2004

The Influence of Schooling on Cognitive Development: Spatial Language, Encoding and Concept Development in India and Nepal

Pierre R. Dasen
University of Geneva

Ramesh Mishra
Banaras Hindu University

Shanta Niraula
Tribhuvan University

ScholarWorks Citation

Dasen, P. R., Mishra, R., & Niraula, S. (2004). The influence of schooling of cognitive development: A review of research in India. In B. N. Setiadi, A. Supratiknya, W. J. Lonner, & Y. H. Poortinga (Eds.), *Ongoing themes in psychology and culture: Proceedings from the 16th International Congress of the International Association for Cross-Cultural Psychology*. https://doi.org/10.4087/QSVT1106

THE INFLUENCE OF SCHOOLING ON COGNITIVE DEVELOPMENT:

SPATIAL LANGUAGE, ENCODING AND CONCEPT DEVELOPMENT IN INDIA AND NEPAL

Pierre R. Dasen
University of Geneva
Carouge, Switzerland

Ramesh Mishra
Banaras Hindu University
Varanasi, India

Shanta Niraula
Tribhuvan University
Kathmandu, Nepal

Most developmental psychological research takes place in contexts where all children go through the process of schooling at much the same age; hence, two variables, chronological age (representing maturation, or more generally ontogenetic development) and schooling (representing one major aspect of social learning) are confounded. Comparative cross-cultural research offers the quasi-experimental paradigm to disentangle, or unconfound these two variables.

Mishra and Dasen (this volume) have reviewed research carried out in India on the influence of schooling on cognitive development. In this paper, we present some empirical results on the same topic, comparing schooled and non-schooled children in a study of language development, spatial encoding and spatial concept development in India and Nepal. Moderate support is found for an impact of schooling on spatial concept development, and to some extent on the use of spatial language, but not on the choice of the frame of reference (egocentric or geocentric) for encoding spatial arrays. In the relationships between spatial language and concept development, both schooling and age were found to be independently influential.

This study is part of a larger research program, the purpose, theoretical background, design and overall results of which are to appear elsewhere (Dasen, Mishra & Niraula, in press; Niraula, Mishra & Dasen, in press). The theoretical premise is that there are two competing frames for speaking about, and for encoding spatial information. In the egocentric (also called relative) frame, the referent is the person and the biologically given left-right and front-back; in the geocentric (also called absolute) frame, reference is made to an overarching, more distant orientation system, that is independent of the particular speaker (such as the cardinal directions of North, South, East and West, up and down in relation to the slope in the terrain, etc.). These two frames correspond respectively to the projective and Euclidean spatial concepts described by Piaget and Inhelder (1956). Our study examines the relationships between ecology, culturally favoured spatial orientation systems, spatial language development, the spatial frames of reference used for encoding a spatial array, and spatial concept development in three samples.

The part of the research reported here is designed to answer the following research questions:

1. What are the effects of age and of schooling on spatial language, encoding, and spatial concept development in three locations in India and Nepal?
2. While age and schooling are confounded in most developmental studies, the inclusion of non-schooled children should allow us to unconfound these two variables. This possibility will be used to study the relationship between language and concept development.

Method

The sample characteristics in terms of age and schooling are presented in Table 1. The two village samples were chosen because they were known from pilot work to represent geocentric spatial orientation systems of two different sorts, in India cardinal directions (NSEW), and in Nepal an Up/Down (U) system in which "up" represents the North and East quadrants, and "down," South and West.

The city and village samples in India were chosen because the same language, Hindi, is spoken. Hindi contains a rich vocabulary of directional terms, but the use of these terms indicates a clear preference on the part of village people: they use NSEW in referring to objects and places in their environment, also the proximal features. Left-right and front-back (LRFB) are used very rarely, and only to refer to objects that are either part of one's body (e.g., the glass is in the right hand), or placed close to one's body. Children are socialized from early childhood to make a distinction between the right and left hand, because the use of the right (socially accepted) hand for purposes like eating, drinking and writing is greatly emphasized. The NSEW terms have a functional value for the society, because many activities are oriented to different directions. For example, South is believed to be an inauspicious direction (abode of Yama, the god of death). Hence, facing South is avoided while eating, engaging in religious activities, during excretory behaviors and sleeping. Verbal interactions in the community involve the use of conventional landmarks (e.g., headman's orchard, pond, road, Kali or Durga temple, and mosque) that are known to all people of the village. Interactions with young children in restricted settings (e.g., in a room) may also involve reference to local environmental features (e.g., door, wall, window, chair), but people refer to various rooms by using cardinal directions (e.g., Eastern room, Northern room). In the city of Varanasi, the same NSEW system may be used, but it is frequent, both for route descriptions and object localization, to use the LRFB system. The city is very old, with a complex pattern of small alleys and roads, almost none of which are aligned in a grid pattern. Although the Ganges River and two of its affluents on each side of the town provide some overall guidance, finding one's way in the city requires a close familiarity with it.

Tasks

The tasks used in this study were divided into three main categories:

A. Spatial encoding tasks. These are tasks initially devised by the Cognitive Anthropology Research Group (CARG) at the Max Planck Institute of Psycholinguistics in Nijmegen (Levinson, 2003). Hence they are referred to as the Nijmegen tasks. These tasks are basically non-verbal, and always start with extensive training to insure the children's comprehension of the instructions.

Table 1

Number of Children According to Schooling and Age-Groups in Three Locations

	Number of children (N)			
	Nepal	India Village	India City	Total
Schooling (years)				
0 (unschooled)	72	78	73	223
1-4	58	34	34	126
5-9	14	47	39	100
Age (years)				
6-8	48	53	50	151
9-11	49	54	48	151
12-14	47	52	48	147
Total	144	159	146	449

1. Animals in a row. This task presents the child with three animals (chosen in this study from locally available models of duck, elephant, horse, tiger, and tortoise) aligned on a table, all facing in one direction. The child is asked to remember this display ("just how they are standing and which way they are looking"). No spatial language is used in the instructions. After some training items, the child moves to another table approximately 5 meters away, after a 180° rotation, and is asked to align another set of the same animals the way they were shown before. Five trials, with animals oriented to right (R) or left (L), are given in the RLLRL sequence.

The encoding is deemed "absolute" (A) or geocentric if the animals face in the same geographic direction on table 2 as on table 1, and "relative" (R) or egocentric if the right or left orientation is maintained.

This task is also repeated at the end of the testing (for children aged 6 to 14 years) in order to see if the child can shift from one encoding to the other. Depending on whether the child had previously encoded the display in an A or R manner, instructions are imparted to encourage an encoding just opposite to the previous one, by using appropriate language. To induce R encoding, the table on which the animals are displayed is placed 30° off the main direction, so that an A encoding is less obvious.

2. Chips. For this task, two-dimensional shapes (small or large, red or blue and yellow or green, circles and squares) are drawn on cards, two at a time. The child is shown five cards of a series, all with the same orientation, and is asked to notice that all of them are identical. Then one of the cards is rotated by 90°, and the child is asked to tell how it is now different from other cards. Following this exercise, the child is presented with a card oriented in a particular direction by the configuration of shapes, and is asked to remember this orientation. Then the child moves on to another table approximately 5 meters away (after a 180° rotation) to choose from a set of four cards, set out as a cross, the one displaying the same spatial orientation as seen before. One of the cards represents an A encoding, another R encoding, and there are two other cards as "distractors." If the child points to one of these, s/he is asked to go back to table 1, and to try again; the second attempt is the one used for scoring. A series of practice trials are given before moving on to actual testing, that includes 5 items.

3. Steve's maze. This task consists of six maps of landscapes that depict a house, rice fields, trees, and an incomplete pathway. The child is presented with a map and is told a story, showing the route that one can take from the end of the drawn path back to the house. The child is asked to remember this route while moving on to another table approximately 5 meters away (with 180° rotation) where three cards are displayed showing three different path segments. One of these represents an R encoding, another A encoding, and the third one an irrelevant choice (called distractor). If the child points to one of these, s/he is asked to go back to table 1, and to try again; the second attempt is the one used for scoring. One item is used for demonstration, another five items constitute the test series.

The scores, called R-A gradients (Levinson, 2003) consist of the proportion of items out of 5 on which the child uses an A encoding, with D (choice of distractor) counting as ½. A higher gradient indicates a higher tendency towards A encoding; a gradient below .50 indicates the predominance of R encoding.

B. Spatial cognitive development tasks. These tasks are used to assess spatial concept development, and are mainly based on Piaget's theory. Except for task instructions, accompanied with sufficient training, the tasks are mainly non-verbal, the children are not asked to give extensive explanations of their thinking and no counter-suggestions were used.

1. Route memory. A pathway is laid out on the ground, consisting of several segments (six for children up to age 9, eight for older children) with right angle turns, set out along the main cardinal directions, one diagonal and a circular turn. A number of objects (six for children up to age 9, nine for older children) are placed at different points of the route. The child moves along the route, and names each object as it is encountered. On reaching the end point, in another room, the child is turned 180°, and is asked to tell how to go back to the starting point. Then the child is asked to recall the objects that were placed along the route, and arrange, on the basis of memory, the models of those objects at appropriate locations along a miniature display of the route. The task is scored on the accuracy of the return path description, the proportion of objects correctly recalled, and the proportion of objects correctly placed.

2. Rotation of landscapes. The task proceeds in three phases, the first two being used for training. In the first phase, two similar landscapes are displayed side by side in front of the child on a table. Attention is drawn to different parts of the landscape (e.g., house, river, bridge, hill, etc.), and their location. The experimenter (E) puts a doll on one of the landscapes, and the child is asked to set another doll in the same place and position on the other landscape. In the second phase, one of the landscapes is rotated by 180° in full view of the child, who does the same exercise as in the first phase (placing and positioning the doll). In the third phase, used for scoring, a screen is placed between the landscapes. The child looks at the E's landscape and on the basis of memory puts the doll in the other landscape exactly at the same place and position as seen before. Five such trials are given. The task is scored into five sub-stages, the early stages reflecting the use of topological space only, the middle stages projective space, and the last stage Euclidean space.

3. Horizontality. A bottle half-filled with colored water is presented on a table. The child's attention is drawn to the level of water in the bottle. Then, the bottle is hidden in a cloth bag and the child is asked to draw the level of water in the outline of the bottle presented on the record sheet. The hidden bottle is presented in five different positions: (1) right side up; (2) upside-down; (3) on the side; (4) tilted at 45° to the right; (5) tilted upside-down at 45°. The child each time draws the level of water on the outline of the bottle.

The task is scored in 5 stages: (1) All positions wrong except position 1; (2) All positions wrong except positions 1 and 2; (3) Positions 2 and/or 3 correct and/or some movement of the water drawn for one position among 4 and 5; (4) Movement of water in positions 4 and 5, but not horizontal; (5) Correct for positions 4 and/or 5.

4. Perspectives task. Three familiar non-fronted objects (a square yellow cube, a big round red box, and a small round green box) are set on the table in a triangle. The child is asked to describe the display from three different positions (cf. next section), and to choose among three pictures the one that represents what s/he sees. The child is then asked to stay at one position and describe the display from the point of view of E (i.e., "how the E sees the display") as E moves to different positions, and to choose from a set of three pictures the one that matches with E's view of the display, E being either opposite to the child, to the right of the child, or at a diagonally opposite corner. In the last phase, the child is presented with a picture (the display seen from the left of the child) and is asked to tell where E should go to see the display as depicted in the picture.

The task is scored as the number of correct descriptions on the four items, and the number of correct choices of pictures.

All the tasks are presented as games. The child is allowed enough practice to ensure complete understanding of the tasks. If needed, the child is allowed to come back to the display on the tasks that place reliance on memory (i.e., Animals, Chips, Steve's Maze, Rotation of landscapes). The E does not rush; the child is allowed enough time on each task.

C. Language tasks. The following procedures were used at the beginning or the end of some of the above tasks for eliciting spatial terms used by children.

1. Route description. In this task, the child is asked to guide one of the experimenters, who is blindfolded, to move along a pathway laid out on the ground. All verbalisations of the child are tape-recorded for later transcription. The path is the same as the one used for the Reverse route memory task, but without objects placed along the path, and the route description is carried out before the cognitive part of the task.

2. Description of table top display. Three familiar non-fronted objects are set on the table in a triangle. The child is asked to describe the locations of these objects three times, while moving to different positions around the display (opposite to first position, and at 90° to the right). These descriptions are recorded. The display is the same as the one used for the Perspectives task, and the description is performed before the cognitive part of the task.

3. Language on spatial encoding tasks. These include the "Animals in a Row," "Chips" and "Steve's Maze," described above. On items 4 and 5 of each task, the child is asked to tell the reason for his choice, i.e., what s/he did to remember the display. The language used is recorded. This is a departure from the standardized form of these tasks (Levinson, 2003), in which no explanation is asked, but this format was also used by Wassmann and Dasen (1998) in Bali; asking for an explanation only on the last two items of each task was thought to interfere minimally with the non-verbal aspect of the tasks.

Language Coding Scheme

The terms are grouped into the three broad categories of egocentric, projective and geocentric language. Egocentric references are often called relative (R) because they depend on the speaker's position. The reference to landmarks implies a direction away from the display and from the viewer, and hence projective properties; it can be considered intermediate between egocentric and geocentric language, because it implies a distancing from the display, but not the application of a right-angle (Euclidean) geocentric grid. Within this category, there is also a progressive distanciation between situationally specific landmarks (SL) that are nearby and inside of the room, and Conventional landmarks (CL) that are further and even quite far if they are localities out of view.

The language produced on these three tasks was coded using a scheme shown in Table 2.

Table 2

Language Coding Scheme

E	Egocentric	
R	Relative	Right, left, in front, in back in relation to speaker
P	Projective	
SL	Situationally specific landmarks	Towards the window, the door (landmarks within the room)
CL	Conventional landmarks	Towards the temple, the hospital, a locality (landmarks outside the room)
G	Geocentric	
U	Up/down	Up to the mountains/down to the valley (in Nepal)
N	NSEW	Cardinal directions, North, South, East, West
Other		
I	Intrinsic	One object related to another, e.g. next to, near, before, etc.
D	Deictic	"This way, that way" (usually accompanied with the gesture of a finger or the whole hand)

The frequency of spatial words used by children on each language elicitation task was counted and converted to proportions of the total words recorded; for each child, these proportions were averaged over the three tasks.

Results

We present in Table 3 the results of a multivariate analysis showing the effect of schooling and that of age on language use, spatial encoding, and spatial concept development; for this analysis, both variables were categorized into three groups.

Table 3

Multivariate Analysis of the Effects of Age and Schooling on Various Tasks in Three Samples. Only Significant Values (p < .05) Are Reported

	Schooling			**Age**		
	Nepal	**India Village**	**India City**	**Nepal**	**India Village**	**India City**
Language						
N (geocentric, NSEW)	.000*	.006		.020		
R (relative, LRFB)			.050			.006
Proportion of geocentric encoding						
Animals				.030		
Chips	.030			.008		
Maze						
Concept development						
Horizontality	.001			.000	.008	
Rotation	.010		.001	.001	.020	.006
Path, number of objects	.020	.030	.020	.000		.020
Path, accuracy			.020	.060		

• Also significant school effect in Nepal for U (up-down) ($p < .001$) and CL (Conventional landmarks) ($p < .03$).

Language Development

In Nepal, geocentric language is used by a large proportion of both schooled and non-schooled children, but the schooled children tend to use more N (NSEW) while the non-schooled use U (up and down). The latter is the more frequent use of a spatial orientation system in the adult population; the use of cardinal directions is actually taught in school. The unschooled children also use significantly more conventional landmarks. In India, schooling also has a significant effect on the use of geocentric language for cardinal directions NSEW, but in the village only; while this is the dominant use in the adult world as well as for children, it is even more prominent for the schooled children. In the city, schooling has an effect on the use of egocentric language (relative, LRFB) again used by all children, but more by the schooled ones.

Spatial Encoding

As can be seen in Table 3, schooling has a statistically significant effect only for one task (Chips) in one sample (Nepal), the schooled children producing a significantly higher rate of A encoding. In the city, there is a statistically significant age by schooling interaction: with increasing age, the proportion of A encoding increases in schooled Ss, while it is curvilinear for the non-schooled ones. This finding is puzzling, because it is the same schooled, older children who tend to use more relative language.

Spatial Concept Development

Overall, the spatial cognitive development tasks show a systematic relationship to both age and schooling. Contrary to what had been found in a number of previous studies, where schooling did not affect Piagetian concept development (Mishra & Dasen, this volume), this effect was also significant for the two Piagetian tasks (Horizontality and Rotation of landscapes) in Nepal, and for Rotation in the Indian city. The effect of schooling is quite systematic on the Number of Objects recalled along the path, and in the city also for the Accuracy of their placement.

Why should the effect of schooling be less marked in the Indian village? In all three samples, the schooled children attended government schools, the quality of which was not noticeably different. At this time, we can only speculate that the school is less relevant, and hence less valued in the village than in the city. In Roopchandpur, the village in India, livelihood is derived almost exclusively from agriculture, and there is very little contact with the city; the village cannot be reached by public transport, and there are only minute shops for essential goods. The village in Nepal, Bhimeshwor, although further away from Kathmandu than Roopchandpur is from Varanasi, is near the Dolhaka district head town, that can be reached by public transport, receives the visit of occasional tourist trekkers, and has a market, several shops and even some hotels. While agriculture is the main economy people depend on, animal husbandry, some small cottage industry, business and government jobs are other sources of income. Although the soil is fertile, lack of irrigation is hampering cultivation, and many young people leave the village for employment in the city. In this context, education is highly valued. In the village, there is also a private school, with which the government school may be attempting to compete.

Unconfounding Age and Schooling

As mentioned above, in most studies of developmental psychology, the two variables of age and schooling are confounded because all children enter school at about the same age, and except for a few cases, age and grade are closely linked. The inclusion of unschooled subjects, when it is possible, as in India and Nepal, allows us to separate these two variables.

We shall illustrate this point in relationship to the hypothesis, developed by Niraula (1998; Niraula & Mishra, 2001), that children who use more geocentric (NSEW) language have a better performance on spatial developmental tasks. The results are illustrated in Table 4.

In the villages both in Nepal and in India, there is a significant correlation between the use of geocentric language and age and schooling. Hence the correlations that appear with the cognitive tasks may be due to either variable or both. To answer the question whether there is a structural link between language and cognition, beyond the developmental or schooling effects, age and schooling have to be partialed out.

Table 4

Correlations between the Use of Geocentric Language and Performance on Tasks of Spatial Concept Development (Only Correlations Significant at p < .05 level are Reported)

		Age	School	Horizontality	Rotation	Path: Number of Objects	Accuracy of Objects on Route
Simple correlations	NEPAL	**.27**	**.35**	**.45**	**.26**	**.33**	.02
	INDIA VILLAGE	**.43**	**.36**	**.32**	**.36**	**.41**	**.25**
	INDIA CITY	.02	.07	.13	.13	**.24**	.05
Controlled for age	NEPAL			**.38**	**.18**	**.26**	-.03
	INDIA VILLAGE			.13	.12	**.25**	**.21**
	INDIA CITY			.14	.12	**.26**	.07
Controlled for schooling	NEPAL			**.36**	**.17**	**.25**	-.10
	INDIA VILLAGE		**.15**	.10	**.20**	**.20**	
	INDIA CITY			.11	.09	**.23**	.05
Controlled for age and schooling	NEPAL			**.35**	**.14**	**.22**	-.11
	INDIA VILLAGE			.11	.07	**.21**	**.19**
	INDIA CITY			.13	.10	**.25**	.05

Significant values are highlighted; *r* values of.20 and above are significant at.01 level.

The hypothesis is that the use of geocentric language may be linked to Euclidean spatial concepts (particularly measured through Horizontality task, but also rotation) and should facilitate the accuracy of placement of objects on the Reverse Route Memory task. The hypothesis is partly confirmed by the data: the correlations between N and cognitive tasks are statistically significant. Controlling for age and schooling reduces the value of correlations, but several remain statistically significant, particularly in Nepal. On the other hand, the highest correlation occurs with the number of objects recalled on the Reverse Route Memory task (free recall), and not with the accuracy of their location. Age and schooling are both contributing variables, and one does not appear to be more influential than the other.

Discussion and Conclusions

In sum, our study shows a moderate, quantitative impact of schooling on spatial cognitive development, but none of the processes we have examined are particular to schooled children, which suggests that schooling does not produce new cognitive processes (see Mishra & Dasen, this volume). The schooled children use cardinal directions somewhat more than non-schooled ones, if only because these are taught in school and in the city they also use more relative language. However, this has virtually no influence on the spatial frames of reference (egocentric or geocentric) used for encoding spatial arrays.

The most systematic impact of schooling is on spatial concept tasks, but there again it is only a matter of degree. It is not the case that schooled children would use concrete operational thinking while non-schooled would not do so, it is only the rate of development through the various sub-stages that is more rapid for schooled children, and this is true only for some tasks in some of the samples. It could be argued that the standard Piagetian tasks are somewhat school-like, be it Horizontality, in which outline drawings are used, or Rotation of landscapes that uses scale models. Even remembering objects along a path and where they were placed, although more akin to daily life, may still be somewhat strange because scale models of the path and objects were used, and because of the unfamiliarity with the testing situation in which the children are asked questions by adults. Hence, we are no more able than most of the studies reviewed by Dasen and Mishra (this volume) to certify that some of the supposed impact of schooling is not an artefact of method.

We cannot claim that our study shows that developmental effects had been wrongly attributed to chronological age when in fact they were due to schooling. Both schooling and age are independently contributing factors. However, when both of these are controlled, there remains a significant relationship between the use of geocentric language and spatial concept development.

References

Dasen, P. R., Mishra, R. C., & Niraula, S. (in press). Ecology, language, and performance on spatial cognitive tasks. *International Journal of Psychology.*

Levinson, S.C. (2003). *Space in language and cognition.* Cambridge: Cambridge University Press.

Mishra, R. C., & Dasen, P. R (in press). The influence of schooling on cognitive development: A review of research in India. In B. N. Setiadi, A. Supratiknya, W. J. Lonner, & Y. H. Poortinga (Eds.), *Ongoing themes in psychology and culture. Selected papers from the Sixteenth International Congress of the International Association for Cross-Cultural Psychology.* Yogyakarta: IACCP.

Niraula, S. (1998). *Development of spatial cognition in rural and urban Nepalese children.* Unpublished doctoral dissertation, Banaras Hindu University, Varanasi, India.

Niraula, S., & Mishra, R. C. (2001). Spatial orientation of the Newar children in Nepal. *Social Science International, 17,* 36-48.

Niraula, S., Mishra, R. C., & Dasen, P. R. (in press). Linguistic relativity and spatial concept development in Nepal. *International Journal of Behavioral Development.*

Piaget, J., & Inhelder, B. (1956). *The child's conception of space.* London: Routledge and Kegan Paul.

Author Note

The study reported in this paper was funded by grant 11-54101.98 of the Swiss National Fund for Scientific Research attributed to the first author. Correspondence may be addressed to R.C. Mishra, Department of Psychology, BHU University, New G5 Jodhpur Colony, Varanasi 221005 India, to P. Dasen, FPSE, University of Geneva, 9 rte de Drize, CH-1227 Carouge, Switzerland, or to S. Niraula, POB 2964, Kathmandu, Nepal.

Dasen's e-mail address: **Pierre.Dasen@pse.unige.ch**