

Cognitive Processes

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INTRODUCTION

This chapter presents a brief report on the trends of the research carried out by students of psychology and education on cognitive processes during the last few years. It is for the first time that "cognitive processes" have been given special attention in a survey of educational research. This event marks a welcome change in the attitude of educationists in the context of what has been taking place on the contemporary educational scene on the one hand, and in the realm of other sister disciplines, on the other. Cognitive processes have represented a major topic of research in the field of psychology since decades. The literature has been so voluminous even in this country that in every survey of research in psychology since 1971, cognitive processes have received separate treatment (Gupta, G.C. 1980; Tripathi, L.B. 1988; Mishra, R.C. in press). The field has been characterised not only by empirical focus, but also by theoretical concerns.

Broadly speaking, cognitive process refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered and used (Neisser, U. 1967). It represents a group of processes by which the organisms obtain knowledge of various objects of their environment and make use of this knowledge to achieve solutions to their problems. These processes range from the

simple perceptual to the more complex thinking and reasoning processes. Recognition, labeling, analysis, categorisation and planning are considered some of the basic cognitive processes. These are often viewed as intellectual, and it is believed that through these processes people try to comprehend their environment and achieve solutions to a wide variety of problems that they encounter.

Due to its widespread usage, the study of cognitive processes has for a long time been fundamental to all researchers who have some concern with the acquisition, retention, retrieval and utilisation of knowledge. For example, learning theorists have always shown concern with the formulation of general principles of acquisition of knowledge and skills; developmental psychologists have tried to understand the growth of knowledge and skills as a function of the biological maturation of human organisms, and their ever-increasing and qualitatively changing interaction with the physical and social worlds surrounding them; psychometricians have attempted to develop tools and techniques for the measurement of the skills and abilities of individuals; and educationists have been concerned with the application of psychological knowledge about individuals for teaching a variety of skills in the most effective ways.

Such a widespread interest of scholars of different disciplines in the topic has

generated not only a sizable amount of empirical work, but it has also led to the proposition of a number of theories about cognitive processes and their development. Historically, the emphasis on the study of cognitive processes finds its roots in the cognitive tradition reflected in the pioneering works of Wertheimer, Tolman, Lashley, Bartlett and Freud. In one way or another, all of them were concerned with what goes on inside the "black box" of the organism, and they all emphasised the role of mental processes and activities often exhibited in a holistic and hierarchical fashion. In later years, great figures like Lewin, Piaget, Werner, Bruner and Witkin represented this viewpoint in their studies of cognitive development. Among others, Piaget and Witkin have been the two most influential figures. Both have proposed their theoretical frameworks to comprehend the basic processes underlying cognition, and have demonstrated the utility of the cognitive processes in adaptation of individuals to the demands of the social and cultural environments in which they carry out their day-to-day activities.

TRENDS IN RESEARCH ON COGNITIVE PROCESS

In order to comprehend and assess what has been going on in the field of cognition in this country, we need to know about the trends of development reflected in other parts of the world in respect of the concerned processes. Broadly speaking, two major traditions of research on cognitive processes currently seem to be in evidence. One is the tradition of hard-core "experimental research" in which the major emphasis seems to have been placed on describing how an individual receives information, transforms it into somewhat familiar meaningful codes, recollects it when needed, and makes its effective use in solving a wide variety of problems. An information-

processing approach to behaviour has been adopted in these studies. The computer analogy has often been used to comprehend the nature of information processing. Consequently, behavioural outcomes have been widely viewed in terms of the "levels of processing" of information and the "use of strategies" by individuals. Variability in these aspects tends to account for significant variations in behavioural outcomes such as the degree of learning, retention or problem-solving. Since a number of organismic and task-related variables can influence the level of processing as well as the use of strategies, much effort has been devoted to the identification of such variables and the assessment of their probable effects on cognitive outcomes of individuals.

A second tradition is represented largely by "developmental research" in which the concern is to examine the growth and development of cognitive processes from biological (maturational) and socio-cultural perspectives. In this approach, the evolution of various cognitive processes is systematically traced from early infancy to the whole developmental span of individuals. Both qualitative and quantitative changes occurring in cognitive structures and functions at various age-levels are analysed and described in a developmental sequence. The emphasis is placed on the child's own activities in the course of its interaction with the surrounding environment. The extent to which different environments provide different opportunities for learning and place certain cognitive demands on individuals or groups in their day-to-day living determines not only the extent but also the direction of the individual's cognitive development. Differences in the level of processing and the use of strategies have been found to be associated with variations in both physical and cultural features of environments (Berry, J.W. 1976; Berry, J.W. et al., 1986; Mishra, R.C.; Sinha, D. and Berry, J.W. in press).

MAJOR ISSUES IN RESEARCH ON COGNITIVE PROCESSES

The research pursued on cognitive processes has posed a number of issues which are still very much under debate. The issues appear to be of vital concern, particularly in studies pursued in the tradition of "developmental research".

The nature and course of development of cognitive processes is one of the most important issues. The questions asked are: Do cognitive processes unfold in a clear, systematic, predictable manner, or are the trends of development less clear, less systematic or less predictable? Is the trend of development linear from early infancy to adulthood, or is it a non-linear trend exhibiting a "step-like" character in development? The findings are not consistent, particularly for the second question.

The dimensions of development of cognitive processes represent a second issue of concern in research in this field. The qualitative and quantitative aspects of development have particularly been in focus. The contents of different individuals' cognition do present evidence of qualitative differences, but quite often these qualitative aspects are quantified, and a general conclusion about an individual's cognitive competence is drawn. While qualitative differences can be easily evaluated on a "horizontal plane" which characterises a value-free bipolarity in different individuals' cognition, quantitative differences are evaluated on a "vertical dimension" in which individuals placed on the higher pole are characterised as "better", whereas those placed on the lower pole are characterised as "poor" in terms of the concerned cognitive processes. Thus, some individuals are considered as more able, competent and intelligent than others. The question is: Intelligent for what? Able for what? Competent for what? Does a higher score on a test or task really mean a better individual in all respects? The conceptualisation has

generally been ethnocentric.

A third issue relates to the direction of development of the cognitive processes. We know that social and cultural demands vary considerably across individuals and groups. We also know that people do different things with their lives in their ecocultural environment and undergo different sorts of experiences. In the face of these differences, can we assume that the cognitive processes of individuals would move and develop everywhere in the same direction, or would there be differences in the direction of development such that some individuals or groups would turn out to be cognitively "analytical", whereas others would turn out to be cognitively "social", that is, some would exhibit "cognitive competencies", and others would exhibit "interpersonal competencies" or some other competencies? The question posed here is: Is there just one direction of development of cognitive functions, or are there many directions of development?

A fourth issue relates to the relative importance of biological and cultural influences on cognition and cognitive development. All individuals share a common biological structure which reflects a predictable pattern of growth. If the development of cognitive processes is largely a result of the biological unfolding of individuals, then we would assume a universality in these processes. On the other hand, individuals tend to have considerable variations in a number of eco-cultural features (e.g., settlement pattern, subsistence activities, family type, socialisation experiences and role specifications, etc.). If the development of cognitive processes is under such eco-cultural influences, we would assume an eco-cultural shaping of cognitive processes. The question is: How do these factors interact to determine cognitive development? Which one of the two plays a dominant role?

The fifth issue relates to the interpretation

of differences observed among individuals or groups on tests of cognitive processes. When a cognitive test is given to different groups of individuals (e.g., children or adults, boys or girls, rural or urban), we find considerable variations in their performance. While one may prefer to look at these variations simply as "differences", another may prefer to consider them as "deficits", particularly in terms of high and low scores. Whereas a difference-based interpretation generates regard for others, a deficit-based interpretation generates a tendency to look down on individuals who happen to evidence a lesser amount of cognitive competence.

A final issue is related to the organisation of cognitive abilities. We have seen earlier that a variety of processes (abilities) are involved in cognitive processes (e.g., recognition, analysis, reasoning, etc.). Since all of these form part of our broader cognitive domain, some pattern of relationship or organisation among them should be in evidence. Whether they all form a cohesive cluster such that one can have something like a "g", or they stand so isolated and independent of each other that one can consider them as "specific skills", or they exemplify a variable organisation of the various skills or abilities such as the one conceptualised in Witkin's cognitive style approach to cognition, is still a major issue of debate.

These issues, along with some others, have received substantial attention in research on cognitive processes during the last one decade or so. Contrasting positions exist on each of these issues, though commendable attempts towards achieving compromises on some of the issues have also been made in more recent years. For example, Piaget's theory of genetic epistemology and Witkin's theory of psychological differentiation are drawing together and coming to terms with each other by sharing certain common concerns in respect of cognitive development (Dasen, P.R.; Berry, J.W. and Witkin, H.A.

1979). Despite many unresolved controversies, nevertheless, the study of cognitive processes is considered to be of great importance in the sphere of education. Research demonstrates that learning, retention and problem-solving depend considerably on the level at which the information is processed, and on the strategies that are employed in its reception, encoding and retrieval. Promotion of effective learning, memory and problem-solving skills among students is one of the important goals of education. Since these skills are largely acquired by pupils through strategic functioning in learning situations, the study of cognitive processes seems to have very positive consequences for educational achievement of pupils of different age, grade, residential, cultural and educational background.

STATUS OF EDUCATIONAL RESEARCH ON COGNITIVE PROCESSES IN INDIA

It is in the context of the above mentioned developments in the field and the perceived as well as documented utility of cognitive processes for education that the trends of research on cognitive processes need to be reviewed and evaluated. The following pages present a brief account of research on cognitive processes largely carried out by doctoral students of various Indian universities in the field of education. Since the review is largely based on the summaries of dissertations, a number of constraints and limitations are inherent. It should be taken to exemplify only the trends of research rather than real accomplishments on cognitive processes. However, we shall address some of the conceptual, methodological and theoretical issues towards the end of the chapter.

A bird's-eye view of the studies reveals that both the traditions of research (i.e., experimental and developmental) are significantly represented in the field. The studies focus on the processes of learning, memory, reasoning and thinking,

and often there is a trend to comprehend the processes in a developmental perspective even in experimental work. While reviewing these studies, an attempt has been made to categorise them into certain major groups. The exercise towards such an organisation is rewarding in the sense that it makes easier to capture the trends of research in a particular field. We first focus on studies that deal with cognitive development, and then move on to a consideration of more of the experimental research.

COGNITIVE DEVELOPMENT: PIAGETIAN AND OTHER APPROACHES

Among various approaches to the study of cognitive development, Piaget's approach has been widely used to comprehend the nature of changes that take place in cognitive processing from infancy to childhood years. According to his view, adult reasoning is intelligible only insofar as we succeed in retracing its development. The processes of development is considered to proceed through four successive "stages" (sensorimotor, pre-operational, concrete operational and formal operational stages) which unfold in a fixed sequence. At each stage, the "structures" of the previous stage are reconstructed in a process called "equilibration". This process simultaneously involves "assimilation" (the integration of new external elements) and "accommodation" (the adaptation of internal structures to external novelty). A variety of conservation tasks (e.g., conservation of mass, weight, volume, density, etc.) have been developed to assess cognitive changes over the span of childhood years. The use of these tasks has provided evidence of certain age-specific features of cognitive development which are almost universal.

Much of the Indian research on cognition has represented this approach. Sharma, S. (1988) developed and administered Piaget-like standard tasks for measuring the development

of science concepts of weight (W), volume (V) and density (D) among 11-16 years of age students. The findings revealed that the concept of W was fully conserved by the age of 10+ and the concept of V was conserved around the age of 15+. The concept of D showed only about 50% conservation by the age 16+. A developmental increase of various rates was noted on all concepts, however, on the D concept the Indian sample was found to lag behind the Genevan sample by 5 years. The development of logical thinking among students in a sequential manner was clearly in evidence.

Kumari, I. (1990) examined the development of abilities of conservation of mass, weight and volume, and of seriation and classification in relation to intelligence and socio-economic status (SES). Predictions were made about age-specific developments in various abilities and their relationship with SES and intelligence. While there appeared to be a general increase in the percentage of mass, weight and volume conservers with an increase in children's age, the development was not clearly age specific. Similar results were found on seriation and classification tasks also. High intelligent children showed an earlier conservation of mass, weight and volume including the abilities of seriation and classification than low intelligent children. However, none of these abilities appeared to be significantly related with the SES factor.

Some studies have attempted to examine the development of classification logic. Malhotra, A. (1990) adopted the tasks of Bruner and Piaget, and administered these to 1,000 students from the age 11+ to 15+ years. The classification behaviour, logic used in classification, and the patterns of change in the criteria of categorisation were analysed. The findings revealed that the functional mode was the most specific mode of classification in the selected age group (11+ to 15+ yrs). The younger children used extensive superordinate and complexive modes more often than the

older children. Classification skill showed a continuous increase from 11+ to 13+ years of age, but the criterion of internalising the class-inclusion skill was achieved only at the age of 15+ years. The complexity of task was found to adversely affect the degree of conservation and the skill of hierarchical classification.

Piagetian tasks are often used as individual tests. However, in some studies, they have been used in a group setting as well. Jain, M. (1984) gave 16 Piaget-type tasks in a group setting to adolescent boys and girls of varying age and typology of school. Non-verbal intelligence, differential aptitudes and the personality of subjects were also assessed. The study yielded a number of significant results. For example, there was decrease in concrete thought with decreasing age-levels; however, the incidence of this thought was greater among girls and government-school students than among boys and private-school students, respectively. Classification and combinatorial skills showed a fairly clear development in accordance with age, whereas probability, proportionality and conservation of volume did not provide such clear evidence of development. On classification tasks, the private-school students generally performed better than those of government schools. Girls performed better on reasoning and combinatorial skills, while boys performed better on problem grasping and proportionality skills. Generally, the variables of adolescent thoughts were significantly correlated with intelligence, linguistic ability and personality traits. Factor analysis yielded "total adolescent thought" and "grasping the essence of the problem" as factors which accounted for major variance in performance on various cognitive tasks.

The Role of Social and Cultural Supports in Cognitive Development

Research has indicated that cognitive development proceeds through certain clearly defined stages which are often reached by

children at particular age-levels. However, Piaget, J. (1972) himself has acknowledged that "cultural transmissions" can "speed up" or "slow down" the development of a particular function. Hence, there may be some variability in the age at which a child enters into pre-operational, concrete operational or formal operational stage in different socio-cultural environments. Behera, M. (1989) studied the effect of home environment and caste on the development of conservation ability of primary school-children. Brahmin and Harijan children from enriched and poor home backgrounds were given a conservation ability test. The analysis revealed superiority of performance of Brahmin children over Harijans and of children from enriched home environment over those from poor home environment.

The effects of deprivational variables such as those used in Behera's study have been examined in other works as well. Gupta, S. (1991) identified deprived and non-deprived adolescents of high and low SES, and analysed differences in their personality traits, level of adjustment, intelligence and academic achievement. She found male students and students of non-deprived home environment to exhibit extrovert tendencies. The non-deprived students were more intelligent, more creative and high achieving as compared to deprived students. On the other hand, deprived students appeared to be overprotected, depressive, submissive, and worried, and yet they showed a high academic self-concept.

The influence of certain organised early experiences on cognitive development of children has also been assessed in studies. Gopal, A.K. (1992) studied the effect of early stimulation received at Anganwadi centres on the cognitive development of children between 4 and 5 years of age. He compared village children attending Anganwadi centres with those staying home. Since the familial, educational and economic profile of these

groups was almost homogeneous, no discernible differences in the cognitive development of the two groups were found. The study highlighted the importance of family support in cognitive development.

Language represents the most remarkable cultural achievement of human beings. In countries characterised by cultural diversity school-children often have to learn two (sometimes more than two) languages. The effect of bilingualism on cognitive development is a highly debated issue (Mohanty, A.K. 1991). In a well formulated study, Mishra, H.C. (1989) investigated the impact of bilingual experience on the cognitive skills, metalinguistic competence, coding processes and educational achievement of tribal children of different grade levels. A wide variety of tests and tasks measuring intelligence, conservation abilities, memory, reasoning and metalinguistic abilities were given to subjects. The findings revealed a general superiority of bilinguals in respect of abstract and verbal logical reasoning, concrete operational thinking and general proficiency in memory and the use of strategies over unilinguals. Bilingualism also promoted children's metalinguistic competence, including their analysed knowledge and control over language, and academic achievement. The findings revealed a greater differentiation in the cognitive structures of bilinguals than in those of unilinguals. These results bring out the experience of bilingualism as a "facilitator" of cognitive development.

Bruner's model of concept attainment has been tried out in some studies. Rajeshwari, B. (1988) studied the levels of concept attainment in middle school-children and examined their relationship with intelligence and scholastic achievement. Variations in understanding taxonomic relations, problem-solving and principles of learning were particularly in the focus of this study. The pupils of higher grades were found to score

higher than those of lower grades at the concrete and identity levels of concept attainment including taxonomic relations and application of principles with evidence for minor differences for different types of concepts (e.g., tree, cutting tool, equilateral triangle). Boys generally scored higher than girls on the classificatory and formal levels of concept attainment, and on problem-solving and application of principles. A complex pattern of correlation between intelligence and various levels of concept attainment and between concept attainment and scholastic achievement was noted, and a similarity in the factor structure of concept attainment of pupils of all grades was demonstrated.

Effect of Training on Cognitive Development

Educational psychology is characterised by an inherent assumption about the positive effect of training on the development of a variety of skills and abilities among children and adults. A number of techniques have been developed to train children for effective performance on conservation tasks. The relative merits of these techniques have often been in question. Gaysu, A. (1988) examined the performance of some conservation tasks as a result of children's exposure to Smedsund's Cognitive Conflict Training (SCCT), Bruner's Language Activation Training (BLAT) and Beilin's Verbal Rule Instruction Training (BVRIT). While SCCT technique did not promote conservation skills among children either at the non-conservation level or at the transitional level, the BLAT and BVRIT appeared to be quite effective techniques in improving the conservational status of non-conservers.

Development of some specific skills such as division and decision-making through certain educational programmes was examined in a study by Shah, S.H. (1992). Boys and girls of Class IX were given a series of

lessons which aimed at promoting the development of the concerned skills. The effect of the decision-making programme was found to be highly placed among girls as compared to boys in the samples characterised by low intelligence. The programme aimed at the development of creative thinking skills appeared to be equally effective for all the groups. Even the intelligence scores showed a significant increase, particularly on the items of opposite words, class identification, mathematical reasoning and social reasoning as a result of exposure to educational programme.

Studies have also attempted the analysis of the effect of education on cognitive processes through a comparison of schooled and unschooled children using certain non-conventional measures such as the contents of dreams. Chhotray, B. (1989) analysed self-developmental planning, future perceptions and dreams of Nolia (a fishermen's community in Orissa) children. The Piagetian clinical interview technique was used in the collection of data. It was found that schooling shaped not only the anticipation of the future and the development of self, it also influenced the contents of dreams of children. Schooled children of high-caste groups appeared to be more ambitious and confident about achieving future goals than schooled or unschooled Nolia children, but the schooled Nolia children were able to recall the exact dreams more clearly than other groups.

Cognitive preferences of students have also received some attention in research. Mohan, G. (1988) studied some such preferences among high school students in relation to certain attitudinal academic and personal variables. Generally, the aptitudinal and personality variables (extroversion, neuroticism and achievement motivation) showed no significant relationship with any of the cognitive preference dimensions. Similarly, no significant relationship between academic achievement

and cognitive preference dimensions of "reception-discovery", "passivity-activity" and "superficiality-depth" was discovered; however a negative relationship was indicated between academic achievement and cognitive preference dimensions of "concreteness-abstractness", "induction-deduction" and "analysis-synthesis".

These studies clearly reflect a pervasive influence of Piaget and his theory on the study of cognitive development in the Indian setting. While age-specific trends in the development of logical thinking parallel to those mentioned by Piaget are not clearly borne out, the sequence of development and the influences of social, cultural and educational factors in accelerating developmental process are clearly in evidence.

Cognitive Style: Correlates and Outcomes

In the studies of perception Witkin, H.A. et al. (1962) had reported a consistent tendency on the part of individuals to psychologically operate on a number of tests measuring perception of upright and restructuring of perceptual field. It was found that individuals either showed a consistent reliance on field forces (hence called field-dependent, FD), or exhibited a tendency to function independently of field forces (hence called field-independent, FI). Since the tendency was found to be generalised to other tasks that required cognitive operations (Witkin, H.A. and Goodenough, D.R. 1981), the construct was referred to as "cognitive style".

Voluminous research on the FD-FI cognitive style (though there are other styles too) has been carried out in all parts of the world including the Indian subcontinent. The stability of the construct and its psychological correlates have been much under question in studies of earlier decades. In recent years, there has been a dramatic shift in focus from these issues to the study of eco-cultural and socio-demographic

factors as determinants of the FD-FI cognitive style (Mishra, R.C. in press; Sinha, D. and Mishra, R.C. 1988). Developmental and gender differences have also presented certain important issues of discussion.

Some scattered work on the FD-FI cognitive style has been carried out in the school setting with an educational component represented in it. Panda, S. (1991) studied age and gender differences in the FD-FI cognitive style of preschool children, and examined its relationship with intelligence, receptive vocabulary and nine different aspects of autonomous achievement striving. The findings revealed no significant difference in the level of field-independence of boys and girls, whereas a developmental increase towards field-independence was quite evident. Intellectual ability and the variables of autonomous achievement striving were generally found to be significantly correlated with field-independence only for the 5-year old boys' sample. For the 4- and 6-year age samples, none of the variables appeared to be correlated with field-independence.

Since the early formulation of the cognitive style construct (Witkin, H.A. et al. 1962), child-rearing or socialisation practices have been considered as the single most important cultural factor in the genesis of the FD-FI cognitive style among individuals (Witkin, H.A. and Goodenough, D.R. 1981). Following this lead Shukla, M. (1991) studied the influence of child-rearing practices on the development of cognitive style and locus of control among individuals of different locale, SES and family structure. The findings revealed virtually no relationship between cognitive style and locus of control. While the relationships among child-rearing practices, family structure, SES and locale were positive and significant, only the family structure, (nuclear) and SES (low) were found to be positively associated with field-independence. On the locus of control, the effects of locale, SES and family structure

appeared to be significant.

Cognitive style has also been implicated as a variable in the analysis of need patterns of managers and workers in an industrial setting. Sharma, P. (1990) examined the relationship of n-Ach., n-Aff., n-App. and n-Power with cognitive style. The effects of age, educational status and other biographical factors on the acquisition of motivational structure and cognitive style were also analysed. The findings revealed a very weak relationship between cognitive style and the four need patterns. In general, the managers appeared to be more field-independent than workers, and their n-Power was significantly affected by the cognitive style variable. The FD and FI employees also showed significant differences in the level of their n-Aff (FD having higher scores).

The educational implications of cognitive style have been pointed out in several studies. To the extent to which it can encourage the use of certain strategies to operate on learning tasks, it works as a major determinant of learning outcomes. Vyas, J.G. (1992) compared the effectiveness of exemplar and attributal strategies of concept learning in relation to the learner's cognitive style in "pre-test", "on-task", "post-test" and "retention-test" conditions. The findings revealed that although the FI style appeared to be more effective than the FD style for learning in all the four conditions, its effectiveness for the "on-task" and "retention-test" conditions was determined by the learning strategy (exemplar, attributed or both) employed by students.

Memory

Memory constitutes a very significant component of the teaching-learning process. It is basically in terms of the retention of the acquired experiences or skills that the effectiveness of any educational programme

can be evaluated. Research in educational psychology for a long time has shared a major concern with improving the memory of pupils. Consequently, in earlier studies a number of variables relating to the task, the teaching-learning strategies, and the characteristics of learners were identified, which governed better or poor retention. Recent developments in the field have brought out the importance of certain strategies related to reception, acquisition, organisation, coding and retrieval of information in determining retention and subsequent recall (Ackerman, B.P. 1985; Bjorklund, D.F. 1988). These processes are facilitated or inhibited by certain factors involved at the various stages of processing. An understanding of these processes can greatly help learning and retention of a variety of materials.

Studies on memory have addressed some of these issues, but in a very sporadic manner. There is little effort towards the analysis and understanding of the process. On the other hand, organismic and socio-cultural variables have drawn considerable attention in research on memory. Donga, K.M. (1989) studied the effect of certain personal and social variables such as age, sex, grade, family-size and SES. A variety of memory tasks/tests were given to boys and girls of Classes III and XII. Factor analysis revealed a set of five factors to account for the memory of the subjects. These were: Numerical and alphabetical memory, picture content memory, numbers of alphabet and association memory, figure and colour association memory, and symbol and order memory. Age, birth-order, family-size and SES exercised significant influences on memory of the tasks. There were some differences according to grade level, but these were not systematic, and the effect of sex was not at all significant.

Dhaliwal, V. (1989) analysed the effects of age, sex, sense modalities and distribution of practice on short-term memory (STM) and long-term memory (LTM) using a serial learning

task. The findings revealed age and sense modalities to be significant determinants of STM and LTM. The effect of sex was not significant on either measure. Spaced practice facilitated only the LTM performance of subjects; intelligence (as measured by Raven's Standard Progressive Matrices) was found to be positively correlated with STM as well as LTM.

Verma, K. (1988) implicated motivation and personality as additional variables along with age, sex and sense modality which were studied by Donga, K. (1989). Both STM and LTM of 12-20 years of age subjects were studied with the help of a list of paired associates. The findings revealed better STM and LTM for the older than for the younger age-group, and for visual than auditory presentation condition. The high-motivation group showed better memory than the low-motivation group. Among personality variables (extroversion, neuroticism and psychoticism) only extroversion was found to be positively correlated with STM of 12- and 16-years of age samples.

Information Acquisition and Problem-solving Strategies

The structures and components of strategies used in acquisition and processing of information have represented topics of research in their own right. Since much variability in memory is accounted for by these strategies, they have been analysed in a wide variety of contexts. Dixit, S. (1988) studied 35 information acquisition strategies of college students in relation to a number of social-demographic and psychological variables. Factor analysis revealed 11 factors to represent 35 strategies and to account for variance in performance. These were: Deep processing, elaborative processing, fact retention, information dependence, success dependence, prediction orientation, organisation orientation, precision orientation, knowledge of results, methodical study and inferential measurement. Factors

like sex, birth order, number of siblings, I.Q. and achievement in mathematics, language and sciences were not associated with the selection of a particular strategy, whereas type of family, parent's income and education appeared to be significantly associated with the selection of strategies.

Kumari, V.M.P. (1991) studied the problem-solving strategies of 10-12 years of age children and examined their relationship with certain cognitive capabilities (e.g., conservation, combinatorial thinking, proportionality and probability reasoning). The findings revealed that overall problem-solving ability and the success on different types of problems was significantly and positively related to each cognitive ability, separately as well as globally. There was also evidence for some sequential steps in problem-solving, and for different forms of responses to be associated with the tactics used by children. A wide range of variations in the strategies appeared to be related to the nature of problems.

Dutt, S. (1989) studied the effect of the problem-solving strategies on the problem-solving ability in science, and also examined its relationship with certain cognitive (intelligence and field-independence) and personality (anxiety) variables. There was a distinct relationship between problem-solving strategy and problem-solving ability. A focusing strategy encouraged greater problem-solving than scanning strategy. Higher levels of intelligence (verbal) and field-independence contributed significantly to the total variance in problem-solving ability. On the other hand, anxiety did not make any significant contribution.

Verbal maze learning has also been used as a device to study problem-solving. Sawade, S.D. (1989) examined the effect of FD-FI cognitive style, extroversion, neuroticism and intelligence on verbal maze learning of Class IX students. The findings revealed different measures of learning (e.g., trial, time and error) to be

positively correlated with each other. FI students took a lesser number of trials, lesser time, and committed a lesser number of errors than FD students. High- and low-intelligent subjects presented an evidence of difference similar to FI and FD subjects. Extroversion showed a negative relationship with the measures of trial, time and errors, whereas neuroticism showed a positive relationship with these measures.

Efforts have also been made towards developing problem-solving ability tests for students. One such attempt was made by Parasnis, H.N. (1990). He developed a ten-item problem-solving ability test for Marathi students of Class IX which has a reliability index of 0.72 and a discriminant validity index of 0.68.

Success in the examination represents one of the important goals of most of the teaching and learning that takes place in the classroom. A search for the factors that contribute to success in examinations has been pursued in a number of studies, and a wide variety of suggestions pertaining to examination reform have been offered. In a study, Gupta, P.C. (1990) assessed the relative contribution of memory and speed factors to students' Intermediate examination scores. Analysis revealed that both performance on psychological tests (e.g., Wechsler's Adult Intelligence Scale, Differential Aptitude Test, Verbal Reasoning Test and Culture Fair Intelligence Test) and in the college examination was accounted for by factors of verbal reasoning, non-verbal reasoning, memory, speed, language competence and rule-learning. Memory and speed did not contribute significantly to the examination scores of arts and science students, whereas the performance of both the groups in language subjects, such as English and Oriya, was significantly determined by the factors of language competence and rule-learning. On the other hand, specific factors called

"knowledge of humanities" and "knowledge of science" significantly accounted for the examination scores of arts and science students, respectively.

Cognitive processing

We have discussed earlier that recognition, labeling and analysis, etc., are the basic processes underlying all cognitive behaviour of individuals. Confronted with a complex task, such as of reading, the various processes at the command of an individual are organised into a definite pattern to increase his behavioural efficiency. Analysis of these underlying processes has been attempted in some studies. For example, Dash, M. (1991) focused on the analysis of cognitive and speech-related processes of good and poor readers with high and low I.Q. A series of tests measuring different basic processes were given to Class III children. The findings revealed that good readers were superior to poor readers in selective attention, figure memory, serial recall, and verbal processing variables requiring simultaneous or successive processing. On the other hand, no reliable differences between good and poor readers on speech-related tasks were noted. Such differences were unrelated to I.Q. of good and poor readers.

Mishra, P. (1991) analysed developmental changes in decoding competence and speech-related cognitive processes, using samples of good and poor readers from Class I and Class III children. Decoding, serial word recall, naming time, speech rate and sequence repetition of good and poor readers were analysed. The findings revealed significant differences in the performance of good and poor decoders in naming time, speech rate and sequence repetition, but not in serial word recall. There was also evidence for performance in decoding as well as speech-related processes to improve as a function of the age and grade level of the children.

Planning represents one of the higher-

level cognitive processes which has a futuristic perspective. A number of factors can predispose individuals to engage in planning in a particular manner. Considering search as a measure of planning, Kar, B.C. (1989) in a series of three studies traced the developmental course of search, and examined on it the effects of naming, verbalisation and practice. A number of naming, matching and search tasks were given to children of Classes V, VII and IX. It was revealed that auto search in general was faster than controlled search. Except for matching numbers, the search performance showed improvement as a function of age in both auto and controlled search conditions. Generally, pictures took a longer search time than letters. Strategy verbalisation during the pre-post interval facilitated search performance. The search latency was generally longer for "target absent" than "target present" trials, and there was evidence for search latency to systematically increase as a function of the serial position of the element searched. The effect of practice in naming of stimuli (used in search tasks) did not influence search performance.

The issues of interrelationship among non-verbal measures of cognition and sex difference in performance on these measures were addressed by Dei, S.L. (1991). Wechsler's Digit Span Test, Raven's Coloured Progressive Matrices and Non-language Test of Working Memory were given to Class V boys and girls of low SES level. The findings revealed no significant differences between boys and girls on the non-verbal cognitive measures. On the other hand, the interrelationship among the three measures was found to be positive and significant.

Structure of Reasoning Abilities and Intellect

Developmental studies indicate that the development of cognitive processes proceeds from an undifferentiated to a differentiated

state. Heterogeneity of functions is the most important characteristic of differentiation which is reflected in the segregation of psychological functions (Witkin, H.A. et al. 1962). Thus, in early stages, while a particular "structure" may be responsible for a variety of functions, more and more specialised "structures" emerge in later years to accomplish different kinds of functions. Complex abilities like reasoning involve a variety of structures which may be organized uniformly or differently across groups of individuals depending on whether groups represent "culturally homogeneous" or "culturally heterogeneous" units (Irvine, S.H. and Berry, J.W. 1988). Cultural diversity is one of the common characteristics shared by societies the world over. Hence, the structure of abilities is expected to vary considerably across groups.

Suri, I.S. (1989) tested this assumption in a study of the reasoning ability of rural and urban students. Factor analysis of data yielded cognition of semantic classes, cognition of semantic relations and convergent production of semantic implications as three major factors accounting for the reasoning ability of rural children. For the urban group, on the other hand, convergent production of semantic classes emerged as the only factor to account for students' reasoning ability.

In a similar study, Garg, K.P. (1988) analysed the factorial structure of the reasoning abilities of schoolboys of 14+ years of age. Thirty-seven tests of reasoning abilities were administered to children. Factor analysis revealed different factor structures for heterogeneous and homogeneous groups of students. The findings also revealed that differentiation of reasoning abilities occurred around the age 14+, and that it was possible to identify differentiated dimensions of reasoning abilities.

In an ambitious project Ramachandrarachar, K. (1989) attempted a factor analytic study of 25 "structure of intellect" factor based tests in

Kannada language, including two tests of creative thinking (Ramachandrarachar, K. and Passi, B.K. Tests). Factor analysis yielded five prime factors which accounted for a major portion of variance in the intellectual performance of high school students. The analysis did not yield a separate factor which may be referred to as the "originality" factor.

Intellectual disposition and commitment seem to have far-reaching consequences for educational interest of students. Kumari, D. (1986) analysed both the intellectual commitment and educational interest of 16+ age students and examined their relationship with intelligence, SES, academic achievement, adjustment and the introversion-extroversion dimensions of personality. Analysis revealed a general preference of boys for science; only girls and low achievers showed preference for home science and humanities. Higher intellectual commitment was related to father's lower qualification, whereas lower intellectual commitment was associated with father's higher qualification, high intelligence and high SES. There was no sex difference in intellectual commitment. Interest in humanities and science was positively correlated with achievement in English, whereas interest in fine arts, agriculture and home science had a negative relationship with achievement in mathematics, particularly in the girls' sample. Intelligence and introversion were positively correlated with the academic achievement of boys. On the other hand, intelligence and intellectual commitment were positively related with the academic achievement of girls.

CONCLUSIONS AND FUTURE DIRECTIONS

The studies reviewed in this chapter present fairly clear evidence of a widespread interest on the part of students of psychology and education in the study of cognitive processes. The tradition of "developmental research" seems to dominate the research scenario, as a large number of studies have been addressed to

the developmental aspects of cognition. Perception, learning, memory, reasoning and thinking, all find substantial representation in research, particularly in the context of socio-cultural and organismic variables. Task and teaching technology related factors tend to have receded to the background. There is relatively less emphasis on the analysis and understanding of the processes. Search of determinants or correlates of various processes appear as more important goals of studies. Barring a few studies which deal with the application of "strategies" in the teaching-learning process, there is hardly any concern reflected among researchers to examine the educational relevance of their studies. The general impression that one gathers is that no major educational problem has been addressed through research on cognitive processes. The studies largely appear to be sporadic; there is no vigorous programmatic effort towards an understanding of the educational reality in terms of the cognitive processes of children, adolescents or adult learners. There is a need for the coordination of research activities for children in view of the high rate of their drop-out from schools even at the primary level of education.

Despite producing methodologically and theoretically viable studies on cognitive processes, the researchers have not succeeded much in relating their work with the grave realities that prevail in the educational sphere today. Age, sex, caste, SES, family type, birth order and other social-demographic variables often implicated in studies are no more new to students of psychology and education. As "packaged" variables they speak nothing about themselves, or about the process for whose understanding they are used. In order to understand anything meaningful from them, we need to analyse the manner in which children's interactions with parents, other family members, peers and teachers are encouraged or discouraged by these factors. Thus, from a correlational

approach that has been so widely represented in research, we need to move on to adopt an interactional approach in studies.

Our country is characterised by a unique cultural diversity. Education forms an important dimension of this diversity. We have not only high and low facility schools modelled on the Western system of education, but also a variety of traditional type of schools such as Sanskrit schools, Quranic schools, and community schools (e.g., Bush schools among the nomadic tribes). They all have some curriculum, be it written or hidden, and they all aim at developing certain cognitive and motor skills often considered useful for learners. The teaching-learning processes in these schools, and their cognitive consequences need to be analysed in order to understand the dynamics of education as well as development of cognitive processes in a wider context of schooling. Some efforts have already been made in this direction (Mishra, R.C. 1988; Mishra, R.C. and Agrawal, A. 1993), but they need to be further strengthened.

Another limitation of research on cognitive processes is its preoccupation with samples which are conveniently available and easily testable. Primary and secondary school students, often drawn from urban settings, have represented samples in a disproportionately large number of studies on cognition. Children and adults from rural areas, particularly from those which are remote and relatively inaccessible, have been rarely used as samples in studies.

Researchers' attention has also not been drawn to the educational problems of children of tribal and other ethnic groups. There is a need to examine the consistency between the cognitive abilities present among children of these groups, and those intended to be developed among them in schools. This exercise is essential to evolve a policy of fruitful education for tribal people in general, and for

people of traditional groups, in particular, who still evade contact from the outside world. It would also be rewarding to pursue an analysis of eco-cultural pressures that operate on children in different settings, and to examine the effect of these cultural pressures on the development of cognitive skills, strategies and abilities among them. Studies on weavers of Varanasi (Anandalakshmi, S. and Bajaj, M. 1981) and on nomadic Birhors of Bihar (Mishra, R.C.; Sinha, D. and Berry, J.W. in press; Sinha, D. 1979) provide tremendous insights, and encouragement for planning studies with other groups to make similar analyses which may help to understand both the extent and direction of the development of cognitive processes as "cognitive adaptations" to eco-cultural pressures operating on people's life.

The pursuit of such a culturally sensitive psychology of education from a cognitive orientation would demand a re-examination of Western models and theories for use in a Third World country like India. It would not be wise to take them all for granted. We shall also have to question the appropriateness of tests and tasks borrowed from the West for use with Indian samples (Sinha, D. 1983). It is greatly risky to adapt a test without ascertaining its conceptual, functional and metric equivalence (Berry, J.W. 1980) for the culture in which it is to be used.

In a review of psychological research on higher mental processes, Tripathi, L.B. (1988) has observed that in most of the research the selection of variables, their manipulation and treatments were replicative, repetitive and devoid of systematisation. It was also indicated that if such a trend continued, replicative and repetitive studies without promise for explaining mental functions would continue to dominate the scene. These assertions nicely characterise the state of research on cognitive processes in the discipline of education. There is certainly a need to get over this state of affairs, and

produce some original, creative and socially relevant work on the concerned processes.

Despite many limitations and weaknesses, there is a very positive sign reflected in educational research on cognitive processes. The predominant use of organismic, social and cultural variables in a large number of studies suggests that human welfare has been the most important concern of educational researchers working in this area. It may be hoped that such a concern will be more widely shared in studies in the years to come, and that a new approach to the understanding of these processes will soon be perceptible on the horizon of educational research.

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