Constructive-Reconstructive Processes in Children’s Memory

Introduction

Psychologists since the time of Ebbinghaus have been interested in the study of memory. Even as early as 1885, when Ebbinghaus published his essay Über das Gedächtnis, he realized that memory and recall of continuous passages of prose or verse would be affected differentially by people’s experiences and prior knowledge. To overcome this problem, or so it seemed at the time, and give everyone an equal start, some psychologists including Ebbinghaus advocated the use of nonsense syllables to determine memory reactions. Such an advocate was Myers (1911) who, commenting favourably upon the use of these methods, said that by employing meaningless syllables, “we have been able to eliminate associations by meaning and to arrive at the conditions affecting the sheer retentivity and reproducibility of a presentation, and to determine the number and course of the associations which are formed among the numbers of a series of such subjects” (p.144).

It did not take long for other psychologists to realize that even lists of nonsense syllables set up a mess of associations which may vary more from person to person than those aroused by common language with its conventional meaning. In addition, nonsense syllables are not necessarily simpler to learn as it has been proved by experiments that trying to connect long strings of meaningless material is in fact more difficult.

Interest in children’s memory initially focused on the development of tests of retention found among subtests in standardized tests of intelligence. Systematic investigation of the developmental change in memory only began attracting the attention of many developmental psychologists about 10 to 15 years ago. This interest can be attributed to three causes. First, developmental psychologists had long been interested in how children learn languages. Much of the research during the 1950s and 1960s hypothesized a stimulus-response interaction. The young child responds to stimuli in his environment while the older child verbalizes and produces verbal labels for stimuli. Psychologists began to question this hypothesis and consequently, research interest shifted from tests of the verbal mediation hypothesis to describing the developmental changes in the acquisition and retention of information.

Around this time, there was renewed interest in Piaget’s description of cognitive development in which the role of the processes of memory played a critical part in a person’s acquisition, organization and use of knowledge. This renewed interest in Piagetian theory changed the nature of research in children’s memory from simple investigation of age-related changes in memory span to more complex studies of the relation of mnemonic development to cognitive development.

A final contributory factor for the interest is the emergence of memory as an important area of study within experimental psychology. During the 1960s, psychologists realized that learning could not be studied in isolation from memory. Also, at this time, information-processing theory, computer simulation and linguistics began to attract more attention and interest from researchers. Later, total interest and attention was focused on an information-processing system in which memory played a key role. This shift from learning to memory helped to create a conducive atmosphere for research into children’s memory.

Memory cannot be studied in isolation too as it “encompasses many cognitive processes and cannot be considered either an isolated mental faculty or a passive storehouse of experiences” (Paris and Lindauer, 1977). As a result, the analysis of children’s memory must be studied in conjunction with the study of perception, comprehension and problem solving. As children develop, they learn complex and creative ways to understand, represent and remember experiences. This paper will review some of the related literature and discuss the constructive and reconstructive nature of children’s comprehension and memory skills.
Constructive and Reconstructive Processes in Children's Memory

According to Stevenson (1978):

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Semantic Integration

Two kinds of semantic integration can be observed. The first concerns children's ability to integrate information given in different sentences. This was demonstrated in a study by Barclay and Reid (1974) who tested five-, six-, eight- and ten-year-old children. Short stories were presented describing critical relationships in either (a) full passive sentences, (b) truncated passive sentences with no actor mentioned in the story or (c) truncated passive sentences with the actor stated in another sentence. Children were told to recall the sentences verbatim. They recalled sentences in active or full passive form significantly more often than for truncated passive sentences with no actor. This showed that children integrated information from several sentences and changed the sentences systematically in recall. It seems intuitive that children as well as adults should integrate similar and redundant features of a message and "look back" to search through previous knowledge in order to either add or delete information.

A second type of semantic integration involves inference making from given sentences to get at additional relationships. Paris and Carter (1973) conducted a study with seven- and ten-year-old children to test their ability to make inferences. Sets of three sentences were presented to the children. The first two sentences consisted of premise statements which allowed for additional relations to be inferred while the third statement was a filler item. A recognition memory task followed in which children were asked to identify the exact statements they had heard earlier. Children reported that they had previously heard the novel inferences that were similar semantically with the premise statements and did so with a high degree of certainty. When this study was replicated on mildly retarded children (Paris, Mahoney and Buckhalt, 1974), it was found that these children too tended to infer relationships among sentences and integrate these into their recall.

Similarly, Bransford and Franks (1971), Coder (1973) and Jenkins (1974), in their experiments with adult subjects, found that their subjects, besides acquiring something more general and abstract than simply a list of sentences experienced during acquisition, also integrated the information communicated by sets of individual sentences to construct wholistic semantic ideas. Subjects thought that they recognized novel sentences which contained combinations of semantic relations never expressed in any single acquisition sentence. Franks and Bransford (1972) modified their 1971 study by using abstract, not-readily-imagined ideas, for example, "The arrogant attitude expressed in the speech led to immediate criticism" and replicated the results once more. Franks and Bransford explained that memory for each recognition sentence is a function of the number of subides it contains in the complete integrated idea. As the number of ideas increases, so does memory for that sentence — or so increases the certainty of having heard it before.

When pictures were used with children instead of sentences, similar results to those of sentences were obtained. The direct comparison between verbal and pictorial integration was made in a study by Paris and Mahoney (1974). They asked eight- and ten-year-old children to remember sets of three sentences or pictures that contained the same theme. Later, when they were required to recall either pictures or sentences, children of both age levels responded with a high degree of certainty that they had either seen the new pictures or heard the information schematically contained and presented earlier. Further, that children were able among the pictures and that this integration helps comprehension and recall.

In addition, when in pictures and information obtained, children remembered when the objects were (Hale and Piper, 1976). Takanishi, 1969; Reese, in a picture (Mandler et al. own schematization and Ross, 1975) have also used memory.

Closely related to the ability to make explicit and implicit memory to remember logical relations (Paris and London, 1974) are the example given by Paris (1973) where Max is taller than Max and Max. Children may infer that John is taller than Max. This type of logical relations is referred to as a "linear array in memory representation" and is often problems. Trabasso's studies done on adults and Handel, 1965; Potts, 1967; in which people learn partial relations for example — leads to constructing a "linear anchoring or ends-inward strategy" to solve comparative problems.

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Closely related to semantic integration of explicit and implicit relationships is children's ability to remember logical, temporal and causal relations (Paris and Lindauer, 1977). In the example given by Paris and Lindauer, "John is taller than Max and Max is taller than Fred", children may infer that John is taller than Fred. This type of logical relationship with three elements is referred to as a "three-term series problem". In a series of experiments, Trabasso (1975) has shown that children are able to construct "linear arrays in memory for transformation inferential relationships" among five- and six-term series problems. Trabasso's findings concur with other studies done on adults (De Soto, London and Handel, 1965; Potts, 1972; Barclay, 1973) in which people learn pair-wise comparative relations (for example - longer, shorter), use them to construct "a linear array in an end-point anchoring or ends-inward strategy, and subsequently solve comparative problems based on inferences".

Children's performance on the five- and six-term series problems and inferential "syllogisms" investigated by Trabasso showed no developmental changes. This led Trabasso to conclude that children and adults devise similar integrated memory representations: "We are forced to conclude that the cognitive processes of children and adults are very much alike" (1975, p. 34).

This conclusion was challenged by Paris and Lindauer (1977) who objected to the way the experiments were designed, specifically subject selection and the criterion training used. Trabasso had specifically trained his subjects over many trials to a high criterion and those children who did not learn all the pairs during training were dropped from the study. Because of this, Trabasso had eliminated all initial age differences in constructive abilities and his conclusion that children performed the judgment and inferences similar to adults is questionable.

In her study to demonstrate that ordered relationships require constructive processing involving temporal and causal sequences, Brown (1975) has shown that children as young as five years can apprehend and reconstruct temporal sequences from pictorial arrangements. A reconstructive memory test with original objects available in which memory for the objects is confounded with correct sequential ordering was used. Brown concluded that even kindergarten children can comprehend temporal relationships - "The superiority of ordered over random sequences suggests that pre-operational children, reconstructing logical sequences, are capable of using inferential reasoning to seek and produce the most probable order of events" (1975, p. 160). In another experimental condition, Brown demonstrated that five-year-olds could construct logical sequential stories that describe pictures and then could use these self-generated conceptualizations as easily as experimenter-provided stories to understand and remember the temporal sequences.

In another series of studies, Brown and Murphy (1975) demonstrated that information about order of events is retained by four-year-old children when it concerns semantic memory and is essential to the story's meaning. Providing an ordered narrative to a sequence of nouns allowed children to "elaborate relationships within a given story context", and this greatly helped reconstructive memory for the sequences.

These studies which demonstrated the integration of logically, temporally and casually ordered relationships is evidence enough that young children are able to sequence events in memory. Age-related differences in performance can be expected in children's spontaneous construction of ordered relationships but extensive training will eliminate most, if not all, change with age.

Memory for Stories

The cognitive processes that enable children to construct, infer and integrate semantic relationships among small sets of sentences and pictures are also the processes essential for their listening and reading skills in more complex tasks. In a few studies designed to investigate children's memory for stories, there is some evidence that children do seem to organize story relationships in memory by using such constructive processes as influence...
and integration. Among these studies is that by Stein and Glenn (1975) which investigated children's recall of narrative stories to determine what structural features of the story were retained. They used Rumelhart's (1974) system of parsing prose to classify relationships in the story. Such units as the setting, activity, goal and consequence of the story were identified. Two different passages were read to first and third grade children, who were asked to free recall the ideas of the stories immediately after presentation as well as after an interval of one week. In general, more information was recalled by older children than younger children, and information was recalled immediately than after a one-week delay. Further, it was found that the semantic categories of events and consequences were recalled most often by children in both grades and all the children elaborated on the original ideas given in the story. Stein and Glenn concluded that children's story recall was highly organized and included many implicit and explicit subunits or ideas. Also, a great deal of elaborations and inferences were observed and there was more constructive processing after one week than immediately, confirming Bartlett's (1932) observation about adult recall. Stein and Glenn also found more inferential and elaborative recall by the third graders than by first graders suggesting a developmental improvement in constructive processing.

Paris and Upton (1976) also suggested an age-related improvement in constructive processing. In their study, children in kindergarten through first grade were read six stories, followed immediately by a series of yes/no questions regarding the information that was either implicit or explicit in the passages. It was found that older children remembered the stories better and correctly answered all the questions more often than the younger children. In addition, the older children made more inferred presuppositions and consequences indicating that the best predictive of overall memory for the story ideas was the child's ability to comprehend and remember implied relationships. The predictive value of inferential processing for later recall increased significantly from the six- to the ten-year-old children. This seemed to point to the fact that the functional value of constructive processing for substantial retrieval from memory appears to increase with age.

The studies reviewed demonstrate that many factors influence the amount and kind of constructive processing applied to stories. In addition, the learning of new information and retrieval over time will result in new distortion to the schematic information (Bartlett, 1932; Kintsch, 1974; Stein and Glenn, 1975). Repeated recall of an experience can also distort memory because it allows rehearsal to be applied to the memory representation.

### The Role of Inference

Fundamental to semantic integration and understanding of stories are the abilities to comprehend inferred relationships and to blend implicit and explicit information together in memory. Inferential processes have proved to be important for memory and comprehension, and the retention of implied relationships in stories seems to improve as a child grows up — between the ages of five and twelve (Paris and Upton, 1976; Stein and Glenn, 1975).

Webster's *New World Dictionary* defines "inference" as "the drawing of a conclusion by induction or deduction". Most of the studies reviewed do not offer a definition, but Paris and Lindauer (1977) offer some "tentative conclusions" regarding inferential processes in comprehension and memory. They state: "Inferential operations are directed, constructive acts that synthesize relationships during encoding, retrieval, or problem solving." Inferences may also be drawn spontaneously as automatic "efforts toward understanding". According to them, inferences allow a person to expand the given information and embellish it with additional idiosyncratic operations and recall increases with age (Paris and Upton, 1976) as does the effectiveness of implicit retrieval cues. The developmental improvement can be traced to changes in the same four factors that influence semantic integration and cognitive processes involved in deducing and inducing probabilistic and logical inferences.

Paris and Lindauer (1976) did three studies to demonstrate developmental improvement in inferential processing. In the first study, seven-, nine- and eleven-year-old children were read eight sentences that contained an instrument that was stated explicitly in the sentence presented. Older children recalled the instrument only if it was stated explicitly in the sentence presented. Older children recalled the instrument whether it was stated implicitly or explicitly. The second study compared the effectiveness of implicit instrument cues for recall.

Although the sentence prompts, the well with explicit cues were read to the older children, the more subtle cues were read to the younger children. The third study examined the role of contextual cues involving the use of tools. In a subsequent implicit statement, effective as retrospective, forced the children to more thoroughly develop the relationships in the passages. The developmental improvement was traced to changes in the same four factors that influence semantic integration and cognitive processes involved in constructing context.
Although six-year-olds had great difficulty recalling the sentences cued with implicit instrument prompts, the ten-year-olds performed equally well with explicit as well as implicit cues. The significant interactions in the two studies between age and type of cue suggest that older children are able to integrate the inferred information in memory and use it to arrive at the entire sentence effectively.

In the third study, children were read a list of ten sentences with explicit and implicit statements about instruments to seven-year-olds. In addition to repeating the sentences, the children were also asked to act out each sentence involving the use of the imaginary instrument. In a subsequent memory test, both explicit and implicit statements about instruments were equally effective as retrieval cues. The procedure apparently forced the children to process the sentences more thoroughly and to construct implied relationships in memory. This procedure resulted in a higher level of recall than in the first two studies and attested to the functional value of inferential, constructive processes in memory.

The Role of Context and Elaboration

Although all stimuli and behaviour are embedded in physical psychological contexts, experimental evidence suggests that adult understanding and retention depend on mapping relationships between the new information and surrounding contextual cues (Bransford and Johnson, 1972; Chafe, 1972; Haviland and Clark, 1974; Jenkins, 1974). Klein, Klein and Bortino (1974) have shown that sixth graders use context to determine word boundaries whereas fourth graders show less use of contextual cues. Although nine- and ten-year-olds can spontaneously map relations and draw inferences from the context, younger children must be directed or taught to use the context.

Despite the limited number of studies regarding children's use of context cues to aid comprehension and memory, many research findings provide indirect support for the importance of context in children's comprehension and memory. For example, in the finding that elaboration enhances recall, the provision of elaborative relations by the experimenter dramatically improved memory for words. When children were directed to construct their own sentence elaborations, they generally remembered the words better than when the experimenter provided the elaborations (Reese, 1977). Providing a relational context expands the available information about the stimuli and adorns the events with additional associations, relationships and cues. With increasing age, children become more proficient in employing their own elaborations to achieve recall with greater effectiveness.

Improvement of Memory Over Extended Time Periods

Empirical support for constructive cognition is derived from evidence of progressive changes in memory over time. Piaget and Inhelder (1973) summarized a number of pioneering studies investigating improvement in children's long term memory. A popular example of a Piagetian memory experiment is the seriated stick problem. At first the child is shown an array of seriated sticks ranging from tallest to shortest. A week later, the child is asked to reproduce the array from memory. A similar request is made six months or a year later. The five- or six-year-old child normally produces a non-seriated array at the first trial but usually gets them correctly seriated a year later. These findings of improved memory over time have been replicated in a number of studies (Altemeyer, Fulton and Berney, 1969; Furth, Ross and Youniss, 1974).

One explanation for this improvement in long term memory is that as new information is acquired through experience over time, constructive changes take place in the memory representation. This concurs with Piaget's notion that the operative level of the child determines, in part, the developmental improvement in memory and is based on the belief that incoming information is actively incorporated with the memory representation and causes constructive changes in the stored information. Although this explanation is only a simplistic view of what really happens, the consistent finding that memory over time changes according to cognitive schematic changes is strong support for constructive transformations in memory and the interaction between memory and other cognitive processes.

The review of literature discussed so far provides overwhelming evidence that children and adults routinely perform cognitive transformations in attempts to comprehend and remember meaningful stimuli. Devices such as chunking, rehearsal, imagery, elaboration and use of context are different kinds of strategies that children can apply to situations in order to understand them and relate experiences to an existing cognitive schema. The constructive process is like a recursive mapping of an event on to the existing schema. Continuous reorganization and reinterpretation occur...
until the event is terminated and the individual scores the derived representation (Paris and Lindauer, 1977). Bartlett (1932) concluded from his studies that memory is a schematic process, people remember a general impression of a passage they have read and a few details; out of these components they constructed or reconstructed a version which they think is a fair representation of the original.

Implications for the Teaching of Reading

Psychologists engaged in memory research were on the whole not concerned with its implications for education, as much as they were concerned with trying to understand the mysteries of the human mind. As such, implications of memory research for the teaching of reading can only be extrapolated from the findings of the experiments conducted.

The structure of memory as information-processing presents a very different view of the nature of learning from that which results from studying learning as building up associations in a stimulus-response interaction. Learning in an information-processing system is achieved through an active interaction with the environment. The understanding of a concept continues to be elaborated even though the concept may never directly be encountered again. As more information about the world is accumulated, the memory system's understanding continues to grow and become elaborated.

The continual evolution of stored knowledge within the memory system has very profound effects on the way new information is acquired. It suggests that there must be a tremendous difference between the way a child and an adult learn. What implications has memory research for reading teachers? Teachers should realize that for a young child, each concept encountered has to be built up from scratch. A great deal of rote learning must take place during the initial construction of the "data" base. Understanding is only slowly elaborated as properties are accumulated, as examples are learned, and as the class relations in contextual mapping evolve. One of the axioms of instruction for concept development is that there is no substitute for direct experience. If we want children to really know about lions, we should take them to the zoo or, better still, to their natural habitat to observe lions in action. I will gladly agree that direct experiences enhance and enrich children's concepts, but at the same time, I will agree that the realities of classroom instruction make it impossible to rely entirely on direct experience as a vehicle for concept development. When direct experiences are not possible, teachers should shift their emphasis towards searching for concepts already known to children and then developing new concepts from those that are known. In other words, comprehension consists of relating the new to the known.

Since understanding evolves through a combination of external evidence and internal operations, teachers should realize that it is extremely unlikely that any two children will develop in exactly the same way nor possess the same concepts to represent the world they experience. The implication of this for classroom instruction is that in order to introduce reading to a young child successfully, the teacher should try to match the language of the book with the language of the child, thus encouraging the child's intelligent use of context. If reading materials are within familiar sentence patterns, that is, similar to those he has used in speech and writing, he will be able to comprehend them much more readily. In order to ensure that this parallelism can be accomplished, reading teachers should utilize the child's experience stories and those of his peers as much as possible during the introductory stages in the reading programme. In other words, use the language experience approach to teach beginners to read.

The use of children's experience stories or charts also enables the teacher to develop children's ability to construct logical sequential stories that describe events in their lives. Through discussions and questions during teacher-pupil conferences to elaborate on their stories, teachers can help to develop children's reconstructive memory for stories and this ability will be useful in helping them to comprehend better oral and written discourse.

Educators have pointed out that our primary school children are able to read word correct but most are unable to comprehend what is read. If this is true, then these children have difficulty learning from reading. From discussions with teachers in some junior colleges, this appears to be the problem for many students in pre-university classes as well. These students and those in the primary schools would seem to lack the ability to make inferences from what is read and integrate the inferred information to arrive at the information required. To counteract this, students should be taught to grasp both textually explicit and implicit meanings and to relate them by generalization. The inability to construct implied relationships would result in a lower level of recall, thus affecting comprehension.

Conclusion

Reading as inherently a form of communication cannot help but lead in accordance with the axioms of the topic under discussion. Simply put, what has been described is a deal of inferred information, the ability to interpret the dialogue between the child and the teacher, hence we interpret the data and create a perception of what children comprehend when we inform us, persuading us to accept that we need to develop the development of the teaching of reading.

The investigation points to the need for a wide variety of new materials for primary school use which furthers understanding of the world and encourages children to read and in turn help teachers to develop reading programmes which will challenge their ideas.
affecting comprehension. Some may argue that the fault lies in the teaching and questioning techniques used. Few would disagree that the classroom teacher can help students improve if they improve their questioning techniques and create a classroom environment in which students know that it is not a sin to be wrong. However, it is not my intention to explore this hypothesis in this paper.

Comprehension is active, that is, the reader cannot help but interpret and alter what he reads in accordance with prior knowledge about the topic under discussion. Comprehension is not simply a matter of recording and repeating verbatim what has been read, but involves a great deal of inference making. Comprehension is a dialogue between the author and the reader, and hence we interpret statements according to our perception of what the author is trying to do—inform us, persuade us or direct us.

Conclusion
Reading as information-processing behaviour has not given us that much new information. Its real contribution to the teaching of reading is found in the integration of scientific information from a wide variety of sources and the organization of these data into a coherent concept of reading which furthers one's understanding of how children read and in turn helps us understand how we as teachers may better help them.

The investigation into constructive processes should have some implications for the teaching of reading. Educators and psychologists believe that reading is a manifestation of all the skills of thinking. In the past, the teaching of reading has often been concerned with sound-symbol (phoneme-grapheme) correspondences in decoding the printed word. In more recent approaches, such as the language experience approach, it is argued that reading is greatly dependent on semantic and inferential processes (Stauffer, 1969). Successful comprehension and memory during reading depend on reorganization, inference and evaluation of the meaningful relations described. Horn (1937) described this process in the following way:

The author . . . does not convey ideas to the reader; he merely stimulates him to construct them out of his own experience. If the concept is already in the reader's mind, the task is relatively easy, but if, as is usually the case in school, it is new to the reader, its construction more nearly approaches problem-solving than simple association (p. 154).

Learning to read does not occur simply as an information-processing act isolated from the dramatic effects of the child's emotions, attitudes, personality, motivation, attention, and cultural and language backgrounds. Memory research will bring us new insights into the learning process, but it does not deal with human interrelationships present in the teacher-pupil interaction which I, for one, believe are of utmost importance for a child's success in school.
References


