of a tachistoscopically presented stimulus field irrespective of whether it operates within perception' (Brown, 1960, 176). His research verified that a selective process may operate during perception, and he concluded, like the study of Lawrence and LaBerge, that the selective process should be attributed to memory.

Using stimuli similar to those used by Lawrence and LaBerge, Harris and Haber (1963 and Haber, 1964a, 1964b) investigated whether the order in which information was reported was as important a factor as the order in which information was put into storage. The results of these experiments are about the place the literature is at in discussing the effects of instructions on the description of multidimensionally varying arrays.

Harris and Haber suggested that all of the measured effects of set on tachistoscopic recognition may be attributable to the fact that while the visual memory of the tachistoscopic presentation fades very rapidly, it takes time for the subject to encode in more permanent form all the things he might be asked to report about the stimulus (Hochberg, 1970). The subject has available to him, therefore, information about those aspects of the display that he encodes first. When the subject comes to encode the features that he has not been specifically set to report, his immediate (uncoded) memory of the stimulus display is too degraded to be of much use. Hochberg (1970, 105) summarises: 'the primary characteristic of the tachistoscopic experiment appears to be that it forces the subject to respond to a memory that he cannot refresh, whose validity he cannot check, and whose detail he cannot extend because the stimulus is no longer present. The fragility of immediate memory plays a heavy role in the explanation of the selective effects of attention ... here the selected material is the material that resists being lost because it has been encoded in a more permanent form.'

Mental Concentration

Wittenborn, in 1943, conducted a large number of simple tests in order to develop a possible test of attention. Of the number administered two, he claimed, seemed to be almost pure measures of the ability to do sustained mental work. This ability he labelled 'mental concentration' or attention.

Woodworth and Schlosberg (1954) pointed out, however, that although Wittenborn's tests may well be loaded with a factor not related to previously recognised factors, such as rote memory, perception and visual space, there was no reason to conclude that the new factor was attention.

To examine the validity of Wittenborn's tests of attention, Moray and Taylor (1958) conducted research to ascertain the relationship between Wittenborn's attention and selective listening. Results showed negligible correlations between performance on the two kinds of attention.

Very little work has been conducted, in recent years, on the Wittenborn kind of test. The notion of mental concentration, meaning concentration on a particular task while trying to exclude all incoming stimuli which might interfere with the performance of the specified task (Moray, 1969) has survived, in a slightly altered form, in the work of Kahneman discussed earlier in this chapter.

Briefly, Kahneman's (1973) approach would suggest that ability to concentrate on mental tasks, to the exclusion of other activities, would depend on the degree to which the concurrent activities were mutually interfering and, therefore, on the load which they imposed on the common pool of limited capacity. Interference in tasks of mental concentration is explained, therefore, in terms of a competition for a general limited capacity.

CHAPTER SEVENVIGILANCE/MAINTAINING ATTENTION

The present chapter is organised in two parts. Part One concerns itself with the classical research into 'vigilance', and Part Two discusses 'sustained attention'. While the differences between these two categories are not, at this stage, clear, the differences will become obvious throughout the course of the discussion.

Vigilance

Many tasks require an individual to attend for a long period of time with only occasional events occurring that require some kind of action. An assembly line inspector, for example, must watch the line continuously in order to detect the infrequently occurring flaws. In jobs such as this one, individuals must remain alert constantly to ensure a significant event is not missed. This alertness over a long period of time has been labelled 'vigilance'. 'Vigilance' for the psychologist, is on an aspect of the general problem of attention.

In the typical vigilance task the subject is presented with stimuli. Some stimuli are signals which need to be reported while others are non-signals which are not usually reported. The special features of the vigilance experiment, according to Jerison (1970), are in the parameters:

1. The vigil is maintained without interruption for periods of a half-hour or longer,
2. Signals are presented infrequently and without forewarning,
3. The signals are strong in a psychological sense, (nearly always reported correctly with almost no false alarms in two-alternative forced choice setting), but they would be described as weak by most observers because they are not "attention-demanding"

(Jerison, 1970,128)

Throughout the task the subject must remain alert so that all signals may be detected and reported.

During World War II a study of radar watchstanding was conducted which concluded that man is a poor monitor. Mackworth, as a result, became interested in discovering why an observer's performance becomes less efficient as he continues to work on a monotonous task. In order to study this phenomenon, Mackworth developed the first vigilance task - the Clock Test (Mackworth, 1950).

In the experiment, the subject was directed to watch a hand moving in jumps around a blank clock face. The hand moved around the face in regular steps once each second. Occasionally the hand moved a double step. The double step was the signal to which the subject had to respond by pressing a key. The experiment lasted two hours and the important finding was that a large decline in performance took place as the watch progressed. After only half-an-hour of watching, the percentage of signals correctly reported dropped substantially (the mean proportion of signals detected fell from 85 per cent in the first half hour to about 74 per cent in the second and subsequent half hours - Mackworth, 1970). This fall in performance was labelled 'vigilance decrement', and is the major vigilance effect.

Five theories were proposed over the following decade to account for the performance decrement in vigilance situations. Mackworth (1950) suggested that the decrement was related to principles of classical conditioning - particularly the principle of inhibition. Broadbent's (1953a, 1953b, 1957, 1958) theory, in the same tradition, was designed to explain the facts of classical conditioning and performance on repetitive tasks. Because of the limited capacity of the human perceptual system, as posited in Broadbent's filter theory, a selective operation is performed on all inputs to that system. During watchstanding on a vigilance task, the observer will select irrelevant competing stimuli with increasing frequency as time on watch progresses. The result will be a decline in the percentage of signals detected - the vigilance decrement (McGrath, 1963).

For Deese (1955), maintaining alertness was a problem in the ability to maintain a background sensory input to offset the dissipation of an initial excitatory state of vigilance. Or, as he said, 'the maintenance of a given level of vigilance in an observer depends to some extent upon stimulus events extrinsic to the observer' (Deese, 1955, 360). Thus

prediction of the vigilance decrement, here, is based on the assumption that monotonous and constant stimulus conditions will ultimately lead to a lowering of critical arousal and consequently to less efficient responding.

Hebb (1955) suggested that stimuli serve as a cue function (guiding and controlling behaviour through the efficient transmission of information) and also to arouse or activate the organism. 'Without a function of arousal the cue function cannot exist' (Hebb, 1955, 243). Scott (1957) related the loss of efficiency during vigilance tasks, considering Hebb's views, to the reduction, during watch, of stimulus variation.

The final theory of performance decrement during vigilance tasks was proposed by Holland (1957, 1958), who equated observing responses, in the Skinnerian tradition, to sense receptor orientations, suggesting a parallel between detection probability and observing rate, assuming that signal detections reinforce observing responses.

Until recently most researchers did not question that watchkeeping tasks did in fact produce a decrement in detection probability - particularly as other tests, for example, the 'jump-clock test', a 'synthetic radar test', and 'listening test' also produced similar results.

Some tests however, particularly those with multiple stimulus sources, did not show a performance decrement. Response time, in tests of this nature, was found to be as short at the end of the watch, as at the beginning (for example, Broadbent, '20-dials test', 1958).

The emergence of signal-detection theory has led researchers to question whether a performance decrement does, in fact, occur in any of the common vigilance tests. Signal-detection theory suggests that the proportion of signals detected should not be regarded as a valid measure of signal detectability (Tanner and Swets, 1954; Swets, 1964; Green and Swets, 1966). This view was proposed because the proportion of signal detected was shown to reflect nonsensory factors that influence a subject's willingness to report a signal, and signal detectability or sensitivity.

The question of the performance decrement has not, and is not likely to be, resolved for some time. The difficulties surrounding the study

of the vigilance aspect of attention in the laboratory setting are many. McGrath (1963), for example, questions whether studies of human vigilance have, in fact, been studying the same phenomenon. This indecision has arisen principally because the term 'vigilance' has been used ambiguously. 'It has sometimes referred to a central process determining performance on certain types of tasks. In other instances, the term has referred to the performance itself, or has referred to a general area of human discourse - human watchkeeping' (McGrath, 1963, 227).

Whatever definition or conception is used in the devising of experimental work, studies of vigilance have, significantly, all taken place in the laboratory setting, with little, or no, conclusions being able to be drawn for classroom learning situations. For example, Gale and Lynn (1972), in their Developmental Study of Attention, administered a 40-minute auditory vigilance task to over six hundred children between seven and thirteen years of age, obtained results that could not easily be used, with any confidence, in an educational setting. Although they found that performance on vigilance tasks improved with age, with possible critical changes occurring between eight and nine years of age, and that attentional capacity (vigilance) is independent of intelligence, because the task could not be considered, in the authors' own words, 'as ecologically appropriate to the classroom', little of real worth, in a practical sense, was gained from this study.

In the past decade an increasing amount of literature has come forward which has investigated vigilance - but in an educational framework. The emphasis, in this research, has moved to look at a pupil's ability to complete a task once begun, rather than to study ability to complete long, monotonous, and boring tasks. This change in emphasis has led to research on individual ability to maintain attention. Maintaining attention forms the basis of discussion in the second part of this chapter.

Maintaining Attention

The ability to maintain attention to the task once begun is particularly important in the learning environment. Obviously a child who cannot sustain attention for the period required to complete an examination for example, will not perform well and, therefore not score highly on that examination. Because examinations and other testing devices are employed to evaluate children there would appear to be some correlation between school achievement and ability to maintain attention to the task.

Maintaining attention has become linked, most prominently, with the educational 'problem' syndrome, with those children experiencing difficulty in sustaining attention being labelled variously as "flighty", "fidgety", "distractable", and "hyperactive". These children are described, usually, as possessing short "attention spans".

Difficulties in sustaining attention are not, it would appear, limited to learning disabled pupils - all pupils may experience some difficulties in maintaining attention to a task long enough to complete it. Although reasons may vary from child to child, the results, in an educational sense, are likely to be the same. A pupil, in order to achieve, must attend to the material presented, and must maintain attention to the task long enough to complete it.

Educationalists, for some time, have accepted that academic success is related to the ability of an individual to complete the task. Experimental evidence supporting this view has not, however, come to hand, until relatively recently. Previous studies, as discussed in Part One, were concerned predominantly with laboratory experiments involving adult subjects (Buckner and McGrath, 1963; Davies and Tune, 1969, Mackworth, 1969, 1970).

Margolis (1972), studying the relationship existing between academic achievement, IQ and sustained attention, worked with 135 third-grade children in normal classroom settings utilising an auditory-visual vigilance task. Her results suggested that a link does exist between achievement and attentiveness to the task and also that within the normal range of intelligence, 'sustained attention is as important a factor in school success or failure as is IQ' (Keogh and Margolis, 1976, 24).

On a visual vigilance task, in which high achieving second-graders were compared with low achievers, superior performance was demonstrated by the high achievers (Kirchner and Knopf, 1974). Noland and Schuldt (1971) obtained similar results with a vigilance task, finding that adequate readers could be distinguished from retarded readers by their vigilance performance.

Examples of the inability to maintain attention and resulting lack of academic success are most dramatically provided by groups of children with learning disorders. In a study conducted by Luria (1961) in which hyperactive children were compared with normals on several physiological measures of attention, results led Luria to suggest that the learning problems of hyperactive children could be attributed to susceptibility to fatigue of attention.

Similarly, Dykman (1971) studying hyperactive, normoactive and hypoactive groups found that the combined learning disabled groups responded with the same speed, and not more slowly as would be expected, to signals as did their normal counterparts. Hyperactive children were found, however, to be more subject to fatigue and less able to remain vigilant than other groups, thus supporting Luria's (1961) findings.

Although the ability to maintain attention is important for school learning and academic success (Rosvold et al., 1956; Campanelli, 1970; Sykes et al., 1961; Anderson, Halcomd and Doyle, 1973), research to date is very unclear as to whether training to increase attention results in concomitant gains in scholastic achievement. In fact, very few studies reviewed showed gains in this area (Surratt et al., 1969; McKenzie et al., 1968).

A study by Ferritor et al., (1972) however, obtained both improved academic performances and attentive behaviour, although the two behaviours were found not to be complementary. Using operant conditioning techniques, altering contingencies and comparing the levels obtained when reinforcement was given for both, the researchers found:

... contingencies that increase attending behaviour and reduce disruptions do not necessarily increase student performance, at least in arithmetic drill. Contingencies on attending alone increased attending behaviour and decreased disruptive behaviour, but had little effect on measures for correct work accomplished. Reinforcement contingencies for "correct work" alone increased the accuracy of work but had little effect on attending behaviour and appeared to correlate with increased disruptive behaviour.

(Ferritor et al., 1972, 116)

This data suggests, therefore, that when operant conditioning techniques are employed to increase attention, academic improvement will only occur if reinforcement is given to correct work. A number of other

studies have supported these findings (Graubard et al., 1970; Wagner and Guyer, 1971).

Unfortunately a number of fallacies and misconceptions have arisen surrounding the concept of sustained attention and attention spans. First, a number of reporters have tended to speak of an individual's mean attention span. Moyer and von Haller Gilmer (1955), however, rightly point that this is meaningless because the measure of a child's mean attention span depends significantly on the selection of a task suitable for the child's age. In other words, attention span or ability to maintain attention is task specific and an individual should be seen to have "attention spans" rather than an "attention span" (Moyer and von Haller Gilmer, 1955).

A second belief surrounding the notion of attention span, according to Martin and Powers (1967), is that it is sometimes discussed as though it were a faculty or process and the observed behaviours are considered as symptoms of the underlying short attention span. Adoption of this approach leads investigators to discuss or view attention spans as absolute, unchanging characteristics, with, particularly in retarded groups, certain educational activities not attempted because pupils are thought to have short attention spans that interfere with the necessary task attendance (Martin and Powers, 1967).

Individual differences in ability to maintain attention to a task are common, but the reasons for these differences are complex and varied. Distractibility has been interpreted by some clinicians as a sign of neurological impairment (Clements and Peters, 1962). Other investigators have reported changes in ability to sustain attention occurring with age or developmental level (Gale and Lynn, 1972; Routh, Schroeder and O'Tuama, 1974), and Moyer and von Haller Gilmer (1954, 1955), using hypothesis about effects of stimulus complexity on attention, emphasise the importance of stimulus holding power.

Keogh and Margolis (1976) state that in discussing individual differences in sustained attention, 'common sense implicates affective or motivational influences, as demonstrated by an educationally distractible child's ability to sit quietly in front of a television set for a prolonged period of time, or changes in the span of attention, under differing reinforcement conditions' (Keogh and Margolis, 1976, 25).

Similarly, ability to attend has sometimes been equated with "good citizenship" (Harris, 1976, 48), or willingness to conform. Therefore, pupils who fail to complete a task may not, in all cases, be unable but rather, unwilling to do so. Whatever view is taken, clearly ability to maintain attention is associated, significantly, with school success.

Vigilance/Maintaining Attention: Summary

Because an increasing number of jobs in our society require the performance of dull, monotonous, repetitive tasks, interest has grown in an individual's ability to remain alert and vigilant. Beginning with Mackworth's work in 1943, vigilance studies, in laboratory settings, have yielded much information and debate on this aspect of attention.

In attempting to study vigilance in the educational setting, researchers have tended to discuss individual attention spans, or ability to maintain attention to a task. Implications from research in maintaining attention can now be tested in the classroom.

Attention and Learning Summary

The review presented clarifies in some way the knowledge of attention at present available in the literature. The review was undertaken in two parts. The initial discussion centered on the historical development of attention making particular reference to the difficulties encountered when attempting to define the concept. The second part established a framework into which existing research could be classified and reviewed pertinent literature.

The Review - A Recapitulation

Before moving on to Part Two of this study, a recapitulation of the main points of the review is undertaken. This will serve the purpose of highlighting findings and issues relevant to the discussion that takes place in the concluding chapters.

Attention Before 1950

Although attention was reported to be the very essence of the psychological system at the turn of the century:

'The doctrine of attention is the nerve of the whole psychological system, and that as men judge of it, so shall they be judged before the general tribunal of psychology'

(Titchener, 1908,171).

Its demise in popularity as a topic of research was rapid and definite. This demise has been attributed most frequently to the rise in Behaviourism as the dominant systematic approach in experimental psychology with the consequent interest in problems of learning and motivation, and disinterest in mentalistic concepts.

Gradually a renewal of interest in the problem of attention occurred, brought about by a growing demand by S-R psychologists, particularly Berlyne (1960), for more complex analyses of stimulus reception; the need recognised towards the end of World War II, to identify how a human operator would react if required to perform two tasks at once; and the development of increasingly sophisticated equipment, capable of measuring the outcome of attentional experiments.

Attention Since 1950

Perception and Communication, Broadbent's book (1968) provided a renaissance for employing the concept of attention to describe how humans perceive and remember sensory inputs. A new impetus for attentional research was provided. Attention, still as elusive a concept to define as ever, became the subject of numerous experimental studies.

Research has taken place in at least seven different directions. These directions, identified by Moray (1969) include: mental concentration; activation; search; set; selective attention; vigilance; and analysis-by-synthesis.

Of the categories identified, three in particular have been extensively researched. Numerous studies have investigated 'activation' or the neurophysiological correlates of attention. The neurophysiological studies have been conducted most rigorously by Sokolov, Hernandez-Peon, Livingston and Lacey.

Selective attention has had the most detailed elaboration. Beginning with the work of Broadbent, investigating human information processing in

dichotic listening experiments, knowledge has increased rapidly through the contributions of Triesman, Cherry, Moray, Deutsch and Deutsch and many others.

Investigations of vigilance started with the classical experiments of N.H. Mackworth and interest in this aspect of attention continues to provide productive experimentation and theorising.

Reviewing the Literature

In order to adequately review the literature on attention a framework to classify and categorise this literature needed to be found. Acknowledging that Moray's (1969) sub-categories of attention required some review the following framework was adopted:

- (i) activation
- (ii) selective attention
- (iii) vigilance/maintaining attention

The review of the literature pertaining to activation included the research findings regarding the orienting reaction and the function of arousal in attention. Pre-attention, as discussed by Neisser (1967) was also reviewed.

Selective attention, as reviewed, covered bottleneck models and capacity models of attention. It was concluded that each type of model has a place in attentional theory and should not, therefore, be seen in a competitive light. The sub-components of search, set and mental concentration were also reviewed under the general category of selective attention.

The vigilance/maintaining attention section of the review covered classical investigations of vigilance and more recent laboratory studies. Unlike the laboratory research orientation of vigilance studies, maintaining attention, in the sense of completing a task, was put forward as a useful way of looking at attention in the classroom setting.

Although the review was not exhaustive, it did cover the major theoretical viewpoints and research findings on the concept of attention.

PART TWO

ATTENTION AND LEARNING

CHAPTER EIGHTATTENTION AND LEARNING

Chapter One asserted that attention is essential for learning. It suggested also, that educational practitioners, particularly teachers, have little or no knowledge of how attention enters the learning process or, therefore, how it can be manipulated or controlled in the learning situation.

The literature reviewed in Part One of the this study suggests strongly that some aspects of attention can be manipulated and modified to assist learning but that this manipulation can only come about if the role of attention in learning is more fully understood by those who participate in the learning/teaching process. To aid greater understanding of the concept was the aim of the review.

Greater understanding is meaningless, however, unless educational practitioners can transfer this knowledge into useful teaching principles. Part Two of the study aims to assist this process.

The present chapter proposes a model of attention that teachers can apply in learning situations. Essentially the model is suggested by the review of attention as discussed in Part One. It does, however, present the model from a teacher's viewpoint.

Chapter Nine, titled Attention in the Learning/Teaching Situation, is a practical guidebook for teachers concerned to suggest ways in which knowledge of the role of attention in learning may be translated into useful teaching tools.

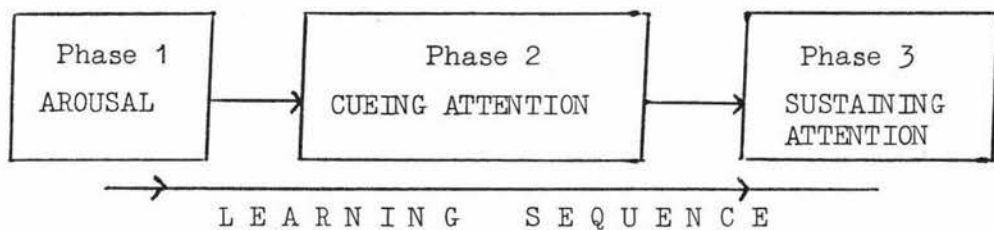
The guidebook is organised in terms of the questions a teacher interested in applying knowledge of attention in learning sequences, may ask. The answers are provided within the framework of the model of attention applied to learning presented in this chapter. References and research are cited wherever possible.

Attention Applied to Learning - A Model for Teachers.

The problem of attention in learning is essentially the teachers, for it is the teacher who must develop techniques that ensure pupil attention is elicited throughout learning sequences so that success in learning may be achieved.

The model presented here, therefore, seeks to assist the teacher to overcome this problem.

Fig.8.1: Model of attention applied to learning.



From the teacher's viewpoint attention can be seen to take place in three phases: arousing; cueing attention; and sustaining attention. The task of the teacher, then, is to design methods whereby pupils will be aroused, their attention cued and sustained until the task is completed.

Arousal is employed in this model, in the same sense as activation. In other words, one must have arousal before one can have attention, attention being a consequence of arousal. This phase can be likened to Neisser's (1967) notion of a pre-attentive stage, particularly in terms of the two classes of movements Neisser believes to be under pre-attentive control, namely guided movements and reorientation movements.

Phase 2, cueing attention, proposes that in order for a learning sequence to be initiated the individual must not only be aroused, he must also know to what aspects of the task he must attend. Essentially then, cueing attention, implies that on stimulus presentation, the learner will be directed to attend to the features of that stimulus in order that he can make an appropriate response. This phase deals with the selective aspect of attention, and it is particularly important in learning for unless the dimensions of the task are understood (that is, the learner

knows to what he is to attend) success in learning is unlikely.

The third, and final, phase of the model is sustaining attention. Although a pupil may be aroused and his attention cued, methods must then be employed to ensure that the task is completed, that attention has been maintained. Like Phase 2, sustained attention is particularly important for without it achievement in learning is impossible.

The three phases of attention in learning are seen to be inextricably linked. Phase 2 and 3 cannot take place without arousal. Similarly, while the cueing attention phase attempts to cope with selective effects of attention, some of these effects will undoubtedly influence sustaining attention. Also methods developed to ensure sustained attention may be used in modified form to cue attention.

Although the model of attention proposed here has not been tested in any way - it is seen, none-the-less, to provide a framework that teachers can apply when investigating the problem of attention in learning. As such it is believed that a critical gap in the capabilities of a large number of teachers can be closed, or at least diminished.

By recognising that attention is essential for learning, having some knowledge of the attentional concept, and being able to apply a model for designing lesson sequences that takes cognisance of attention, the confidence of the teacher and success in the learning situation can only be enhanced.

CHAPTER NINE

ATTENTION IN THE LEARNING/TEACHING SITUATION

A Practical Guidebook for Teachers

Designing learning/teaching sequences involves the teacher in asking a number of questions. What questions need to be asked about attention?

These are three basic questions the teacher must ask. They must say: "In this learning/teaching sequence

- (i) what methods will I use to arouse or activate pupils?
- (ii) what methods will I use to cue pupil attention? and
- (iii) what methods will I use to sustain attention to ensure task completion? "

What methods can be used to arouse attention?

Teachers, generally, seem to have developed adequate methods for arousing pupil attention. Commonly, standardised signal systems are used, like hand clapping, verbal phrases ("Right! everyone looking this way"), and, in some infant classes, the ringing of a small bell may serve to arouse attention.

It is suggested, however, that teachers have failed to fully recognise and manipulate the stimulus characteristics that will elicit arousal. Berlyne's work (Chapter Five), for example, shows that properties of the environment - change, size, movement, intensity, repetition and vividness - can be manipulated to arouse, and indeed, cue attention. Teachers can, therefore, attempt to present stimuli that contain pronounced departures from earlier experience, involve movement of focal objects, and contains vividness of colour, contour and contrast.

Similar principles are used most effectively in motion pictures and television commercials. Those that are compelling or attention getting often incorporate such environmental features to arouse, cue and hold attention.

Teachers themselves can manipulate markedly the stimulus characteristics that elicit arousal. For example changes in voice tone (very loud to a very soft whisper) seldom fails to arouse attention and changes in facial expressions can also be used effectively.

In the interest of clarity could the distinction between arousing attention and cueing attention be illustrated?

In terms of the model of attention applied to learning, presented in Chapter Eight, attention is seen to consist of three phases.

- (i) arousal
- (ii) cueing attention
- (iii) maintaining attention

Arousal of the individual is a prerequisite to either of the proceeding phases, and is used in a similar sense as the orienting reaction.

Cueing attention such that learning sequences may be initiated, implies somewhat more than this arousal function. Not only must the pupil be alert, and looking in the right direction, he must also be able to distinguish the features of a presented stimulus so that an appropriate response can be made to that stimulus. Cueing attention involves much that is discussed under the selective component of attention.

How can a teacher assist pupils in the cueing phase of attention?

Assisting pupils in cueing attention requires the teacher to focus pupil attention appropriately. The teacher must ensure that when the initial steps of a task are presented, they are presented with clarity and explicitness to ensure that pupils understand the requirements of the task in order that it may be completed successfully.

Using reading, can you provide an example?

Reading tasks involve visual discrimination of stimuli, meaning that an individual must learn to identify those features which make a particular stimulus different from all other stimuli. Research shows that this process takes place in two stages. 'The first stage involves learning to attend to the distinguishing

features of a stimulus, while the second stage is learning to quickly identify and remember the feature(s)' (Allington, 1975,22). Search theory, as previously discussed, suggests that on first presentation of two stimuli only the gross features common to both, will be identified, with distinguishing features being more difficult to differentiate.

Depending on a pupil's preparation for, and understanding of the learning task, he will either make a discriminative response to the stimuli or he may instead first respond to the gross featural similarities of the presented stimuli. Therefore, the teacher's task becomes one of focussing student attention appropriately.

If the reading task then, is one where discrimination of letters and words is required the teaching sequence is initiated by directing pupils to look at, or attend to, the distinguishing features of the stimuli. Thus, for example, when easily confused words are presented (what-that) then attention needs to be directed at beginning letters as they are the distinguishing features.

Cueing attention may be accomplished in a number of ways, such as underlining key features, pointing or by verbally directing attention to distinguishing features.

Will accurate discrimination between stimuli lead to appropriate verbal responses?

Not necessarily. In fact Vellutino et al., (1972) suggest that while some pupils can adequately discriminate between stimuli they may not have developed the appropriate verbal association.

Focussing attention on distinguishing features is somewhat meaningless then.

Although focussing attention simply on visual features of the stimuli will not, in all probability, correct habituated inappropriate responses this focussing of attention on distinguishing features is an important step in developing accurate verbal responses in as far as it will ensure that the pupil does not attend only to the features which seem to catch the eye first, like beginning letters, configuration, and length.

Can attention be cued using modalities other than the visual?

Assisting pupils to come to attention or to cue attention may be accomplished by using a variety of modalities; verbal, visual, auditory, or by combining one or more modality. Some interesting research has been conducted illustrating this possibility.

Allington (1974), using kindergarten subjects combined verbal directions with visual cues. A single hue colour was used to emphasise the distinctive features of letter like figures. Results of this study showed that the effect of the colour cue was to direct attention more effectively than verbal directions alone.

Knafle (1973) used visual cues without overt instructions and found that subjects attended to a particular feature or letter position without verbal instructions being issued. Similarly, McCrae (1976) found that a colour border placed around print on a page improved attention. This he attributed to the border providing a kind of perceptual closure for the page which helped contain the reader's gaze.

These studies indicate that focussing attention through the use of a variety of cues effectively increases attending to appropriate featural differences or similarities, depending on the nature of the learning task (Allington, 1975).

The much espoused kinesthetic method proposed by Fernald (1943) can be seen to operate in much the same way. The kinesthetic or tracing method is designed to allow a "kinesthetic learner" to make progress in reading when he has failed to learn by visual-auditory techniques. Because a pupil traces the word to be learned with his forefinger pronouncing its component parts as he does so, he is effectively being forced to attend to all features in the stimulus. Incorporating some of the elements of the kinesthetic method into pre-school and early primary school programmes in particular would be useful in ensuring appropriate cueing of pupil attention.

Reading tasks are not always visual. How can attention be gained in an auditory reading task?

Once again, the teacher's role is to direct the individual to listen for the distinctive features of the spoken words such that a discriminative response can be made.

There are a number of ways a teacher can do this. For example, an individual may simply be directed to listen to the beginning or the ending of the words spoken to ascertain whether the two words sound the same or different. Focussing attention here indicates where the individual should listen in order to be able to make an appropriate response.

The "say it slow - say it fast" technique discussed by Engelmann (1969) would be well utilised in the classroom setting to assist in auditory cueing. In this system the individual is presented with an exaggerated, or distorted, auditory stimulus or stimuli, which emphasises the distinctive auditory element. The individual learns to attend to the discriminative features during the learning task as the teacher highlights the appropriate features through increased emphasis; intonation and exaggeration or extension (Allington, 1975).

The cueing phase is essential then for success in reading and other curriculum tasks?

Yes. Reading tasks, like all other learning tasks, require attention. Success in reading is significantly related to a pupil's understanding of the nature of the reading task presented. Thus success will only be guaranteed when the teaching sequence begins by arousing attention and then directing this attention to appropriate featural characteristics, limiting the possibility of pupils attending to inappropriate characteristics.

The classical experiments of Zeaman and House (1963), comparing retardate with normal subjects, confirmed this. These researchers have found that when so-called bright and dull children are tested on various discrimination learning tasks 'it is not the rate of improvement once it starts, that distinguishes between bright and dull, but how long it takes for improvement to begin' (Zeaman and House, 1967, 204). This suggests, according to Zeaman and House, that dull children may perceive relevant and irrelevant cues differently from bright children, and that, dull children fail to attend to relevant stimulus dimensions.

More recently, Denney's research (1974) has added support for the Zeaman and House argument. He found that the difficulties of poor readers lay not in the total amount of time they spent attending to the problem, but rather in the proportion of that time spent productively examining the relevant stimuli in their visual field. This inability to focus on the relevant stimuli hindered, concluded Denney, the poor reader in the act of reading itself, and also in the process of learning how to read.

In sum, therefore, success in all learning tasks will be improved if the teacher undertakes to focus pupil attention and thereby simplify the learning task.

Once a pupil has been aroused, and their attention cued, the teacher would then need to employ methods to maintain attention?

Yes, in order to achieve, a pupil must attend to the material being presented, and he must sustain attention to the task long enough to complete it.

The importance of this phase of attention is emphasised by Skinner in The Technology of Teaching he suggests that capturing attention is less important to instruction than is teaching pupils to continue to look at and listen to the relevant stimuli.

Skinner would, no doubt, see maintaining attention as manipulable through reinforcement contingencies. How could a teacher employ the principles of reinforcement to sustain pupil attention?

Reinforcers, or rewarding events, can be used by teachers who wish to make certain behaviours, in this case sustained attention to a task, more frequent. A reinforcer is 'a stimulus, the presentation of which, following a response, increases the probability of future occurrence of that response' (Martin and Powers, 1967, 566). In this framework then, ability to sustain attention is a function, primarily, of presenting reinforcement which is contingent upon attending behaviour. Also, therefore, behaviour incompatible with attending goes unreinforced.

Teachers should find this step easy as they have used rewards and reinforcement for centuries.

Rewarding desired behaviour is certainly not new to teaching or teachers, but three important variables of reinforcement may need some thought.

Firstly, if a teacher wishes to increase the attention span of a pupil a logical contingency relationship must be

established between the desired response and the reinforcer. Only when this desired response occurs must the reinforcer be presented. This is a little different from the way the majority of teachers use reinforcement, it is suggested, as many reward behaviour without any contingency relationship identified and pupils then find themselves in a pleasant or rewarding situation without actively having done anything.

The second variable that needs to be taken into consideration is that of the immediacy of reinforcement. Delay in the presentation of reinforcers results in less effective conditioning. Teachers will need, therefore, to ensure that there is room in a lesson sequence for reinforcement to take place.

The final variable of reinforcement to receive attention is that of the teacher as reinforcer. The attention of a teacher to a child can enhance the child's attention - particularly in cases where disruptive behaviour in learning settings is common. A study by Hall, Lund and Jackson (1968) for example, clearly indicated that the contingent use of teacher attention can be a quick and effective means of developing desirable classroom behaviour, including attention to the task.

Proximity of teacher to child is also an effective technique to ensure sustained attention. A study of the effects of teacher attention on attending behaviour of two boys at adjacent desks conducted by Broden et al. (1970), indicated that increasing the appropriate attending behaviour of one of two pupils seated at adjacent desks may be correlated with an increase in the attending behaviour of the second pupil as well. A possible explanation of why the second pupil's attending behaviour increased when a neighbouring pupil received increased teacher attention for attending suggested by the researchers, is that the second pupil got some "spillover" of reinforcement from the teacher (Broden et al., 1970, 202). The "spillover" effect of teacher attention could well be developed and effectively used by teachers attempting to promote sustained attention.

What other principles of teaching can be used to develop sustained attention?

- The two principles, most fully discussed in the literature, are questioning and stating learning goals and objectives.

Stating learning goals or objectives does seem to influence attention. Duell (1974) studying the effect of the type of objective, the level of test questions, and the judged importance of tested material upon post-test performance, concluded that behaviourally defined objectives function by selectively directing attention to information which would not otherwise be considered important (Wittrock and Lumsdaine, 1977).

Stating objectives would appear to operate in a similar way as reinforcement in promoting sustained attention. The premise "nothing succeeds like success" serves to illustrate the point. When objectives are stated, and the programme of learning is constructed in such a way as to ensure that the learner will be successful at each step, illustrating thereby, that goals are being reached, continued attention is likely to be the outcome.

One important point should be made regarding objectives, however. Although stating objectives, particularly specific objectives, has been found to be effective in selectively directing attention, they may not lead to comprehensive learning. Teachers would need to ensure, therefore, that if behavioural objectives are used to assist maintenance of attention, then their programme of instruction is not overly conceptually oriented merely to allow for the measure of attainment of objectives. A balanced programme would need to be instituted allowing for both specific and comprehensive learning.

How can questioning be used in this attentional area?

Questioning can be used to arouse attention, cue attention, and maintain attention - thus it is a technique that can be used at each phase of the attentional process as it applies to learning.

Both Kubis (1948) and Berlyne (1965) claim that all questions act as an effective arousal stimuli. According to Berlyne (1960) the arousal potential of a question is determined by the degree of uncertainty that the question arouses in the individual. This uncertainty is caused by conceptual conflict which arises in the individual when he encounters questions which are complex, surprising, novel, incongruous or incompatible. This finding, that questions act to arouse the individual, has important implications for designing teaching/learning sequences, in so far as arousal precedes attending responses.

And questioning in cueing and maintaining attention?

Preadjunct questions and postadjunct questions may be employed to cue attention and to sustain attention. Research conducted in the 1950's, and reported by May and Lumsdaine (1958), in subject matter and other prose learning, has led to the conclusion that the insertion of questions into instructional material may influence its retention (Wittrock and Lumsdaine, 1977). Inserting questions, it is believed, brings about the maintenance of an attentional set.

Questions have been placed either before the text or after the segment of text to be studied, and have been labelled adjunct prequestions or adjunct post questions. The effects of such questions inserted into instructional material are as follows: 'Adjunct prequestions ... often increase learning or retention of the specific information to which the questions direct the student's attention, but commonly reduce learning or retention of information presented. Compared with adjunct prequestions, adjunct postquestions may sometimes facilitate learning and retention of related material as well as material specifically asked about' (Wittrock and Lumsdaine, 1977, 419).

In other words, prequestions tend to narrow the range of attention by providing the individual with a criterion for acceptable behaviour. Post questions, on the other hand, facilitate both question specific and general learning, because attention is paid to the whole passage, not a particular stimulus within the passage.

Using reading again, can an example be provided?

Frase (1968) studied the role of pre- and postquestions in aiding reading in an article titled "Questions as aids to reading: Some research and theory".

In the reading situation, if postquestions are used, the reading sequence includes: a general attentive response to the text; reading of specific statements; reading the question; emitting an answer; and reinforcement for the correct response. In this situation the specific statements become secondary reinforcers for the attentive response. The question, itself, becomes the discriminative stimulus, because it cues certain processing skills for the attentive response. The reader is reinforced for paying attention and inputting the information.

The sequence of events in prequestions is: the question; the attentive response; and the specific statement which serves to reinforce the attentive response. Here the discriminative stimulus precedes the attentive response to the passage and serves, thus, as a discriminative cue for specific stimuli.

Doake (1972) studied the effects, not only of the placement of questions, but also the type of questions, on learning. He concluded that when liberal type questions are used to guide textbook reading then the most effective position for them is the postreading adjunct position' (Doake, 177, 119). On the other hand, the most effective position when reasoning-type questions are used was in the pre-reading adjunct position. Further, questions of this type and in this position were the strongest facilitators of learning on a long term basis while the use of pre-reading literal questions was found to be the most effective way to facilitate learning and remembering from reading textbooks.

Many of the techniques discussed for arousing, cueing and sustaining attention appear to arise spontaneously from the lesson. Is there, in fact, any need to plan for attention in designing lesson sequences?

Planning for attention is an essential element in designing lesson sequences. Whilst the more commonly used signals to arouse attention - verbal, hand-clapping, ringing a bell - need little or no planning, more imaginative attempts to arouse attention through the manipulation of stimuli characteristics which elicit attention, do require planning.

If, for example, attention is to be aroused by the presentation of a novel stimulus some organisational tasks must be undertaken. It implies that the lesson will be initiated by the presentation of the stimulus which has been prepared in advance and stored in an easily accessible place. It does not imply (i) that the pupils have already seen the stimulus because it was left lying around the classroom, (ii) that the pupils wait while you prepare the material, and (iii) that the pupils wait while you leave the lesson area to get something that should have been within reach to begin with.

The very nature of the techniques discussed to assist in maintaining attention suggest that planning is essential. Similarly when cueing attention, it is necessary to know which are the critical attributes of the task so that attention may be focussed accordingly. This implies that a thorough task analysis has been completed in the planning phase so that during lesson execution the teacher can select those features appropriate to the learning task to direct pupil attention to.

Are there any classroom management principles that can be adapted to assist in the attentional process?

As discussed earlier, the proximity of the teacher to his pupils can have a very important influence on attending behaviour, suggesting that close contact with pupils is important. The size of classes makes this somewhat difficult but a number of management principles should be manipulated

to ensure maximum possibilities for teacher/pupil interaction in the classroom.

Seating arrangements for example are very important. Arrangements that make it difficult for the teacher to physically attend, in terms of proximity, to a child should be discouraged, as should arrangements that make eye contact difficult.

Where class numbers are very large activities should be planned on a group basis thus enabling the task to be based at the group level, and also allowing teachers to interact with group members, attending to them so that they can attend to the task. These situations allow the teacher to easily detect and eliminate distracting behaviour and to reinforce immediately, appropriate behaviour.

Many teachers now plan reading programmes in this way. They cater for three groups of pupils working on a rotational basis, allowing, in many cases, personal contact with each pupil daily. Similar programmes could well be designed in other curriculum areas.

Environmental management is yet another aspect related to attention and learning. For example, easily distracted pupils are best situated in places where distracting objects can be avoided. Better still these objects may best be stored in cupboards or out of sight so that the source of distraction is eliminated.

Opportunities for pupil/teacher interaction may also enhance attention. These opportunities most frequently take the form of conferences, be they formally planned for in the classroom programme or arising spontaneously as the needs of the pupils suggest.

A study of the effect of adult-child conferences on the independent reading of elementary school children showed the positive results of such conferences,

In the study conducted by Schwenn, Sorenson and Bavary (1970), children at various levels of reading competence in an elementary school in Wisconsin, participated in a programme in which they discussed their out-of-class reading with their teacher or a teaching aide. A control group had no conferences. The adults were coached to serve as models for the children (as indicated by their own expressed enthusiasm for reading), as reinforcers (through smiles and praise), as goal setters (helping children move on to more difficult books), and as sources of feedback (such as telling children how many books they had read). In contrast to the control group, children who had conferences read more books and tended to show greater gains in reading achievement, as measured by standardised tests. The researchers concluded that the gains at least in part resulted from the fact that the children in the experimental groups received more attention than those in the control groups (Lindgren, 1976).

Are there any other issues or questions that need to be considered?

Attention, it has been argued, is aroused when stimuli are presented. One question that arises then is, in a teaching sequence, what is the stimulus that arouses attention? When a teacher presents, for example, a book as the arousing stimulus how can he be certain that it is the book and not the writing on the book, or indeed the action of holding up the book, that acts as the arousal source? Obviously there is no answer available to this question but it is raised so that blithe identifications of arousing stimuli are avoided and the complexity of this phase of attention is stressed.

SUMMARY

A brief outline of the ways in which principles of teaching may be adopted to cater for the attention factor in learning has been provided in the preceding pages.

In sum, the educational practitioner, according to the model of

attention in learning proposed, must:

- (i) develop techniques that arouse or activate pupils;
- (ii) develop techniques that assist pupils to cue attention; and
- (iii) develop techniques that ensure attention is maintained long enough to allow task completion.

A number of techniques that could well be developed in the classroom by an ordinary classroom teacher have been presented. Perhaps some of these suggestions raise difficulties or warrant further investigation. To this end, a collection of reference material (sparse though it is) is provided.

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