Subject	PSYCHOLOGY
Paper No and Title	Paper No. 11: Human Development
Module No and Title	Module No. 15: Information Processing Approach to Cognitive Development
Module Tag	PSY_P11_M15

Principal Investigator	Co-Principal Investigator	Co- Principal Investigator (Technical)
Prof N.K.Chadha Head and Professor, Department of Psychology, University of Delhi	**Dr Jaswinder Singh** (Principal) and **Dr.H.V.Jhamb**, Associate professor SGTB Khalsa College University of Delhi	**Dr Vimal Rarh** Deputy Director centre for e learning Assistant Professor, Department of Chemistry, SGTB Khalsa College, University of Delhi *Specialised in : e-Learning and Educational Technologies*
Paper Coordinator	**Author**	**Reviewer**
Dr. Rajni sahni Associate Professor Department of Psychology Daulat Ram College University of Delhi	**Dr. Rajni sahni** Associate Professor Department of Psychology Daulat Ram College University of Delhi	**Dr. Chavi Bhargav Sharma** Director Faculty of Managemnt Studies Manav Rachna International University
Anchor Institute : SGTB Khalsa College, University of Delhi		

TABLE OF CONTENTS

1. LEARNING OUTCOMES

After studying this module, you shall be able to understand:

- What are the different Information Processing Approaches
- IPA from a Developmental perspective
- How Attention, Memory and Metacognitive abilities develop in children

2. INTRODUCTION

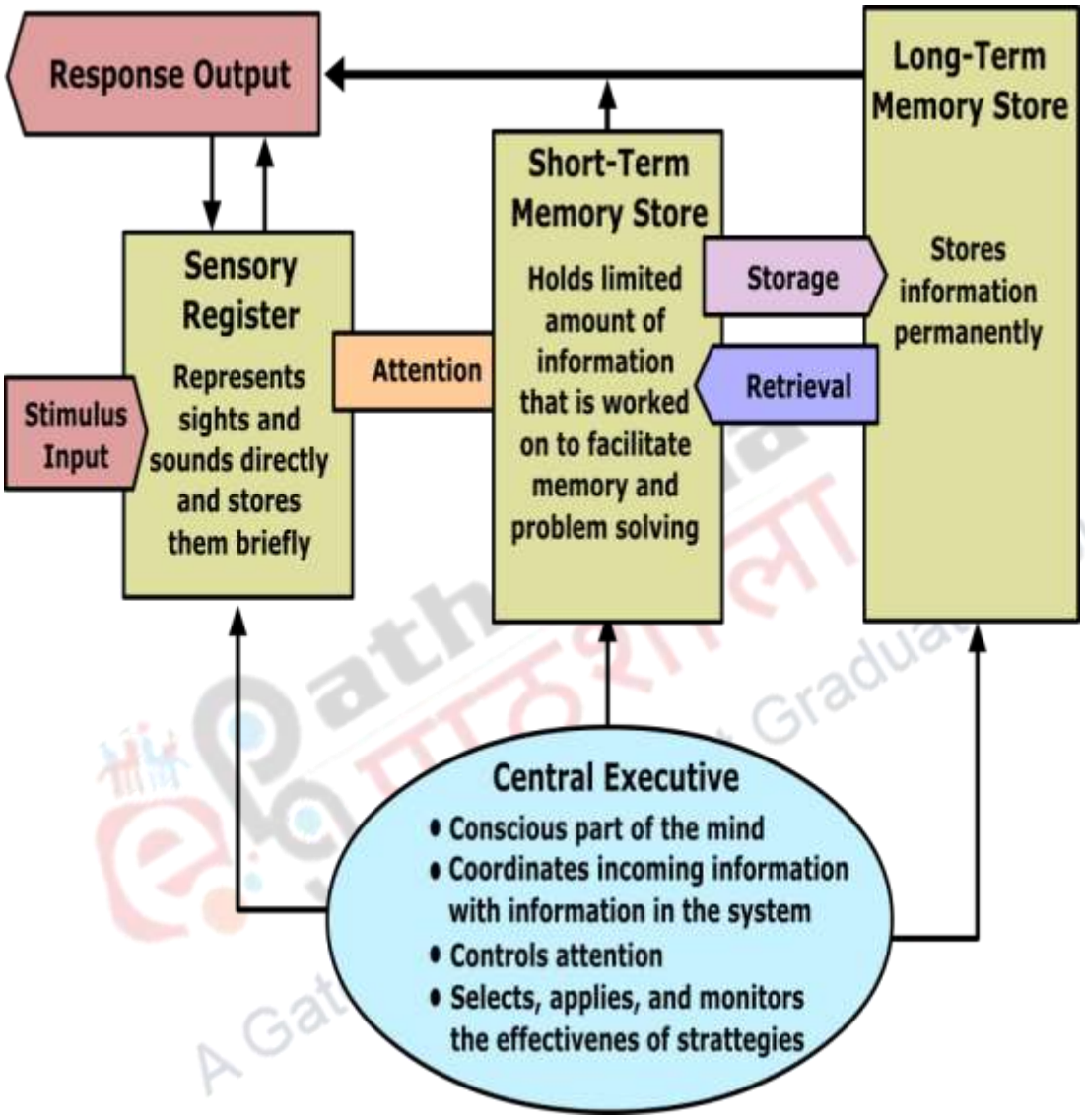
Behavioral scientists considered human behavior in the lines of Stimulus and Response disregarding any mental causal agents. According to them only what was observable was deemed to be empirical. Information processing approach to cognitive development projects that human beings process sensory information that they receive from their immediate environment mentally and not merely respond to sensory stimuli. Mental processes take place in the sequence of Registering, storing and retrieval of information and is precursor to any behavioral outcome, be it that of activation or inhibition.

3. MODELS OF INFORMATION PROCESSING

The initial ideas that emerged as the information processing view were that of computer like cognitive systems that considered brain a storage system. This Store view emerged in the late 1960s and the early 1970s. The store view considered sensory register and memory at its core while another relatively recent view is of Connectionism, related to the understanding of cognitive change and functioning.

3.1 Store Model

Atkinson Shifrin in 1968 introduced a store model of the human information processing system. This comprised of a *Sensory Register*, *Working/ Short Term Memory*, and a *Long Term Memory*. The sensory register holds information of sight, sound, touch and olfaction storing this information very briefly. Working memory or short term memory is more restricted and focused. It is the information we make sense of and keep in store for operation. For example if the line you read in this module says to turn over to page 3 after you complete this paragraph, you will be using your working memory to store that information and retrieve it for jumping to page 3. Central Executive is a part of working memory that directs the flow of information. It sifts the new information on basis of meaning, for importance or significance, coordinates between old and new upcoming information and monitors the strategies to accommodate both. The central executive is also considered or referred to as the *Metacognition.* Long Term memory is where information is stored with relative permanence. It is the largest storage area. For example mathematical concepts studied in class 7th that you still remember are stored in your long term memory.



3.2 Connectionism

The theory of Connectionism deals with the processes that take place in the brain when children master new skills, or perform a mental task. Thus this theory deals with the changes in brain taking place with experience and growth. Neuroscientists use computers to simulate brain neural networks. These connections are artificially manipulated or strengthened and their effects on cognitive capacities studied. These artificial neural networks simulate the brain's complex neural networking and structure. It comprises of an input layer, responsible for encoding of task; one or more hidden layer(s), storing information needed for performing a task; and an output layer that generates a response. The human brain works simultaneously with its different units working

altogether in a parallel fashion. This is why the artificial neural networks are also called Parallel Distributed Processing Systems.

4. DEVELOPMENTAL THEORIES OF I.P.

The models mentioned above only explain how information may be processed in the human brain but neither takes up a purely developmental perspective. There are two basic theories that take a developmental route. The first is Case's Neo-Piagetian Theory and second is Siegler's model of Strategy Choice.

4.1 Neo- Piagetian Theory

This theory incorporates Piaget's stage theory along with certain changes in all the stages of development described by Piaget. It is a theory of cognitive change and what factors influence change at each of these levels (Sensorimotor, Preoperational, Concrete Operational and Formal Operational). The first factor contributing to this change is the Brain Development of the infant. As the infant is growing, it undergoes varied changes in the brain structure, forming newer connections via synaptic growth and discarding redundant ones via synaptic pruning. Cognitive capacities lie in a particular bracket for every age determined by number and strength of these neuronal connections. The second is practice with schemes and automization. Automization of information takes place when a particular processing is so well rehearsed that it requires minimal mental/ cognitive effort and space such that the schemes become well embedded in and easily retrievable from memory.

Case in his studies with children found that they show increase in capacity to coordinate the number of tasks dimensions with increasing age. This theory has been applied to arithmetic word problem tasks, story comprehension, picture drawings, sight-reading music, handling money and interpreting social situations. (Case 1992,1998). The theory proposes the concept of *Continuum of Acquisition* which holds fast the view that many understandings appear in specific situations at different times rather than all at once.

4.2 Siegler's Model of Strategy Choice

Seigler's Model bases itself on more recent evolutionary perspectives of cognitive development. According to Seigler the strategies that a child may choose or select to solve a challenging problem may be determined by experience. Certain strategies are more frequently used and 'survive' the test of time while others die off. '*Variation'* and *'selection'* is claimed to be an evolutionary characteristic of the mental strategies as well and not just physical attributes. The research Seigler used to study these strategies were known as microgenetic research design by presenting children with problems to solve and observing the strategies used by them. Children followed overlapping-wave patterns for basic math facts. This involved trying varied strategies and progressing to more advanced forms. Children select strategies on the basis of accuracy and speed. They try varied methods and then choose the best ones refining them or combining methods to reach upon the most accurate and speedy ones i.e. the most efficient strategy. Seigler's finding regarding the children's strategies for problem solving depicted that children vary their methods even when presented with the same problem twice or a similar one. Also no two children use the same strategy. He implicated this variability in strategy selection to be an adaptive developmental feature since these may contribute to newer ways of thinking and cognitive advancements.

5. ATTENTION

Attention system is the most basic and primary cognitive system for the input and registering of information or any higher order cognitive functioning. Attentional system is what mostly filters incoming information, participates in selecting information or orienting sensory organs to external stimuli.

5.1 Sustained Attention

Sustained attention is an important contributor to goal directed behavior. The child needs to be less distractible by novel stimuli and have increased capacity to hold attention to single particular event. Something like building a train track from pieces. Infants' attentional responses are judged using eye catching novel stimuli, slowing of heart rate which is an indicator of sustained attention, longer looking time at a particular toy object or event. It has been seen that infants and young children focus longer on complex visual stimuli like movie/video clips. It is in toddlerhood that researchers have claimed a child to display goal directed and intentional behavior. Sustained Attention is also associated with selectivity of attention.

5.2 Selective Attention

Selective attention involves focusing on particular information/ stimuli in the environment while inhibiting other competing ones. This ability for selective attention increases with age. Researchers have found that selectivity of attention increases sharply between 6 and 10 years of age (Goldberg, Maurer & Lewis, 2001).

As mentioned before Sustained Attention depends on Inhibition. Sustaining attention doesn't simply involve orienting and focusing attention toward stimuli it also involves active inhibition of orientation to other distracting stimuli. We are constantly bombarded with multisensory input from our environments. If we did not master inhibitive control, every other sensory stimulus would distract us from the course of action being pursued. Mastery in complex inhibitory tasks in children comes around early to middle childhood.

Miller and colleagues worked with 3- to 9- year old children on their attentional strategies. She proposed that there were four kind of deficiency each specific and corresponding to every age group. She enlisted *Production Deficiency* i.e. the preschoolers rarely ever engaged in any strategies; *Control Deficiency*, children produce strategies but sometimes and very often inconsistently and thus display not controlled execution of these strategies; *Utilization deficiency* where young children use strategies consistently but lack any significant progress or improvement in performance; and finally Effective Strategy use displayed by mid-elementary school years in which case there is a consistent use of strategies leading up to improved performance on the task.(Miller, 2000).

5.3 Planning

Goal directed behavior begins in toddlerhood and progresses in its complexity uptil adulthood. The difference between goal directed behavior and its execution between toddlers is not just of complexity but also that of control. The indicators to Planning, which means strategizing and thinking ahead in time of regarding the allocation of resources to particular task units, are evident even in infancy though not mastered until ages 7-9 years. Research done on 2-3 month old infants has displayed precursors to effective planning.(Wentworth & Haith, 1998). This skill is usually strengthened with practice in everyday situations like parents teaching children

to plan their day/week ahead or planning a vacation. Planning discussions with parents, during the age of 4-9 years, was found to be a related to planning competence in adolescence (Gauvain & Huard, 1999).

6. MEMORY

Attention is said to improve memory strategies for retaining information in the working memory store and its transfer to the long term store. Memory retention increases with age as the baby grows its capacity to store information increases. Even though infants hold memory capacities and this capacity only grows with time, it's not until middle childhood that their strategies are efficient and mastered.

6.1 Strategies for Storing Information

The basic strategies used by humans to store information to the working memory or even long term memory system are Rehearsal, Organization and Elaboration. Rehearsal involves repetition and rote memorization. It might involve somewhat deeper processing like Organization. It has been found that to store information more effectively there is an innate tendency to group and categorize objects when presented randomly. Even infants hold the tendency to group objects and beings in categories even if it is superficial (based on physical characteristics).

Even as old as 7-8 year olds much time show deficiencies of inconsistency in rehearsal and even when they use these techniques they are not always successful on the task. It is found that it is between ages 8-10 years that in children, organization is used successfully and consistently. As the brain develops in case of older children, the ability to apply multiple strategies simultaneously increases. This results in much more speedy performance on recall or memory tasks as well as experimentation with different strategies. The child may arrive upon particular strategies that may be more effective and productive in certain conditions while others may be more effective with different other tasks.

Children start using elaboration by end of middle childhood and it further becomes more popular and productive towards adolescence. Children might derive associations between two events, objects or words to hold them both in memory even when they do not belong to similar category or hold perceptual similarities.

6.2 Retrieving Information

The third component of memory is Retrieval. Retrieval of information from the storage facility of the brain involves recognition, recall and reconstruction of information. These are the three forms in which retrieval of stored information is studied.

6.2.1 Recognition and Recall

Recognition and Recall: Habituation research provides a rich pool of data and evidence on recognition capacity in infants and even neonates. Though the number of stimuli that can be recognized at one point of time only grows with age, the near adult level of recognition is achieved almost during the preschool years. Recognition is implied to be an automatic process considering its innate nature as observed in very young infants and its tendency to grow at such a fast rate and mature as early as preschool age. While recognition begins early Recall of stored information is studied to appear by the end of the first year that too for memories which are strongly cued.

Deferred Imitation is implicated in Recall memory research and it grows rapidly by the end of 6 months of age. In early childhood the rate of recall is drastically poorer than rate of recognition of previously presented stimulus. Language development during the preschool years improves recall rates drastically. Language development research stresses the importance of enhanced mental representation of objects and events as child begins to use language effectively. Thus it is implied that better representation leads to increased performance on recall.

6.2.2 Reconstruction

Reconstruction: is used when a large amount of information needs to be stored and rote learning may also not help. For example: preparing a long answer type question. Here instead of learning word by word students make associations and meaningful connections, filter information for meaning and concepts and reproduce the same in their own words which might not be identical to the material or books the student studied the topic from. Children also reconstruct using strategies like condensing, integrating, and adding information. By 5-6 years of age children remember gist and important segments of stories while forgetting or leaving out the unimportant particulars, sequencing the events in order and a logical fashion. This gist is also referred to as 'Fuzzy' and vague version of a story. This gist carries the essential meaning of the sequence of events that have taken place. It has been seen that despite the fact that adult memory capacities can hold verbatim of stories, there is an evident bias towards these 'gists'. The theorists abiding by this view refer this theory as The Fuzzy Trace theory

6.3 Knowledge Base and Memory Performance

Knowledge and its width has been claimed to improve memory and better storage by increasing the information's meaningfulness and hence deeper semantic storage. Knowledge is thus considered after many studies done in this area (Michlene Chi, 1978) as an influential source of improved memory and processing of information. The relation between memory processing and knowledge is now believed to be bidirectional and supports each other.

Scripts are general descriptions of what occurs and when it occurs in a particular situation and are formed out of interaction with people and objects in the immediate environment. These scripts have socio-cultural influences as well. Every day and the wide knowledge base system that each individual holds is stored as Semantic memory. Semantic knowledge grows out of episodic experiences though eventually the individual holds little recall of particulars about how or when did the acquired the knowledge and only the knowledge or information remains. For example: knowing the capital of India. Scripts are said to support taxonomic and categorical information which children usually master by 7years of age.

7. METACOGNITION

As the child grows the child's knowledge and skills become more deliberate and controlled. The child eventually develops greater awareness regarding his own problem solving capacities and strategies and develops insight into these processes involved in mental thought. This awareness in thought is known to be Metacognition. Just like attention and memory, metacognition also grows during childhood and is associated to the development of what researchers refer to as the Theory of Mind.

7.1 Theory of Mind

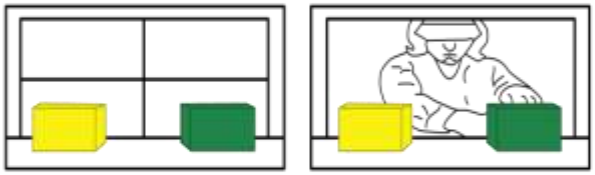
Theory of mind is considered to be a mind reading of people's intentions and the insight that other people possess an intentionality that may or may not be different than one's own. Metacognitive processes include knowledge about cognitive capacities that one may have. Initially developmental researchers proposed that it isn't before the age of 4 years of age that children develop a theory of mind but later experiments proved that it wasn't so. Young infants also displayed clues to the theory of mind and an understanding of internal representation of objects in other people that may be different than theirs. While preschooler's knowledge of working memory is limited, school age children have more complete grasp of cognitive processes. By the age of 10 years children can make differences between "remember", "Know", or "understand" means better certainty than words like "guess" "estimate" or "compare". School age children are more aware regarding mental strategies than preschoolers.

Theory of mind in infants and early childhood has been studied using false belief tasks to understand children's understanding of intentionality and mental states of other than themselves. As mentioned previously violation of expectation and eye tracking methods are used to record child's responses.
Baillargeon and colleagues have studied theory of mind in 15 month old infants using violation of expectation. The following image shows the test trials used to study infants understanding of others false beliefs.

Familiarization trials

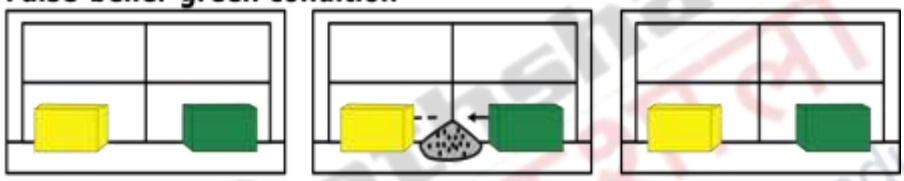
Trial 1

Trials 2 and 3

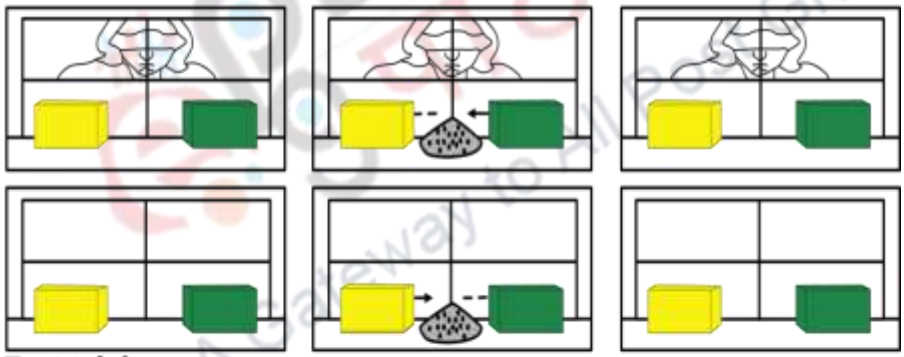


Belief-induction trial

False-belief-green condition

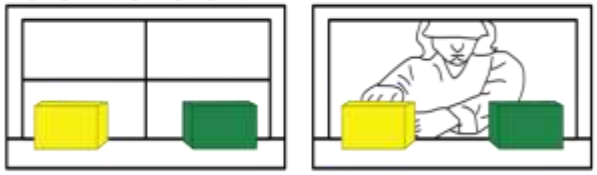


False-belief-Yellow condition

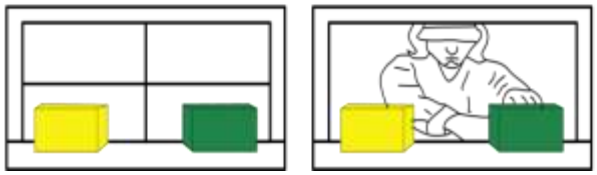


Test trial

Yellow-box event



Green-box event



7.2 Cognitive Self-Regulation

Cognitive Self- Regulation is another metacognitive activity which involves monitoring strategies employed with respect to the problem and the probability of solving it with success, checking outcomes, and re allocating resources in case of unsuccessful attempts. Cognitive Self- Regulation is a higher order cognitive function and is considered to be a strong predictor of academic success in adolescence. Parent child interaction is a good determinant of efficient Cognitive Self- Regulation. Using methods such as explaining effective strategies, like telling why to do a certain thing and not just what to do, is particularly helpful. Children whose parents guided them and helped with problem solving back at home were much more resourceful with multiple approaches and strategies to a problem.

8.APPLICATIONS

Application of information processing approach in area of child development is found in development of children's academic skills. The focus is on identifying specific cognitive skills in different areas of academic functioning, strategies that will improve the child's performance, generating awareness between good and poor skills, etc. Based on research in this area, developmental psychologists hope to design teaching methods that may improve children's learning capacity. Many developments have been made in Reading skills, Mathematical skills and Scientific Reasoning.

9. SUMMARY

Information Processing Approach focuses on the mental processes often called cognition. It deals with how performance on a task is regulated by internal cognitive abilities that develop and mature over time. The precursors of this ability show from infancy. Human beings are gifted with cognitive and metacognitive abilities that distinguish them from other beings. These cognitive processes include Attentional System which incorporates selection of information, focusing and maintaining attention and inhibiting as well. Memory system is aided by different processes of Attention and is responsible for storage and retreival of information having varied components(Sensory memory, working memory, longterm memory). Finally the higher order cognitive system is the metacogntive system that children develop through experience with solving problems and controlled guidance. It matures later than all the other systems and deals with awareness regarding strategies employed by self and others.

The central criticism of information Processing Approach has been that it has been unable to develop a wholesome and comprehensive model of processing. It organizes cognition into separate components and the problem has been in reassembling these components. Imagination and Creativity is one aspect that a computer model of cognition cannot explain. These topics are more human and are gaining considerable popularity in research and the Information Processing Approach has yet to develop an explanation for it. Its perspective is accused to be linear and logical to explain such real life experiences. Despite these drawbacks the approach displays a promising future in areas of cognitive neuroscience and development.