DEVELOPMENT OF SPATIAL COGNITION IN MOUNTAINOUS AND PLANE NEPALESE CHILDREN

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Environment is a continuous and communicative medium for human beings to acquire knowledge of spatial world from a very early age. Ecological demands placed on children through cultural adaptation lead to changes in spatial abilities and spatial behavior as the development proceeds. Spatial conceptualization is so central to human cognition that it is considered as representing the first intellectual domain to explore physical world in relation to human psychobiology (Levinson, 1991).

Spatial cognition refers to knowledge of the space either as a continuous and homogeneous entity or as discrete spatial categories such as location, direction, distance and depth of objects (Bowerman, 1993). It is an aspect of individual's behavior which involves dealing with space and is mediated by higher level cognitive activity (Kritchevsky, 1988).

The study of spatial cognition has greatly attracted the attention of researchers since last few decades. Spatial categorization was viewed simply as a reflection of a deep- seated properties of human perceptual and cognitive organization (Piaget, 1954). Piagetian tradition suggests that child's knowledge progresses through three different development stages consisting of an egocentric stage, allocentric stage and a geocentric stage. These stages represent the sensori-motor, pre-operation, concrete operation and formal operation. At each stage certain cognitive structures emerge that incorporate the previous structures, which are invariant manner, taking into account only it's point of view. "Perspective taking", projective and Euclidean spatial concepts develop later on.

Behavioural scientists have returned to an ecological perspective after environmental determinism (Berry, 1971). The nature of ecological behavioural interactions have been well documented in several disciplines (in psychology Hammond, 1966: Barker, 1965: 1969" Wholwill & Carson 1972) anthropology (Steward, 1973 & Vayda, 1969). Advocates of specific skills approach (Cole, Gay, Glick, & Sharp, 1971) laid emphasis on the study of the relationship between a particular feature of the eco-cultural context (e.g., on an experience or role) and specific cognitive performance (e.g., on a classification task). However, the basic cognitive processes have been found to be universal (Dasen, 1993: Mishra, 1977 & Seagall et al., 1999).

The surrounding ecology shape human behavior and culture. Culture is a source of behavioral adaptation to ecological pressures. The ecological demands

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and cultural adaptation placed on a group of people would lead to the development of certain perceptual skills (Berry, 1975, 1992; Berry, Poortinga & Dasen, 2002), specially children who inhabit mountainous ecology develop spatial skills quite different from the children of plane ecology.

What may be the reasons for age related improvement in children's spatial cognition? Researches have shown some qualitative difference in spatial cognition with increase in age (Voyer, Voyer & Bryden, 1995). In a relatively recent study Allen and Ondracek (1995) found that older children acquired knowledge more rapidly than younger children as they were more quick and skilful at encoding and retrieving information from complex visual arrays. Other studies suggest that children's acquisition of spatial knowledge becomes accurate and efficient during the period of middle and late childhood, i.e., roughly between 6 to 12 years of age (Allen, Kirasic. & Herman, 1979; Cohen & Schupfer, 19801; Cornell, Heth & Broda, 1989). The literature on cognitive development indicates that other abilities show significant improvement over this span of childhood (Allen & Ondracek, 1995). However, there have been few attempts to link spatial cognitive development to other specific changes in cognitive abilities (Allen, 1995; Newcombe, 1982)

On the other hand, Voyar et al., (1995) suggest that the effect of age is difficult to evaluate because a variety of other factors associated with the acquisition and development of spatial skills have not been examined along with age.

In a review of studies Gauvain (1993) suggested that findings concerning spatial cognition must be evaluated with reference to the environmental and socio-culutral situation in which they are acquired. Socio-cultural conditions provide children with different opportunities to acquire, organize, and use spatial knowledge. The cultural characteristics of the groups influence the spatial orientation (Niraula & Mishra, 2001), perception and description of space in children (Spencer & Darvizeh, 1983). Lack of attention towards the eco-cultural context of spatial development has resulted in a superficial understanding of spatial cognition.

Studies (Niraula, 1998; Mishra & Niraula, 2001, a, b) have pointed out the development of spatial cognition and psychological differentiation among Newar children of Nepal. However, relationship between the plane and the mountainous residential characteristics and spatial cognition of children related to ecological contexts also requires exploration.

The present study aims at investigating the role of ecology in relation to culture for the development of spatial cognition among the Nepalese children residing in the mountainous and plane settings of Nepal. It was hypothesized that:

- The older children would score higher on the test of spatial cognition (SPEFT, IAEFT) than the younger children.
- The performance of children from the mountainous ecology would be better than those of the plane ecology.

METHOD

DESIGN

The study involved two variables, namely age and ecology. A 6x2 factorial design was used with six levels of age (5 , 6, 7, 8, 9, 10) and two levels of ecology (mountainous, plane). The effect of these variables was examined on the development of spatial cognition.

SAMPLE

The sample consisted of 120 children, 60 from each ecology with 10 numbers of children each age group. Mountainous sample was drawn from government schools of Bhimeshwor municipality of Dolakha district. Plane sample was taken from Hariwan VDC of Sarlahi district, Janakpur Zone of Nepal.

Dolakha, Bhimeshwor is 183m (6000') above sea level situated on the lap of snowy peak of Gauri Shanker Himalaya (7183m) on Rolwaling range gives it an enchanting view in the surrounding. The land is slope with small terraces. Although they represent a settled agricultural community, and agriculture is the main source of economy, lack of irrigation facility in the region allows growing only rainy season crops. Corn, millet, rice and potatoes are the main crops. Most of them are engaged in small business and collect herbs that usually grow around the area as their alternative source of income. The problem of drinking water cause the ladies of the nearby houses gather together around the water tap and wait in a long queue to fetch water in their vessels. They have both Indo-Aryan and Mongloid physical features. They speak Nepali, Newari and Thami languages. Hinduism is the main religion. Most of the houses have mud walls and thatched roofs; other have brick walls with titled roofs, very few have cemented roofs.

Samples from the plane represented the Indo-Aryan Hindu culture. Agriculture is the main source of income. The land is fertile but lack of irrigation facility is causing to depend on rain. Some of them harvest rice, wheat, sugarcane, cereals, vegetables etc. which is sufficient for their families for the whole year and gain extra income through selling. Others survive about half a year from their land. thus, work on daily wages basis in sugarcane factory and others' fields. Fishing in the river, weaving wool etc. are the other alternative sources of income for these families. Most of the houses are constructed with wood; tiled roofs while others have mud walls and thatched roofs. The sample consisted of the mixed ethnic groups lie Brahmins, Chhetries, Maghis, etc. Nepali is their maternal language.

Initially it was thought that the samples would be selected randomly, but a number of difficulties were faced in the random sampling of subjects. Major problem was to get the actual age of the subjects in both the settings. Generally, the school records were incomplete.

So, the children were requested to ask their parents to provide with their date of birth and address on a piece of paper given for that purpose. Based on this information, 6 lists were prepared, according to their age and residential setting.

Information brought back by the subjects was also verified with the school register. Children, whose age appeared doubtful, were dropped from the list prepared for the purpose of sampling. From each final list, a random sample of 10 children was drawn using the popular "chit lifting" technique.

TEST ADMINISTRATION

Each child was administered about the Story Pictorial Embedded Figures Test (SPEFT) and the Indo-African Embedded Figures Test (LAEFT) developed by Sinha (1984). The SPEFT consists of eight sets of test cards, with three set of practice cards (PI-P3). Each set has two cards, a simple and a complex one. Each simple card contains picture of some objects familiar to children. Each complex card contains picture of some objects familiar to children. Each complex card, on the other hand, contains the picture of familiar settings that camouflage the stimulus objects of the simple card. The test was administered like a "object search game". The child was presented with the complex card (P1) for about 10 seconds and was asked to identify the contents. Then the simple card (P1) was presented and the child was asked to identify and count the objects depicted therein. If the child encountered any difficulty, s/he was helped to identify and count the objects. The complex card (P1) was presented and a story, which described the circumstances leading to the hiding of the objects in complex picture, was told, and the child was asked to locate the hidden figures. No time limit was imposed for this purpose. However, the child was asked to indicate as soon as all the hidden figures were discovered. The time taken and the number of the simple figures correctly disembedded were noted down.

LAEFT consists of disembedding a triangle of a standard size in a series of complex meaningful drawings of triangular forms of various sizes. The test consisted of 5 cards, P1-P5, for practice and 15 complex cards for testing series. The complex cards contain drawings of simple and familiar objects like a bicycle, a basket, a pitcher, a table, a chair etc. While taking the test prior to the main testing, discrimination cards P1-P5 are presented to enable the child to identify and locate the stimulus figure, namely, triangle of standard size. It is necessary for the child to succeed on all the five discrimination cards so that he is able to identify the stimulus to be located in the complex cards.

In pre-testing, the discrimination card P1 was presented and the subject was asked which of the two figures was bigger, within 30 seconds. Then P2 was presented and was asked to indicate the figure that he had identified previously, i.e., the bigger triangle. If within 30 seconds he was unable to locate it, he was helped to identify and continue on to the next card, namely, card P3. Again the subject was asked to locate the same figure; if he does not succeed, he was helped to locate the same. The same procedure was followed with rest of the cards. In case of failure on identification of these discrimination cards, the whole procedure from P1-P5 was repeated. But if the subject could understand and discriminate cards by himself without an aid, he was given the test trials directly.

Procedure for the test series was the same as followed with the practice series. The test series was stared only after the researcher was convinced that the

child had understood the task. The child was encouraged to look around and not to confine the search to a particular place in the card.

SPEFT had already been used with Gurung and Brahmin children of Nepal without any difficulty (Shrestha & Mishra, 1996; Sinha & Shrestha, 1992). However, some difficulty was encountered with Newar children on practice Card (rural children had difficulty with cricket bat, badminton shuttlecock) and Test Card 5 (teacher's shoes and sticks). Hence, these were not used. With this change, the maximum disembedding score on the test was 34, and a minimum was zero. Even though LAEFT was not used with Nepali children before, no difficulty was encountered in its application. Thus, all 15-test cards were used. Each right response was scored as one. Hence the maximum score was 15 and the minimum was zero.

RESULTS

The analysis was done on both the SPEFT and the LAEFT scores.

Table 1: Mean score of groups on the SPEFT and IAEFT

Age		**Mountain**		**Plain**	
		SPEFT	**IAEFT**	**SPEFT**	**IAEFT**
10 years	Mean	29.00	11.10	27.90	7.70
	SD	1.42	1.37	4.31	3.38
9 years	Mean	28.30	9.10	24.10	6.70
	SD	3.77	1.73	6.54	2.36
8 years	Mean	26.60	7.00	24.60	5.50
	SD	3.75	2.40	4.45	2.72
7 years	Mean	24.50	4.70	22.50	4.20
	SD	5.40	2.63	4.74	3.16
6 years	Mean	21.90	4.40	22.30	2.40
	SD	4.63	2.72	5.01	1.96
5 years	Mean	18.70	3.50	14.80	1.90
	SD	3.77	2.88	3.19	2.38

Table 1 presents the mean scores obtained by different groups on SPEFT and LAEFT. There are clear differences according to the age level of subjects in each group. At each level, children from mountainous region have generally scored higher than the plane. The score obtained on SPEFT was generally higher than the scores obtained on LAEFT.

Table 2: Mean scores, SD, and t -ratios of plain and mountain subjects on SPEFT and IAEFT

Test	Plain		Mountain		Mean diff	t-ratios
	Mean	SD	Mean	SD		
SPEFT	22.70	6.11	24.83	5.27	2.13	2.05**
IAEFT	4.72	3.38	6.63	3.56	1.92	3.03*

**P= 0.5: *P=0.1

Table 2 presents the mean scores and SD of plane and mountainous subjects on SPEFT and LAEFT. The mountainous children scored higher on SPEFT than the plane subjects.

The difference in performance of mountainous and plane children on SPEFT (t =2.05, df =118, P< .05) and LAEFT (t = 3.03, df = 118, P<01) were found to be significant. It may also be observed that differences between the mountainous and plane children were of the somewhat greater in magnitude on the LAEFT than on SPEFT.

DISCUSSION

The findings support the hypothesis of the study. The first hypothesis, which predicted the development of spatial cognition to be related to the age level of children, was supported by the findings. Older children scored higher than their counter part younger children did. Thus, a clear development trend was in evidence. As children advanced in age, they became more capable of dis-embedding objects in the complex pictures. It is difficult to explain on the basis of the present study the mechanism through which age brought about a change in psychological changes in differentiation. Assuming that biological factors lay at the root of development changes in differentiation, the role of experiential inputs cannot be ruled out. Piaget (1952) observed that a child at the preoperational stage begins to function symbolically with specific cognitive acquisition, but with limitations of the capacity of reasoning. With the attainment of concrete operational stage (7-12 years), some major changes like decentration, reversibility, hierarchical classification, spatial operations, seriation, allocentrism, and horizontal decalege are evident. Piaget (1952) described maturation, experience, social interaction and transmission, and equilibration as factors to account for transition from lower to a higher cognitive stage. Our findings also suggest that development changes can properly understood only by a progressive analysis of forces operating on the child in different contexts.

The hypothesis, which predicted the development of spatial cognition to be related to residential background of subjects, was supported by the findings. Children of mountainous residential settings scored higher than their counterpart children of plane residential settings. A number of reasons can be held responsible for this mountainous and plane difference in spatial cognition. Our field observation revealed that children from the mountainous settings have a

different socialization experience, social structure, language and social relations. They have more differentiated system in a relatively heterogeneous state. Bhimeshwor well known for the excellent natural beauty and scenes is one of the tourist-destined places. Bhimeshwor the famous Hindu temple attracts a lot of pilgrims from different part of Nepal. Children thus, come into contact with many tourists and visitors. The establishment of Korean hospital, participation of different NGO, INGOs etc. directly influence the life of the local people. Above all, Dolakha bazar was a famous trading and business center in the past supplying necessary goods to all mountaineering areas including the highest peak Mt. Everest. Such interactive experiences of children may be held as another important factor in grater development of cognitive differentiation. Training and practice, which take place with acculturation, greatly influence the performance of individuals on cognitive tasks (Within & Goodenough, 1981).

A more reasonable explanation for differences in spatial cognition of mountain and plane children can be offered in terms of their socialization and acculturation experiences in respect of spatial activities. Piaget (1952) assumed that social world affects the child in the same way as the inanimate physical world. Plane environment has high population density, high socio- cultural stratification and socialization emphasis on compliance which lead to low level of development in spatial cognition (Berry, 1976; Barry, Child and Bacon, 1959; Mishra, 1996 & Niraula, 1998). Achievement, self-reliance and independence were emphasized in mountainous samples. The mountainous centered on the functional adaptation of child rearing practices in order to mould adults with personality characteristics best suited to their particular economic pursuits.

The ecological and psychological variables thus appear to be inter-linked and provide adaptive qualities to the group through ecological behavioural interaction. Thus the study reveals that age and residence are the important factors in the level or difference on spatial cognition. The result tends to support the socio-cultural approach to cognitive development, as some performance differences are at least clearly patterned according to residential characteristics of children.

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