CHAPTER 1

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Memory does not refer to a single process or structure; in the broadest sense it is a complex higher order process which includes the collection, storage and retrieval of information (Erickson and Scott, 1977). Russell (1975) defines memory as the closeness of fit between an output and an input on some specific dimensions. It is an assortment of cognitive processes, elaboration, and schemas (Kail & Hagen, 1973). Memory refers to the processing - storage - retrieval function of the mind that must be seen as embedded in a context (West & Swinott, 1992).

Memory develops as children grow older, they remember more effectively. There are a number of different factors that coalesce to produce these developmental changes in memory. Memory is reflected in the diversity of the behaviour described in the examples. Memory is not an isolated intellectual skill. Rather, it is intimately involved in many of the child's intellectual and social endeavors. As Flavell (1971) put it, memory is in good part just applied cognition. That is what we call "memory processes", but as they are applied to a particular class of problems. One important implication of this view is that from research on the development of memory we can gain valuable insights into more general changes in children's intellectual functioning.
Another characteristic is that memory refer to different skills in each of the examples. An individual's recognition of a face, for instance, seems to represent a different type of memory behaviour from his preparation for an examination. Both are instances of mnemonic behaviour, but they just represent different kinds of memory skills. The implication is that memory is not a single process or structure. Instead, memory is really a convenient descriptive term for a collection of cognitive processes.

Memory and Cognition:

The concept of cognition is difficult to circumscribe because there are virtually no psychological events that do not involve cognition. It denotes a sequential increase in the structural or functional complexity of a system. What Flavell called "higher mental processes" (Flavell, 1985). Cognitive-developmental theory explains changes in the child's mental representation of the physical world and the social world, including the self, from birth to maturity. These mental representations are the internalized schemas or frames of reference which the child uses in his interaction with the external world (Duregowski, 1977).

Children actively construct, organize, and transform information. The data-processing system must be able to encode input, that is, recognize and/or construct an internal representation of it. It must also have a processing
capacity large enough to hold information and transform it. However, by "chunking" items into composite units, a large amount of information could be contained in smaller units.

Miller (1956) identified "immediate memory", also called short term memory, as the locus of information processing, and chunking as the central strategy for increasing the effective processing space. Chunking may be seen as an aggregate of related facts, concepts or percepts. Chunks tend to enlarge with experience and become hierarchically integrated. Anderson (1983) proposed that two fundamental types of knowledge are stored in long term memory, namely, declarative knowledge and procedural knowledge. The former is the knowledge of facts and concepts, whereas the latter is knowing how to do things. Procedural knowledge operates by automatic processes that are out of awareness and apparently effortless (Schiffrin and Schneider, 1977).

Knowledge is represented in declarative memory as a network of nodes that represent the most basic elements of knowledge. The relationship among nodes is referred to as links. In Anderson's scheme, "The nodes of the propositional network stand for ideas, and the linkage among the nodes represents association among those ideas" (Bert, 1989).

Retrieval of ideas or images from long-term memory involves spreading activation (Collins & Loftus, 1975). Activation controls the rate of information processing and
it spreads through the declarative network from original sources to associated concepts. Information becomes active depending on the current sources of activation (Anderson, 1983). The "firing" (or not) of a node influences the ongoing direction of the activation. Particular nodes may be more or less easily involved in this chain reaction, depending on the relevance of their content to the current situation and the closeness of the association to already activated nodes.

Cognitive development may be interpreted in terms of increased processing space and speed and/or organizational complexity of representational structures. All these yield increasing processing capacity with experience, which is usually correlated to increasing age Kail (1979).

Young children are unable to handle complex or higher-order cognition because this "would require them to attend to and interrelate more pieces of information than their working memory capacity can handle" (Flavell, 1985). Initially, the infant's processing capacity is limited because most experiences are so novel that there are only the most rudimentary structures in place to encode and process them. A great deal of attentional energy is required to hold the experience. Attention is a multidimensional construct composed of such phenomena as strategic scanning, the exclusion of irrelevant stimuli, sustained attention, divided
attention, the inhibition of impulsive action and the selection and monitoring of appropriate responses. Between 5 and 7 years, a shift occurs: Attention comes under the control of inner logical processes such as selective strategies. As children mature, they become more systematic, more flexible and less egocentric. With repeated experience, elements of the task are chunked into aggregates, and mental networks are assembled that allow responses to become automatized or proceduralized, and the experience is processed more efficiently. Children acquire increasingly effective and sophisticated cognitive strategies for encoding and representing information and matching input with memory store. The amount of mental attention or processing capacity required to solve any task decreases with experience.

Relationship of Attention, Perception and Memory:

Attention, perception and memory are three processes that are inextricably entwined and they operate in concert. Without memory and selective attention, apperception would not be possible, the search for and location of objects requires durable mnemonic representations, for it is through them that objects are recognized. Without attention and perception, memory could not be registered. Gibson (1969) describes the child as extracting available information from the stimulus field. The information elicited can vary from concrete (e.g., receiving an object) to abstract (as in the
apperception of a melodic structure or pattern). Perception grades imperceptibly into conceptualization as the child learns the distinctive features of particular objects. Perceptual processes would not be possible without search strategies, selective attention and the exclusion of irrelevant input. Perceptual differentiation proceeds linearly, not in stages. A gradual shift from perception to conceptualization takes place as the child learns the distinctive features of a particular object, the common features of similar objects, and the abstract structure of stimulus arrays. Perceptual processes would not be possible without search strategies, selective attention, and the exclusion of irrelevant input. According to Gibson (1969) perceptual differentiation proceeds linearly, not in stages.

Under the age of 5 years, childrens' attention is captured by the feature of a novel stimulus and is stimulus bound. Between 5 and 7 years, a shift occurs and attention comes under the control of inner logical processes, such as selective search strategies. As children mature, they become more systematic, more flexible, and less egocentric.

Pre-school children can demonstrate accurate recognition memory, particularly when interpretation is not required (Brown, 1975). Later development is characterized by the acquisition of more efficient encoding and retrieving strategies and by the increasingly effective matching of
mnemonic strategies to learning tasks. The older child appreciates when something must be deliberately remembered and has a repertoire of mnemonic skills that can be applied to new learning situations (Myers & Perlmutter, 1978). Kail and Hagen (1982) have reviewed the developmental acquisition of mnemonic strategies. The preschool child tends to rely on nonverbal strategies such as pointing and looking. More complex strategies such as rehearsal, semantic organization, imagery and cueing develop between 7 and 10 years of age. The "primary effect" is seen in children after the age of eight years, which occurs as a result of rehearsal. Not until they are older than 10 years do children regularly use hierarchical categorization or category cues to store and retrieve memories. Between 7 and 10 years, they pass through a transitional phase during which mnemonic strategies are acquired but not consistently exhibited. Adolescents adopt rehearsal to the semantic structure of the material to be remembered, estimate its difficulty, allot sufficient time to study it, and judge how well it has been remembered. Bach and Underwood (1970) have suggested that the fundamental developmental change is the evolution of conceptual memory "a perceptual-to-conceptual encoding shift". Presented with a prose narrative to remember, children over 6 years of age recall the gist of the story rather than its details and are prone to embellish the original story according to logical inferences derived from the abstracted theme. However,
subsequent investigations have indicated that pre-school children are also capable of conceptual strategies in certain circumstances (Perlmutter & Myers, 1979).

Nature of Memory Process:

I) The general process of memory has been outlined by several workers (Broadbent, 1958; Kesner, 1973; Miller, 1956, Warrington & Weiskrantz, 1973).

The process of memory begins with an input of sensations into the organism according to its focus of attention, and this, in turn, is immediately placed into a very brief sensory register called the sensory memory (Craik, 1979).

II) The next stage in the memory process is that of Short Term Memory (STM), a temporary storage that acts as the working memory for cognitive processing. It is a part of the control mechanism of conscious cognitive processing (Atkinson & Schiffrin, 1971). STM has been called primary memory, immediate memory and span memory (Kelley, 1964). The visual memory has been called iconic memory, while the auditory equivalent has been called echoic memory.

III) The third step in the process appears to be encoding and consolidation of items into Long Term Memory (LTM). Material selected from the STM to be permanently recorded is given a code so that the material can be retrieved at a later time (Craik, 1979). LTM has been referred to as long term store, secondary memory or delayed memory.
IV) The consolidation of memories involves two different sub processes: the transfer of material into LTM storage and the consolidation of memory in the storage. Transfer is the movement of material either from STM to LTM storage or perhaps directly into LTM storage from sensory input, guided by STM (McGough, 1966).

V) Storage is only one of the several memory processes. Long term storage consists of a relatively permanent storage of material that has been consolidated. Memory trace is a permanent physical change in the brain (Hebb, 1949, 1961, Zangwill, 1969).

VI) Retrieval is the final process related to LTM and refers to the process of locating and removing material from the long term store. The material that is retrieved from memory is exactly the same as that which was placed in memory.

Several models of memory have stimulated research during the past few decades. Some of the most influential of these are as follows:

I Guilford's Structure of Intellect Model

Guilford (1961) proposed a structure of the intellect (S-I) model for categorizing intellectual abilities. In this model, intellectual abilities are ordered in terms of a three dimensional schema or model. The first dimension--"operations"--consists of five types of intellectual
abilities including memory. The second dimension, "content" has different types of material such as figural (non verbal) concept, symbolic concept (manipulating letters and numbers), semantic concept (dealing with meaningful verbal units) which can be operated on by intellectual abilities. The third dimension, "products", consists of six different ways in which intellectual operations can be applied to a particular type of content.

Guilford has verified the existence of at least 18 to 24 factors (Guilford & Hoepfer, 1971), which include almost all types of memory that have been isolated by various studies. Though it was criticized (Humphreys, 1967), Guilford's model has made a definite contribution in placing memory into a theoretical model of cognitive abilities, resulting in the development of new tests.

II The Multistore Model

Atkinson and Shiffrin (1968) have proposed a three part model of memory involving a) a sensory register that decays rapidly, b) a short-term store with limited capacity, and c) a long term store with unlimited capacity. Short term memory can be enhanced by rehearsal. With development, the child acquires more efficient strategies for transferring memory into long term storage (encoding) or for retrieving it from the long term store. They offer a distinction between the invariant features of memory as determined by the biology of
the organism and certain transient phenomena (e.g., control processes) which are dependent on such factors as instructional set, the experimental task and past experience.

III The Constructivist Model

Piaget (1971) proposed a constructivist model of memory. In accordance with pre-existing knowledge, the child assimilates new information into existing knowledge, constructing the meaning of what is to be stored and reconstructing what needs to be recalled (Norman & Bobrow, 1976). The essential features of the depth-of-processing model are incorporated here, in which the emphasis is on the organism as a constructor of information.

The burden of too much information poses a limit on the pre-school child's ability to encode, retain, and construct new organizations. Over a period of years the automatization of perceptual processing takes place, thereby freeing much of the channel capacity of the central process to perform other activities under conscious control. The automatization information in storage (or schemata) and certain categories of newly received information can now be handled automatically thereby allowing attention to be focused on the task at hand.

IV) The Levels of Processing Model

Craik and Lockharts (1972) modified a model which contrasts with the multistore model which related the
persistence of memory to the depth of processing. Superficial memories based solely on perceptual features tend to be transient, where as memories based on abstracted meaning are deeper and more durable. At the initial levels, physical or sensory features of the external stimulus are processed. At a deeper level, pattern recognition occurs and the meaning is extracted. As the processing becomes deeper, it may involve semantic elaboration and enrichment of the stimulus. The deeper the processing, the more resistant is the memory trace to forgetting. Attention to an item to be remembered can be maintained through the use of active rehearsal.

V The Developmental Model

Brown (1975) proposed three developmental dichotomies, namely, a) strategy versus no strategy, b) mediation deficiency versus production deficiency, and c) episodic memory versus semantic memory. The first dichotomy refers to the tendency of older children to use mnemonic encoding strategies. The second dichotomy refers to the differences in development between the child who cannot and the child who can be taught a mnemonic strategy. The third dichotomy contrasts direct experience of perceptual memory based on the abstraction of meaning.

VI The Tetrahedral Model

Jenkins (1979) proposed that memory tasks have four
unrelated aspects: a) the nature of the stimulus material (e.g., mode of presentation or conceptual difficulty), b) the criterial task (e.g., recognition, recall or problem solving), c) the learning activity, and d) the characteristic of the learner (e.g., mnemonic skills, knowledge or motivation). Boyd (1988) recommended a systematic variation of the first three factors in order to assess the fourth factor.

Prior to 1960, the dominant model in developmental psychology was behavioristic in nature. Behaviorists viewed development as the cumulative acquisition of units of behaviour under the control of the environment, and they eschewed theorizing about internal processes. The classical behavioral theory could not explain the reversal shift phenomenon, and that internal mediational processes must consequently be postulated. During 1960's, the constructivist model of Jean Piaget became increasingly influential. In Piagetian theory, particularly the doctrine of stages, the operational structures of seriation, classification, transitivity and conservation were not found to develop synchronously, as would be predicted, even within each domain of operations, different abilities appear to emerge unevenly. Piaget's theory of the process of developmental change depends upon abstract concepts, which have proven difficult or impossible to operationalize. However, the information -
processing paradigm has been criticized in that it emphasizes strategy execution at the expense of strategy selection. The computer is not a satisfactory analogue for the self-awareness, meaning-seeking, strategy - selection and execution-monitoring person. The difficulty appears to lie in the incorporation of meta cognition into the information processing model. Moreover, in contrast to the behaviorist model, the information - processing approach lacks a powerful experimental methodology.

Scope and Application of Memory:

One important implication from research on the development of memory is that we can gain valuable insights into general changes in children's memory functioning. An understanding of deficits in memory functioning, a frequent concomitant of various mental disorders is of help to the clinician from both diagnostic and rehabilitative points of view. To assess such memory disabilities, batteries of memory tests have been developed. By and large, such batteries have inadequate norms, with certain limitations in their scope and emphasis.

The adult version of Rivermead Behavioural Memory Test (Wilson, Cockburn & Hicorns. 1989) has been used successfully to screen children who cannot cope with memory tasks of everyday life. There have been attempts to assess various aspects of learning and memory using simple tasks. However,
not many attempts have been made to evolve or construct tests from a developmental perspective to assess various aspects of memory in a comprehensive manner.

There is, thus, a need to develop a battery of memory tests and standardize it on a normal sample of children, with extensive coverage of the various aspects of memory disabilities. Such a well standardized battery of tests also can provide an overall measure of memory functions of various modalities. This, in turn, would facilitate clinical interpretation of memory scores and help clinicians achieve a better understanding of the nature of memory in general and would throw light on memory dysfunctions associated with various clinical conditions. Such an effort has not been undertaken in India.

While the tests currently available for use with children may provide useful answers to theoretical questions, they provide little guidance in alleviating practical difficulties encountered by children in academic settings. The present study attempts to meet the demands made on memory by normal daily life without being based on a single theoretical construct. The subtests would be chosen following an empirical study of the memory problems. These subtests tap a range of verbal and visual, short and long term memory functions, all of which are essential to the ability to cope normally with everyday life activities.
Developmental studies in the area of memory functioning have been meagre. The area of memory assessment has grown in response to the need for more reliable and valid tests. Tests should be sensitive enough to make discriminations to differentiate clinical conditions. Moreover, they should also contribute in quantitatively establishing the index of the memory functioning so that findings can be reported in a more objective manner. The present study was undertaken to assess memory development in children.

There is growing evidence to suggest a number of relationships between epilepsy and a range of learning problems (Stores, 1981). Involvement of the hemisphere dominant for speech may result in impairment or delay in verbal skills. Perceptual skills may be affected if the epileptic activity occurs in the nondominant hemisphere. Specific epileptic activity in the left temporal lobe seems to be associated with a wide range of disturbances. Such children may be more anxious, inattentive, overactive or socially isolated. Finally, there may be adverse effects on school performance stemming from the consequences of antiepileptic drug therapy. Pond and Bidwell (1960) found that one third of children with epilepsy had substantially impaired reading abilities.

Voelker, Carter, Sprague, Godowski and Lachar (1989) examined the development of memory strategy, knowledge and
spontaneous use of strategy by 6 to 12 year old boys with attention deficit disorder with hyperactivity (ADD-H). Metamemory knowledge of 12 ADD-H boys unmedicated for study participated, and 12 ADD-H unmedicated boys were compared with 12 normal controls on a structured interview. Use of categorization was assessed using free recall of word lists differing in category composition (acoustic Vs semantic categories) and list organization (clustered by category Vs unclustered). Interview data indicated no difference between groups in development of metamemory knowledge. Analysis of free recall performance showed that ADD-H subjects were less likely than controls to benefit from that knowledge when strategy was less salient and involved effortful reorganization of stimuli. The results were consistent with production deficiency.

In India, developmental studies in the area of memory are sparse. The focus has been on age changes in memory span (Nayar & Sen, 1981; Pandey, 1976 ; Pershad, 1979 ; Pershad & Wig, 1977; Saraswathi, 1976) strategies used in coding and recall (Kool & Agarwal, 1981; Saraswathi, 1977) and relations between memory and experimental deprivation (Mishra & Shukla, 1979). Increase in memory capacity during childhood has been discussed by Saraswathi (1976) as indicating three possibilities. i) An increase in short term capacity; ii) An ability to avoid distracting stimuli and focus attention; and iii) Change in the strategies of coding and retrieval.
Production and mediation deficiency are present in young children (6-7 years). Young children are unable to use spontaneous categorization to aid coding and recall. However, when provided with cues they improve their performance, though not to the same extent as do children in the older age group of 12-13 years, (Saraswathi, 1977). Words are held in short term memory by virtue of the semantic links between them, and these links are age dependent (Kool and Agarwal, 1981).

Assessment of Memory:

Though a great deal of attention has been given to the study of learning and memory, relatively little has been paid to the construction of tests for assessing memory functions in the clinical settings. The most vital need in the area of memory testing is the development of tests especially for children.

Memory tests are used to provide an estimate of a person's memory ability. An alternative explanation is that individual differences in children's memory such as developmental change in memory, variation in IQ, might be attributable to differences in children's use of mnemonic strategies. Some children may use strategies consistently and execute them well, with the result that they remember accurately. Other children of the same age may use strategies poorly, or not at all, and remember inaccurately
as a consequence. Thus, general strategic ability seems to emerge as a source of individual differences in memory. The development of a number of tests that represent different kinds of memory is the first prerequisite for assessment.

The Wechsler memory scale (WMS) Wechsler, (1945), a major clinical test of memory, was used to derive the factor structure of memory. Three major factors were obtained (Bachrach & Mintz; 1974. Kear-Colwell. 1973). The first was primarily composed of the orientation and mental control subtests. The second factor was composed of digit span subtest, and the third comprised subtests such as logical memory, visual reproduction and association. The Wechsler Memory Scale (Russell. 1970) standardized on adult population, with various revisions and extensions of age norms to lower age groups is still a measure of brain damage in general as a measure of memory.

Memory impairment is frequently associated with such clinical conditions as head injury, cerebral tumors, intracranial infections, cerebrovascular accidents, progressive degenerative disease, nutritional disorders, attention deficit hyperactivity disorder, learning disabilities and epilepsy. In such conditions, evaluation of memory plays a vital role in differential diagnosis especially between organic and functional disorders. Objective evaluation of memory is often sought for diagnostic, therapeutic and prognostic purposes.
There seem to be certain inherent difficulties in the development of objective tools to measure such functions in the clinic population, such as comparability of the present memory functioning, with the past, the difficulty in verification of the information related to 'personal' past events, and preparation of items which can safely be assumed to be known to everyone. Keeping these difficulties in view, memory cannot be adequately assessed by one or two tests. Thus, a battery of tests would be required for a comprehensive assessment. Memory testing makes a vital contribution to the understanding of the pattern of damage. It also helps in the localization of damage.

Another function of memory tests is to assist in the diagnosis of a specific organic condition since memory is affected differentially in various conditions due to the involvement of damage to specific areas by the nervous system.

Russell, (1975) pointed out that the area of clinical memory testing is still woefully underdeveloped. Certainly, the theoretical foundations for memory test development now far outstrip the actual construction of clinical tests at this point. Thus the time appears ripe to review the theory and pathology of memory with the aim of providing a basis for the development of a better clinical measure of memory although, no single test is adequate as a measure of
organicity (Boll, 1978). The PGI memory scale (Pershad 1976) is a standardized, comprehensive test of memory evaluation for adults in India. As yet there is no battery of tests of memory for children reported in India.

A Critique of Memory Development:

Developmental changes in memory take place rapidly, however no theoretical model has been provided to explain the observed changes. Developmental psychologists currently emphasize the information processing model (Reese, 1973); yet this model is not strongly developmental nor able to consistently explain changes over the entire life span. It is likely that a better understanding of memory development will come, not from the study of memory alone, but rather from a consideration of the child's ability to organize and control his entire repertoire of cognitive processes and strategies of which only a limited number are specifically useful as memorizing strategies. It was assumed that the general theories of memory are applicable to all ages, although the memory capacity of children is less than that of adults. Information processing theory is yet to generate a rigorous account of the mechanisms of development. It also requires adequate integration of cognitive changes from point to point in childhood into a developmental perspective.

The developmentalists have ignored general models of memory in the developmental literature. When we focus on
quantitative comparisons of a model's predicted results with those of actual data, the developmental literature is barren. Instead, there is an enormous amount of research that can be characterized as studies of "age-related changes". Sometimes this research is simply descriptive, and there is no interest in determining the processes underlying experimental outcomes. The developmental literature is in need of research in which multiple models of processes are formulated that yield precise predictions regarding experimental outcome so that 1) the accuracy of a given model can be evaluated with reference to date and 2) the predictive power of models can be evaluated comparatively.

The present study was undertaken to develop a battery of memory tests for children in order to study developmental changes in memory.