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ABSTRACT

After reviewing the literature relative to culture and cognition, an hypothetical model was developed to explain some aspects of concept learning and cognitive development. To test aspects of the model, 3 tests which had had prior use in cross-cultural studies and 5 original tests were administered individually to 34 Stoney Indian and 34 Euro-American 8-year-old children derived from the same geographic region in Alberta, Canada. Tested was the relationship between cognitive learning and: (1) field independence, (2) abilities to perceive and compare attributes, (3) category width, (4) level of abstraction, (5) memory, and (6) general intelligence. Results suggested some support for the proposed model and identified some areas of cultural differences. For Euro-American children, field independence was correlated with the ability to perceive attributes and both were related to the ability to verbalize concepts. For the Stoney children, more than one ability or set of abilities was involved in concept learning. Memory played a greater role in problem solving for Stoney Indian subjects, and they did better on the first two Stone Games and relatively better on the tests of field independence and memory, while Euro-American performance was more markedly superior on the remaining measures. (Author/JC)

THE UNIVERSITY OF CALGARY

A CROSS-CULTURAL STUDY OF CONCEPT LEARNING

by

IAN ROYSTON BROOKS

A THESIS

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ABSTRACT

Accepting the assumptions that, heretofore, Western systems of education have not been notably successful with Canada's native population, and that the basis of general problem solving and, thus, the school curriculum is conceptual learning and conceptual reasoning, the present studies were concerned with exploring concept learning abilities in Stoney Indian and Euro-American eight-year-old children.

Initially, the approaches taken during the past one hundred years, to study the relationships between culture and cognition, were reviewed, as were the results of experimental studies of concept learning conducted with Euro-American subjects, primarily university undergraduates. An hypothetical model was then proposed to explain some aspects of concept learning and cognitive development. To test several aspects of the model, *viz.* the relationship between field independence, abilities to perceive and compare attributes, category width, level of abstraction, memory, general intelligence, and concept learning, eight tests were chosen or developed. Three of these had seen some prior usage in cross-cultural research, whereas the remaining five were of the writer's design and thus untried prior to pilot testing. All tests were administered individually to 34 Stoney Indian and 34 Euro-American, eight-year-old children by the writer or by his wife.

Results suggested some support for the proposed model and identified some areas of cultural differences. For Euro-American children, field independence was correlated with the ability to perceive attributes and

both were related to the ability to verbalize concepts. In addition, an apparently unique concept learning factor was observed for this group. For the Stoney children, on the other hand, results suggested that more than one ability or set of abilities was involved in concept learning. For two concept learning tasks, performance was related to a "concept learning" ability; whereas for two others it was related to the abilities to compare and perceive attributes, memory, and general reasoning ability. Furthermore, it was found that memory played a greater role in problem solving for Stoney Indian children than it did for Euro-Americans. There was also evidence to suggest two distinct patterns of abilities for the two groups. Stoney subjects did better on the first two Stone Games and relatively better on the tests of field independence and memory, however, Euro-American performance was more markedly superior on the remaining measures.

Due to several limiting factors, the results must be considered tentative; nevertheless, sufficient support was found to recommend further work, both with the model and with some of the research instruments.

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FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Cross-cultural Study of Concept Learning," submitted by Ian Royston Brooks in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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TABLE OF CONTENTS

Chapter | Page

Chapter | Page

LIST OF TABLES

LIST OF FIGURES

PREFACE

Numerous studies (cf Brooks, 1975; Brooks and Marshall, 1975) have attested to the high rates of grade retardation, scholastic failure and drop-out for Canada's native pupils. As a result, both native people and professional educators are concerned with the reasons for Indian, Métis, and Eskimo pupil underachievement and with discovering ways in which steps can be taken to remedy the situation.

Changes in curriculum content have been stressed by native groups who encourage the teaching of their native language, history, and culture. Other groups have pointed to the lack of qualified Indian, Métis, and Eskimo teachers as being a major source of problems. The point is made that teachers who come from the same cultural group as the students (and the parents) will be more able to understand the behaviour of their students and the cultural milieu in which the school operates. In response to this demand, several universities in both Canada and the United States implemented teacher training programs specifically orientated to the training of native teachers.

The psychological factors contributing to the problems extant in native education have been relatively ignored, albeit more so in Canada than in the United States. Studies conducted in the area of cognition have been more concerned with cognitive "products" than "processes" (cf Bruner, 1973). Hence, little knowledge was gained about how native children learn and think.

The argument has been advanced that the basis of general problem solving, and indeed the school curriculum, is conceptual learning and conceptual reasoning (Taba, 1965, p. 531). Consequently, should there be cultural differences in conceptual learning and reasoning, and should the pedagogy of the occidental North American schools be unaware of these differences, it might be expected that native pupils would experience considerable difficulty with school work. Further, the school staff might be unclear as to how to assist these children.

Thus, the present studies were concerned with these aspects of cognition. The studies were not intended to be definitive, but rather explorations into the modes of thinking and learning, and the relationship of these modes to underlying psychological processes employed by Indian and non-Indian children. It is therefore hoped that the present studies contribute to the search for an answer to the question: Are there cultural differences in conceptual learning and conceptual reasoning?

Western psychologists were intrigued for several decades with the relationship between culture and cognition. Therefore, it is perhaps useful to review the scientific paradigms, research methodology, and researcher biases employed in the past in order to be cognizant of the successes and failures of previous studies, of the historical antecedents of current research, and of the directions required for the future. Similarly, concept learning was a popular topic of study for North American psychologists operating in the post-World War II period. As was the case with cross-cultural studies of cognition, there were notable successes and notable failures. Once again, a review of this work is a useful step in sythesizing what is now known (and unknown) about concept learning, and in formulating a model which can be taken out of the experimental laboratories of Western psychology and tested in different cultural settings.

CHAPTER 1

APPROACHES TO THE STUDY OF CULTURE AND COGNITION

Theory of Cultural Evolution

The relationship between culture and cognition has been the subject of speculation for the last one hundred years. Spencer (1852), Tylor (1874), and Morgan (1877) adopted the position that differences in culture, particularly the "stage of cultural evolution," explained differences in cognition. Their belief that human societies evolved from primitive to civilized societies was strengthened by the biological theories of Darwin (1958) and Huxley (1906). Haeckel's (1883) aphorism that "ontogeny recapitulates phylogeny" summarizes the theoretical position of some of the early anthropologists who believed that because the evolution of primitive societies was behind that of the civilized societies, the primitive adult was equivalent to the civilized (that is to say, European) child.

Darwin's theory had an influence on the emerging science of psychology also, with the result that Haeckel's aphorism applied to many psychological theories. Chamberlain (1901) described several interesting parallels of a general sort between the mind of the European child and that of the primitive man, even when socio-cultural, ecological, and maturational factors were supposedly taken into account. Chamberlain also raised the point, often discussed in anthropological literature, that primitive people suffered from arrested development.

This theory was expanded by others (for example, Miller, 1928) who asserted that children from primitive groups were precocious until puberty, at which time their development came to an abrupt halt. It was often thought that sexual excesses and alcoholism were responsible for the "arrest."

A somewhat more judicious approach was adopted by Rivers in his discussion of the 1899 Torres Straits expedition. Rivers (1901), who was in charge of the physiological and psychological studies, remarked on a number of the problems which confront the cross-cultural researcher, such as those of adapting tests to, and testing in, differing cultural contexts. As a result of this and later studies with the Todas, Rivers (1905) concluded there was no major difference between the perceptual acuity of "savage" and "civilized" races, although the balance of superiority might be in favour of the former.

Rivers, however, took his analysis one step further and in so doing contributed to the widely held belief that mental operations among savages were concrete, as opposed to the abstract operations of Europeans. He argued that the emphasis native people placed on the perception of minute detail inhibited intellectual development:

> If too much energy is expended on the sensory foundations, it is natural that the intellectual superstructure should suffer. It seems possible also that the over-development of the sensory side of mental life may help to account for another characteristic of the savage mind. (Rivers, 1901, pp. 44-45)

The assumptions implicit in the cultural evolutionist theories of Chamberlain and Miller were also challenged in 1911 by Boas. After studying both primitive and modern societies, Boas concluded that cultural evolution was neither a viable nor a valid construct. His position is reflected in his assertion: "the existence of a mind absolutely independent of conditions of life is unthinkable . . . . [and furthermore] . . . the functions of the human mind are common to the whole of humanity" (Boas, 1911, pp. 133, 135).

One of Boas's criticisms of the "evolutionists" was directed to the belief that inferences about thought processes could be drawn from the traditional beliefs and customs of a people. Boas argued it would be equally misleading to explain the thought processes of Americans by referring to traditional American beliefs.

Although Boas observed that primitive man tended to respond quite differently from civilized man, placing more emphasis on belief rather than logic, and exhibiting a lack of control of will (1911, pp. 98-99), he concluded that this did not necessarily mean the minds of different cultural groups reflected differences in organization. Rather, he argued:

> It may also be that the organization of mind is practically identical among all races of man; that mental activity follows the same laws everywhere, but that its manifestations depend upon the character of individual experience that is subjected to the action of these laws. (Boas, 1911, p. 102)

Boas arrived at a conclusion similar to that of Rivers, admitting that, although the perceptual ability of primitive man was excellent, there appeared to be a deficiency in the area of logical interpretations. This Boas attributed to the cultural context in which the perceptions are interpreted, claiming that the society's traditional ideas influence the conclusions so drawn:

> When a new experience enters the mind of primitive man, the same process which we observe among civilized man brings about an entirely different series of associations, and therefore results

in a different type of explanation. (1911, pp. 202-203)

Wundt, an eminent figure in experimental psychology, also delved into the field of ethnopsychology. Although he approached the subject from the point of examining the mental basis of cultural development (as opposed to Boas's analysis of the cultural content and context of intellectual development), his conclusions were in agreement with those of Boas and Rivers. Wundt (1916) cautioned that although the culture of primitive people remained at a low stage of development, it was not necessarily indicative of low intellectual development. Instead, he suggested, it might be due to the "limited nature of his wants" and to the isolation of the culture. Wundt did not, however, consider these to result in intellectual deficiences, but rather concluded:

> The intellectual endowment of primitive man is in itself approximately equal to that of civilized man. Primitive man merely exercises his ability in a more restricted field; his horizon is essentially narrower because of his contentment under these limitations. (1916, p. 113)

In spite of the writings of Rivers, Boas, and Wundt, the earlier theoretical position continued to be popular. In 1910, Lévy-Bruhl, a French anthropologist, maintained that every culture was characterized by a set of general beliefs and whereas for Europeans these beliefs were intellectual, for primitive people they were fused with emotional concepts. He further assumed that primitivity in materials and religion was sufficient to prove the existence of primitive mental processes.

Moreover, Lévy-Bruhl was concerned with demonstrating that primitive thought was prelogical. The use of the prefix "pre" rather than "non" suggests that he did not consider prelogical to be antilogical or alogical, but an earlier stage in the evolutionary sense (Berry & Dasen, 1974). Thus Lévy-Bruhl observed:

> This mystical and prelogical mentality will evolve only when the primitive syntheses, the preconnections of collective representations are gradually dissolved and decomposed; in other words, when experience and logical claims win their way against the law of participation. (1966, p. 92)

Although Lévy-Bruhl admitted that the thought process of primitives "will appear to be normal under the conditions in which it is employed, to be both complex and developed in its own way" (1923, p. 33), he was criticized by researchers who argued that many cross-cultural studies indicate all cultural groups utilize a variety of thought processes ranging in complexity from concrete to abstract. Morever, which process is employed is likely to be a function of situational variables. In some situations, explanations may be formulated on the basis of abstract reasoning, such as objective probable causation, and in others, explanations may relate to more perceptually-based reasoning processes, such as apparent cause. Furthermore, it has been contended that all people hold certain basic premises that are taken for granted. Given these premises, their reasoning is logical (Herskovitz, 1962).

Concrete-Abstract Distinction

In psychology, researchers developed Rivers's (1901) suggestion that mental operations of primitives were concrete (or perceptual), whereas those of the civilized races were abstract (or conceptual). This view continued for many years, primarily on the strength of research results obtained in Africa. For example, Ziegle (1951), Carrothers (1953), and Ibarrola (cited in Grant, 1972) concluded, on what appears to be little evidence, that Africans were incapable of abstract thought.

Haward and Roland (1954), using the Goodenough Draw-A-Man Test, summarized that Nigerians also operated at a concrete level. Wintringer (1955), basing his conclusions on test scores, speculated that qualitative differences existed between intellectual functioning in Europeans and in Africans. He maintain[illegible] African functioning was more concrete and global in nature, characterized by syncretic perception and a general lack of the ability to abstract. Werner (1957) also described the thought processes of primitive man as being syncretic, that is to say concrete, pragmatic, and individual:

> The thought of primitive man differs from the higher and above all from the scientific thought of western man in that it has a concrete and in consequence, syncretic character . . . . Typical European reflection is universal in nature, abstract; it functions more or less independently of the immediate, concrete reality, and is governed by an awareness of general laws. The thought of primitive man is pinned down to the reality of the thing-like world, and is therefore pragmatic, concrete, individual. (p. 299)

Gradually, evidence was compiled to challenge this widespread belief. McConnell (1954), using an adaptation of Kohs Blocks with Tepehuan Indians, argued there was sufficient evidence to indicate Tepehuans were capable of abstract thought. Maistriaux (1955), working in the then Belgian Congo, suggested that the ability to think abstractly was related to cultural factors, in this case schooling. In 1956, Jahoda found that on Kohs Blocks, Raven's Progressive Matrices, and the Goldstein-Scheerer Cube Test, Nigerian schoolboys from literate homes surpassed those from illiterate homes. He concluded that tests of abstract thinking were just as culturally influenced as tests of intelligence. Similarly, Ombredane and his co-workers (cited in Faverge &

Falmagne, 1962) reported: when age was held constant, performance on the Raven's Progressive Matrices was related to length of schooling. Consequently, on the basis of this and other evidence, Cryns (1962) concluded that although it appeared Africans were weak at forming concepts, the issue had not been clarified. Like Biesheuvel (1949, 1952), he suggested lack of schooling, unfamiliarity with test materials, and poor home environment to be reasons for poor test performance.

Subsequently, both Price-Williams (1962) and Kellaghan (1968) examined abstract thinking in Africans, following the concept formation approach of Hanfmann and Kasanin (1937) and using the concrete-abstract continuum postulated by Goldstein and Scheerer (1941). Price-Williams explored the ability to sort plants and models of animals native to Nigeria. Goldstein and Scheerer's criterion, shifting from one classification base to another, was taken as being indicative of abstract thinking. No significant differences were found between illiterate children and those attending primary school, and in addition, the rate of development was similar to that of European children of the same age range. Similarly, Kellaghan (1965, 1968) administered three Goldstein-Scheerer tests to Yoruba children differing in degree of "Westernization." Two of the tests were also administered to a comparable sample of Irish children. Kellaghan's results indicated that when test materials familiar to both cultural groups were used, no differences appeared between African and Western children in their ability to classify at an abstract level. It was noted, however, that when unfamiliar materials were used with African children, the ability to classify at an abstract level was related to degree of acculturation (see also, Okonji, 1971).

Grant (1965a, 1966) observed that performance on his Form Series Test (1965b) was influenced by length of schooling and degree of urbanization.* As a result of further work, Grant surmised that three levels of reasoning were evidenced by African subjects:

> Some function at a 'concrete' level of reasoning, some at an 'adaptable' level and others at an 'abstract' level. It is suggested that those who function at a 'concrete' level are in a state of transition and those who function at an 'abstract' level are differentiated. It is further suggested that formal education and urbanisation underlie these three levels of functioning. (1966, p. 43)

Grant (1972) joined others (for example, Copi, 1958; Payne, 1961; Pikas, 1966) in criticizing Goldstein and Scheerer's concrete-abstract continuum largely because of the variety of meanings conveyed by the term "abstract." Pikas (1966) suggested that a clearer understanding of the construct would be facilitated by using the term "concept." Grant further contended that the dimension in question is one of "conceptual reasoning." This he defined as being:

> The ability to discover or apply a rule by relating concepts to one another . . . . [adding] . . . . Whether this is done in a deductive or inductive way will probably depend upon the explicit nature of the test items and/or the cognitive styles of the subjects. (Grant, 1972, p. 174)

Factor Analytic Approach

Another approach to exploring the relationship between culture and

*Similar results have been obtained in North America; see, for example, Lesser, Fifer, and Clark (1965).

cognition has been comparative studies of factor or ability patterns of culturally differing groups of subjects, in an attempt to determine the effects of culture and related variables on the clustering and organization of mental abilities. Most important of these are the cognitive skills which, as Ferguson (1954, 1956) pointed out, are culled from a variety of experiences, transferred to other situations, and through over-learning become stable abilities. As P. E. Vernon (1969) explained, it would be useful to develop a common scale based on the adaptability of a cultural group and the complexity of its symbols and reasoning; however, because these qualities are manifested in different ways in different cultures, this is virtually impossible. Hence, P. E. Vernon's studies, like all ability studies, were concerned with "the extent to which groups differ in their facility at the various abilities comprised under western-type Intelligence B, and why they differ" (1969, p. 24).

MacArthur, who made extensive use of the factor analytic approach in his researches in northern Canada, considered the development of abilities to result from a "sort of cumulative transfer," as innate pre-dispositions interact with environmental conditions. Thus, he reasoned:

> Since environmental conditions may differ from one culture to another, so may the patterning and nature of the abilities at all levels of the hierarchy . . . . The form and environmental correlates of these variations in abilities can be a matter for empirical cross-cultural research with a view to better understanding, and in time to better control of intellectual development. (MacArthur, 1967a, pp. 1-2)

Similarly, while conducting research in the Canadian Arctic, P. E. Vernon noted, "different groups at similar levels of education, and with similar language difficulties may show very different patterns of scores" (1965a, p. 732).

Following this approach, both P. E. Vernon (1965a, 1965b, 1969) and MacArthur (1968a, 1969, 1972a, 1973) observed different ability patterns in different cultural groups, as have other researchers (for extensive reviews see Klingelhofer, 1967; Ord, 1970, 1972; Cronbach & Drenth, 1972). Thus, research data (for a review, see Frost, 1965) suggest that different socio-cultural and physical environments do contribute to the development of differing ability structures.

Consequently, MacArthur argued (1973) that research must now concentrate on discovering those intellectual abilities least or most affected by differences in social environments and, more particularly, to find which environmental factors affect which abilities. As the practical application of this approach to native education was a concern of MacArthur's (1969), he also recommended exploring the relationship between abilities and such variables as sex, socio-economic status, and scholastic achievement, as well as analysing how these abilities change with age.

MacArthur's attention was also focussed on those abilities which have been developed by native peoples to cope with their ecological and cultural environments, and on those which are likely to be useful in adapting to a more technological way of life (cf MacArthur, 1972a). As people move from a traditional to a transitional way of life, it is expected that changes in ability patterns will be revealed (MacArthur, 1968b).

Notwithstanding its usefulness in cross-cultural research, the factor analytic approach has been criticized on several grounds. For example, MacArthur (1972b, 1973) noted that research results demonstrate the importance of establishing the construct validity of tests used in different cultural settings, as studies often show the same test loading on different factors for different cultural groups.

Irvine (1970) similarly questioned the construct validity of tests used to examine ability patterns in non-Western cultures:

> Intelligent behaviour as measured by tests in school might be very little related to intelligent behaviour in the village, but that the underlying processes of memory, evaluation, discrimination and cognition that Guilford proposes would be common across all behaviours, irrespective of the mode or product of thinking. (p. 28)

The model used to identify and structure mental abilities might, therefore, be suitable; however, tests designed to tap these abilities may, in fact, be tapping something else.

Factor analytic studies represent an example of research into quantitative differences in cognition among different cultural groups. In assessing quantitative differences, it is established whether one group is more competent in a given ability or set of cognitive operation than another. Concomitantly, it must be asked, more competent for what? The latter raises a question of values; attempting to ascertain which abilities are better developed, or perhaps searching for those processes which are independent of cultural values (Berry & Dasen, 1974).

The problems experienced in adapting tests to the cultural setting (for full discussions see P. E. Vernon, 1969; Ord, 1970; Cronbach & Drenth, 1972; Schwarz & Krug, 1972; Brislin *et al.*, 1973), particularly the problem of construct validity, perforce allow only tentative conclusions as to quantitative differences in cognition. Moreover, the results so obtained suggest that more fundamental differences underlie the observed quantitative differences. As P. E. Vernon noted:

> One cannot say that there are merely differences in degree, not of kind. In a sense every society is unique, and there are certainly differences between them in modes of perception or conception arising from their different languages, physical circumstances, traditions and values. (1969, p. 19)

Exploring Qualitative Differences

An alternative approach has been a study of the qualitative differences in cognition; an analysis of whether the nature of the cultural experience influences the cognitive processor (Berry & Dasen, 1974). The question was asked whether there is a relationship between the cognitive strengths of the individual and the preferred mode of cognition in his cultural group:

> Although it may be the case that there are *no* differences in cognitive processes *available* for use, certain ones are actually in use (to the exclusion of others), thus giving rise to apparent qualitative differences in cognitive processes. (Berry & Dasen, 1974, p. 12)

Anthropologist Bateson (1942), in collaboration with Mead, developed the concept of "deutero learning," referring to how the individual in a cultural group learns to learn, or to the content and logical processes of learning. This development represented an early attempt to study qualitative differences in cognition; however, it is unfortunate this potentially useful concept was not developed further (Gladwin, 1964).

Many researchers explored the relationship between culture and cognition by focussing on the relationship between language and thought. The question was posed, "does the structure of a given language affect the thoughts (or thought potential), the memory, the perception, the learning ability of those who speak that language?" (Lenneberg, 1953, p. 463). Numerous attempts were made to answer these questions (cf Morris, 1946) and several scientists (for example, Lévy-Bruhl, 1910; Whorf, 1941; Sapir, 1949) accepted the assumption that the individual's view of the world is directly related to his first language:

> The fact of the matter is that the 'real world' is to a large extent unconsciously built up on the language habits of the group . . . . We see and hear and otherwise experience very largely as we do because the language habits of our community predispose certain choices of interpretation. (Sapir, cited in Whorf, 1941, p. 123)

Although it is clear that each cultural group differs in the vocabulary available for labelling attributes, concepts, objects, and so forth, it is less clear whether modes of thinking are so linguistically bound. Indeed, experimental tests of the "Whorfean hypothesis" provided little supportive evidence (P. E. Vernon, 1969).

Arguing that the study of language can play an important role in the study of human mental processes, Chomsky (1968) admitted that present approaches have been largely unsuccessful and that new perspectives are necessary. Structural phonology, Chomsky contended, made a valuable contribution to psychology by showing that the organizational features of a language play a basic role in the use and acquisition of that language; however, the real richness of phonological systems, he further argued, "lies not in the structural patterns of phonemes but rather in the intricate systems of rules by which these patterns are formed, modified, and elaborated" (1968, p. 334). Chomsky considered human language to be related to a qualitatively different system of intellectual operations from those possessed by sub-human species; one which is not simply a function of higher intelligence. Consequently, he suggested that a study of the "universal grammar" of human languages might provide valuable insights into human mental activity. The approach, as Chomsky noted, is indeed in its infancy and beset with problems (cf Chomsky & Halle, 1968); however, it may yet prove to be a more fruitful undertaking than the structural linguistic approach of Sapir-Whorf.

An approach related to language and thought has been the study of ethnoscience (Sturtevant, 1964), which examines the terminology used by a cultural group to describe various objectively definable features of their environment such as kinship, disease, plant life, and so forth. Because this approach deals with cognitive products such as those embodied by language, rather than processes, it was criticized as being of limited utility in the study of qualitative differences in cognition, revealing little about the development of the product nor its use in novel situations (Greenfield & Bruner, 1966).

In psychology, a recent and popular approach to the subject is to employ Piagetian tasks. Greenfield and Bruner (1966) pointed out, however, that Piagetian studies have been largely confined to a quantitative assessment of the age lag of some specified "foreign" children compared to Euro-American children.

Bruner and his colleagues (Bruner, Olver, & Greenfield, 1966; Greenfield & Bruner, 1966; Goodnow, 1969) addressed themselves to the question of how heredity and environment relate; their aim being to discover "what kinds of cultural difference make an intellectual difference, at what points in development and how it comes about in some particular way" (Greenfield & Bruner, 1966, p. 89).

An interesting and potentially fruitful approach emerged from the studies of cognitive style (Witkin *et al.*, 1962), attempting to document the relationship between physiological, environmental, and cultural factors with psychological differentiation. Cognitive style is defined as being a characteristic self-consistent mode of functioning found in cognitive processes of the individual. As such, it goes beyond the cognitive sphere and is inextricably bound up with personality factors (Witkin, 1967). The construct is quite similar to Bateson's "Eidos," a standardization and expression in cultural behaviour of the cognitive aspects of the individual's personality (Bateson, 1958, p. 220).

During the past fifteen years, many psychologists have attempted to explore the role of ecology in shaping human behaviour (cf Berry, 1971) and, indeed, as Berry (1971) noted, the notion that ecological factors influence behaviour is basic to the science of psychology. For over twenty years, Witkin and his co-workers have explored the area of cognitive style (Witkin *et al.*, 1954, 1962), particularly the dimension they term "analytic-global." Witkin has argued that cognitive style is related to differences in socialization practices. Indeed, studies in both North America (Witkin *et al.*, 1954; Seder, 1957; Witkin *et al.*, 1962; Corah, 1965; Dyk & Witkin, 1965; Chiu, 1972) and in non-Western cultures (Dawson, 1963, 1967, 1972; Berry, 1966a, 1966b, 1971; MacArthur, 1967b; Wober, 1967; Okonji, 1969; Siann, 1972; for a review see Witkin & Berry, 1975) found cognitive style related to such variables as pattern of child rearing, education, urban-rural differences, sex, hand-eye dominance, and ecological environment.

In 1966, Berry advanced the hypothesis that "ecological demands" reflected in mode of sustenance, such as hunting and gathering or sedentary agriculture, would influence the development of perceptual skills and spatial abilities. In addition, Berry (1971) argued that "cultural aids," such as language coding, arts and crafts, and pattern of socialization, would be related to both mode of sustenance--that is to say, to ecological demands--and to spatial-perceptual development. A study of eight subsistence-level peoples (Berry, 1971) found considerable support for the hypotheses. The results of this and similar studies have led to the hypothesizing of an ecological dimension with hunting and gathering economies at one end of the continuum and sedentary agricultural communities at the other. It is suggested (Witkin & Berry, 1975) that at the hunting and gathering end of the continuum an "ecological press" exists to foster disembedding, loose social structure, and patterns of socialization fostering personal autonomy, all considered to be predictive of high differentiation. On the other hand, at the other end of the continuum are sedentary agricultural groups with no such ecological press, with a tight social structure, and a pattern of socialization stressing conformity, all considered to be predictive of low differentiation. Considerable evidence has been gathered from a variety of cultures to support the hypothesized dimension. As Witkin and Berry (1975) noted, however, whether the patterning of levels of differentiation is due to any one factor or to several interactional factors is not possible to determine.

Whether this eco-cultural patterning of differentiation is due primarily to one factor or another is not easily answered since all work to date has sampled from groups characterized by a coherent cluster of antecedent variables. Since it is virtually impossible to disentangle ecological setting from adaptive cultural patterns, a test of individual variables is very difficult. (1975, pp. 61-62)

One advantage of this approach has been its moderate success in identifying which aspects of the physical and cultural environment affect particular aspects of cognition. A cogent argument was advanced by P. E. Vernon (1972), cautioning, however, that the distinctiveness of Witkin's dimension of cognitive style has not been unequivocally demonstrated, and suggesting that much of the variance in field dependence-independence might be more properly attributed to "g," the general intelligence factor.

The above approach has by no means been the only attempt to isolate the environmental variables that influence cognitive development. Other studies (cf P. E. Vernon, 1969; Brooks, 1973) have shown that nutritional and health conditions, human contact and sensory stimulation, schooling and literacy, the nature of the mother-child interaction, language patterns, social class, and attitudes and values held by the family or the group also act to influence cognitive development.

Anthropologist Lévi-Strauss (1966) chose to explore cultural variations in cognition by examining differences in the kinds of categorizations produced by disparate cultural groups. These differences were then used to infer both differences and similarities in underlying thought processes. An important difference between Lévi-Strauss and his predecessors is the view: systems of classification differing from those used by Europeans do not indicate lower levels of thinking or earlier stages of development, but rather reflect the different stages by which people attempt to understand and order their world.

Lévi-Strauss remarked that major differences in classification systems involve the nature of attributes employed in forming classes. Primitive classificatory systems appear to be based on concrete or readily observable attributes, whereas those of modern science are more abstract. This, Lévi-Strauss maintained, is related to problem solving. Primitive peoples have a collection of problem-solving "tools" that are not related to any specific task but are kept because they may be useful. On the other hand, Western man has a fixed and stable structure for making and using "tools," tools which are used for solving specific types of problems (Lévi-Strauss, 1966).

Although some anthropologists (for example, Horton, 1967) examined similarities and differences in the role thinking plays in different societies, it was only in the hypotheses of Lévi-Strauss that an attempt was made to demonstrate that Western and non-Western category systems lead to different modes of problem solving.

An approach similar to those of Lévi-Strauss and Horton was adopted by Cole (Cole *et al.*, 1971), who, with his co-workers, attempted to move towards an "experimental anthropology"; a combination of ethnography and experimental work. Cole criticized traditional cross-cultural research for using experimental methods developed in Europe and North America to assess the relationship between culture and cognition throughout the world. It was argued that because experiments are occasions which demonstrate skills, poor performance by non-Western subjects may not indicate inferiority in those skills, but rather that the experimental situation is inappropriate for tapping them. Cole (1971) explained:

> We thus make ethnographic analysis prior to experimentation in order to identify the kinds of activities that people often engage in and hence ought to be skillful at dealing with. (p. 217)

Similarly, Wober (1969) distinguished between what he termed a centri-cultural approach and a truly cross-cultural one. The former revolves around the investigator's culture, involving tasks and criteria brought from his culture to that of the subjects. In contrast, a cross-cultural approach determines the skills developed and valued in the subjects' culture and then assesses how well they are developed and employed (for an example of the latter, see Wober, 1974). Thus, Wober (1974) reasoned:

> One can either give Western tests and try to infer from the results --from which sections are easier or cause more difficulty--how a particular culture emphasizes some skills and neglects others. Alternatively, one can study the goals of mental development set within a culture and see how these may or may not resemble Western specifications of intelligence. (p. 262)

Current Issues

When the first scientists were venturing into the field, the distinction between psychology and anthropology was far from marked. In the decades that followed, however, the two disciplines went their separate ways; anthropology following the path of examining natural phenomena, psychology the path of experimentalism. Today the gap between the two disciplines is still wide, in spite of attempts at rapprochement. Edgerton, a psychological anthropologist (1974), maintained that convergence is more apparent than real, and that fundamental differences still remain.

The major obstacle to convergence appears to lie in the often inadequate treatment by psychologists of independent variables. Whiting (1973) complained that variables such as sex, culture, education, and socio-economic status are treated as packages and must be unpackaged to determine more systematically how they relate to test scores. Triandis and his colleagues (1971) made the same point. Taking the oft used independent variable "education" as an example, they asked what aspects of education influence cognitive development:

> Is it literacy, participation in institutional environments, the manipulation of symbols, conformity to a life style requiring attention to time, getting rewards for what you do rather than who you are, being able to communicate with people you do not see and being able to receive communications from the outside world, or some other variable that mediates between education and cognitive development? (Triandis *et al.*, 1971, p. 66)

Current emphasis appears to be placed on developing a qualitative analysis of both the cognitive processes of the subjects and of the environment in which they operate, with specificity of the independent variables being a key factor. Lonner (1974) argued that in the future psychology will depend increasingly upon the use of models. This, he contended, "will be done so as to integrate strategies and findings which may lead to more complete and valid generalizations about human behaviour" (Lonner, 1974, p. 14).

Summary

During the last one hundred years, cross-cultural psychology developed from the ethnocentrism of the "cultural evolutionists" to the more enlightened position of "cultural relativity." Concomitant with this development, an increasing awareness has emerged of the limitations of current methodology and occidental scientific paradigms, and indeed, of the biases of Western researchers. Unless native people participate in the planning and execution of cross-cultural research, it has been argued, approaches will continue to remain ethnocentric (P. E. Vernon, 1974).

Contemporary cross-cultural psychologists are less inclined to view different thought processes as inferior, or to believe that native people are incapable of abstract thought. Factor analytic studies have suggested that culture and ecology influence cognitive development; however, it is unclear which aspects of these "packaged" independent variables have the most influence, or which abilities are most or least affected. Consequently, some researchers turned their attention to the study of qualitative differences in cognition; an investigation of the influence of culture and ecology on cognitive processors. The preferred mode of cognition of the individual and of the cultural group, rather than the potential cognitive abilities available, became the focus of attention.

In light of the development of cross-cultural psychology, the present studies were concerned with the qualitative aspects of cognition. Moreover, attention was focussed on conceptual learning, an aspect of cognitive processing which heretofore has received little attention in cross-cultural studies. Further, Lonner's (1974) suggestion that increasing use be made of models encouraged the formulation of a model to describe conceptual learning in terms of its relationship to other psychological constructs (see Figure I, Chapter

3). At the outset, of course, the model was derived from the theories of conceptual learning developed in Western laboratories, and was therefore considered to be an imposed etic (cf Pike, 1966; Berry, 1969).

CHAPTER 2

CONCEPTUAL LEARNING

An essential factor in human thinking is the use of concepts. As Maslow (1954) pointed out, when a familiar object is perceived little attention is paid to its idiosyncratic characteristics. Instead, to be expeditious, that which is perceived is quickly catalogued according to ready-made sets of concepts. The development of concepts begins at an early age. Children learn to discriminate and recognize certain objects and events some time before they are able to speak.

Concept Defined

A variety of definitions has been employed to explain the term "concept." S-R theorists took the view that concepts are:

> The associative meanings, or implicit mediating responses, that the individual has formed between stimulus and response events whereby he treats otherwise dissimilar objects or events as belonging to the same class. (Klausmeier & Ripple, 1971, p. 397)

Bourne, another researcher active in the field of conceptual behaviour, defined a concept as existing when:

> Two or more distinguishable objects or events have been grouped or classified together and set apart from other objects on the basis of some common feature or property characteristic of each. (1966, p. 1)

In a similar vein, Bruner *et al.* defined a concept as:

> A network of sign-significant inferences by which one goes beyond a set of observed criterial properties exhibited by an object or event to the class identity of the object or event in question, and thence to additional inferences about the unobserved properties of the object or event. (1956, p. 244)

Many researchers theorized that concepts not only allow the individual to go beyond the information presently available, but they are the means by which the individual can organize both present information and past experience. For example, Vinacke (1952) described a concept as being a system of learned responses, the purpose of which is to interpret and organize data provided by sense-perception. Past experience is applied automatically to present situations through the use of concepts.

More expansive definitions were given by Sigel, and Klausmeier and Ripple. Sigel (1964) considered concepts to be intellectual tools used by man to organize his world and to solve problems. Symbols and classes, he asserted, are used to order diversity and to develop a repertoire of behaviours including automatic response sets. Discrimination learning and perceptual learning are seen as being important steps in the acquisition of response sets, as are transposition and generalization. Sigel conceived of the adult as having a large number of schemata available to him which then free him from a dependence upon the sensory and perceptual aspects of the environment.

Klausmeier and Ripple (1971) described a concept in a similar manner:

> A mental construct or abstraction characterized by psychological meaningfulness, structure and transferability that enables an individual to do the following:
> 1) cognize things and events as belonging to the same class and as different from things and events belonging to other classes,
> 2) cognize other related superordinate, coordinate and subordinate concepts in a hierarchy,
> 3) acquire principles and solve problems involving the concept,
> 4) learn other concepts of the same difficulty level in less time.

> Operationally, a concept may be defined as the level of mastery at which an individual has attained the concepts; not merely whether he properly categorizes two otherwise dissimilar stimuli as belonging to the same class. (p. 402)

Although there are varying opinions as to how extensive a definition of concept should be, most theorists agree on several points. Firstly, concepts involve grouping in the same class two or more objects or events which differ in some respects. Thus, conceptual learning involves classificatory behaviour. Secondly, classification is according to some criterion which may or may not be related to the physical properties of the stimuli. Hence, rule learning or mediating responses are involved. Thirdly, previously formed concepts facilitate coping with novel stimuli. Fourthly, concepts are the tools used in problem solving. Fifthly and finally, concepts are organized hierarchically.

General Model

Bourne (1966) suggested that the fundamental component of conceptual learning is recognition of all or most of the relevant attributes.* Stimuli vary along several dimensions, with each dimension having, by definition, two or more discriminably different values or attributes. Not all of these dimensions and attributes are important in defining a particular concept; however, those which are important, termed relevant attributes, must be recognized if conceptual learning is to take place.

Stimulus attributes are continuously variable and merge imperceptibly

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*An attribute is defined as any discriminable feature of an object or event which is susceptible to change from object to object or event to event (cf Thomson, 1959, p. 68).

from one to the next; nevertheless, members of a given culture learn to divide the continuous dimensions into discrete categories. The number of gradations on this noncontinuous scale depends *inter alia* on the importance and usefulness of fine discriminations to the individual and to the culture. The individual may also learn names which define each category; however, this, too, varies from culture to culture and is dependent upon the importance of such discriminations.

Bourne considered two processes to be important in attribute learning: perceptual learning and labelling. Several experiments have demonstrated that perceptual learning facilitates attribute learning (for example, see de Rivera, 1959; Engen, 1960; Rasmussen & Archer, 1961; and E. J. Gibson, 1963). Furthermore, the process of labelling, defined as the process of associating distinctive names with discriminable attributes, enhances the discriminability of stimulus objects and their attributes (Goss & Moylan, 1958; Rasmussen & Archer, 1961). It is in this area that cultural differences might be expected to be significant.*

Thus, fundamental to conceptual learning is the development of attribute categories and attribute labels. If the conceptual problem requires finer differentiation among attributes, or the acquisition of new labels, discrimination learning is involved. In most conceptual learning situations, however, the individual has previously developed

*For example, Brown and Lenneberg (1954) argued that in a culture where the difference between square and rectangle is not important, the individual's concept of squareness may remain undifferentiated throughout his life.

attribute categories and labels and hence is called upon only to identify the relevant attributes varying from stimulus to stimulus in the task. This latter activity has been termed attribute utilization as distinct from attribute learning (Bourne, 1966).

The second important component of conceptual learning is the development of rules for combining relevant attributes. Bourne maintained that rules specify how attributes are combined for use in classifying stimuli, and that even in single attribute concepts rules are used to facilitate sorting. Furthermore, it should be noted that rules and attributes are considered to be independent. Demonstrations of rule learning in animals were given by Harlow (1949, 1959); however, rule learning in humans is more difficult to demonstrate as most rules are learned at a very early age. Nevertheless, there is evidence to suggest that the ability to form concepts with disjunctive rules improves with practice (Bourne, 1966).

A distinction was made between rule learning and rule utilization, similar to that between attribute learning and utilization. Once the individual has acquired a set of rules, he is equipped with powerful conceptual tools which facilitate classification of novel stimuli, the development of more concepts and problem solving. At that point, whether the rules will be used to solve a given problem becomes a function of situational variables and the individual's set (cf Maier, 1930).

Explanatory Theories

In the limited space available, it is not possible to present an exhaustive description of all theories and models developed to explain conceptual learning. Rather, only the more widely employed models, which have been the subject of recent studies, are discussed. In addition, no attempt will be made to examine the epistemological view of concept formation as described by the writings of Piaget (for example, 1953). Piaget's theories extend far beyond conceptual learning *per se* and, in fact, Piaget has not directly discussed the topic (Hunt, 1962). For example, although Piaget used the terms "concepts" and "acquisition and utilization of concepts" (cf Piaget, 1947), concept was customarily employed in the sense of explanatory principle:

> [Le concept] n'est qu'un schème d'action ou d'opération, et c'est en exécutant les actions engendant A et B quel on constatera si elles sont compatibles ou non. (Piaget, 1947, p. 41)

and also

> Un concept est la compréhension de la signification d'un terme. (Piaget *et al.* 1957, p. 51)

In a similar vein, the developmental stages and cognitive structures postulated by Piaget are difficult to equate with the constructs of experimental psychology since a structure may be more or less than a concept (D. M. Johnson, 1972). Further, the methodology used by the Geneva school makes it difficult to discuss the approaches of the experimentalists and Piaget in the same breath. An issue disturbing to the experimentalists, for example, is the method employed by the Geneva school for inferring the existence of a cognitive structure, that is to say, the gathering of data from responses to questions and by naturalistic observation (cf Bourne, 1966; D. M. Johnson, 1972).

Most theories in experimental psychology have treated conceptual learning as being a more complex version of learning theory. There have been two main trends in the development of conceptual learning theory: associationistic theories and hypothesis testing theories. Associationistic theories are characterized by the position that the individual is under the control of environmental stimuli; whereas hypothesis testing theories take the opposite view, *viz.*, the individual actively chooses an hypothesis and his choice is the result of internal events, situational variables, and past experience. There has also been a third, more recent trend in theory construction: the simulation of human conceptual behaviour by computer programs. This approach can be based on either associationistic or hypothesis testing theories, although recently the latter has been more prevalent (cf Deese & Hulse, 1967).

Associationistic theories have customarily considered conceptual learning to be a more complex form of discrimination learning, with classes of stimuli being those which are discriminated (H. H. Kendler, 1964). Consequently, S-R theorists have defined a concept as being the acquisition or utilization of a common response to dissimilar stimuli (T. S. Kendler, 1961). Conceptual learning is, however, seen as differing from discrimination learning in that differential responses need be associated only to the relevant attributes of the stimuli.

Two types of associationistic theories have been expounded, those which assign an important role to internal mediating processes and those which do not. The non-mediating view was pioneered by Hull (1921) who attempted to show conceptual learning could be explained in unelaborated

S-R terms. A passive process was envisaged in which the response was conditioned to the stimulus via contiguous association. Skinner (1953) similarly argued that when reinforcement follows a response, all characteristics of the stimulus acquire a degree of control over the response. It was further argued that when behaviour becomes controlled by a few relevant attributes in a variety of otherwise dissimilar objects or events, behaviour is an abstraction, termed conceptual behaviour (see also E. J. Gibson, 1940 and Baum, 1954).

To many researchers, non-mediational theories have inadequately explained complex conceptual learning and therefore an intervening link between stimulus and response was proposed. Hull (1930) was also the first to postulate the existence of a mediator, called a "pure stimulus act." Its function, Hull contended, is to produce additional stimulation which further serves as a cue for overt responding. H. H. Kendler and T. S. Kendler (1962) similarly considered the role of the mediator to orient the individual to the critical attributes of the stimulus. Other theorists, such as Osgood (1953), have suggested that mediators convey the meaning of the stimulus. It should be noted that in human adults most mediators are considered to be verbal in nature.

There have been equivocal results from studies examining the existence of mediators, and indeed, as Bourne (1966) has pointed out, this is not surprising as there are undoubtedly situations wherein mediational processes are at work and situations wherein they are absent. Consequently the most appropriate construct may depend upon situational variables and individual differences.

The associationistic view attributes only a passive role to the individual; however, many researchers have contended that the individual actively adopts a strategy for selecting instances to discover the concept. This was not intended to negate entirely the role of associative learning, but to say that the individual has some choice, and that the choice he makes is a function of past learning, situational variables, and individual differences.

This latter approach has been preferred by Bruner and his co-workers. Although Bruner did not explicitly formulate a theory of conceptual learning, his work implied such a theory. Stated simply, Bruner suggested that a concept is a category (Bruner *et al.*, 1956) and whether an object or event qualifies for membership in a certain category depends upon the discrimination of identifiable attributes and the utilization of these attributes as the basis for classification. Thus, an individual learns a new concept by recognizing which attributes are the defining characteristics. Placing such emphasis on attribute discrimination however, is not shared by all theorists. Bourne (1966), for example, claimed that it is rule learning not attribute learning which is the essence of conceptual learning.

A mathematical model of hypothesis testing was developed by Restle (1962) that has the advantage of being an *a priori* model capable of deductive and predictive possibilities, rather than being a *post hoc* interpretation of data, such as that conducted by Bruner. One of the limitations of the model is, however, it assumes independent sampling of hypotheses and therefore cannot predict such relationships, between hypotheses, as hierarchical ordering or strategies, that have been found in other experiments (cf Bruner *et al.*, 1956; Hunt, 1962; Bruner *et al.*, 1966).

The similarities between concept learning, that is to say, decision making, and the information processing operation used by computers has led to the construction of computer programs which simulate human behaviour. The earliest work done in this area was by Hovland (1952) and Hovland and Hunt (1960) (for a complete review see Hunt, 1962; for criticism see H. H. Kendler, 1964).

The computer simulation of conceptual learning, although yielding some interesting results, has provided little evidence showing that programs reflect the subtleties and complexities of human behaviour. This is notwithstanding the fact that computer programs have incorporated some features resulting from empirical studies with human subjects (Deese & Hulse, 1967).

Another weakness of the model is the failure to deal with some of the key issues in conceptual learning, such as the nature and origins of information processing units. It has yet to be established whether these are learned, are reducible to S-R units, or are innate abilities. Similarly, two further issues remaining unexplained are veridicality and degree of memory for previous instances, and the way in which the model simulates transfer.

Experimental Paradigms

Two experimental paradigms have been used in the study of conceptual behaviour: the reception paradigm (Hull, 1921) and the selection paradigm (Bruner *et al.*, 1956). The difference between the two procedures lies in the method of stimulus presentation. In the reception paradigm, the more widely used of the two, the subject has no control over the order in which the stimuli are sampled as they are presented in a pre-determined sequence (or random order). On the other hand, in the selection paradigm, the entire stimulus presentation is shown to the subject at the outset and the order in which they are sampled is entirely in his hands.

Huttenlocher (1962), using a sample of Grade 7 children, examined differences in performance due to the type of paradigm employed. Results indicated that significantly more correct solutions were attained in the reception paradigm and these were attributed to the additional operations subjects, using the selection paradigm, had to perform in choosing instances to be sampled. Huttenlocher added, however, the advantage of using the selection paradigm was that it allowed the subject to select instances in the order he considered to be the most fruitful. Consequently, information was provided into the strategy employed; information which was not provided by the reception paradigm. Hence, he concluded that unless researchers were concerned with maximally efficient performance, there was some advantage to using the selection paradigm.

Learning Strategies

Most of the work exploring strategies in concept learning has been done in the laboratories of Jerome Bruner (Bruner *et al.*, 1956, Bruner *et al.*, 1966). Bruner considered an individual who is acquiring a new concept by learning its defining attributes, to be in a problem-solving situation involving a number of decisions which themselves form a pattern. These patterns of acquiring, retaining, and utilizing information exhibit a certain consistency and order and it is this behaviour Bruner termed strategies.

Bruner's work has suggested that the aims of a strategy are threefold: to increase the likelihood of encountering instances that will contain relevant information; to render less stressful the task of assimilating, recording, and storing information; and to regulate the risk undergone in attaining a correct solution within a limited number of choices (Bruner *et al.*, 1956, p. 82). Strategies, it should be noted, need not necessarily be consciously formulated by the individual; they are merely patterns of behaviour actually observed in a conceptual learning situation.

In one of the two strategies observed by Bruner in the reception paradigm, termed a focussing strategy, all of the attributes of the first positive instance comprised *in toto* the initial hypothesis. Henceforth, everything was ignored except that which was common between the current hypothesis and any positive infirming instance encountered. By comparison, in the part-scanning strategy, the second strategy observed, only some of the attributes of the first positive instance were used to form an initial hypothesis. When this hypothesis was not confirmed by a future instance, an attempt was made to change it by referring back to all previously encountered instances.

An advantage of the focussing strategy is that memory load is reduced by carrying all relevant information in one hypothesis, thus obviating the need to recall past instances. Further, the user of the focussing strategy will, by definition, never encounter the psychologically disrupting of all instances, the negative infirming instance (cf Bruner *et al.*, 1956). Yet another advantage to the focusser is the reduction of search behaviour. If the rules of the strategy are followed, attention need not be paid to attributes already encountered after they have been used to correct the hypothesis.

Similar strategies were found with selection paradigms. Two types of focussing have been identified, focus gambling and conservative focussing. In both cases the first positive instance is used as the focus; however, in conservative focussing only one attribute is varied at a time, whereas in focus gambling more than one is varied. Consequently, focus gambling may reduce the number of instances needed to identify the concept, but it also increases the likelihood that an instance will be encountered which conveys no information. By way of contrast, conservative focussing is "slow but sure," as every instance encountered will convey information. Both strategies, because they are focussing strategies, reduce memory load, inference load, and search behaviour.

Two scanning strategies were also identified from selection paradigms. One of these, however, called simultaneous scanning, in which the individual uses each instance encountered to deduce the tenable hypotheses, is such an exacting strategy that it is not used in practice. There is apparently no way to reduce the heavy load placed on inference and memory resulting from carrying several independent hypotheses simultaneously.

The scanning strategy actually observed in human conceptual behaviour is successive scanning, which is a strategy of hypothesis testing similar to sudden learning. Single hypotheses are successively tested until the correct one is discovered; therefore, choices are limited to those stimuli which provide a direct test of the hypothesis. The probability is thus increased that logically redundant stimuli will be chosen, some feature of which has been used to test a previous hypothesis. Successive scanning provides no method for regulating risk and although it reduces inference, remembering which hypotheses were tested increases memory load.

The results of Bruner's studies suggest that subjects do conform to one of the above-described strategies and are consistent in the strategy they employ. Most individuals (approximately 62% from reception paradigms) prefer the focussing strategy and, indeed, it is the more efficient of the strategies so far identified. It would appear, however, the strategies identified by Bruner emerge less clearly when concepts other than class concepts are involved. E. S. Johnson (1964), for example, studying several different kinds of concepts, identified only two main categories of strategies. These were low level scanning and complex strategies, with the latter being used only occasionally. The results of this and similar studies failed to yield the more precise information obtained by Bruner.

Laughlin (1968) has rejected Bruner's view that focussing and scanning are two discrete strategies and instead argued that focussing is a continuous variable with some subjects displaying more or less focussing than others. Accordingly, an "index of focussing" was developed, calculated by dividing the number of focussing choices by the total number of choices made, thus yielding a continuous score of .00 to 1.00. To qualify as a focussing choice, each must have obtained information on a new attribute and the hypothesis must have been tenable.

Laughlin's own work (1965, 1966, 1968) confirmed the existence of focussing and scanning strategies and demonstrated that they are empirically as well as theoretically distinguishable. Nevertheless, Laughlin (1965) pointed out that the method of stimulus presentation may influence the strategy used:

> In applying a focusing strategy, attributes are successively abstracted from the unified object and the set of hypotheses involved tested for the applicability to the concept. The S may thus be set to use a focusing strategy because of the nature of the stimulus display. (pp. 323-324)

This hypothesis, however, has received only partial support (Laughlin, 1965, 1966).

Using a slightly different methodology in a reception paradigm experiment, Denny (Denny, 1969; Denny & Benjafield, 1969) observed three strategies quite different from those noted by Bruner and Laughlin. The first, a formal strategy, was described as being a correct case of deductive reasoning, corresponding to the Piagetian stage of formal operations. Once established, conclusions held for all successive instances and were abstract in so far as the conclusion was maintained, despite the nature of the stimulus in succeeding instances. The second, defined as a concrete strategy, corresponded to the concrete operations stage of the Piagetian model. It was considered to be concrete in so far as the subject was overly stimulus bound, drawing separate conclusions from different pieces of information. Often a conclusion about an attribute was drawn in one instance which contradicted those drawn about it in another. The third was judged as being a non-processing strategy, as the subject appeared to record the information gained from the task but was unable to process it. Consequently, at the conclusion of the task, the subject was unable to identify the concept.

A proponent of computer simulation of human conceptual behaviour, Hunt has also considered strategies to be an integral part of concept learning. His definition of strategy was quite similar to Bruner's:

> A strategy is a plan for arriving at a pre-defined goal at a minimum cost. The goal in concept learning is the attainment of the concept which provides a satisfactory decision rule for assigning names to objects. (Hunt, 1962, p. 163)

Hunt further contended: "the value of a decision rule depends on the situation in which it is used, and since cost factors vary from situation to situation, and from learner to learner, no general statement about appropriate strategies is possible" (Hunt, 1962, p. 164). Consequently, the advisability of guessing class membership from a partial description (that is to say, to focus gamble) would depend on the cost involved and the probability of error.

Also, a relationship between the strategies employed and the subject's abilities was postulated by Hunt. In concept learning, the individual must make statements about objects and then perform logical operations on the sets defined by the statements. Furthermore, the more powerful the basic operations he can perform, the easier the problem will be. Thus, Hunt argued, the individual will presumably use his strongest ability to perform the operation, and this will define the operation to be applied. Since different strategies involve different operations, the strategy the individual will employ depends upon which of his abilities are the strongest.

Hunt further contended that focussing strategies are valuable for conjunctive concept learning but not disjunctive, as in the latter there is no unique focus common to all positive instances. To Bruner's list of possible strategies, Hunt has added two: scanning using negative instances, a strategy of double negation wherein the concept is defined by what it is not; and conditional focussing, a method of using positive instances to define a disjunctive concept. As a result of a conceptual learning experience, the individual not only learns the correct concept, Hunt concluded, but also develops strategies, better tests of his strategies, and perhaps even learns a concept to define the types of problems on which particular strategies will work.

In summary, the study of strategies in conceptual learning has suggested identifiable strategies are employed in a relatively consistent fashion (cf Eifermann, 1965). These studies have, however, for the most part been confined to a small segment of conceptual learning, class concepts, and those few studies which have attempted to examine performance in learning other types of concepts have yielded only equivocal results. Although as Thomson (1959) stated, there is no doubt that class concepts play an important role in the organization of perceptual data and that these are frequently used in human daily activities, further research is needed to examine the nature of human behaviour in the attainment of other types of concepts and to examine the relationship between strategies, cognitive style, ability structure, and culture.

Role of Memory in Concept Learning

Two kinds of memory, it is thought, are involved in concept learning: the retention of stimulus attributes, hypotheses, and other information during the process of acquiring the concept; and the retention of the concept once learned. Regarding the latter, results have generally indicated that the retention of concepts once learned is quite good (for a brief review see Dominowski, 1965).

Postulating response contiguity as a necessary requirement for conceptual learning, and admitting that no data existed at the time of writing to confirm or reject the hypothesis, Underwood (1952) suggested: the number and the complexity of stimuli would influence performance, and "because of the fallibility of memory we would expect that the greater the time between pertinent stimuli the slower the rate of acquiring a concept" (p. 213).

Support for Underwood's contention that greater contiguity facilitates performance came from a large number of experimental studies (Kurtz & Hovland, 1956; Newman, 1956; Peterson, 1962; Richardson, 1962; Bourne & Jennings, 1963; Schulz, Miller, & Radtke, 1963; Whitman & Garner, 1963). Interpreting response contiguity in terms of information feedback (Bourne, 1957), further support for Underwood's hypothesis has come from the work of Bourne and Restle (1959) and from Bourne and Bunderson (1963).

A number of studies have explored the effect of stimulus availability and once again the impetus was provided by Underwood: "the work on concept formation has suggested that concepts are more difficult to attain if S has to draw on memory to supply the characteristic defining the concept" (1949, p. 459). Bruner *et al.* (1956) noted that subjects having the stimulus array available to them performed better than subjects from whom the array was removed. Similarly, in another study it was observed that an ordered stimulus array was more conducive to concept attainment than a random array. Attempts to replicate this finding, however, have yielded conflicting results (Laughlin, 1964).

Studies by Hovland and Weiss (1953) revealed that a simultaneous presentation of stimuli was superior to a successive presentation in facilitating concept learning, but only when negative instances occurred. In the case of positive instances, the number of correct solutions was too high to detect any difference in performance. Dealing with concepts involving only negative instances, Cahill and Hovland (1960) also found a significant difference in favour of simultaneous stimulus presentation. Most errors, they concluded, were due to the subject's failure to remember previously seen stimuli in such a way as to be able to draw inferences from them. Bourne, Goldstein, and Link (1964) obtained results confirming earlier memory studies, but suggested that the effect of stimulus availability is related to stimulus complexity. One or two attribute problems were not seriously influenced by stimulus unavailability and this was attributed to the relative ease of the task.

The effects of memory in concept learning have also been related to strategies. Focussing has appeared to be the more successful strategy, a finding which Bruner has attributed to the more difficult memory requirements of scanning. In an experiment with selection strategies, Laughlin (1965) discovered greater use of focussing with three-attribute concepts than with two-attribute concepts. Consequently, it was suggested that the greater memory requirements of the three-attribute problem may have influenced the subjects to adopt a focussing strategy. As a further test of this hypothesis, Laughlin (1966) compared performance on four-attribute and two-attribute concepts. The results showed more focussing strategies were used in the four-attribute concept than in the two.

Effects of Amount of Information

Related to the study of memory factors in information processing is the examination of the effects of amount of information present in a conceptual learning task. Archer, Bourne, and Brown (1955) found that as the amount of irrelevant information increased performance decreased, although not as rapidly, the relationship being non-linear. Similar results were obtained by Bourne (1957), Brown and Archer (1956), and Bourne and Pendleton (1958). Furthermore, Walker (1957) and Walker and Bourne (1961) noted that as the amount of relevant information increased, performance decreased exponentially.

Studies departing from the customary method of using only visual stimuli and conjunctive concepts have generally yielded results similar to those described above. Lordahl (cited in Bulgarella & Archer, 1962), for example, reported that varying the amount of auditory information had little effect on performance when both visual and auditory inputs were used to identify the concept. This was interpreted by Lordahl to mean that individuals have either a preference for visual stimuli or they are better able to ignore auditory stimuli. Bulgarella and Archer (1962), however, found that when only auditory stimuli were available for concept identification, performance decreased as a linear function of the amount of relevant information present.

Using bi-conditional concepts, Kepros and Bourne (1966) discovered that the effects of amount of relevant and irrelevant information were the same as in conjunctive concept learning. On the other hand, Haygood and Stevenson (1967) reported generally increased information resulted in decreased performance, but that rate of performance decrement was related to the difficulty level of the conceptual rule being learned.

Bourne and Haygood (1959, 1961; see also Haygood & Bourne, 1964) have shown that redundant relevant information facilitates concept identification both in the presence and in the absence of irrelevant information. Not surprisingly, it was also found that redundant irrelevant information interferes with performance. The facilitative effect of redundant relevant information has been attributed to the increased number of cues thus provided that can be used to identify a set of stimuli (Bourne & Haygood, 1959).

Hence, studies into the effect of amount of information present in conceptual learning tasks (cf Glanzer, Huttenlocher & Clark, 1963) have suggested that increased information inhibits problem solution unless the additional information is redundant and relevant. Consequently, performance decrement, it appears, is due to memory factors* rather

*There is some evidence (Zeaman & House, 1963) to suggest that attentional factors influence discrimination learning and thus would be expected to influence the ability to perceive attributes and attain concepts. Consequently, many of the above results, for example the facilitative effects of redundant relevant information, may be more a function of attention than of capacity for information storage and retrieval.

than information processing ability. Were limitations in information processing the cause, redundant relevant information would be expected to inhibit performance as well.

Relationship to Intelligence

Using a card sorting test of conceptual learning and a battery of ten cognitive ability tests, Baggaley (1955) observed that scores on reasoning tests correlated significantly with scores from the conceptual learning task. These findings confirmed earlier results (for example, Smoke, 1932); however, Baggaley was surprised to find that tests of closure correlated more highly with conceptual learning than any of the three reasoning tests. Baggaley (1955) explained his findings thusly:

> In solving the card sorting test the analytic thinker evolves and tests hypotheses by concentrating on one dimension and ignoring the other. . . . Thus the common process in these tasks seems to be concentrating on one aspect of a complex stimulus situation. (p. 304)

Further, Baggaley argued, the analytic method is not the only method of concept formation since for many subjects the wholistic approach is important. Consequently, from performance on closure tests, Baggaley's work has suggested two styles of conceptual learning: analytic and wholistic.

In a study using groups of below average, average, and above average intelligence, Hoffman (1955) noted a positive correlation between intelligence and conceptual learning ability, but only for the below average and above average groups. Hoffman attributed the lack of a positive relationship for the average group to the heterogeneous nature of the average group's abilities.

Similar results were obtained by Griffith, Spitz, and Lipman (1959) and by Osler and Fivel (1961). In the latter study, a significant relationship was observed between both age and conceptual learning ability and intelligence and conceptual learning. When subjects were divided into groups of sudden and gradual learners, however, group membership was found to be a function of intelligence not age.

Osler (Osler & Trautman, 1961) further hypothesized that children with superior intelligence attain concepts through hypothesis testing, whereas children with normal intelligence do so through S-R associative learning. In a study exploring the relationship between intelligence, stimulus complexity, and concept attainment (Osler & Trautman, 1961), the hypothesis was confirmed. A later study (Osler & Weiss, 1962) suggested that children of superior intelligence were also more effective at concept learning under conditions where only vague instructions were provided, but not when explicit instructions were given. The authors concluded that superior intelligence gave the children an advantage in the problem-finding phase of the task but not in the actual problem solution.

Attempting to isolate specific cognitive abilities influencing concept learning, Dunham, Guilford, and Hoepfner (1969) administered a battery of cognitive ability tests and conceptual problems to 177 high school students. Results showed that concept learning scores were correlated with the ability factors but that these correlations were low. Similarly, success in verbalizing the concepts also yielded only low correlations with the ability factors. Another factor analytic study of conceptual learning (Lemke, Klausmeier, & Harris, 1967) obtained somewhat similar results, indicating factors of general reasoning, induction, and verbal comprehension in conceptual learning ability.

Studies of intelligence and conceptual learning have suggested that a positive relationship exists between the two, and there has been some indications as to which cognitive abilities are involved in conceptual learning. Baggaley's study is of particular interest as it posits a relationship between conceptual learning ability and cognitive style (as described by Witkin *et al.*, 1962).

Relationship to Cognitive Style

Very few studies have explored the role of individual differences in concept learning (Hunt, 1962; Bourne, 1966), and those which have, as discussed previously, concentrated primarily on intelligence or learning strategy as the independent variable. A few studies, however, appear to have explored the results obtained by Baggaley (1955).

Doyle (1965) designed a study to investigate the effect of cognitive style on the ability to attain conjunctive concepts and the ability to perceive embedded figures. The particular cognitive style variable chosen was the analytic-global construct operationally defined by the preference for forming analytic conceptual groupings on the Conceptual Style Test (CST). The study, conducted with junior high school students, failed to support the hypothesis that "analytic" subjects would perform better than "global" subjects on tests of concept attainment and embedded figures.

A more recent study, however, has yielded results inconsistent with those observed by Doyle. Davis and Klausmeier (1970) undertook to explore the relationship between performance on concept learning tasks and the cognitive style dimension of analytic-global as described by Witkin (Witkin *et al.*, 1954). Simply defined, this dimension is "concerned primarily with the manner in which an individual perceives and analyses a complex stimulus configuration" (Davis & Klausmeier, 1970, p. 423). The two poles of the dimension are characterized by those subjects who differentiate the components of a complex stimulus (analytic pole) and those who react to the stimulus as a whole (global pole).

Davis and Klausmeier postulated that subjects who could discriminate the component parts of the stimulus complex in an embedded figures test would also be able to identify concepts more easily than those who could not. The results of two experiments, conducted with 170 grade 12 students, confirmed the hypothesis. It was further concluded that although training facilitated performance on concept learning tasks, it did so equally for both groups.

Socio-economic Differences

Studies exploring the relationship between socio-economic status and the ability to attain concepts have generally shown that children from lower-class homes perform less well than those from middle-class homes. Many of these studies, however, have been criticized (cf Pishkin & Willis, 1974) for giving verbal ability such a major role in experiments that it has almost become the factor under investigation. This criticism has been strengthened by some studies (for example, Prehm,

1966) showing that verbal pre-training facilitates concept acquisition, although other studies (for example, Kofsky, 1967) have not found improvements resulting from pre-training.

Assuming intelligence tests are biassed against lower-class children, Findlay and McGuire (1956) hypothesized that lower-class children would out-perform middle-class children on a test of concept learning if both groups were matched for IQ. The hypothesis was not confirmed; the results showed that middle-class children were significantly superior. Similarly, Siller (1957) obtained significant differences in favour of middle-class subjects on a test of non-verbal classification; however, when the subjects were matched for verbal ability, non-significant differences were obtained. Scholnick, Osler, and Katzenellenbogen (1968) reported: although middle-class children performed better than lower-class children on tests of discrimination learning, no significant differences emerged on tests of conceptual learning using the same stimuli. In another study based on card sorting, Pishkin and Willis (1974) likewise found no significant differences between lower- and middle-class subjects.

The results of these studies suggest socio-economic status may be related to conceptual learning ability when language plays an important role; however, when only minimal verbal skills are required, non-significant differences emerge.

Cultural Differences

Most studies of concept learning with non-Western subjects have suggested that such individuals have difficulty with abstract problem solving. Initially this was interpreted to mean non-Western people operate at a concrete or perceptual level in contradistinction to the abstract or conceptual thinking characterized by members of Western societies (cf Chapter 1). It has been suggested, however, that an important element in the solution of conceptual problems is familiarity with the stimulus objects (cf Price-Williams, 1962; Kellaghan, 1968; Deregowski & Serpell, 1971; Okonji, 1971).

Few studies, indeed, have investigated concept identification in non-Western cultures. Knowles and Boersma (1968) studied mediating responses in the optional shift performance of Canadian Indian and non-Indian Children. Their results led to the conclusion:

> Children from a culturally different environment, lacking in verbal experience, tend to display a retarded development of mediating responses in a concept formation task. (Knowles & Boersma, 1968, abstract)

In Liberia, Ciborowski and Cole (1971) explored the relationship between concept learning and the logical rules which define different types of concepts. Specifically, they tested Bruner's hypothesis: the relative ease of conjunctive concept attainment might be specific to Western societies because of the scientific paradigms traditionally found in such societies (Bruner *et al.*, 1956).

In earlier studies (Cole, Gay, & Glick, 1968) Cole found that conjunctive and disjunctive concepts were learned with equal difficulty by the Kpelle, but that disjunctive concepts were more difficult for American subjects. Later, using a different approach (cf Cole *et al.*, 1971, p. 198), the results were replicated for the Kpelle but for the American subjects discordant results were obtained, showing that American grammar school children solved both types of problems with equal ease. This led Cole to conclude that perhaps experimental procedure influenced the process of conceptual learning (Ciborowski & Cole, 1971).

Yet a third approach, using a modification of Haygood and Bourne's (1965) procedure, was taken. Results showed that, for both the Kpelle and American subjects, conjunctive concepts were easier to attain than disjunctive; thus, Bruner's hypothesis was not confirmed. Furthermore, when the attributes to be combined were from the same dimension, neither group showed a bias in favour of one type of concept or the other. The only significant difference occurring between the two groups was the ability to verbalize the concept. For American subjects a strong correlation was noted between ability to perform the conceptual learning task and ability to verbalize the concept; however, this was not the case for the Kpelle subjects (Ciborowski & Cole, 1971).

The series of studies by Cole *et al.* was a rare attempt to replicate, in the field, studies of conceptual learning designed in Western laboratories. More important than the results obtained, therefore, are the methodological implications of their work. Cole's suggestion, for example, that experimental procedure may influence the process of concept learning is not without significance for the researcher attempting to adapt Western research methods to the cultural setting.

Summary

Much of the research into conceptual learning has been conducted using adult university students as subjects, and therefore, since university students are not representative of the total adult population, the generality of the results cannot be assumed. In addition, it is not known whether conceptual learning in the adult is qualitatively similar to conceptual learning in children, that is to say, bears the same relationship to other psychological constructs such as intelligence, attribute perception, memory, and so forth. Finally, with the exception of Cole's studies, no concerted attempt has been made to examine conceptual learning in cultures other than those of occidentals.

A need exists, therefore, to examine conceptual learning not only in children, but in children from non-Western cultures. A cross-culture approach to the topic, it is argued, will facilitate the teasing out of "universals" in conceptual learning and, furthermore, knowledge of the cultural differences will aid the development of more appropriate curricula and educational methods for the "culturally dissimilar." Consequently, the present studies were concerned with an analysis of the relationship between the ability to attain conjunctive concepts* and underlying psychological processes and abilities; moreover, they were concerned with the cultural variations in that relationship. To begin the analysis, a model describing conceptual learning was developed.

*The term conjunctive concept refers to both "simple" and "multiple" attribute concepts. Examples of simple attribute concepts satisfy one requirement (for example, black in colour); whereas examples of multiple attribute concepts must satisfy two requirements (for example, black in colour and large in size) (cf Wickelgren, 1964).

CHAPTER 3

THEORETICAL FRAMEWORK

Discussion

The theoretical framework underlying the present studies is represented in Figure 1. The model, at this stage, should be considered an imposed etic (Pike, 1966; Berry, 1969); that is to say, it is a model developed from studies within one culture, the Euro-American (an emic), which is then applied to a second culture with the acknowledged limitation that it is probably a poor approximation of an understanding of behaviour in that system (cf Berry & Dasen, 1974). It is hoped, however, that research data will suggest modifications leading to a model appropriate for both cultural groups (a derived etic) which in turn can be tested in other cultural settings.

The physical environment, the culture, and the pattern of socialization* provide learning experiences for the young child. It is through an interaction between the child's genetic pre-dispositions and these learning experiences that the child develops a cognitive structure allowing him to meet environmental and cultural demands and to cope with new learning experiences.

Cognitive structure [illegible] not considered to be static, but rather

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*Although pattern of socialization is technically considered to be part of culture, Berry's (1971) approach, singling out socialization for special attention, has been adopted because of the dominant role it plays in shaping human behaviour and because of its adaptive relationship to environmental variables (cf Barry, Child, & Bacon, 1959).

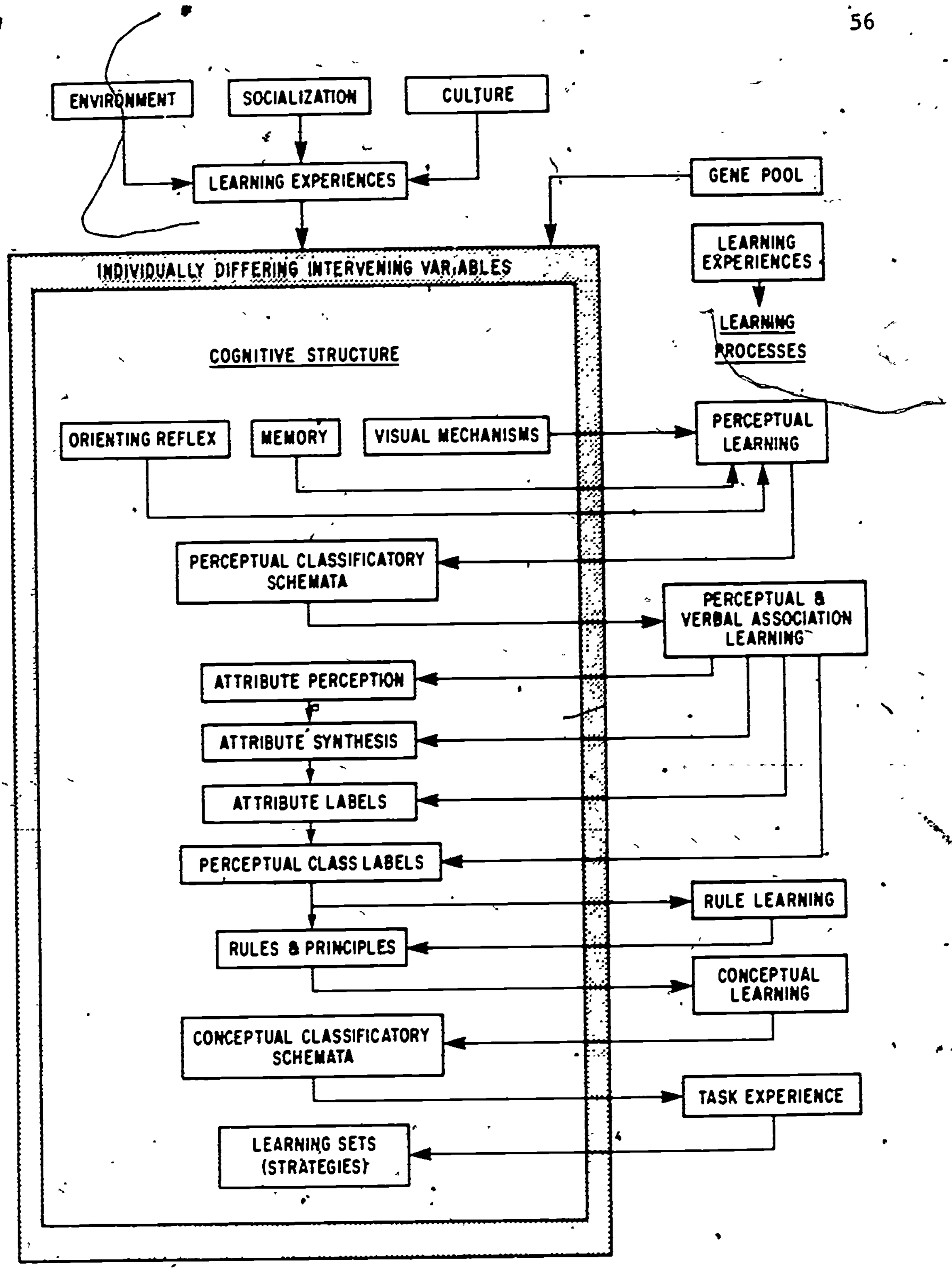

FIGURE I

A Model Representing the Relationship Between Conceptual Learning and Various Underlying Processes and Components of Cognition to be a dynamic organization of mental abilities and processes which is continually developing as a result of maturational factors and interactions with new learning experiences. At any given time it may be considered to be the individual's "initial mental set." That is to say, after n experiences the individual has an initial cognitive structure he may use to interact with experience n + 1. As a result of that experience the individual's cognitive structure may be altered so that he has a different cognitive structure for experience n + 2, and so on. The degree to which the cognitive structure is changed by any one experience is a function of the impact of the experience.

Cognitive structure, of course, is not the sole determinant of the individual's cognitive behaviour, nor does it operate in isolation. All inputs and outputs, that is, all stimuli travelling to, and all responses travelling from, the cognitive domain pass through or are mediated by "individually differing intervening variables" (cf Fig. 1). This rather broad term includes personality factors, neurological and physiological variables, and cognitive style. Thus, individually differing intervening variables are those traits and processes varying from individual to individual which are not strictly cognitive but which mediate in the process of cognition. These variables may have genetic origins, may develop from learning experiences, or may result from both. Nevertheless, they are relatively consistent individual traits which influence behaviour, making it characteristic of the individual.

In the neonate, several basic components, predominantly related to sensori-motor activity, comprise the cognitive structure. As has been well documented (for a review see M. D. Vernon, 1970), the mechanisms for vision are sufficiently developed at birth to provide a basis for visual perception. Furthermore, recent evidence has been advanced to support the hypothesis that the perception of form is innate (M. D. Vernon, 1970). Thus, there appear to be genetically determined basic components of the cognitive structure present in the infant at birth for the development of visual perception. On the other hand, if perception is to continue to develop, two other basic components are required: memory and the orienting reflex.

As M. D. Vernon (1970) noted:

> Clearly, before any discrimination can occur, the infant's attention must be attracted, so that he observes an object and differentiates it from its background. We noted that even at birth attention is aroused and gaze attracted by bright lights and moving objects; and a little later by certain types of patterns. (pp. 12-13)

That which directs the individual's attention to particular types of stimulation is the "orienting reflex" (Pavlov, 1949; Sokolov, 1958, 1961) or "preparatory set" (J. J. Gibson, 1941). Thus, the orienting reflex appears to be an innate mechanism basic to the development of visual perception. Research in physiology has suggested that the orienting reflex has its origins in the reticular formation of the brain, a network of cells in the brain stem and thalamic region having two main functions (cf Samuels, 1959; Berlyne, 1960). Although the reticular formation in the brain stem produces general arousal to sensory stimulation, it is the thalamic reticular formation which "gives rise to a more persistent and localized response, sometimes called the 'orienting reflex,' in which attention is directed towards particular types of stimulation" (M. D. Vernon, 1970, p. 69). The orienting reflex thus acts as a conditioner of all incoming stimuli.

The development of the orienting reflex goes hand in hand with the development of memory. Although Sokolov argued that a type of transient memory is involved in the orienting reflex, research has indicated that there is little capacity for memory storage in the neonate and that each new presentation of a stimulus is treated as a new and unrelated event (Bower, 1965; Fantz, 1964). Increasing age brings with it increasing memory span and as memory expands so does the child's capacity to learn from previous experiences. With the development of memory, the role of the orienting reflex is refined; it becomes not just a monitor of incoming stimuli but also a controlling mechanism of the amount of information processing occurring as a result of stimulus presentation. This is compatible with Sokolov's (1958, 1961) view that the orienting reflex allows the organism to compare new incoming stimuli to that which it has previously experienced. If a new stimulus matches the representation of the previously encountered stimulus, no information processing occurs because the stimulus information has already been analysed.

Consequently, visual mechanisms, the orienting reflex, and memory are basic components of the cognitive structure, which are present in some degree at birth, and which are continually developing throughout childhood. In so developing, these basic components facilitate the development of visual perception through discrimination and synthesis learning. A result of the interaction of cognitive structure and perceptual learning experiences* is the formulation of what Bruner (1957)

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*Perceptual learning is defined as a relatively permanent change in the termed perceptual categories into which stimulus objects may be sorted. Piaget (1952, 1955) also postulated that during the first months of life infants begin to form perceptual schemata, thought to be organizations based on familiar objects and the integration of their sensory qualities, behavioural characteristics, and possible uses (Head, 1926). Developm of perceptual schemata involves the child's examination of both his ac and the characteristics of the object:

> Piaget has particularly stressed the significance in formation of schemata of the child's actions in relation to objects. But also he begins to investigate the characteristics of objects as such, independently of the effects on them of his own actions. New objects may be assimilated into existing schemata, any unfamiliar characteristic being ignored; and familiar actions are applied to them. (M. D. Vernon, 1970, p. 19)

The development of perceptual schemata or categories is the primary factor in perceptual readiness according to Bruner (1957). Moreover, Bruner argued, it is the accessibility of these categories which determines the amount of stimulus information needed for classifying. As the accessibility of the category increases, the amount of stimulus information needed decreases, and consequently the amount of information processing necessary decreases. The development and accessibility of a category is dependent upon previous learning experiences, which, in aiding the formulation of categories, also influence the ability to process future inputs:

> The more frequently in a given context instances of a given category occur, the greater the accessibility of the category. Operationally, this means that less stimulus input will be required for the instance or event to be categorized in terms of a frequently used category. . . . the principal form of probability learning affecting

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way in which a stimulus is perceived, solely as a result of past experience. It is seen as being an intermediate step between motor learning and conceptual learning.

category accessibility is the learning of contingent or transitional probabilities — the redundant structure of the environment. (Bruner, 1957, p. 128)

Figure I thus depicts the three* basic components of cognitive structure which interact with perceptual learning experiences provided by the cultural and physical environments and which lead to the development of perceptual classificatory schemata. These schemata, as they develop, form another important component of cognitive structure which in turn interacts with future learning experiences to develop further skills and abilities. It should be noted that all interactions between the components of cognitive structure and learning experiences are mediated by individually differing intervening variables. Thus, the gap between "reality" and "perceived reality" may be quite wide, therefore influencing not only the perception of the learning experience but also the process and results stemming from that experience.

The development of more and more perceptual schemata necessitates the development of conceptual categories to cope with the increasing amounts of information. When a particular perceptual schema can be related to a class of objects, subsequently encountered objects can be identified by relating to this class, whereupon its main features and functions are then known. Both the development of perceptual schemata and conceptual categories require the skills of attribute discrimination and attribute synthesis. The former is defined as the ability to

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*The basic component, visual mechanisms, is of course only one of the many sensory mechanisms present at birth. Nevertheless, because only visual perception is of direct concern to the present studies, the other mechanisms have been omitted. It is, however, envisaged that they operate in much the same way.

differentiate, recognize, and identify attributes; the latter as the ability to compare, contrast, and integrate attributes. Furthermore, in the process of acquiring adult conceptual categories:

> The child must first be able to discriminate from the numerous qualities of similar objects those characteristics which indicate their essential nature and similarity; and then generalize from these as to the fundamental properties of the whole category. (M. D. Vernon, 1970, p. 23)

In other words, the child must learn which attributes and attribute labels are considered by his cultural group to be the defining characteristics of the conceptual categories in question. Indeed, there is considerable evidence to demonstrate that in the early stages of conceptual learning children may classify and label objects according to irrelevant and superficial perceptual attributes or with relation to emotional reactions (see, for example, Werner, 1957; Bruner *et al*., 1966), but that, gradually, they acquire "adult" labels and categories.

The development of attribute discrimination and attribute synthesis is facilitated by associative verbal learning. The process of associating distinctive names to discriminable attributes, called labelling, has been shown by Russian psychologists to enhance perception (Luria, 1961; cf Simon, 1957; Sokolov, 1961). Moreover, the acquisition of labels which may become associated with classes of objects, facilitates the construction of conceptual classificatory schemata. Not only does labelling enhance the discriminability of attributes and classes of objects, but it serves also as an important input in the process of rule learning. As Bourne (1966) observed, rules and attributes are the two basic ingredients of conceptual learning, and furthermore, operate independently of one another. Hence, once the ability has been developed to perceive, synthesize, and name attributes, it is necessary to acquire an understanding of the rule joining the attributes to learn a concept successfully. Bourne argued, specific concepts are acquired through conceptual learning experiences, and also the rules that join attributes are learned.

Rule learning is an important process in conceptual learning because it facilitates the formulation of rules and principles which are then stored in the memory for use in future conceptual activity. Moreover, if a set of rules or principles becomes associated, as a result of previous learning, with a particular situation or type of task, a learning set is developed. Learning sets, considered to be the elimination of certain "error tendencies" brought by the individual into the learning situation (cf Harlow, 1949, 1959), are response patterns developed as a result of prior experience with a particular type of task, evoked by problems having characteristics similar to the original learning experience.

Consequently, learning sets act as strategies which the individual has at his disposal for dealing with new learning experiences or problem solving situations;

> Both strategy and learning to learn refer to the same phenomenon: the individual works or practices at something; develops some ability or skill related to the specific task content, and with higher development of the ability performs tasks of a similar kind much more effectively. (Klausmeier & Ripple, 1971, p. 608)

Bruner and his associates (Bruner *et al.*, 1966), who defined a strategy as being the overall manner in which the learner develops his hypotheses, demonstrated that concept attainment is facilitated or impeded by the strategy employed. Further, they and others (for example, Laughlin, 1965, 1966; Denny, 1969) found that conceptual learning tasks reveal identifiable strategies which appear to be relatively consistent. Therefore, strategies or learning sets are a component of cognitive structure which result from experience with such processes as conceptual learning, rule learning, labelling, and perceptual learning, and the concomitant development of rules, attribute names, attribute synthesis, and attribute perception.

Earlier, mention was made of individually differing intervening variables. One aspect of this broad construct relevant to the study of conceptual behaviour is cognitive style, defined by Messick (1969) to be typical modes of perceiving, remembering, thinking, and problem solving, which are inferred from consistencies in the manner or form of cognition, as distinct from the content of cognition or the level of skill displayed. Thus, cognitive style refers to the characteristic way in which the individual perceives and interprets learning situations, organizes the components of cognitive structure to solve problems, and modifies his approach in light of information feedback.

Many facets of cognitive style have been postulated (for example, Gardner, 1953; Pettigrew, 1958; Gardner *et al.*, 1959; Gardner, Jackson, & Messick, 1960; Clayton & Jackson, 1961; Goodenough & Karp, 1961; Witkin *et al.*, 1962; Kagan & Moss, 1963; for a review see P. E. Vernon, 1972); however, for the purpose of the present studies only three will be considered: Witkin's dimension of analytic-global (in conceptual terms) or field independence-dependence (in perceptual terms); category width or equivalence range; and level of abstraction.

It has been argued (Witkin *et al.*, 1962) that the analytic or field independent child is more capable of differentiation, that is to say, is more capable of breaking a complex stimulus field into smaller units and then restructuring these units in a problem solving situation. Bourne (1966) and others have maintained that the perception of stimulus attributes is a key factor in conceptual learning. Therefore, due to the importance of disembedding in attribute perception and synthesis, it is postulated that analytic children will show superior performance in conceptual learning tasks.

Studies exploring the degree of differentiation employed in the categorization of heterogeneous objects (Gardner, 1953; Gardner *et al.*, 1959; Gardner, Jackson, & Messick, 1960; Clayton & Jackson, 1961; Gardner & Schoen, 1962) have shown consistent individual differences in categorization which are largely independent of the level of abstraction employed. Gardner (1953) originally described these individual consistencies as being "equivalence range dispositions," operationally defined as being the number of groups containing two or more objects formed in response to object-sorting tests. Further researches (cf Gardner & Schoen, 1962) suggested that although low conceptual differentiation (or broad category width) is associated with overgeneralization, subjects who formed few groups were not lacking in the ability to perceive differences but rather were less inclined to act according to the perceived differences. Messick and Kogan (1963), on the other hand, found that category width was positively correlated with a measure of vocabulary, leading them to conclude:

> Ss with a more differentiated knowledge of word meanings tended to use a large number of categories in sorting the objects, possibly because they had more varied conceptual labels available to

characterize potential categories, or because their superior verbal knowledge provided a basis for critically restricting the meaning of class rubrics, or both. (pp. 49-50)

Consequently, on the basis of these results, it might be expected that individual differences and, indeed, group differences in the number of categories formed (or alternatively, differences in the average number of objects placed in each group) will emerge; however, if category width, as Gardner asserted, primarily reflects an attitude towards perceived differences rather than the ability to perceive differences, no relationship between category width and concept attainment would be expected. On the other hand, if category width is related to the number of conceptual class labels available, as Messick and Kogan suggested, a relationship between the two might be expected.

In 1960, Gardner, Jackson, and Messick noted that category width was relatively independent of level of abstraction as represented by the definitions subjects gave of the groups formed. Furthermore, level of abstraction did not appear to correlate significantly with intellectual ability scores. Consequently, Gardner (Gardner & Schoen, 1962) distinguished between three aspects of abstraction: capacity to abstract, the level of abstraction at which the person usually functions, and the preferred level of abstraction. Gardner also remarked that the role of preferred level of abstraction was an area of conceptual learning largely unexplored. Thus, Gardner and Schoen (1962) undertook to replicate the earlier study by Gardner, Jackson, and Messick and, indeed, obtained similar results. Evidence suggests then, that preferred level of abstraction is not indicative of the capacity to abstract. Furthermore, it might be expected that although individual and group differences exist in preferred level of abstraction, these would not be related to the ability to attain concepts.

The model represented in Figure 1 is not unlike the theory of cognitive organization and meaningful learning proposed by Ausubel, although important distinctions do exist between the two. Ausubel (1968) also used the term "cognitive structure" to refer to the individual's state of cognition prior to any learning experience. Further, as cognitive structure was seen as being modified by the learning experience via the processes of assimilation and differentiation, Ausubel, too, considered it to be dynamic. An important distinction exists, however, between Ausubel's construct and the present model, in so far as, for him, cognitive structure referred to "the substantive and organizational properties of the learner's existing knowledge in a particular subject-matter field" (1968, p. 133); whereas in the present model cognitive structure includes both existing knowledge *and* existing skills and abilities developed and crystallized through an interaction between prior learning and genetic pre-dispositions. These skills and abilities, termed by Ausubel as "cognitive processing equipment" (1968, p. 126), were seen by him to be related to cognitive structure in terms of cognitive readiness, but nonetheless were seen as being differentiated from cognitive structure.

Although Ausubel has not explicitly dealt with the components of cognitive processing equipment that are present at birth, his theory has described in depth the role of memory in the processes of rote and meaningful learning. Indeed, going far beyond the present model, he explained how limitations in human memory facilitate, through "memorial reduction," the development of more abstract concepts which subsume more differentiated concepts. Consequently, Ausubel described this tendency towards reductionism as being a function of assimilation, wherein all new "bits" of meaningfully learned information are incorporated into the existing cognitive structure. Similarly, as discussed, the present model postulates that both perceptual schemata and conceptual classificatory schemata are developed to reduce a large number of bits of information into manageable and operational units.

It has been further noted by Ausubel that the degree to which new learning is discriminable from established learning would facilitate the learning process. The notion of discriminability is central in the present model also; however, in this case emphasis has been placed on the ability of the individual (developed through perceptual learning and labelling) to discriminate the components of the new learning and to establish in which ways they differ from, or are similar to, components of established learning.

Finally, Ausubel's (1968) construct of "advance organizers" which act to incorporate and enhance the retention of new meaningfully learned material is compatible with the idea of learning set or strategy included in the present model. Both constructs contain the view that, through prior learning and over-learning, organizational components of the cognitive structure are formed which serve to facilitate the future learning of similar tasks.

Hence, Ausubel's theory of how knowledge is assimilated and organized in the cognitive structure has much in common with the proposed model hypothesizing the development of conceptual schemata and learning strategies. Nevertheless, important differences do exist between the two views, particularly in the construct of cognitive structure and in the locus of discriminability.

Conclusion

The theoretical framework for the present studies is represented by the model shown in Figure I. A dynamic cognitive structure is developed, it is suggested, as a result of interactions between learning experiences generated by the environment, the pattern of socialization, and the culture, and genetic pre-dispositions. Further, cognitive structure operates not in isolation, but is mediated by individually differing intervening variables--a global term to include personality, neurological, physiological, and cognitive style variables. Numerous components comprise cognitive structure of which three are both basic and relevant to the present studies: visual mechanisms, memory, and the orienting reflex.

Through interactions between the basic components of cognitive structure and perceptual learning, particularly discrimination and synthesis learning, perceptual schemata are developed. These, in turn, interacting with both perceptual and verbal association learning experiences, lead to the formulation of the skills of attribute perception and synthesis. Moreover, these skills develop more quickly and at a higher level for the analytic child due to his increased ability to disembed attributes from complex stimulus patterns. Attribute perception, attribute synthesis, and the process of labelling facilitate the development of attribute names and conceptual rules. Only when rules are understood is conceptual learning possible. Attribute perception and synthesis alone are not sufficient.

Through experiences with different concepts and different types of concepts, learning sets or strategies are developed for dealing with certain classes of problems or tasks. The more varied the learning experiences, in terms of the number and types of concepts encountered, the greater the number of strategies available. When confronted with a conceptual problem, the individual examines the nature of the task to see if it resembles any encountered in the past. If so, and if an appropriate strategy was developed for that type of problem, it will be called into play. The process of examining the task and evoking appropriate strategies, it should be noted, is not necessarily conscious or deliberate, but is itself a component of cognitive structure developed for the purpose, acting in a manner similar to an "executive program." Nevertheless, the strategy employed is a function of task variables and past experience. Also, as Hunt (1962) pointed out, it may well be related to the individual's abilities.

A study of conceptual learning, particularly an exploration into the cultural differences in conceptual learning, should consequently be concerned not only with conceptual learning *per se*, but also with the underlying processes and cognitive structure components outlined above. Therefore, the present studies were designed to test various aspects of the model presented in Figure I, *viz.* the interrelationships between memory, attribute perception, attribute synthesis, concept attainment, ability to verbalize concepts, and conceptual learning strategies. Furthermore, the effects on the aforementioned components of cognitive structure of such individually differing intervening variables as field independence, category width, and preferred level of abstraction were assessed. Finally, the relationship was examined between the aforementioned components of cognitive structure and individually differing intervening variables, and the more global cognitive construct, general intelligence. Consequently, eight tests were chosen or constructed to tap these constructs.

The theoretical framework described above places considerable importance on experience with environmentally determined learning situations in the development of components of cognitive structure. As a test of this hypothesis, a cross-cultural methodology was adopted with the expectation that, if the hypothesis were correct, each cultural group would have a profile of strengths and weaknesses unique to itself, and furthermore, that the relationship between the constructs measured and conceptual learning ability would differ for each group.

CHAPTER 4

PRESENT STUDIES

Sample Description

A Stoney Indian sample and a sample of Euro-Americans from two small towns in the Alberta foothills were selected for the present studies. To a large extent the decision to limit the study to two groups was dictated by practical considerations. In the present writer's view, it is extremely difficult to equate socio-economic status across cultures and therefore no attempt was made to match subjects on this variable. Instead, the two samples were drawn from the same geographic region and from communities and schools which, as far as was possible to determine, were comparable according to population size, economy, and life style.

Further, it was decided to select only those pupils between the ages 8 years 0 months and 8 years 11 months, on the grounds that eight-year-old children would, in all probability, be more influenced by their home culture as opposed to the culture of the school, but yet would be sufficiently mature to perform the tasks required by the research design.

Subjects were chosen irrespective of grade level achieved. Although age and grade are usually highly associated in Euro-American samples, this is not the case with Indian children (cf Brooks, 1975). Moreover, the organization of the school from which the majority of the Indian children were taken precluded definitive grade identification.

Stoney Sample

The Indian sample was drawn exclusively from the Bearspaw, Chiniquay, and Wesley Bands of the Mountain Stoneys. These three bands, unlike their neighbours the Blackfoot, Blood, Piegan, and Sarcee, were Woods rather than Plains Indians and, therefore, were hunters and trappers more dependent on moose and bear than on buffalo. The social structure of the Stoneys reflected this difference. Whereas the Plains Indians were tribal, the Stoneys were more band-oriented and, in fact, are today among the very few groups which have retained official recognition of their distinct bands in the form of separate representation on contemporary band councils (cf Jenness, 1958; Monroe, 1969).

Historically (for an historical review see Monroe, 1969), each of the three bands occupied a separate area in the foothills of the Canadian Rockies. The Chiniquays roamed the Bow River area, Lake Minnewanka, and the Ghost River, while the Bearspaws were situated near their present Reserve at Eden Valley, on the Highwood River near Pekisko Creek. The Wesleys, the most isolated of the three bands, are thought to have occupied an area slightly north of their present Reserve at Bighorn, on the North Saskatchewan River. The epidemics of 1780, 1830, and 1865 encouraged the Stoneys to increase their isolation by confining themselves to the Kootenay Plains-High River area. In 1874, however, a permanent mission was established by McDougall in the Chiniquay territory in the Bow Valley and about 700 Stoneys agreed to make this the headquarters for all three bands.

Although the loss of the buffalo had little effect on Stoney life-style, the national and industrial expansion during the latter half of the 19th Century increased both isolationism and poverty;

> For the Stoneys, treaties and Reserve settlement was followed by isolationist reaction and poverty -- perhaps it should be called, further isolation and greater poverty. (Monroe, 1969, p. 23)

Hunting and other traditional activities were restricted by ranchers, homesteaders, railways, and the establishment of federal and provincial preserves and parks. Further, the survey conducted after signing of Treaty 7 revealed that the three bands were to receive only half the land to which they thought they were entitled. The increasing restrictions and poverty brought increasing dissatisfaction. Finally, a group of Wesleys left the Bow Valley Reserve for their former territory near the Kootenay Plains, where they hoped to return to a more traditional way of life. Their occupation of this area led to continual strife with the federal and provincial governments until a Reserve was established at Bighorn in 1940. Shortly after the Wesleys left the Bow Valley, a group of Bearspaws moved to their traditional home west of High River to the south of the Pekisko district.

The Chiniquays, already being in their ancestral region, remained in the Bow Valley. Poverty on the Reserve became so acute that finally the federal government loaned $500,000. to the Stoneys for Reserve development. Consequently, a 20,000 acre addition to the Morley Reserve was purchased, a 5,000 acre ranch was obtained in the Pekisko district for the establishment of the Bearspaw Reserve at Eden Valley, and the Bighorn Reserve gained an additional 5,000 acres from the Alberta government.

Morley, the largest of the three Reserves, is situated 35 miles from Calgary, Alberta, nestled in the foothills of the Canadian Rockies. Reserve land is undulating, containing both coniferous forests and broad expanses of grassland. In addition to the many mountain streams, the Reserve is bisected by the meandering Bow River. In more recent times, the area was sub-divided further, first by the Canadian Pacific Railway, and second by the Trans-Canada Highway (such action not always undertaken with approval of the Stoney Indians).

The main industries were charcoal manufacturing, logging, saw-milling, and horse and cattle raising. Recently, projects have been planned and developed to promote tourism on the Reserve. In addition, plans will be made for future capital development made possible by gas and oil royalties. Nevertheless, at the time of writing, unemployment was high and many families were receiving social assistance (Bowd, 1971).

Although the Morley Reserve is only 35 miles from the city of Calgary (population of 450,000), the Stoney people have retained their language and culture with remarkable tenacity. Nearly all residents speak Stoney, and social conversations, band, school, and other meetings are usually conducted in Stoney. In fact, on their first day at school most children arrive speaking only Stoney. The retention of language and culture is undoubtedly due for the most part to the history of isolation and active resistance to affiliations with large social groups. It has been argued that Stoney bands have often opted for short-term contacts with non-Indians as a means of maintaining their language and culture:

It seems the Stoneys perceived outsiders as a means for reducing large coalitions which might have threatened their exclusive way of life -- especially in the case of the Wesleys and Chiniquays. The persistence of their version of the "Indian Way" may have even dictated this type of temporary integration to further long-run isolation. (Monroe, 1969, p. 25)

It would appear that many community leaders are continuing this approach to culture contact; that is, they are engaging in relationships with "outsiders" as a means of preserving the Stoney ways of life. One example of this type of interaction was the Stoney Cultural Education Program (SCEP). The staff of SCEP, who were for the most part Stoneys, were involved in university education programs, taught by non-Indians, leading to teaching qualifications. On the other hand, the program was operated on the Reserve and utilized the existing community supports. In addition to enrolling in university courses, the staff was involved in the development of educational and cultural materials relevant to Stoney pupils, and participated in the instruction of Stoney language and culture in the classroom one-half day per week. A further example was found in the junior elementary school (kindergarten to grade three). Although the teachers were non-Indians with very little knowledge of either the language or the customs, much of the instruction was conducted in Stoney with the assistance of Stoney teacher-aides. Indeed, it was the expressed goal of the school administration and the Band Education Committee to move towards teaching the first three years in Stoney, during which time English would be introduced as a second language.

In addition to the junior elementary school, the Morley school offered grades three to nine. Although the school employed several Stoney teacher-aides, all teachers were Euro-American with the exception of the vice-principal. Students wishing to continue their education at the senior high school level had to attend schools located off the Reserve in neighbouring communities.

From the Morley junior elementary school, a sample of 19 eight-year-olds (9 male, 10 female) was selected. This number represented nearly all the eight-year-olds known to the school and certainly all of those who could be obtained for testing purposes. Because the junior elementary school was ungraded, school entry often delayed, and school attendance quite irregular, it was not possible to obtain a statement of the level of academic achievement attained by the pupils selected for the study. A complete description of the Stoney Indian sample, presented in terms of age, sex, and school, is given in Table 1.

In addition to the 19 children from the Morley school, 4 Stoney eight-year-olds (2 male, 2 female) were chosen from the Stoney Reserve at Eden Valley, located 80 miles southwest of Calgary. Once again, this number represented all but one of the eight-year-old children in attendance at the two-room school house.

To complete the Stoney sample, 11 Stoney pupils (5 male, 6 female) from the provincially operated school at Exshaw were included in the study, bringing the total number of Indians to 34. Although the Stoney children attending the Exshaw school were residents of the Morley Reserve, it could not be assumed that they were similar to the Stoney children attending the Morley school. Indeed, there was considerable evidence to suggest that Stoney parents who sent their children to Exshaw differed in outlook from the majority of the parents of the Morley-schooled children. For example, the attendance rate of the

Table 1

Stoney Indian Sample by
Age, Sex, and School

School	Males			Females			Total		
	N	Mean age*	s.d.	N	Mean age	s.d	N	Mean age	s.d.
Morley	9	100.44	3.8	10	100.20	2.2	19	100.32	3.1
Eden Valley	2	98.00	2.0	2	105.50	1.5	4	101.75	4.1
Exshaw	5	100.40	2.3	6	99.33	1.7	11	99.81	2.1
Total	16	100.13	3.3	18	100.50	2.7	34	100.32	3.0

*Age is given in months, calculated to the day of testing.

Exshaw Stoney children averaged between 85 and 95 per cent as opposed to between 50 and 60 per cent for the Morley pupils, suggesting that parents of the Exshaw pupils placed a greater emphasis on schooling and provided a more supportive environment for academic achievement.

Euro-American Sample

The non-Indian sample was drawn from two provincially operated schools in Alberta, serving the geographic area immediately west of the Stoney Reserve at Morley.

Exshaw is a small community (population approximately 600) located 45 miles west of Calgary on the main Canadian Pacific Railway line. The present economy of the village is based solely on the limestone quarry and cement plant owned by Canada Cement Lafarge Co. Ltd. The parents of the children attending Exshaw elementary and junior high school were either employed by Canada Cement or worked in one of the few commercial outlets in the village.

Similarly, Canmore is a small town (population 2,000) located 67 miles west of Calgary at the gates to Banff National Park. Although the town began as a siding for the Canadian Pacific Railway, its growth was spurred by the discovery of coal in the adjacent mountains. Today, the main industrial products of the town are bituminous coal and brickettes. In addition, because of its proximity to Banff National Park, Canmore has developed into a tourist centre and a "bedroom community" for Banff. Consequently, the parents of the Canmore school children were employed primarily in the coal and tourist industries, or in operating the retail stores serving the area.

The majority of the subjects in the Euro-American sample came from the Canmore elementary school. The sample included 25 pupils (14 males, 11 females), which was, with only one or two exceptions, the entire population of eight-year-olds at the school. Also, nine children (2 male, 7 female), the total number of non-Indian eight-year-olds at the school, were selected from Exshaw. Table 2 gives a complete description of the Euro-American sample.

Thus, the total sample was comprised of 68 eight-year-olds: 34 Stoney Indians and 34 Euro-Americans. Both the Indian and the non-Indian samples contained 16 males and 18 females. A t test (Guilford, 1965, p. 183) was performed to establish whether significant differences existed between the ages of either sample, or between the male and female subjects within either cultural group.* As Table 3 shows, no significant age differences were found between any of the groups.

Test Battery

In selecting tests to tap the psychological abilities considered relevant to the present studies, primary consideration was given to those published tests that were used previously in cross-cultural research and that appeared to have yielded satisfactory results. Where no suitable published tests could be found, instruments were constructed by the writer, with attention being paid to the principles recommended in adapting tests to the cultural setting (cf P. E. Vernon, 1969; Ord, 1970; Schwarz and Krug,1972; Brooks, 1973). Further, since half the subjects were Indian children having little experience with

*For this analysis, all raw scores were transformed to normalized T scores having a mean of 50 and a standard deviation of 10.

Table 2

Euro-American Sample by
Age, Sex, and School

School	Males			Females			Total		
	N	Mean age*	s.d.	N	Mean age	s.d.	N	Mean age	s.d.
Exshaw	2	103.50	1.5	7	100.71	3.5	9	101.33	3.3
Canmore	14	101.00	2.8	11	99.18	2.6	25	100.20	2.8
Total	16	101.31	2.8	18	99.78	3.0	34	100.50	3.0

*Age is given in months, calculated to the day of testing.

Table 3

Analysis of Age Differences Within and Between Stoney and Euro-American Samples

Group	N	Mean	s.d.	t
Stoney	34	49.79	9.7	0.2600
Euro-American	34	50.41	9.6	
Stoney male	16	49.50	10.2	0.4090
Stoney female	18	50.83	8.2	
Euro-American male	16	53.31	8.4	1.8351
Euro-American female	18	47.44	9.6	

Western schools and little fluency in English, attempts were made to construct or choose tests that assumed little prior knowledge, or verbal and reading ability, and for which there were ample practice and demonstration items.

All writer-constructed instruments were pilot tested with a small sample of Sarcee Indian children attending elementary school in Calgary. Although pilot studies showed all instruments to be adequate, the pilot sample was found to be a less than adequate approximation of the Stoney sample used in the research. Due to increased contact with Euro-Americans, particularly in the school setting, and to a higher rate of school attendance, Sarcee children were generally more acculturated than the Stoney. Further, as only a small number of Sarcee were available, children ranging in age from seven to nine years were included in the sample. As a result, measures which, in the pilot studies appeared to yield a relatively normal distribution of scores and acceptable reliability data, failed to do so when a group more restricted in age range, less test sophisticated, and generally less acculturated, was tested.

In the main study, tests were individually administered in a non-threatening environment by the writer and his wife. Pilot studies indicated that Indian children were more forthcoming and cooperative when testing was done by a female. Therefore, the test battery was subdivided, with tests requiring more complex and/or verbal responses given by the writer's wife. With one exception, all were performance tests. Where verbal communication was impossible due to language problems, and where instructions could not be conveyed through demonstration and practice items, a Stoney teacher-aide assisted by translating the instructions; however, such need arose only three times.

In the final analysis, the test battery included the following:

1. Pacific Design Construction Test
2. Children's Embedded Figures Test
3. Creative Response Matrices
4. Memory Test
5. Attribute Sorting
6. Attribute Similarities
7. Object Sorting Test
8. The Stone Game

Pacific Design Construction Test

Kohs Blocks (Kohs, 1923) has been used quite extensively throughout the world in cross-cultural studies as a measure of spatial ability (for a review see Ord, 1970). P. E. Vernon (1969) included a version of the Wechsler designs (Wechsler, 1958) in his cross-cultural studies of, *inter alia*, Alberta Indians and Eskimos from the Northwest Territories, and reported that the test yielded satisfactory results.

Witkin *et al.* (1962) suggested that Kohs Blocks was a good measure of the cognitive style dimension field dependence-independence. Consequently, Kohs Blocks have been quite widely utilized in cross-cultural studies attempting to examine cognitive style (for example, Berry, 1971).

Kohs Blocks, therefore, was selected for the present studies as a measure of spatial ability and field dependence-independence. The version chosen was the Pacific Design Construction Test developed in New Guinea by Ord (1968a). This test was originally part of Ord's P.I.R. battery used in Papua-Guinea for selecting personnel for the Armed Forces, and later became part of the New Guinea Performance Scale (Ord, 1967, 1968b). As such, it was used extensively as a selection device for applicants seeking positions in educational institutions, training courses, and a variety of occupations.

In developing the test, Ord made several modifications to Kohs' original Block Design Test (Kohs, 1923). Resulting from Biesheuvel's (1952) experience, wooden trays were provided to keep the subject's blocks together, and the designs were made the same size as the test pieces. In pilot studies in 1959, however, Ord discovered that unsophisticated subjects had difficulty in reproducing two-dimensional designs with three-dimensional blocks. Thus, the blocks were reduced to 1¼ inch tiles, some of which were red, some white, and some red and white in colour. Subsequent studies showed that the revised test was understood by all subjects and yielded scores reflecting a wide range of ability.

Ord originally used designs similar to Wechsler's, which differed from Kohs' in that they entailed only two colours, red and white. Subsequent to his studies in 1960, Ord added three new items, devised a system for partial scores for four of the items, and varied the item order of the test. The resulting test contained 13 items with a maximum score of two for items 1 to 7 (according to the time taken to complete the design); a maximum of three for items 8 to 11; and four for items 12 and 13; with a maximum total score of 34 points.

Ord reported (1968a) that, taking into account item variance and using a binary scoring system of one point for any scorable item and zero for items on which no score was obtained, reliability was estimated by the Kuder-Richardson 20 formula at $r_{tt} = 0.84$ for a sample of 315. Using the same procedure, with a sample of 170 one year later, a reliability coefficient of $r_{tt} = 0.875$ was obtained.

Similarly, Ord reported results from a variety of validity studies conducted with the Pacific Design Construction Test. For example, in a study with Aboriginal children in Australia, Kearney (1966) found the test correlated highly with Raven's progressive Matrices (r = 0.66, N = 241) and "r = .78 (N = 37) with Mental Age as measured by the Binet and Wisc tests" (Ord, 1968a, p. 22).

Ord's version of Kohs Blocks was chosen for the present studies because it was developed for use in a non-Western culture, was subsequently used throughout the South Pacific with apparently successful results, and yielded reliability and validity data that fell within the realm of acceptability.

Children's Embedded Figures Test

The Children's Embedded Figures Test (CEFT) was developed by Konstadt and Karp (1971) as a variation of the Gottschaldt [Embedded] Figures Test, and as a downward extension of the Witkin Embedded Figures Test (Witkin *et al.*, 1971).

It has been proposed (Witkin *et al.*, 1971) that although embedded figures tests are perceptual tests, that is to say assessments of the individual's ability to locate a previously seen simple figure within a larger more complex figure, they also tap other differences in cognitive functioning.

The relationship between performance on embedded figures tests and cognitive style has been postulated on the basis of over twenty years of experience with such tests (Witkin, 1950; Witkin *et al.*, 1954; Witkin *et al.*, 1962; and Witkin *et al.*, 1971). On the basis of this experience, Witkin and his co-workers (1971) concluded:

> EFT performance taps the tendency to function at a more differentiated or less differentiated level via perception. . . . the perceptual function of disembedding is a universal one in human experience and the task itself may be meaningful to groups of different mental levels and of widely varied socioeducational backgrounds. The EFT is a non-verbal test and may be applied to groups with differing native languages and differing verbal facility. (p. 14)

Indeed, many researchers utilized embedded figures tests to assess field dependence-independence in all parts of the world (for example, P.E. Vernon, 1965b, 1969; Berry, 1966a, 1966b; Dawson, 1967; MacArthur, 1967b; Wober, 1967; Okonji, 1969).

The CEFT was developed by Konstadt and Karp (1971) as an improved version of the original Children's Embedded Figures Test (CHEF) (Goodenough & Eagle, 1963). The CHEF was the first attempt at a downward extension of the EFT, but it proved to be too bulky and too expensive for widespread use.

The improved test, which overcame the problems of the CHEF, was an untimed, non-verbal test consisting of eight discrimination items, two demonstration items, three practice items, and twenty-five test items. The test items were divided into two series, with each series having one particular shape hidden in the test items. At the beginning of the first series, the subject was shown a cardboard cut-out of a triangle, and with the triangle in full view, was asked to choose, from several triangles on a card, one which corresponded to the stimulus piece. Following the discrimination items were two demonstration items in which the subject was shown that the stimulus piece could be embedded in a more complex figure. After two practice items, the stimulus piece was removed from the subject's view, he was presented with the first test item, and was asked to show, by tracing with his finger, where the triangle was hidden. In the first three test items it was permissible to correct the subject's mistakes. The second series of test items was predicated on a different stimulus shape; however, the procedure was identical to that for the first series. The authors reported that the test is suitable for children ranging in age from five to twelve years.

The standardization sample (Konstadt & Karp, 1971) for the CEFT consisted of 160 school children, forty of whom were aged nine and ten years. For this age group, an internal consistency reliability coefficient of 0.89 was obtained. Validity data were calculated by examining the correlation between scores on the CEFT and scores on the EFT. The resulting coefficient was 0.71. Further evidence of the validity of the test emerged from a factor analytic study conducted by Pascal-Leone (1969). This study showed that for ten-year-old boys, CEFT scores loaded on the same factor as the Block Design, Picture Completion, and Object Assembly sub-tests of the WISC, but did not load on a verbal-comprehension factor.

The authors of the CEFT thus concluded:

> These studies suggest that the CEFT is related to some of the measures of psychological differentiation as the EFT. Since validation data are still sparse and incomplete, it is recommended that, for the present, the CEFT be used for research purposes only. (Konstadt and Karp, 1971, p. 26)

Although the CEFT has not been used previously in cross-cultural studies, versions of the EFT and the Gottschaldt [Emdedded] Figures Test have, and with apparent success. Furthermore, the CEFT's non-verbal and untimed nature, adequate demonstration and practice items, and lack of informational content suggested its suitability for use in the cross-cultural arena.

Creative Response Matrices

The Creative Response Matrices Test was constructed by P. E. Vernon (1969) as a non-verbal test of "g." It was developed as an inductive reasoning test of 24 items based on Xs and Os or abstract shapes (see Appendix A). The subject's task was to view the presented series or matrix and draw in "what comes next." The initial item was simple, and the test was designed to allow the subject to learn as he progressed.

In his studies, P. E. Vernon deemed it advantageous to correct all mistakes made on the early items, giving explanations for the correct answer. In the present studies, this practice was followed for items 1 to 10 and, in addition, six practice items were developed.

Scoring was based on one mark for each correct response. As one item required two responses, the maximum possible score was 25. The test was not timed.

Before using the Creative Response Matrices in his cross-cultural studies, P. E. Vernon conducted pilot tests in an English primary school. Based on the results, he reported (1969, p. 139) that matrices had the highest loading on a general intelligence factor, and concluded that it was a fairly pure test of "g," although showing some loading on a spatial factor.

The Matrices Test was used by P. E. Vernon with eleven-year-old male Blackfoot and Stoney Indians, and also with Eskimos from Inuvik and Tuktoyaktuk. Although all of these groups scored below the average for a sample of non-Indian school children from Calgary (with Eskimos attaining higher scores than Indians), their scores on matrices were higher than those on verbal tests administered in the same study (P. E. Vernon, 1969). Consequently, Vernon's results have shown Creative Response Matrices to be a non-verbal measure of "g," and to be as "culturally-reduced" as any test available.

Memory Test

An instrument was constructed by the present writer to measure recognition memory of visually presented stimuli. The format of the test, similar to Kipling's Kim's Game, was designed to present an array of pictures of familiar objects to the subject for his study for 30 seconds' time. The array was then removed and a second stimulus array was substituted, containing all of the pictures in the original presentation, plus additional ones. The subject's task was to identify pictures in the second array that were also in the first.

The test consisted of a practice item plus a test item, the latter being presented to the subject on three consecutive trials. The practice item comprised 9 pictures (approximately 2 x 2 inches) of such objects as a boat, a leaf, a clock, and so forth (for a list of test items, see Appendix B). The second stimulus array for the practice item contained 13 pictures, 9 of which were identical to those in the first presentation, and 4 of which were new. Similarly, the test item contained 20 pictures in the first stimulus presentation and 39 in the second. All pictures were coloured and were taken from children's picture books.

Scoring was based on the number of pictures correctly identified on each of the three trials of the test item. These scores were summed, yielding a total memory score, with a maximum possible of 60. Although logically it was possible for a subject to attain a perfect score by pointing to every picture in the second array of the test item, in practice this did not happen. In actual fact, scores based on the total number of "rights" correlated highly with scores based on the total number of "rights" less the number of "wrongs" for both Stoney (r (32) = 0.84, p < .01) and Euro-American (r (32) = 0.85, p < .01) samples. The investigator was therefore satisfied that scores based on the total number of pictures correctly identified were an accurate assessment of performance and yet did not doubly penalize errors.

Instructions for the test were simple, and with the assistance of the practice item, which can be repeated as often as necessary, were easy to convey to the subject. No verbal responses were required, as recognized items could be identified by pointing. Pilot testing indicated that the pictures were readily understood and that the objects were familiar to the subjects.

<u>Attribute Sorting</u>

The ability to perceive attributes was measured by an instrument of the investigator's design, requiring the subjects to sort and re-sort groups of stimulus objects according to the attributes present (for example, size, shape, colour, and so on). Re-sorting tests have been quite widely used in research both in Western and non-Western cultures (Goldstein & Scheerer, 1941; P. E. Vernon, 1969; de Lacey, 1970; Cole *et al.*, 1971; and Nixon, n.d.), although the main focus of attention was to assess the ability to reclassify at perceptual, functional-relational, and conceptual levels. In the present test, however, because the basis for grouping could be made only according to observable physical characteristics, it was the ability to classify at the perceptual level that was assessed.

The idea for the Attribute Sorting Test came from Bloom and Hess (1969), who devised the Object Sorting Test to assess divergent and convergent thinking (as defined by Guilford). Subjects for the Object Sorting Test were presented with six stimulus objects, which could be divided into dichotomous groups according to nine attributes (for example, curvilinearity, area of base), and they were required to sort the objects into as many dichotomous groups as possible.

The Attribute Sorting Test similarly contained eight sets of stimulus objects (see Appendix C), two of which were practice items. One practice item and four test items contained four objects each, and could be sorted into two groups of two objects in two (or in two cases, three) different ways. Another practice item and two test items contained eight objects each and could be sorted into two equal groups according to two criteria (for the practice item), seven (for one test item), or eight criteria.

In order to perform the tasks successfully, the subject had to perceive all attributes and, selecting them one at a time, sort the objects into two groups according to the chosen attribute. On a *prima* *facie* basis, it was postulated that the test would tap the ability to disembed simple attributes from a complex whole. Since the subject had no record of the sorts made, it was also expected that the test had a small memory component.

Scoring was based on one mark for each correct sort, with a total possible of 25. The test was untimed.

Attribute Similarities

An instrument assessing the ability to compare two stimuli and their respective attributes was designed by the investigator, utilizing stimulus objects identical to those in the Attribute Sorting Test. In the Attribute Similarities Test, the subject was shown a pair of stimulus objects which differed on all attributes but one. The subject's task was to isolate and verbally identify the common attribute.

It was thought the test would tap a process similar to that which Guilford termed convergent thinking: "Convergent production is in the area of logical deductions or at least in the area of compelling inferences" (1967, p. 171). The process was not unlike that required to complete the "Similarities" sub-tests of the Wechsler tests (Wechsler, 1958); that is to say, the ability to identify similarities in the face of apparent differences.

The instrument contained two practice items and 23 test items (see Appendix D). Inasmuch as the attributes encompassed in the test items were the same as those in the Attribute Sorting Test, Attribute Similarities was administered immediately after Attribute Sorting. Scoring was based on one point for each correct response, yielding a maximum possible of 23. The test was not timed.

Object Sorting Test

A modified version of the Goldstein-Scheerer Object Sorting Test (Goldstein & Scheerer, 1941) was developed to study classificatory behaviour. A review of the literature revealed that several object sorting tests of this type have been employed to study classificatory behaviour in both Western and non-Western cultures (cf Halstead, 1940; Bruner *et al.*, 1966; P. E. Vernon, 1969; Ataman & Epir, 1972). Usually these tests contained between 20 and 30 objects familiar to the groups being studied. Each object had, in common with one or more of the others, a perceptual attribute, a use or activity, and a class name. The characteristic forming the basis for their grouping was thought to be indicative of the subject's level of abstraction.

The Object Sorting Test used in the present studies differed little from the general type described above. Pilot studies were conducted to find approximately 20 objects (see Appendix E) familiar to both groups of subjects. The test objects were displayed in a pre-determined order before each subject, who was then asked to sort them into groups which "belong together." There was no re-sorting component in the test.

From the groups of objects formed by the subject, two scores were derived. The first, called category width, was a measure of the inclusiveness of the groups and was calculated by simply dividing the total number of objects grouped by the number of groups formed. The second measure was concerned with the level of abstraction of the subject's classificatory behaviour. Initially, it was intended that level of abstraction would be scored according to the method developed by Olver and Hornsby (Bruner *et al*, 1966), whereby the subject was asked to explain the basis for classification, and the explanation for each group sorted was placed in one of the following five categories:

1. No principle. No explanation was given for group membership.
2. Relational. Group membership depended upon the relationship of objects to each other.
3. Perceptual. Group membership was based upon a common perceptual attribute.
4. Functional. Membership was organized around a common use or activity.
5. Nominal. All objects in a group belonged to the same abstract or nominal class.

Although this method of scoring was possible for the Euro-American children, it was not a satisfactory method for the Indian sample, due to the extreme reluctance on the part of the Stoney children to offer verbalizations. An examination of the test results revealed that the majority of groups falling in categories 1, 2, and 3, that is to say, the non-abstract or perceptual categories, could be identified as a special case of category 3. These groups were "identity" groups, formed by placing objects that were the same--two forks, two knives, and so on --into separate groups. For example, a subject might form three identity groups: one containing two forks, one with two knives, and one with two apples. It was thought that since there was a limited number of objects to be grouped, the greater the number of objects placed in identity groups, the fewer were available for forming more abstract groups.

Consequently, a system of scoring was devised wherein the number of objects placed in identity groups was divided by the total number of object groups to yield a score from .00 to 1.00. It was also thought that the proportion of objects placed in identity groups would be negatively correlated with level of abstraction, as determined by the Olver-Hornsby method, and thus would be an inverse measure of level of abstraction.

For the Euro-American sample, it was possible to score the Object Sorting Test according to both methods. A correlational analysis was then undertaken to test the above-mentioned hypothesis. As predicted, proportion of objects in identity groups was significantly and negatively correlated with the Olver-Hornsby level of abstraction, $r\ (32) = -0.68$, $p < .01$. Accordingly, as identity groups could be recognized without reliance on the subjects' verbalization, and since the proportion of objects in identity groups had been shown to be negatively correlated with the Olver-Hornsby level of abstraction, the former was adopted as the measure of level of abstraction.

The Stone Game

A non-verbal performance instrument was constructed by the investigator to assess the ability to learn concepts. Based on the selection paradigm, the three-part test was designed to yield quantitative scores for concept attainment and verbalization. Because the test was based on the selection paradigm, it allowed the subject to exercise control over the instances to be sampled in identifying the concept and, therefore, was designed to yield a qualitative assessment of strategies in conceptual learning.

Each part of the test consisted of a board, measuring 24 x 20 inches, on which 48 stones were placed in six rows of eight stones. Of the 48 stones, 24 were large (approximately 1½ inches in diameter) and 24 were small (approximately 3/4 inches in diameter). Twelve of the small and 12 of the large stones were painted black, the others were painted white. Consequently, each board contained four groups of stones: large white, large black, small white, and small black. Designs were painted on each, so that four stones of each group showed a stripe, a dot, a cross, or a triangle; four showed two of each design, and four showed three (see Appendix F).

On each test board there was a "correct" conjunctive concept to be discovered by the subject. On the first board (SG1) the correct concept was large and black; on the second (SG2) it was small and white; and on the third (SG3) it was those with dots. It should be noted that the concept in SG2 was a reversal shift from SG1 and that SG3 was a non-reversal shift from SG1 and SG2. Further, each board contained 12 positive instances of the concept to be identified. Since research by Wallace (1964) suggested that negative feedback, that is, verbal feedback emanating from another person, is aversive to subjects, tending to reduce the number of hypotheses about a solution, it was decided to indicate a positive instance of the concept by painting an orange dot on the underside of the stone. Consequently, feedback was provided to the subject in a neutral manner.

In addition to the three test boards, a practice board was constructed to aid in the communication of instructions and to allow the subject to become familiar with the task in a low-difficulty level situation. The practice board, measuring 8 x 8 inches contained 16 stones: four large black, four large red, four small black, and four small red. The concept to be discovered was red stones. Eight positive instances were identifiable by an orange dot painted on the underside.

After explaining to the subject that his task was to find all of the "good" stones, all of which were alike in some way, and all of which were identifiable by the orange dot, a positive instance of the concept was shown to him. The subject was then encouraged to select stones of his choice in order to find all of the "good" stones and as few of the "bad" stones as possible. A record was kept of every stone chosen. Scoring was based on the number of errors made until all 11 positive instances had been selected.* At the conclusion of SG1, SG2, and SG3 the subject was asked to state the concept linking the positive instances identified. The verbalization given was scored according to the method developed by Ciborowski and Cole (1971):

No explanation offered	0
Explanation completely erroneous	1
One attribute correctly identified but the second incorrect	2
One attribute correct and none incorrect	3
Both attributes correct but an irrelevant attribute stated	4
Both attributes correct and none incorrect	5

*Unfortunately, many of the Stoney Indian children had a great deal of difficulty with SG3 and tended to give up before finding all 11 positive instances. Therefore, with SG3, it was possible to score only on the basis of the number of errors made in 40 choices.

Because SG3 involved a single attribute concept, the above method of scoring was modified. Hence, verbalizations for SG3 were scored according to the following criteria:

No explanation offered	0
Explanation completely erroneous	1
One attribute correct but an irrelevant attribute stated	4
One attribute correct and none incorrect	5

In addition to the quantitative assessment, responses were analysed in terms of the strategy employed by the subject in identifying the concept. Data were inspected to test the "goodness of fit" with the strategies described by Bruner (Bruner *et al.*, 1956: Bruner *et al.*, 1966), Denny (1969), and the index of focussing developed by Laughlin (1968).

Hypotheses

The hypotheses which follow were derived from the research findings discussed in Chapters 1 and 2, and particularly from the theoretical framework proposed for the present studies (cf Chapter 3). Since the instrument for measuring concept learning was developed by the investigator and was therefore untried, it was not known whether learning strategies could be analysed in terms of the strategies observed in other studies (cf Laughlin, 1965, 1966, 1968; Bruner *et al.*, 1966: Laughlin & Jordan, 1967). Hence, it was considered inappropriate to generate hypotheses concerning learning strategies. Furthermore, as the present studies were essentially exploratory, hypotheses concerning the factorial structure within each sample were also considered to be inappropriate. Consequently, hypotheses were limited to expected relationships between psychological variables within and between cultural groups.

For each group it was hypothesized that:

1. There are no sex differences on any of the variables measured.
2. The two measures of field independence are correlated, and both correlate with the tests measuring the abilities to perceive and to compare attributes.
3. Measures of the ability to perceive attributes correlate with measures of the ability to compare attributes, and both correlate with the Memory Test.
4. Concept attainment on SG1 correlates with field independence, general intelligence, and the abilities to perceive and compare attributes.
5. Performance on SG2 correlates with performance on SG1 and with general intelligence.
6. Performance on SG3 correlates with field independence, general intelligence, abilities to perceive and compare attributes, and Level of Abstraction.
7. Ability to verbalize the concepts attained in SG1, SG2, and SG3, correlates with field independence, general intelligence, and the abilities to perceive and compare attributes.
8. "Fast learners" on SG1 make fewer errors on SG2 than do "slow learners"; whereas the converse is true for SG3.

For the Stoney Indian sample, it was hypothesized that:

9. Concept attainment on SG2 correlates with the Memory Test.
10. Ability to verbalize the concept attained in SG1, SG2, and SG3 correlates with the Memory Test and Level of Abstraction.

For the Euro-American sample it was hypothesized that:

11. Concept attainment on SG3 correlates with performance on SG1 and SG2.
12. Ability to verbalize the concept attained in SG1, SG2, and SG3 correlates with performance on SG1, SG2, and SG3.

With respect to between-group differences, it was hypothesized that:

13. Stoney Indian performance is superior to the Euro-American performance on tests of field independence, memory, attribute perception, and on SG1 and SG2.
14. Stoney Indian responses to the Object Sorting Test reveal broader category widths than do Euro-American responses.
15. Euro-American performance is superior to Stoney performance on Matrices, Level of Abstraction, Attribute Similarities, SG3, and Concept Verbalization.

Methods of Statistical Analysis

With the exception of the Chi-squared analyses for the normal distribution of raw scores and the internal consistency analysis for the reliability of test scores, all statistical analyses were based on normalized standard scores. Raw scores were normalized by T scaling (Guilford, 1965, p. 518) according to the formula:

$$T = 10\frac{(X - M)}{\sigma} + 50$$

Hence, all tests yielded a distribution of scores having a mean of 50 and a standard deviation of 10.

Differences in scores on a particular variable between two contrast groups were tested for significance by means of t tests for independent samples. This was accomplished by using Fisher's t formula for uncorrelated means (Guilford, 1965, p. 183):

$$t = \frac{M_1 - M_2}{\sqrt{\left(\frac{\Sigma x^2{}_1 + \Sigma x^2{}_2}{N_1 + N_2 - 2}\right)\left(\frac{N_1 + N_2}{N_1 N_2}\right)}}$$

To explore the relationships between variables within groups, a correlational analysis was employed. As all scores had been normalized, it was considered that the assumptions underlying the Pearson product-moment coefficient of correlation had been met (cf. Guilford, 1965). Consequently, correlation coefficients were computed according to the formula (Guilford, 1965, p. 108):

$$r_{xy} = \frac{\Sigma xy}{N \sigma_x \sigma_y}$$

Factorial structures were analysed for each group according to two methods. Initially, factors were derived from each correlation matrix by the Centroid method developed by Thurstone (1947) and outlined by Fruchter (1954). Factors were extracted until the product of the two highest loadings on a factor was less than the standard error of zero r (Guilford's criterion). When sufficient factors had been extracted to satisfy Guilford's criterion, the squares of the factor loadings of each variable were summed. To provide a more precise estimate of communalities than was possible by the unities method, these values were entered as the diagonal values in the SSPS computer program PA1, a method of factoring using principal components. The resulting factors were then subjected to orthogonal varimax rotation.

CHAPTER 5

RESULTS

Distribution of Raw Scores

As several of the tests used in the present studies were of this investigator's design and, thus, except for the pilot studies were untried, an examination of the distribution of raw scores was undertaken. Tables 4 and 5 show that for both the Stoney and Euro-American groups several tests yielded skewed distributions. Consequently, the significance of the difference between the obtained distribution for each test and the expected normal distribution was assessed by means of Chi-square analysis (P. E. Vernon, 1956). Because the distributions of scores might reasonably be expected to differ between groups, the Chi-square analysis was undertaken for each group separately.

Table 6 indicates that for the Stoney sample the Design Construction Test, the Attribute Sorting Test, the two measures from the Object Sorting Test, and the three Stone Games yielded distributions which deviated significantly from the expected normal distribution. In addition, the distributions for three measures: Matrices, Attribute Similarities, and concept Verbalization deviated from the expected normal distribution at a marginal level of significance.

Further inspection of the data revealed that, of the tests deviating significantly from the expected normal distribution, four (Design Construction, Category Width, and Stone Games 1 and 2) were positively

Table 4

Means, Standard Deviations, Medians, Modes, and Ranges of Raw Scores for Stoney Sample

Measure	Mean	s.d.	Median	Mode	Range
Design Construction	11.24	6.9	9.50	5.00	3 - 21 [30]*
CEFT†	7.71	4.1	7.00	6.00	2 - 16
Matrices	5.85	3.8	5.00	5.00	1 - 14
Memory	38.91	8.2	39.50	45.00	22 - 57
Attribute Sorting	13.09	2.3	13.00	13.00	8 - 18
Attribute Similarities	11.94	3.3	11.50	10.00 & 12.00	6 - 19
Category Width	2.51	0.8	2.19	2.00	2.0 - 2.9; 4.0 - 4.3 [5.5]
Level of Abstraction	0.53	0.3	0.54	1.00	0 - 1
Stone Game 1	4.59	5.4	4.00	1.00	0 - 9 [31]
Stone Game 2	2.21	4.2	1.00	0.00	0 - 5 [10; 23]
Stone Game 3	27.59	10.8	33.00	35.00	0 - 15; 22 - 35
Concept Verbalization	6.50	3.6	6.50	7.0	0 - 15

*Bracketed numbers indicate deviant high or low scores.

†Children's Embedded Figures Test

Table 5

Means, Standard Deviations, Medians, Modes, and Ranges of Raw Scores for Euro-American Sample

Measure	Mean	s.d.	Median	Mode	Range
Design Construction	14.68	7.0	13.50	12.00	2 - 25 [30;31]*
CEFT†	8.62	3.7	7.50	7.00	3 - 17 [21]
Matrices	11.88	4.5	12.00	7.00 & 9.00	2 - 20
Memory	45.18	6.9	47.00	47.00	32 - 56 [24]
Attribute Sorting	18.27	2.2	18.00	18.00	14 - 23
Attribute Similarities	17.44	1.9	17.50	19.00	13 - 21
Category Width	3.58	1.0	3.60	2.10 & 5.00	2 - 6
Level of Abstraction	0.12	0.2	0.00	0.00	0 - .57 [.88]
Stone Game 1	7.00	6.5	6.00	6.00	0 - 15 [36]
Stone Game 2	2.00	4.1	0.00	0.00	0 - 5; 10 - 13 [19]
Stone Game 3	18.18	13.0	14.00	32.00	1 - 35
Concept Verbalization	9.94	3.3	10.00	11.00	3 - 15

*Bracketed numbers indicate deviant high or low scores.

†Children's Embedded Figures Test

Table 6

Chi-square: Test for Normal Distribution of Raw Scores for Stoney Sample

Measure	Mean	s.d.	Chi^2	df	p
Design Construction	11.24	6.9	6.50	1	.01
CEFT	7.71	4.1	0.17	1	.70
Matrices	5.85	3.8	5.52	2	.08
Memory	38.91	8.2	1.11	3	.80
Attribute Sorting	13.09	2.3	3.96	1	.05
Attribute Similarities	11.94	3.3	3.02	1	.08
Category Width	2.51	0.8	5.83	1	.02
Level of Abstraction	0.53	0.3	6.99	1	.01
Stone Game 1	4.59	5.4	4.08	1	.04
Stone Game 2	2.21	4.2	4.56	1	.04
Stone Game 3	27.59	10.8	9.61	2	.01
Concept Verbalization	6.50	3.6	3.60	1	.06

skewed. This finding indicated that Design Construction was too difficult for the Stoney subjects, whereas Stone Games 1 and 2 (negatively scored) were too easy. Moreover, the skewed distribution for Category Width reflected the tendency of the Stoney children to form groups in the Object Sorting Test consisting of identity pairs. Many of the objects used in the test could be construed as being identity pairs; for example, a dinner fork and a toy dinner fork, and for the Stoney subjects there was an overwhelming tendency to group like with like. Hence, for nearly all the Stoney subjects, the average number of objects per group was between 2.0 and 3.0.

Scores from Stone Game 3 were bi-modally distributed, with the predominant mode being negatively skewed. For most of the Stoney group, Stone Game 3 was very difficult; however, for a very few it was quite easy. Level of Abstraction yielded a distribution tending to tri-modality, with the predominant mode being leptokurtic and situated in the middle of the range of possible scores, the minor modes being at the two extremes. Hence, although some Stoney children formed no identity pairs, and some formed only identity pairs, the majority grouped approximately half of the objects into identity pairs. The Attribute Sorting Test yielded a uni-modal leptokurtic distribution which peaked at the mid-point of the score range. Although the test was suitable in overall difficulty level, it failed to discriminate sufficiently to yield a broad range of scores.

As predicted, the distribution of raw scores differed considerably between the two cultural groups. Table 7 shows that, for the Euro-American group, only three measures yielded distributions deviating from

Table 7

Chi-square: Test for Normal Distribution of Raw Scores for Euro-American Sample

Measure	Mean	s.d.	Chi²	df	p
Design Construction	14.68	7.0	1.90	1	.15
CEFT	8.62	3.7	8.57	1	.01
Matrices	11.88	4.5	1.19	1	.25
Memory	45.18	6.9	3.14	1	.07
Attribute Sorting	18.27	2.2	7.28	1	.01
Attribute Similarities	17.44	1.9	5.66	2	.06
Category Width	3.58	1.0	0.33	2	.85
Level of Abstraction	0.12	0.2	3.49	1	.07
Stone Game 1	7.00	6.5	2.24	1	.15
Stone Game 2	2.00	4.1	5.49	1	.02
Stone Game 3	18.18	13.0	2.89	1	.08
Concept Verbalization	9.94	3.3	3.13	1	.07

the expected normal distribution at the .05 level of significance (as opposed to seven for the Stoney sample). Scores from a further five measures deviated from the expected normal distribution at a marginal level of significance.

The tests whose distributions deviated significantly, Design Construction, Attribute Sorting, and Stone Game 2, all showed evidence of skewedness. Scores from Attribute Sorting were negatively skewed, whereas those from the other two tests were positively skewed. Thus, Design Construction appeared to be too difficult for the Euro-American eight-year-olds and Attribute Sorting and SG2 too easy.

In summary, an analysis of the distributions of raw scores for each measure for each cultural group revealed that three tests yielded distributions differing significantly from the expected normal distribution for both samples. Design Construction was too difficult for both the Stoney and Euro-American children, whereas Stone Game 2 was too easy. Attribute Sorting, which was too easy for the Euro-American subjects, was suitable in overall difficulty for the Stoney children, but failed to discriminate adequately individual differences. In addition to the tests producing significantly deviant distributions for both groups, four measures yielded abnormal distributions for the Stoney sample only. Once again the distributions tended to be skewed as a result of the tests being too easy or difficult.

Parametric statistics are more rigorous than non-parametric and, therefore, it was deemed advantageous to use the former where possible. In order to correct for the abnormalities in raw score distributions and to satisfy the assumptions underlying parametric statistics, raw scores were normalized to T scores with a mean of 50 and a standard deviation of 10.

Reliability of Tests

Reliability coefficients for six tests were computed according to the method of internal-consistency (Anastasi, 1968). Each test was divided into comparable halves and the two half-scores obtained for each subject correlated in accordance with the basic formula for a Pearson product-moment coefficient of correlation. Resulting correlation coefficients were then corrected for the effects of shortening the test by means of the Spearman-Brown formula.

The corrected coefficients of reliability are presented in Table 8. For the Stoney sample, all reliability coefficients were within the range of acceptability, with the highest being r = .89 for Design Construction and the lowest r = .71 for CEFT. For the Euro-American group, Design Construction, CEFT, Matrices, and Memory Test yielded coefficients of r = .83 or higher; however, both Attribute Sorting and Attribute Similarities yielded only moderately high coefficients, suggesting that for this group the measures were not homogeneous.

For six measures it was not possible to undertake an analysis of internal consistency reliability, and therefore temporal reliability was assessed by re-testing 15 children chosen randomly from each sample. Re-testing took place six months later and was done by the original investigators. The results of this analysis are listed in Table 9.

Category Width and Level of Abstraction yielded the highest coefficients of reliability for both groups, Stoney: r = .89 and r = .68,

Table 8

Internal-Consistency Reliabilities for
Stoney and Euro-American Samples

Test	Stoney*	Euro-American*
Design Construction	.89	.88
CEFT	.71	.83
Matrices	.89	.83
Memory	.82	.83
Attribute Sorting	.79	.61
Attribute Similarities	.83	.52

*N = 34

Table 9

Test-Retest Reliability Coefficients
for Stoney and Euro-American Samples

Measure	Stoney (N = 15)	Euro-American (N = 15)
Category Width	.89	.65
Level of Abstraction	.68	.45
Stone Game 1	.44	.25
Stone Game 2	.44	.06
Stone Game 3	-.12	.03
Concept Verbalization	.31	.39

$r\ (13) = .51,\ p < .05$

respectively; Euro-American: r = .65 and r = .45, respectively, with the Stoney results showing more temporal stability. The reliability coefficients from the Stone Games were disappointingly low for both groups, although once again the Stoney coefficients were slightly higher. The temporal instability of the scores from the Stone Games may be due in part to the fact that all subjects remembered having played the games before. Although the effects of memory are a factor in all test-retest reliabilities, they appeared to play a dominant role in the temporal instability of the Stone Games. In re-testing, it was noted that some children who had done well in the initial testing expressed confidence in their knowledge of how to play the game, and then discovered that they had, in fact, forgotten and began to guess wildly. Others who had produced a poorer performance in the initial testing could indeed remember the approach and, thus, in the re-testing solved the problems quite quickly. Hence, for some subjects, their recollections of the correct approach were correct and there was a corresponding improvement in score. For others, their recollections were erroneous and their performance suffered. Consequently, it was thought that the low reliability figures for the Stone Games were due in part to the proactive inhibition caused by the subjects' recollections of having played the games before.

It was thought, however, that although the Stone games did not demonstrate temporal stability, evidence existed to suggest that they may have been tapping meaningful abilities at the time of testing. Results from the Centroid factorial analysis showed that, for the Stoney sample, Stone Games 1, 2, and 3 and Concept Verbalization had communalities of .35, .57, .23, and .42, respectively. Similarly, the four measures had communalities of .48, .26, .55, and .48, respectively, for the European group. Although these communalities are not large and could be spurious, it was considered that, as most of the test scores yielded low correlation coefficients (partly due to limiting factors discussed below), the communalities obtained for the four measures of concept learning were, relative to those from other variables, moderately high and, therefore, the four measures were sufficiently related to other variables as to imply construct validity (cf Anastasi, 1968).

In summary, internal consistency reliability coefficients suggested that, for the Stoney sample, Design Construction, CEFT, Matrices, Memory, Attribute Sorting, and Attribute Similarities were relatively homogeneous measures. For the Euro-American sample there was some evidence of heterogeneity in Attribute Sorting and Attribute Similarities. Test-retest reliability coefficients computed for the Stoney group were within the bounds of acceptability for Category Width and Level of Abstraction; however, coefficients from the measures were only moderate for the Euro-American sample. Coefficients of reliability from the Stone Games were low for both groups, although on Stone Games 1 and 2 they were appreciably higher for the Stoney sample. Evidence suggested that the low coefficients were due, in part, to the proactive inhibition resulting from the subjects remembering that they had played the games before. Further, there was some evidence from the factorial analyses to suggest construct validity for these measures.

Testing of Hypotheses

Hypothesis 1

As can be seen from Table 10, there were no differences, significant at the .05 level of confidence, between the scores of Stoney males and Stoney females on any of the variables measured. Therefore, for the Stoney sample, Hypothesis 1 was confirmed. Table 11 shows that, with the exception of scores from the Memory Test, there were also no significant sex differences within the scores from the Euro-American sample. On the Memory Test, Euro-American females scored higher than Euro-American males, $t\ (34) = 2.52,\ p < .05$; however, the data gave no suggestion as to why this difference emerged.

Hypothesis 2

A correlation matrix was computed from the scores on all measures for each sample. The resulting two matrices were reproduced as Tables 12 and 13. Before continuing with the testing of Hypothesis 2, it is perhaps advisable to comment in general terms on the size of effects of the correlation coefficients obtained. It can readily be seen from Tables 12 and 13 that, for both groups, the majority of coefficients are in the order of .01 to .20, and that even those significant at the .05 level of confidence fall, for the most part, between .33 and .50. Clearly, then, the amount of variance in the scores of one test that is explained by scores on another test is quite small and often negligible. It is contended, however, that limiting factors inherent in the research design and instruments partially accounted for the size of the correlation coefficients obtained. For example, it was noted previously that many of the tests yielded skewed or leptokurtic distributions and thus

Table 10

Analysis of Sex Differences
Within Stoney Sample

Variable	Males (N=16)		Females (N=18)		t
	Mean	s.d.	Mean	s.d.	
Design Construction	47.81	9.0	52.11	9.6	1.245
CEFT	48.38	6.5	51.78		0.997
Matrices	49.00	11.1	50.28	7.9	0.383
Memory	49.25	10.1	50.56	9.7	0.329
Attribute Sorting	51.56	10.4	48.56	8.7	0.891
Attribute Similarities	49.38	9.8	50.89	9.5	0.444
Category Width	51.19	6.7	49.28	11.4	0.570
Level of Abstraction	51.50	8.3	48.50	10.6	0.383
Stone Game 1	52.38	8.4	48.17	9.9	1.291
Stone Game 2	52.25	8.8	49.00	8.8	1.128
Stone Game 3	49.31	9.3	49.56	7.8	0.080
Concept Verbalization	48.63	8.3	51.39	10.6	0.817

Table 11

Analysis of Sex Differences
Within Euro-American Sample

Variable	Males (N=16) Mean	Males (N=16) s.d.	Females (N=18) Mean	Females (N=18) s.d.	t
Design Construction	48.19	9.1	51.67	10.2	1.016
CEFT	49.19	8.4	50.72	10.9	0.442
Matrices	47.50	9.1	52.39	9.7	1.460
Memory	45.81	10.5	53.83	7.4	2.522*
Attribute Sorting	48.69	10.7	51.11	8.5	0.715
Attribute Similarities	50.25	8.7	49.78	10.5	0.138
Category Width	50.75	10.1	49.61	9.5	0.330
Level of Abstraction	49.38	7.5	52.06	8.6	0.935
Stone Game 1	50.69	8.4	49.22	10.9	0.423
Stone Game 2	52.63	8.2	49.44	7.3	1.159
Stone Game 3	51.56	8.8	48.78	10.1	0.826
Concept Verbalization	49.31	9.3	50.28	9.6	0.289

*Significant at the .05 level of confidence.

Table 12

Correlation Matrix of Scores on All Tests for the Stoney Sample

	DC	CEF	MAT	MEM	ATT SOR	ATT SIM	CW	ABST	SG1	SG2	SG3	CON VERB
Age	.09	.26	.12	.05	.18	.18	-.13	.04	.17	-.05	.29	-.05
Des. Con.		*.61*[*]	*.47*	.13	.07	.09	.11	.14	.17	.08	-.07	-.07
CEFT			*.55*	.19	.23	.17	.13	-.01	.31	.30	.04	.10
Matrices				*.47*	*.46*	*.49*	.09	-.10	.01	.31	*.36*	*.39*
Memory					.31	*.48*	-.14	-.05	.11	*.37*	.22	.26
Att. Sort.						*.74*	.08	-.21	-.10	.10	.28	*.48*
Att. Simil.							.30	.09	.05	.10	.20	*.36*
Cat. Width								*.62*	.04	-.22	.21	.06
Level Abst.									.11	-.23	.13	-.04
Stone Game 1										*.33*	.04	-.06
Stone Game 2											-.02	*.41*
Stone Game 3												.24

[*]Italicized coefficients significant at .05 level of confidence.

Table 13

Correlation Matrix of Scores on All Tests for the Euro-American Sample

	DC	CEF	MAT	MEM	ATT SOR	ATT SIM	CW	ABST	SG1	SG2	SG3	CON VERB
Age	.06	.18	.16	-.12	-.11	.13	.15	.05	.20	-.23	-.12	.07
Des. Con.		*.59**	*.66*	*.34*	*.52*	*.43*	-.02	.05	.32	.17	.21	*.43*
CEFT			*.47*	.32	*.37*	.15	-.01	.04	-.04	.16	.07	.06
Matrices				*.38*	*.63*	*.52*	.07	.12	*.35*	.26	.04	*.44*
Memory					*.34*	.11	-.03	*-.35*	.17	.02	.20	.08
Att. Sort.						*.61*	-.02	.21	.25	*.33*	-.02	*.34*
Att. Simil.							.16	.29	.21	.06	-.03	*.43*
Cat. Width								*.60*	.05	.01	.03	-.13
Level Abst.									.04	.01	*-.33*	.05
Stone Game 1										.30	*.35*	.30
Stone Game 2											.23	.31
Stone Game 3												*.33*

*Italicized coefficients significant at .05 level of confidence.

the range and the variance of the obtained scores was small. As Anastasi (1968) has pointed out, such factors will act to reduce the coefficients of correlation. Similarly, the number of objects in each sample was small and, more importantly, they represented a relatively homogeneous population in terms of socio-economic status, geographic location, and scholastic achievement. Again, it is thought that these factors acted to reduce the variance in obtained scores and, thus, the size of the correlation coefficients (cf Anastasi, 1968). Consequently, in examining the results of testing those hypotheses based on the interrelationships between variables, a coefficient of correlation was considered to be meaningful if: (a) it was of moderate size relative to all obtained coefficients for that sample; and (b) it appeared to have a low probability of having occurred by chance.

Returning to Hypothesis 2, as predicted, the two measures of field independence were relatively highly correlated for both samples. For the Stoney group, the correlation coefficient (r (32) = .61) accounted for 37 per cent of the variance, and was significant at the .01 level of confidence. Similarly, for the Euro-American sample, the coefficient (r (32) = .59) explained 34 per cent of the variance and was also significant at the .01 level. Furthermore, for the Euro-American group, both measures of field independence explained an appreciable amount of the variance in the scores from Attribute Sorting: Design Construction, r (32) = .52, $p < .01$; CEFT, r (32) = .37, $p < .05$. Only one of the measures, however, Design Construction, explained a notable portion of the variance from scores on Attribute Similarities, r (32) = .43, $p <$ .01. On the other hand, for the Stoney sample, neither measure of field independence contributed to the explanation of the variance in the scores for Attribute Sorting or Attribute Similarities. Thus, as only four of the five postulated relationships between the two measures of field independence--Attribute Sorting and Attribute Similarities--were supported by the data for the Euro-American sample, and only one of the five for the Stoney group, Hypothesis 2 was infirmed.

Hypothesis 3

Tables 12 and 13 show that, for both cultural groups, the predicted interrelationship between the abilities to perceive and compare attributes was supported. For the Stoney group, 55 per cent of the variance was accounted for by the correlation coefficient (r (32) = .74) and for the Euro-American sample 37 per cent was explained (r (32) = .61). In both cases the coefficients were significant at the .01 level of confidence. Within the Euro-American sample, scores from the Memory Test contributed to the explanation of the variance for only Attribute Sorting (r (32) = .34, $p < .05$). Thus, as the expected relationship between memory and Attribute Similarities did not materialize, for the Euro-American group, Hypothesis 3 was infirmed. In contrast, within the Stoney sample, scores from the Memory Test explained an appreciable part of the variance of the scores from both Attribute Sorting and Attribute Similarities: r (32) = .31, $p < .07$; r (32) = .48, $p < .01$, respectively. Therefore, for the Stoney sample, Hypothesis 3 was confirmed, the data suggesting that the relationship between memory and the abilities to perceive and compare attributes was stronger in the Stoney sample than in the Euro-American.

Hypothesis 4

Contrary to the predictions made in Hypothesis 4, for both cultural groups, one measure of field independence and the abilities to perceive and compare attributes failed to contribute to the explanation of the variance in the scores from Stone Game 1. On the other hand, for each sample, one measure of field independence did. For the Stoney group, scores on CEFT explained 10 per cent of the variance in SG1 and yielded a coefficient of correlation significant at the .07 level of confidence (r (32) = .31). For the Euro-American group, scores from Design Construction explained 10 per cent of the variance and yielded a coefficient of correlation significant at the .06 level of confidence (r (32) = .32). Scores from the Matrices also failed to explain the variance in SG1 scores for the Stoney sample; however, for the Euro-American group, 12 per cent of the variance was explained by this test (r (32) = .35, p < .05). As only CEFT was significantly related to SG1 for the Stoney subjects, and only Design Construction and Matrices were, for the Euro-Americans, Hypothesis 4 failed to gain support from the data.

Hypothesis 5

In contrast to the results obtained for SG1 and Matrices, for the Euro-American group, scores from Matrices showed a negligible relationship to scores from Stone Game 2; whereas for the Stoney sample, scores from Matrices explained 10 per cent of the variance in scores from Stone Game 2 (r (32) = .31, p < .07). For both groups, scores from SG1 and SG2 were interrelated with 11 per cent of the variance explained for the Stoney sample (r (32) = .33, p < .05) and 9 per cent for the Euro-American (r (32) = .30, p < .08). As a result, Hypothesis 5 was supported for the Stoney sample, but due to the lack of a significant relationship between Matrices and SG2, was infirmed for the Euro-American group.

Hypothesis 6

Table 13 shows little support for Hypothesis 6 for the Euro-American group. Of all the predicted significant relationships with performance on Stone Game 3, scores from only Level of Abstraction contributed to the explanation of variance (r (32) = -.33) and yielded a coefficient of correlation significant at the .05 level of confidence. Similarly, Table 12 shows that scores from only Creative Response Matrices explained a notable amount of variance for the Stoney scores on SG3, yielding a correlation coefficient of r (32) = .36, $p < .05$. Hence, for the Stoney group, performance on SG3 appeared to be related to general reasoning ability. On the other hand and contrary to expectation, for the Euro-American group, those children who were more perceptually orientated in their reasoning, that is, who were more stimulus bound, appeared to be more successful on SG3. Consequently, Hypothesis 6 failed to be supported by the data.

Hypothesis 7

The data showed that, for the Euro-American sample, scores from one measure of field independence (Design Construction), Creative Response Matrices, Attribute Sorting, and Attribute Similarities contributed to the explanation of the variance in the scores from Concept Verbalization; Design Construction: r (32) = .43, $p < .01$; Matrices: r (32) = 44, $p < .01$; Attribute Sorting: r (32) = .34, $p < .05$; Attribute Similarities: r (32) = .43, $p < .01$. Although for the Stoney sample, scores from Matrices, Attribute Sorting, and Attribute

Similarities contributed to the explanation of the variance in scores on Concept Verbalization ($r(32) = .39$, $p < .05$; $r(32) = .48$, $p < .01$; $r(32) = .36$, $p < .05$, respectively), there was no evidence of any significant relationship between the ability to verbalize concepts and field independence. As the data showed no significant relationship between CEFT and Concept Verbalization for the Euro-American sample, and none between either Design Construction or CEFT and Concept Verbalization for the Stoney Group, Hypothesis 7 was infirmed.

Hypothesis 8

The prediction that "fast learners" on Stone Game 1 would make fewer errors on SG2 than would "slow learners" was supported. Results indicated that the difference in the number of errors made by each group on SG2 was significant at the .05 level of confidence, $t(44) = 2.015$, $p < .05$. On the other hand, the hypothesis that slow learners on SG1 would make fewer errors on SG3 than would fast learners failed to gain support, $t(44) = -0.084$, $p > .05$. Thus, Hypothesis 8 failed to gain support from the data.

Hypothesis 9

Table 12 shows that, for the Stoney subjects, performance on the Memory Test explained 14 per cent of the variance in scores from SG2, $r(32) = .37$, $p < .05$. Hypothesis 9 was thus confirmed.

Hypothesis 10

Contrary to prediction, scores neither from the Memory Test nor from Level of Abstraction contributed appreciably to the explanation of the variance in the scores from Concept Verbalization for the Stoney sample.

Also contrary to expectation was the finding that scores from SG2 explained 17 per cent of the variance in Concept Verbalization scores for the Stoney children, r (32) = .41, $p < .05$. Consequently, Hypothesis 10 was infirmed.

Hypothesis 11

As predicted, for the Euro-American sample, performance on Stone Game 3 was related to performance on Stone Game 1 with the resulting correlation coefficient accounting for 12 per cent of the variance (r (32) = .35, $p < .05$). A finding inconsistent with the hypothesis, however, was the lack of a significant relationship between performance on Stone Games 2 and 3. Consequently, Hypothesis 11 was not supported by the data.

Hypothesis 12

Table 12 shows that, for the Euro-American children, performance on Stone Games 1, 2, and 3 appreciably contributed to the explanation of variance for the scores from Concept Verbalization. Scores from SG1 accounted for nine per cent of the variance (r (32) = .30, $p < .08$), scores from SG2 accounted for 10 per cent (r (32) = .31, $p < .07$), and those from SG3 accounted for 11 per cent (r (32) = .33, $p < .05$). Hence, Hypothesis 12 was confirmed.

Hypothesis 13

Table 14 shows that Stoney children, as predicted, made significantly fewer errors on Stone Game 1 than did Euro-American children, t (66) = 2.453, $p < .05$; however, contrary to the hypothesis, no significant differences emerged between the two groups' scores on SG2.

Table 14

Analysis of Between-Group Differences in Test Scores

Test	Stoney (N=34) Mean	Stoney (N=34) s.d	Euro-American (N=34) Mean	Euro-American (N=34) s.d.	t
Design Construction	47.41	9.5	52.50	9.8	2.141*
CEFT	48.15	10.9	51.68	8.7	1.460
Matrices	44.35	8.0	55.68	8.0	5.747†
Memory	46.29	10.0	53.79	8.6	3.266†
Attribute Sorting	42.62	6.6	57.24	6.7	8.929†
Attribute Similarities	43.29	8.0	56.62	7.6	6.928†
Category Width	42.85	8.8	54.97	8.3	5.770†
Level of Abstraction	56.41	7.1	44.12	6.4	7.361†
Stone Game 1	47.09	9.2	52.76	9.6	2.453*
Stone Game 2	51.50	8.4	49.47	8.8	0.959
Stone Game 3	53.88	8.8	44.68	8.2	4.396†

*Significant at the .05 level of confidence.

†Significant at the .01 level of confidence.

Furthermore, inconsistent with the postulate was the finding that, on CEFT, there was no significant difference between the scores of the two cultural groups, and that on the Design Construction Test, Memory Test, and Attribute Sorting Test, all differences were significant but in favour of the Euro-American sample rather than the Stoney: Design Construction, t (66) = 2.141, $p < .05$; Memory, t (66) = 3.266, $p < .01$; Attribute Sorting, t (66) = 8.929, $p < .01$. It can be seen from Table 14 that, with the exception of Attribute Sorting, for all tests on which the Stoney group was predicted to excel the Euro-Americans, the difference between the means of the two groups was considerably lower than the mean group differences on the remaining tests. Thus, relative to their overall performance, Stoney children appeared to do better on the two measures of field independence, the Memory Test, and the first two Stone Games, and, therefore, it was considered that some evidence existed to support Hypothesis 13.

Hypothesis 14

As can be seen from Table 14, Stoney children placed significantly fewer objects into each group on the Object Sorting Test than did the Euro-American, t (66) = 5.770, $p < .01$. Thus, Hypothesis 14 was infirmed.

Hypothesis 15

Euro-American performance was superior to Stoney performance on Matrices, t (66) = 5.747, $p < .01$; Level of Abstraction, t (66) = 7.361, $p < .01$; Attribute Similarities, t (66) = 6.928, $p < .01$; Stone Game 3, t (66) = 4.396, $p < .01$; and Concept Verbalization, t (66) = 2.230, $p < .05$. Thus, the research data provided considerable support for

Hypothesis 15.

Factor Analysis

Results of the Centroid factor analysis for the Stoney sample are presented in Table 15, and those for the Euro-American sample in Table 16. For both samples, the first factor to emerge before rotation was a general factor with all variables except Age, Category Width, Level of Abstraction, and Stone Game 1 (for the Stoney sample) or Stone Game 3 (for the Euro-American sample) having significant loadings. Tables 17 and 18 give the results of the Principal Components factor analysis for the two groups. In both cases the results from the two methods of factorial analysis were similar; the differences which did exist were most likely due to the artificially high correlation between Category Width and Level of Abstraction resulting from the method of scoring the latter. In the Centroid analysis it was possible to reduce arbitrarily the artificially high correlation before computing the factors.

For both groups, the factors which emerged from the Principal Components analyses were subjected to Varimax rotation. Table 19 shows that, for the Stoney group, the first general factor was broken down into a factor tapping a reasoning ability involving the perception and comparison of attributes and possibly verbal mediation. Attribute Sorting and Attribute Similarities had the highest loadings on the factor, and two measures of concept learning had significant loadings. An additional measure of concept learning, Stone Game 2, yielded a loading which just failed to reach significance at the .05 level of confidence. Factor II remained as it appeared in the two unrotated

Table 15

Centroid Factor Loadings for
Stoney Sample*

Variable	Factor I	II	III	IV
Age				
Design Construction	.38	-.44		-.37
CEFT	.62	-.55		
Matrices	.78			
Memory	.53			
Attribute Sorting	.67	.43		
Attribute Similarities	.67	.38		
Category Width			-.36	-.40
Level of Abstractions				
Stone Game 1		-.47		
Stone Game 2	.42		.58	
Stone Game 3	.36			
Concept Verbalization	.47			

*Only those values significant at the .05 level of confidence are reported.

Table 16

Centroid Factor Loadings for
Euro-American Sample*

Variable	Factor I	II	III	IV
Age				-.36
Design Construction	.77			
CEFT	.52		-.42	
Matrices	.83			
Memory	.33		-.48	
Attribute Sorting	.71			.39
Attribute Similarities	.64			
Category Width				
Level of Abstraction		-.56		
Stone Game 1	.48	.33	.34	
Stone Game 2	.34			
Stone Game 3		.63		
Concept Verbalization	.53			

*Only those values significant at the .05 level of confidence are reported.

Table 17

Principal Components Factor Loadings
for Stoney Sample*

Variable	Factor I	II	III	IV	V
Age					.48
Design Construction	.37	-.56			
CEFT	.60	-.63			
Matrices	.81				
Memory	.55				
Attribute Sorting	.68	.42			
Attribute Similarities	.71	.36			
Category Width			.68		
Level of Abstraction			.56		
Stone Game 1		-.39			.34
Stone Game 2	.42		-.54	.40	
Stone Game 3	.34				
Concept Verbalization	.50				

*Only those values significant at the .05 level of confidence are reported.

Table 18

Principal Components Factor Loadings for Euro-American Sample*

Variable	Factor I	Factor II	Factor III	Factor IV	Factor V
Age				.50	
Design Construction	.79				
CEFT	.51		.46		
Matrices	.84				
Memory	.41	-.34			
Attribute Sorting	.76			-.37	
Attribute Similarities	.61	.37			
Category Width		.45			.36
Level of Abstraction		.75			
Stone Game 1	.44		-.42		
Stone Game 2	.34				
Stone Game 3		-.53	-.40		
Concept Verbalization	.55		-.35		

*Only those values significant at the .05 level of confidence are reported.

Table 19

Rotated Factor Loadings for
Stoney Sample*

Variable	Factor I	Factor II	Factor III	Factor IV	Factor V
Age					.58
Design Construction		.73			
CEFT		.81			
Matrices	.62	.56			
Memory	.52				
Attribute Sorting	.78				
Attribute Similarities	.78				
Category Width			.73		
Level of Abstraction			.62		
Stone Game 1				.55	
Stone Game 2	[.31]			.64	
Stone Game 3	.36				
Concept Verbalization	.62				

*Only those values significant at the .05 level of confidence are reported, with the exception of the bracketed value which achieved only marginal significance, $p < .08$.

factor tables, a spatial reasoning or field independence factor. Both measures of field independence had high positive loadings as did Creative Response Matrices. It should be noted that, in this context, both the terms "spatial reasoning" and "field independence" are used to describe these factors. Although Witkin has argued (Witkin *et al.*, 1962) that CEFT and Kohs Blocks measure field independence, there is some doubt as to whether field independence or spatial reasoning is involved in the performance of these tasks. P. E. Vernon (1969) has pointed out that much research has shown that tests of the embedded figures type and Kohs Blocks are good measures of k or k + g. In the present studies it was found that, for both samples, the tests of field independence loaded on the same factor as Creative Response Matrices, which P. E. Vernon (1969) has found to be a good measure of "g." Therefore, these factors could be tapping either of the two constructs.

Due to the artificially high correlation between Category Width and Level of Abstraction, it was decided to consider Factor III as being an artifact. Factor IV showed a clustering of Stone Games 1 and 2 and was, therefore, considered to reflect concept learning ability. Factor V revealed age to be the only significant loading, and no other variables appeared to relate to this characteristic.

Rotated factor loadings for the Euro-American sample are given in Table 20. Following Varimax rotation, the unrotated general factor broke down into a field independence or spatial reasoning factor, with the highest loadings from Design Construction and CEFT, and additional loadings from Matrices, Memory, and Attribute Sorting. It may appear

Table 20

Rotated Factor Loadings for
Euro-American Sample*

Variable	Factor I	Factor II	Factor III	Factor IV	Factor V
Age					.56
Design Construction	.63			.46	
CEFT	.72				
Matrices	.56			.61	
Memory	.54				
Attribute Sorting	.42			.69	
Attribute Similarities				.71	
Category Width			.63		
Level of Abstraction			.72		
Stone Game 1		.59			
Stone Game 2		.36			-.35
Stone Game 3		.72			
Concept Verbalization		.40		.57	

*Only those values significant at the .05 level of confidence are reported.

incongruous that the Memory Test should have loaded on this factor; however, as the stimuli were pictorial and displayed on a large card, spatial orientation and the ability to disembed could be expected to facilitate performance. Contrary to expectation, Attribute Similarities, thought to involve spatial reasoning and field independence, did not show evidence of clustering with these tests.

The second rotated factor to emerge showed a clustering of the four measures of concept learning, and only these measures. This finding was entirely consistent with the hypothesized finding, and suggested that, for the Euro-American sample, the test materials used in the present studies led to a concept learning factor which was independent of the other abilities measured, such as field independence, memory, general intelligence, or attribute perception and comparison.

As was the case with the Stoney sample, and for the same reasons, Factor III was considered to be an artifact. Factor IV indicated that a common ability or abilities were involved in Attribute Similarities, Attribute Sorting, Matrices, Concept Verbalization, and Design Construction. Matrices was considered to involve general reasoning ability and Design Construction to involve spatial reasoning or field independence. Concept Verbalization appeared to tap verbal mediation or labelling, and it was thought that Attribute Sorting and Attribute Similarities tapped the abilities to perceive and compare attributes, respectively. In addition, all tests were based on the spatial presentation of stimuli. Therefore, it was considered that Factor IV reflected an ability comprising spatial reasoning, verbal labelling, and attribute perception and comparison, which was termed "attribute-reasoning" for the purposes of the present studies.

An age factor was the final one to emerge, showing only one other significant loading, Stone Game 2. SG2 was a reversal shift from SG1 and, therefore, involved verbal mediation. The inverse relationship between age and performance on SG2 is thus consistent with other studies of reversal shift learning and verbal mediation (see, for example, Bourne, 1966).

In conclusion, for the Stoney sample the results of factorial analyses suggested that an attribute-reasoning factor on which three measures of concept learning had notable loadings was the first factor to emerge. A spatial reasoning or field independence factor was observed as was a small concept learning factor involving Stone Games 1 and 2 and a small age factor. For the Euro-American sample, a field independence or spatial-reasoning factor was the first rotated factor. There was evidence of a concept learning factor and an attribute-reasoning factor; however, with the exception of Concept Verbalization loading on both, the two factors were independent. A small age factor was observed on which SG2 had a negative loading.

Strategy Analysis

Attempts to analyse the subjects' responses in terms of the strategies postulated by Bruner (1973) were unsuccessful. Similarly, it was not possible to compute an index of focussing, such as that used by Laughlin (1968), which had any more explanatory power than a score based simply on the number of errors. A choice was considered to be a focussing choice if, when compared with the most recent positive instance, it yielded information on a new attribute or value of an attribute and thus altered only one attribute or value not previously proven irrelevant; or, when more than one attribute was altered, the instance was positive. Therefore, using these criteria, the test materials allowed for a maximum of only 13 focussing choices. Further, in practice it was observed that the minimum number of focussing choices made by any subject was 11. Therefore, not only was the range in the absolute number of focussing choices extremely small, but the proportion of instances tested which were focussing choices was a function of the number of errors made. For example, for the Stoney males on SG1, the focussing index was inversely correlated with total number of errors made, $r\ (14) = -.91$, $p < .01$.

In light of the above results, subjects' responses were analysed in terms of the three strategies proposed by Denny (1969). Once again, however, it was observed that, by definition, strategy was related to the number of errors made. The first strategy Denny (1969) reported was the formal or abstract strategy, wherein conclusions once established held for all successive instances and were abstract in so far as the conclusion was maintained despite the nature of the stimulus in succeeding instances. In Stone Games 1 and 2, it took but two incorrect choices to solve the problem logically, given the initial positive instance, and in Stone Game 3, it required three. Therefore, it would be expected that those subjects using the formal strategy would make a maximum of two errors on Stone Games 1 and 2, and three errors on Stone Game 3. Conversely, subjects following what Denny (1969) termed a "concrete strategy," who were overly stimulus bound and drew separate conclusions from different pieces of information, would be expected to make far more errors. Further, it follows that subjects who were unable to solve the problem, and used what Denny (1969) termed a "non-processing strategy," would make the greatest number of errors. Thus, for the present test data, at least, the three strategies described by Denny (1969) would be highly correlated with the total number of errors made.

The third approach taken to examine qualitative differences in conceptual learning was based on dividing the subjects into two groups: "sudden" learners and "gradual" learners. "Sudden learners" is a term referring to those subjects who, after testing several hypotheses and after making several errors, hit upon the correct hypothesis and solved the task without making further errors. "Gradual learners," on the other hand, is a term referring to those subjects who learned the concept by association learning and whose errors were distributed throughout the profile of instances tested.

For the present analysis, a sudden learner was operationally defined as any subject whose last six or more consecutive choices were correct. All others were considered gradual learners. Results of this analysis showed that, as in the preceding two attempts, the qualitative analysis was significantly correlated with total number of errors. For the Stoney group, type of learner correlated with number of errors, $r = .43$, $p < .01$, and for the Euro-American group the correlation was $r = .60$, $p < .01$. Further support for the hypothesized relationship between number of errors and type of learner came from the finding that on SG1, in which Stoney performance was superior to Euro-American performance, there were 19 Stoney sudden learners as compared with 12 Euro-American. By way of contrast, on SG2, for which there was no significant difference between the two groups' scores, there were 23 Stoney sudden learners and 24 Euro-American. Finally, on SG3, where Euro-American performance was superior to Stoney, there were only 8 Stoney sudden learners compared with 18 Euro-American. That the distribution of sudden learners resembled the distribution of scores was taken as further evidence of a positive and significant relationship between type of learner and number of errors.

Consequently, it was concluded that, for the test materials used in the present studies, and the resulting data, it was not possible to isolate qualitative differences in response patterns which were independent from quantitative assessments of performance.

Discussion

The theoretical framework underlying the present studies (see Chapter 3) placed considerable importance on experience with environmentally determined learning situations as a factor in the development of components of cognitive structure. To test this view, a cross-cultural methodology was adopted with the subsequent hypotheses that: (a) each cultural group would have a profile of strengths and weaknesses unique to itself, and (b) the relationships between the constructs measured and concept learning ability would differ for each group.

Results from analyses of the distribution of raw scores and reliability data showed that the major dependent variables in the present studies, those derived from the Stone Games, contained psychometric weaknesses which affected the results of the data analysis. Although these problems are limitations which must be kept in mind, it is argued that they do not negate the results. With respect to the poor temporal reliability demonstrated by the Stone Games, it should be noted that the games served as a set of stimuli in an experiment to explore group differences, and not as a diagnostic test intended to show reliability over time. Evidence did come to light to suggest these measures had both factorial reliability and construct validity. In addition, on some occasions, the shortcomings of the instruments served to decrease the likelihood of obtaining significant results. For example, the inappropriate difficulty levels of Stone Games 2 and 3, the former being too easy and the latter too difficult, reduced the variance of the test scores and, therefore, reduced the coefficients of correlation between these measures and other variables (cf Anastasi, 1968). Thus, in light of this limitation, when significant correlation coefficients emerged, they were interpreted as being meaningful.

Between-group differences in cross-cultural studies are often extremely difficult to interpret (cf Chapter 1) because of the large number of extraneous variables which can affect test performance, thus distorting the measure of "true" ability. Consequently, it is advisable to be judicious in interpreting such scores and to be suspicious in the case of large differences between group scores, especially when they are in favour of the Western subjects in whose culture the tests were designed.

Irvine suggested (Irvine & Sanders, 1972) that one method of double checking construct validity in cross-cultural studies is to compare the difficulty levels of the test items for both groups. If the item analysis yields similar results for both groups, Irvine argued, the test is tapping the same ability or abilities. On the other hand, if there is considerable discrepancy in the difficulty level of the items, it could be due to the test tapping different abilities. Irvine and Sanders' method (1972), thus, was applied to the test of general intelligence, Creative Response Matrices, used in the present studies. The results of this analysis showed that the difficulty levels of the items computed for each sample correlated highly, r (23) = .87, $p < .01$, thus suggesting that the test was tapping the same abilities for both groups. Following from Irvine's argument, it should be possible to check the construct validity of the test battery *in toto* by comparing the difficulty levels of each test for each group. For the present studies, a difficulty level index was computed for six tests* by dividing the mean score by the total possible score for that test. Table 21 shows the results of this analysis. The difficulty levels of the tests were found to correlate highly between the two groups: r (4) = .87, $p < .05$.

The rank order of the tests (from the easiest to the most difficult) were, for the Stoney group: Memory, Attribute Sorting and Attribute Similarities, Design Construction, CEFT, and Matrices; for the Euro-American sample: Attribute Similarities, Memory, Attribute Sorting, Matrices, Design Construction, and CEFT.

It was hypothesized that Stoney children would score higher on Design Construction and CEFT than would Euro-Americans. On Design

*It was not possible to conduct this analysis for the Object Sorting Test or for the three Stone Games, as there was no maximum possible score for these tests.

Table 21

Indices of Difficulty Level for Six Tests for Both Cultural Groups

Test	Stoney	Euro-American
Design Construction	.33	.43
CEFT	.31	.34
Matrices	.23	.48
Memory	.65	.75
Attribute Sorting	.52	.73
Attribute Similarities	.52	.76
Mean	.43	.58
Standard Deviation	.15	.17

Construction, however, Euro-Americans were found to out-perform Stoney children, and on CEFT there was no significant difference between the scores of the two groups. Based on these results, the hypothesis was infirmed; however, the rank order of difficulty levels for tests in the battery suggested that, from a within-group analysis, Storey children found the two field independence tests to be easier than did the Euro-Americans. It is also worth noting that, for the Stoney group, the two tests were easier than Matrices; whereas for the Euro-American sample, the opposite was true. Similarly, as Table 14 showed, the difference between the mean scores for the two groups was considerably smaller for Design Construction and CEFT than for most other tests, suggesting, therefore, that Stoney children found these to be among the easiest of the tests in the battery. Although there was no evidence to suggest that Stoney performance on tests of field independence was superior to Euro-American, there was some suggestion that such tests were easier for the Stoney children, relative to the rest of the test battery, than they were for the Euro-American sample.

Scores from the Memory Test and the Attribute Sorting Test also failed to confirm the hypothesis that Stoney performance would be superior on these two measures. As was the case with the tests of field independence, both the rank order of difficulty levels and the size of the difference between the group means suggested that Stoney children may have found the Memory Test relatively easier than did the Euro-American subjects. On the other hand, there was little evidence to support the same conclusion for the Attribute Sorting Test. The rank order of difficulty levels for the tests showed little difference in the position of Attribute Sorting for the two groups, and the difference in the mean scores for the groups was largest for this test. The tables of rotated factors (Tables 19 and 20) showed that, whereas for both groups Attribute Sorting clustered with tests involving reasoning, for the Euro-American sample there was an additional loading for this test on a spatial-perceptual factor. In generating the hypotheses, it was thought that Attribute Sorting would primarily tap spatial-perceptual ability and that Stoney children would demonstrate superiority in this ability. Results from the factorial analyses, however, indicated that Attribute Sorting tapped reasoning and possible verbal-mediational ability for both groups, and that spatial perception was involved for only the Euro-Americans. As it was expected that Stoney subjects would do less well on tests of reasoning and verbal mediation, the obtained results are not surprising.

Based on the mean number of errors made, it was found that the rank order of difficulty for the three Stone Games was the same for both groups; that is to say, (from easiest to most difficult): SG2, SG1, and SG3. Furthermore, as hypothesized, Stoney children made significantly fewer errors on SG1 than did Euro-Americans. As SG1 involved a conjunctive concept based on a spatial presentation of stimulus pieces in which the ability to disembed would be an asset, it was expected that Stoney children would make fewer errors than would Euro-Americans. Results suggested that the prediction was correct. For the Stoney sample, SG1 clustered with the field independence measures, whereas for the Euro-American group, it was associated with general reasoning rather than field independence. The argument that Stoney children would be more field independent than Euro-Americans, and that field independence would facilitate performance on SG1, thus gained some support from the data.

Contrary to the postulate, on Stone Game 2, no significant differences in scores were observed and, therefore, the hypothesis was infirmed. Once again, however, the difference between the means of the two groups was smallest for this test than for any other. Thus, there was an indication that Stoney children may have performed better on this test, relatively speaking, than did the Euro-American subjects. As expected, for both groups the tables of rotated factors showed that Stone Game 2 was closely related to Stone Game 1. It is interesting to note that, for the Stoney group, SG1 (the original learning task) and SG2 (the reversal shift) were the only measures to suggest a concept learning factor. Thus, Stone Game 3, the non-reversal shift, and concept verbalization did not appear to tap the same abilities. On the other hand, for the Euro-American group, there was evidence to suggest that the original concept learning task and the non-reversal shift were more closely related than were the original task and the reversal shift.

The theoretical model presented in Figure I suggested that the concept learning measures would be highly inter-related, thus showing evidence of what might be termed a concept learning factor. Table 20 indicated that, for the Euro-American sample, the data analysis yielded support for the model, as all three Stone Games and Concept Verbalization loaded on the same factor. By way of contrast, for the Stoney subjects, only Stone Games 1 and 2 showed significant loadings on a factor, which could be considered to reflect concept learning. Stone

Game 3 and Concept Verbalization showed signs of clustering with spatial-type reasoning tests on which Attribute Sorting and Attribute Similarities had the highest loadings. With so few variables, little overlap, and only one or two marker tests, it was expected that difficulties would arise in identifying the resulting factors. Nonetheless, the results indicated with surprising clarity that, for the Euro-American children, the four measures derived from the Stone Game did, indeed, appear to tap a unitary ability, termed "concept learning"; whereas, for the Stoney group, at least two abilities were tapped by the four measures: "concept learning," a spatial reasoning factor involving attribute perception and reasoning, and possibly a verbal-mediational ability.

The theoretical framework also postulated that conceptual learning would be related to the abilities to perceive and compare attributes and to the cognitive style variable, field independence. With respect to the former, the above findings indicated that, for the Stoney sample, both Stone Game 3 and Concept Verbalization tapped an ability or set of abilities similar to those tapped by Attribute Sorting and Attribute Similarities; whereas for the Euro-American group, all concept learning measures tapped a common and unique ability or set of abilities. Although evidence emerged from the correlation matrices (Tables 12 and 13) to show that, for both cultural groups, the abilities to perceive and compare attributes were significantly related to the ability to verbalize the concepts in the three Stone Games, Varimax rotation showed that, for the Euro-American sample, even Concept Verbalization had more variance in common with the three Stone Games than it had with Attribute

Sorting or Attribute Similarities.

Neither the correlation matrices nor the tables of rotated factors gave any support to the postulate that field independence, the cognitive style variable, would be an underlying factor in the ability to learn concepts. Unrotated factors determined by both the centroid and the principal component's methods suggested that, for the Stoney group, performance on Stone Game 1 was related to performance on the two measures of field dependence; however, this was the only suggestion of a relationship between field independence and concept learning.

Field independence was further predicted by the model to be related to the abilities to perceive and compare attributes. The correlational analyses showed that, for the Euro-American sample, the prediction was confirmed, as three of the four correlation coefficients resulting from the two measures of field independence and the two attribute measures were significant at the .05 level. For the Stoney children, on the other hand, none of the four coefficients was significant and, therefore, the hypothesis was infirmed. Following Varimax rotation, a spatial reasoning or field independence factor emerged for the Euro-American sample on which Attribute Sorting had a significant loading; however, Attribute Sorting also loaded with Attribute Similarities on a factor appearing to tap an ability to perceive and compare attributes. By way of contrast, while Varimax rotation produced a field independence or spatial reasoning factor for the Stoney group, neither Attribute Sorting nor Attribute Similarities had a significant loading on it. Instead, both measures clustered with tests involving an ability to perceive and compare attributes. Thus, for the Euro-American sample, there was evidence to support the contention that field independence related to the abilities to perceive and compare attributes, particularly the perception of attributes. For the Stoney group, however, no evidence was observed of a relationship between attribute perception and comparison and field independence.

One cultural difference expected to emerge was the larger rôle played by memory in problem solving for the Stoney sample. Indeed, results showed that, for the Euro-American group, while Memory Test loaded on a rotated factor, which appeared to reflect spatial reasoning or field independence, it was not related to either concept reasoning or the abilities to perceive and compare attributes. For the Stoney sample, on the other hand, Memory Test loaded on a rotated factor which tapped an ability to perceive and compare attributes and on which three measures of concept learning had significant or nearly significant loadings. Thus, the results of the data analysis suggested that memory played a larger role in concept learning and in the perception and comparison of attributes for the Stoney children than it did for the Euro-Americans.

In summary, it was expected that each cultural group would have a profile of strengths and weaknesses unique to itself, and that the relationships between the constructs measured and concept learning ability would differ for each group. Results demonstrated that Stoney children were superior on Stone Game 1, and suggested further that they may have, relatively speaking, been superior on Stone Game 2, the Memory Test, and on the two measures of field independence. In contrast, Euro-American children were shown by the test results to be superior on

Stone Game 3, Concept Verbalization, Creative Response Matrices, and the two measures of attribute perception and comparison. It was further evidenced that the reasons for the observed differences in strengths and weaknesses in test performance lay in the different profile of abilities subsumed by the test battery for each cultural group. Results also indicated that the four measures of concept learning tapped a common ability or abilities for the Euro-American sample, but tapped at least two relatively independent abilities for the Stoney group. One of those two abilities appeared to be an ability to perceive and compare attributes. Finally, there was evidence to suggest that, for the Stoney group, memory played a greater role in problem solving than was the case for the Euro-American sample.

Hence, the results from the present research appeared to coincide with those of other current cross-cultural studies. The suggestion that Stoney Indian children, coming from communities having a more loosely knit social structure and homes fostering autonomous functioning were more differentiated than Euro-American children from communities having a tight social structure and from homes placing less emphasis on independence, is consistent with the findings of other cross-cultural studies of differentiation (cf. Witkin and Berry, 1975). Similarly, the different patterning of abilities found in the two samples is compatible with other cross-cultural factor analytic studies which have showed that, in different cultures, psychological tests may well tap different abilities (cf. P. E. Vernon, 1969; Ord, 1970; MacArthur, 1973). Finally, that Stoney children were inclined to make greater use of memory in problem-solving than Euro-Americans is a finding akin to Jensen's

(1973) observation, based on mean group differences, that American Negroes were relatively superior on rote or associative learning tasks, and, indeed, showed a dislike for conceptual learning tasks.

CHAPTER 6

CONCLUSION, LIMITATIONS, AND IMPLICATIONS

Conclusion

The theoretical framework described in Chapter 3 postulated the development of dynamic cognitive structure as a result of interactions between learning experiences generated by the environment, patterns of socialization, and culture, and genetic pre-dispositions; all mediated by individually differing intervening variables such as personality, neurological, physiological, and cognitive style factors. Further, it was envisaged that through interactions between the basic components of cognitive structure (such as visual mechanisms, memory, and the orienting reflex) and perceptual learning, particularly discrimination and synthesis learning, perceptual schemata would be developed. The schemata, in turn interacting with both perceptual and verbal associative learning experiences, would lead to the development of the skills of attribute perception and synthesis. Moreover, it was considered that these skills would develop more quickly for the analytic child due to his increased ability to disembed attributes from complex stimulus patterns. Attribute perception and synthesis and the process of labelling were seen, therefore, as facilitating the development of attribute names and conceptual rules, both necessary ingredients for concept learning to take place.

Consistent with the theoretical framework, it was hypothesized that, for a sample of Euro-American eight-year-olds, performance on measures of field independence would correlate highly with performance on tests tapping the abilities to perceive and compare attributes, and that performance on four measures of concept learning would correlate significantly with performance on measures of field independence, attribute perception and comparison, and general reasoning ability (as measured by a spatially-orientated test).

As the theoretical model (cf Figure I) assumed that eco-cultural factors play an important role in cognitive development, cultural differences were expected to appear in the present studies. It was postulated that memory would play a more important role in concept learning for the Stoney Indian children than for the Euro-American, and that the four measures of concept learning would be more highly inter-correlated for the Euro-American children, reflecting a more unitary ability or set of abilities. Furthermore, from the scores on all tests, a pattern of abilities unique to each cultural group was expected to emerge.

Results of the data analysis produced support for many aspects of the general model for Euro-American subjects. The two measures of field independence were found to be significantly correlated with the ability to perceive attributes; and the table of rotated factors (Table 20) gave further evidence of clustering between Design Construction, CEFT, and Attribute Sorting. Attribute Similarities, on the other hand, appeared to reflect reasoning abilities rather than field independence. Performance on Stone Games 1, 2, and 3 was not related to either of the two measures of field independence; however, Concept Verbalization was significantly correlated with Design Construction and the abilities to perceive and compare attributes. Concept Verbalization was also related to performance on Stone Games 1, 2, and 3, and thus the ability to verbalize concepts appeared to be a function of both the ability to learn concepts and the abilities to perceive (disembed) and synthesize attributes. Contrary to expectation, general reasoning ability had little influence on concept learning.

As hypothesized, cultural differences were observed from responses to the test battery. The four measures of concept learning showed considerable evidence of clustering, reflecting a homogeneous ability or set of abilities, for the Euro-American sample. For the Stoney group, however, results suggested that more than one ability or set of abilities was involved. Performance on two Stone Games and on Concept verbalization was related to the abilities to perceive and compare attributes, memory, and general reasoning ability. In addition, two Stone Games loaded on a separate factor suggesting that, among Stoney Indians, a specific "concept learning" ability was involved in some learning tasks (or in parts of all concept learning); whereas in other tasks (or parts of tasks) general reasoning, verbal labelling, and attribute perception and synthesis were involved.

Further evidence of cultural differences came from the results showing that memory played a greater role in general problem-solving and conceptual learning for the Stoney children than for the Euro-Americans. The table of rotated factors (Table 19) revealed that memory was a factor in concept learning for the Stoney children and was also associated with the abilities to perceive and compare attributes. For the Euro-American children, however, memory was related neither to the abilities to perceive and compare attributes nor to the measures of concept learning. Instead, it was related to a spatial reasoning or field independence factor as might be expected considering that the stimuli were pictorial.

There was suggestive, if not unequivocal, evidence to indicate two distinct patterns of abilities for the two groups. Stoney children did better on Stone Game 1, and appeared to do relatively better on Stone Game 2, and on the two measures of field independence and the Memory Test; Euro-American children excelled on the remaining seven measures. Other studies (for example, Berry, 1966a, 1971; P. E. Vernon, 1969) have shown that North American natives, particularly Eskimos, tend to be superior on tasks involving spatial abilities. Further it is usually considered that people whose language and history is oral have more highly developed abilities to perceive, store, and retrieve information; thus, the above findings appeared to be consistent with those of other studies. Of the four measures of concept learning, Stone Games 1 and 2 were most conducive to successful Stoney performance, perhaps because the deductions were to be drawn from stimuli and attributes which were spatially rather than verbally orientated. Concept Verbalization, on the other hand, involved a verbal ability or set of abilities and Stone Game 3, being a non-reversal shift from SG1 and SG2, involved an additional reasoning component not found in the first two Stone Games. The fact that Matrices produced a significant coefficient of correlation with only one of the three Stone Games, SG3, supports this argument. All of the tests on which Euro-American performance was most markedly superior appeared to involve verbal labelling and/or verbal reasoning abilities. Consequently, Euro-American superiority on these measures was also consistent with the findings from other studies (for example, P. E. Vernon, 1969).

One of the goals of the present studies was to undertake a qualitative analysis of concept learning by examining the strategies used in concept learning. In this regard, the present studies failed. No method could be found to analyse subjects' choices on Stone Games 1 and 3 which would yield information differing from the results of quantitative analyses. Although part of the problem lay with the materials used in the concept learning tasks, it is difficult to see how information about the subject's strategy could be obtained, with any degree of certainty, without using self-report techniques. Needless to say, this would be a most difficult task with Stoney Indian children.

Limitations

The present studies, like most such works, contained a plethora of limiting factors which must be considered when interpreting the results. For example, the Stoney Indian sample cannot be taken as being representative of the entire Indian population, nor can the Canmore and Exshaw Euro-American children be taken as representative of the total Euro-American population. The latter group was probably more representative than the former, however. Pursuant to limitations in the sampling is the argument that two group studies are not broad enough to show a range of cultural differences in human behaviour. In other words, unlike the groups used in controlled experiments, cultural groups differ on a large number of variables, most of which are unknown to the researcher. Thus, the more cultures sampled, the easier it is to define the nature of the continuum or continua being studied. The present studies used only two groups and consequently could not well define the continua in question.

In addition to those arising from sampling techniques, limitations emerged as a result of the performance of the test battery. As noted earlier, many of the instruments yielded distributions which deviated significantly from a normal distribution. Most abnormal distributions were skewed, as a result of tests being too difficult or too easy and thus having inadequate base lines or ceilings. The subsequent reduction in score variance would serve to reduce the size of the correlation coefficient emerging from that test and any other measure. A few measures yielded poor reliability data, suggesting, in some cases, that the tests were heterogeneous or, in other cases, that the tests lacked temporal stability. Most disturbing was the lack of adequate reliability data for the Stone Games, although it can reasonably be argued that sets of stimuli used as experiments need not demonstrate temporal stability, and that the results of the factorial analyses suggested factorial reliability for these measures.

Related to the subject of reliability is test validity. It was not possible to establish the validity of the various measures used, and as several of the instruments had not had prior use in experimental situations, this could be construed as being a major weakness. On the other hand, there was evidence of factorial validity for most of the novel measures. Attribute Similarities and Attribute Sorting were highly inter-correlated and showed signs of clustering both with other spatial tasks and with the test of general reasoning. Similarly, the four measures of concept learning for the Euro-American group (only two for the Stoneys), loaded on an independent factor showing that the four measures had a considerable amount of variance in common and were independent from the other abilities such as general intelligence, memory, or spatial reasoning. Thus, factorial validity was imputed for most of the novel measures, although more rigorous validity data were not available to confirm these interpretations.

In cross-cultural testing there is always the problem of cultural-fairness in the design, scoring, and administration of the tests. While the notion of culture-free testing has, for the most part, been abandoned in favour of the more reasonable goal of culture-reduced tests, it is the desire of most cross-cultural investigators to minimize, as much as possible, the extraneous factors which distort the assessment of "true ability." In designing tests for the present studies, every attempt was made to follow the guidelines for adapting tests to the cultural setting; however, results suggesting evidence of cultural bias and experience in administering the tests aroused suspicions that perhaps extraneous non-cognitive variables were still influencing test performance.

Results from the factorial analyses indicated that several tests (including, for the Stoney group, two measures of concept learning) clustered around a reasoning ability which included the abilities to perceive and compare attributes and verbal mediation. Yet, unfortunately, no purely verbal measure was included in the battery and, therefore, it was not possible to partial out that variance in test scores resulting from solely verbal ability. Furthermore, to overcome this problem as most of the Stoney children spoke little English, it would have been necessary to gain some measure of verbal ability in Stoney. This, perhaps the major limitation of the present studies, underscores Ortar's (1963) point that until the grammar, syntax, and vocabulary of performance tests are understood, it is preferable to use verbal measures (for which this information presumably exists).

As discussed previously, Irvine (1972) suggested a method for checking the construct validity of tests used cross-culturally. When this method was applied to the results from Creative Response Matrices, the test appeared to have tapped the same abilities for both groups. Furthermore, Irvine's method was extrapolated to examine the construct validity of the test battery for each cultural group. It was found that the difficulty levels for each test correlated highly for each group and it was therefore concluded that the battery tapped similar intellectual processes for each sample.

Cole has maintained (Cole *et al.*, 1971) that the cross-cultural researcher should be able to find tasks on which the non-Western subject excels, as well as those on which the Western subject shows a superior performance, before making comments about cultural differences in abilities. This writer (investigator) is in agreement, for, if environmental demands play a role in shaping cognitive development, each cultural group should have certain tasks it performs best. Therefore, it was encouraging to note that on Stone Game 1 (and perhaps on SG2) Stoney performance surpassed Euro-American; whereas on SG3 the opposite was true. This finding was taken as further evidence that at least parts of the test battery were culturally fair.

From experience gained in administering the tests to the Stoney children came the suspicion that their verbal reticence and general shyness might be having a detrimental effect on their test performance. Steps were taken to reduce this problem by using a female examiner, with whom the children appeared to be more comfortable, on those tests most likely to be prejudiced by shyness; however, it cannot be claimed without fear of contradiction that the entering behaviour of the two cultural groups was equal. On the contrary, this investigator is more inclined to believe that Stoney performance was impaired by the unfamiliarity of the examiners and the testing situation.

Many of the results from the present studies were derived from the factorial analyses. With few subjects, little overlap, and as few marker tests as were employed, these results must be considered only tentative and exploratory. Under these conditions, it is difficult to obtain factors which are readily interpreted, and which reflect recognizable configurations of abilities (Fruchter, 1954). Furthermore, although the major factors will emerge, these do not usually break down into smaller group factors under such circumstances. It was primarily for these reasons that estimates of the relative difficulty level for each test and for each group were calculated from the rank order of difficulty levels rather than by means of factor scores. Although the latter is more customary, it was felt that with the above limitations, factor scores would not be particularly meaningful.

Implications

Being an exploratory study, replete with the limitations discussed above, the present studies contained more implications for future research than for educational practice. For the developer of curricula and the planner of instructional strategies, the most educationally significant result was the suggestion that concept learning is, for Euro-American children, a reasonably unique configuration of abilities; whereas for Stoney Indian children, verbal mediational and reasoning abilities and the abilities to perceive and compare attributes are also involved. Also noteworthy was the finding that Stoney children tended to make a greater use of memory in problem solving than did Euro-American children. In addition, the Stoney sample appeared to do relatively better on spatial tasks than on verbal, suggesting that increased use should be made of spatially-presented rather than verbally-presented material.

In discussing the limitations of the present studies, it was mentioned that no method existed for estimating the amount of variance in scores due to purely verbal-type abilities. This becomes, therefore, an obvious area for future research and, indeed, an important one in the delineation of cultural differences in concept learning. Furthermore, the question is raised whether differences between the Stoney and English languages facilitate or impede concept learning or related abilities for either of the groups. The relationship between language and thought has puzzled psychologists for several decades (cf Chapter 1) and admittedly few answers have been gleaned. Nevertheless, the results of the present studies are a reminder that information about culture and cognition may well be gained from that quarter.

In spite of the problems with score distributions and reliability data, the results of the factorial analyses suggested that Stone Games have potential as a means of assessing concept learning ability. It was found in administering the tests that both Stoney and Euro-American children enjoyed playing the games, and, as mentioned previously, it was encouraging to note that on some Stone Games, Stoney subjects excelled; whereas on others, Euro-Americans produced the superior performance. Although only three concepts were involved in the present research, the potential exists to make as many Stone Games as is necessary to include every type of concept and conceptual rule presently known. This would allow investigators to explore cultural differences in the relative difficulty of certain types of concepts and to examine how underlying abilities relate to concepts of low, moderate, and high difficulty levels. In light of the fact that collecting 48 stones of the same size and shape is not an altogether easy task (not to mention the problems in transporting a complete set of Stone Games), it is suggested that several "design changes" be made. This writer (investigator) plans to pursue the problem in the future.

The present studies were designed to be exploratory and therefore the most obvious suggestion for future research is to replicate the studies with other cultural groups (overcoming some of the present weaknesses) and to expand the study by using more subjects from each group and more overlapping tests in an attempt to define more clearly some of the underlying factors. In addition, using subjects in different age ranges would allow investigators to explore cultural differences in developmental changes in concept learning.

Initially, the questions were asked: do abilities such as those described in Chapter 3 influence concept learning, and do cultural differences exist in the relationship of these abilities to concept learning? The results from the present studies, tentative though they may be, suggest partial confirmation for the former question and an affirmative answer to the latter. Thus, sufficient support was found to recommend further work with both the model and with some of the instruments developed to test various aspects of the model.

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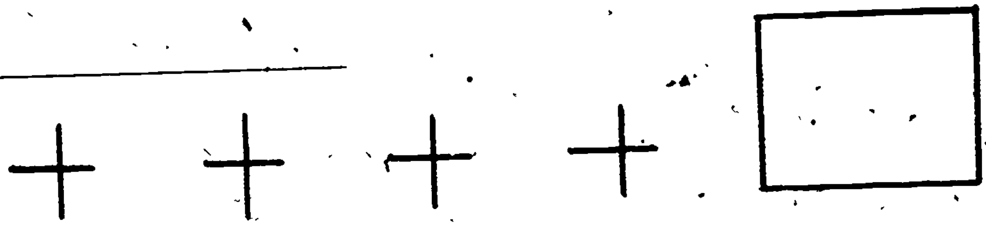
APPENDIX A

Creative Response Matrices

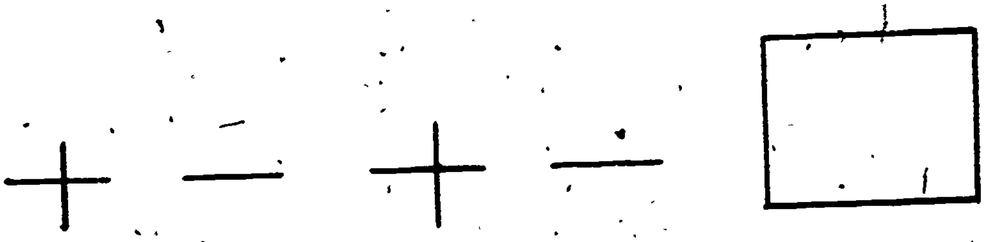
CREATIVE RESPONSE MATRICES

NAME: ______________________

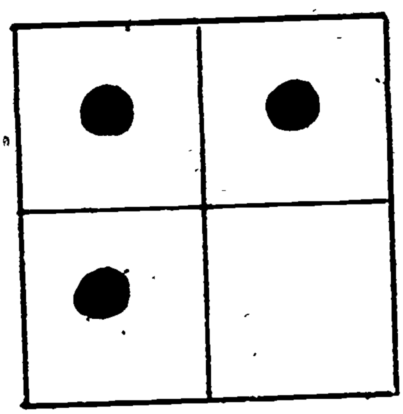
A



B

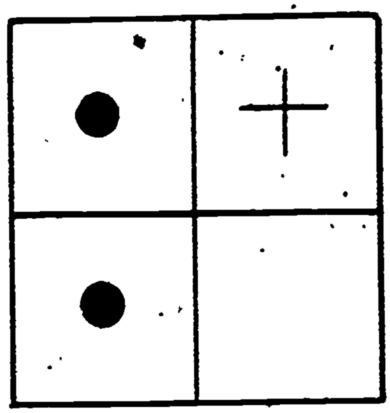


C

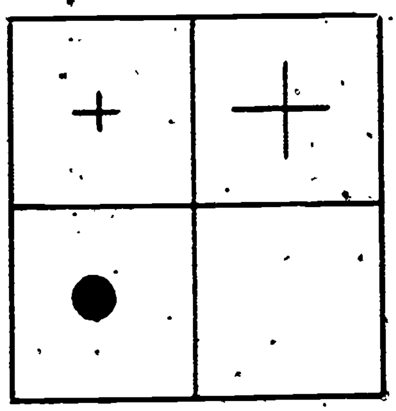


CREATIVE RESPONSE MATRICES

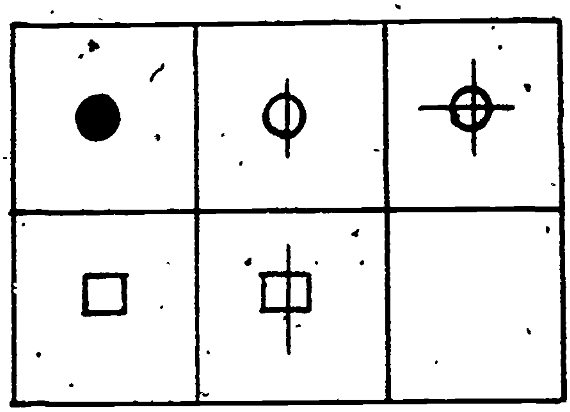
D



E



F



APPENDIX B

Memory Test Lists

List of Pictures Used in Memory Test

Presentation Card

cow	car	apple
pumpkin	hen	boy
squirrel	cup and saucer	house
pipe in ashtray	lion	rabbit
girl	dog	bird
tree	bed	chair
lamp	bike	

Test Card

pie	boy	cow	deer
car	hen	rabbit	desk
apple	bike	aeroplane	chair
pumpkin	umbrella	squirrel	girl
watch	bed	kettle	fire
zebra	house	telephone	bird
sock	dog	ink-bottle	milk carton
lamp	flowers in vase	fish	cup & saucer
scissors	pipe in ashtray	lion	tree
Indian	snowman	ship	

APPENDIX C

Attribute Sorting Test Examples

Examples of Items Used in
Attribute Sorting Test

Practice Item 2

2 large red stones

2 small red stones

2 large black stones

2 small black stones

Test Item C

3 black crosses on red block

3 white circles on red block

2 black circles on red block

2 white crosses on red block

Test Item D

dot outside of rectangle on white card

dot inside of rectangle on white card

dot outside of circle on white card

dot inside of circle on white card

APPENDIX D

Attribute Similarities Test Examples

Examples of Items Used in
Attribute Similarities Test

Practice Series

Item 1. Large red stone and small red stone

Item 2. Small black stone and small red stone

Test Series B

Item 1. 2 white crosses on red block and 3 white dots on red block

Item 2. 3 black dots on red block and 2 white dots on red block

Item 3. 3 white dots on red block and 3 black crosses on red block

Test Series C

Item 1. dot inside rectangle on card and dot outside rectangle on card

Item 2. dot inside rectangle on card and dot inside circle on card

APPENDIX E

Object Sorting Test List

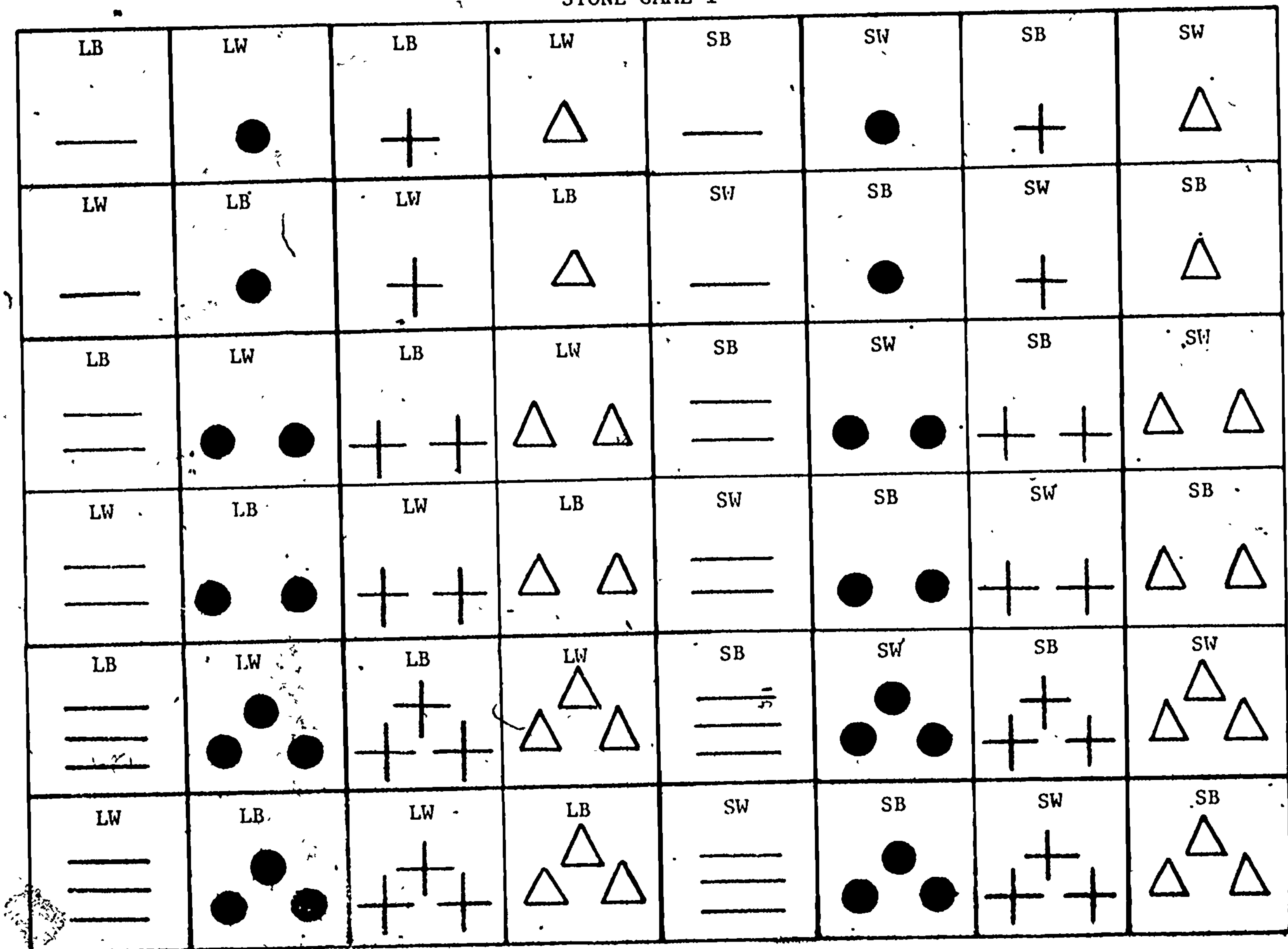
List of Objects Used in Object Sorting Test

1 orange	1 red plastic apple
1 apple	1 toy fork
2 pens	1 toy knife
2 yellow pencils	1 toy spoon
1 yellow plastic bolt	1 cigar
1 yellow plastic nut	1 cigarette
1 pair pliers	1 book of matches
1 white candle	1 smoking pipe
1 red candle	1 screwdriver
2 nails	1 toy hammer
1 piece of chalk	2 forks
1 piece of paper	1 spoon
1 piece wood with nail in it	1 red ball

APPENDIX F

Stone Game 1, Example

STONE GAME 1



Legend:
L Large
S Small
B Black
W White.

Correct concept: Large and Black