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Reports the results of a study done in a mountainous region of Nepal on a sample of 144, 6–14 year old boys and girls, schooled and unschooled. A variety of tasks was selected for the analysis of language children use for describing space and for the assessment of spatial encoding and cognitive performance on spatial developmental tasks. The results confirm that the language people use to describe spatial arrays is linked to the way in which they orient themselves in the environment. The age trends in language development indicate a change from intrinsic and projective to geocentric references, with almost no use of egocentric terms, while the encoding of spatial arrays is predominantly absolute (age changes being task specific). Overall, spatial cognitive development is quite independent of spatial encoding, but shows some statistically significant relations to the use of geocentric language.

Linguistic Relativity and Spatial Concept Development in Nepal[1]

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Piaget's theory suggests that children first build up spatial concepts in relation to their own body, both at the sensorimotor level of action and at the later representational level. This pattern is linked to the assumption that development occurs through decentration. This means that infants and children are first egocentric, i.e., they take into account only their own points of view. The ability to take the other's point of view (perspective taking) is a developmental process. Piaget and Inhelder's (1948/1956) theory also posits the developmental sequence of topological, projective, and Euclidean spatial concepts. While it is well established in research in the Piagetian tradition that topological space comes first and is universal, the sequence between projective and Euclidean concepts is less clear, and seems to be more of a logical than an empirical implication (Laurendeau & Pinard, 1968/1970).

The distinction between these spatial concepts is akin, at the linguistic level, to that established by theorists of spatial language development between three kinds of reference frames: intrinsic or object-centred, deictic or viewer-centred, and extrinsic or environment-centred (Taylor & Tversky, 1996). Although there is some controversy about the best terminology, these three frames correspond to Levinson's (1996; 2003) distinction between intrinsic, relative and "absolute" (or extrinsic) frames that has gained wide acceptance. In an intrinsic frame, the location of objects is described in relation to an object's front, back or sides; they depend on the agreement on the intrinsic orientation of the reference object. In the relative frame, the location of objects is described in relation to a viewer's front, back, left, and right; they are viewer-centred, and require knowledge of the viewer's position and orientation in space. In the geocentric frame, objects are located according to a co-ordinate system that is external to the scene. It has also been noted that different language communities preferentially use diverse reference frames (Levinson, 1996; 2003).

Several studies have been done to explore infants' abilities to locate objects according to body-oriented or geocentric landmarks in the sensorimotor period (Acredolo, 1990; Bremner, 1989; Lepecq & Lafaite, 1989). In general, the findings indicate that babies first use their own body as a reference before establishing outside, independent landmarks. These studies also suggest that a shift in these orientations occurs at an earlier age than Piaget had thought, but it depends almost entirely on the precise way the task is set up.

Research carried out at the representational stage has led to similar results. Whether or not a child can be described as egocentric depends largely on the task situation rather than on some inherent property of stage-wise development. Thus, while the ability to use geocentric landmarks varies with age depending on the experimental conditions, it seemingly does not occur before the child has built up body related spatial representations. Occasionally, it has been suggested that both these abilities may develop together, but there never seems to be any complete reversal from the sequence originally described by Piaget. The theory that spatial representation is basically built up from the point of view of the human body is still current. According to Taylor and Tversky (1996),

> One of the first aspects of space that we confront is our own bodies. Our bodies have three axes, that formed by our heads and feet, that formed by our fronts and backs, and that formed by our left and right . . . . space as we perceive and experience it is anchored, asymmetric, and biased. These facts about the space of our bodies and the world they interact form the basis of our conceptions of the spatial world (p. 3).

One problem with the field of spatial concept development is that it has almost entirely depended on research with western samples. Whether the same sequence of stages of development would hold in other cultures is not known. It is possible that the very centration on the individuals' construction of space on the basis of their body is a bias due to western individualism (Kagitçibasi, 1997).

Cross-cultural research on spatial cognition can be described as a contrast between the emic (culture specific) and etic (universal) approaches (Segall, Dasen, Berry, & Poortinga, 1999). On the emic side are anthropological descriptions of how space is organised in different cultures (Gladwin, 1970; Hutchins, 1995; Pinxten, Van Dooren, & Harvey, 1983), but they have little to say about developmental aspects. On the etic side is the cross-cultural replication of Piaget's theory, using classical "Piagetian" tasks (Dasen & Heron, 1981). However, this research neither suggests any possibility of reversals in the sequence of stages, nor indeed any culturally specific cognitive processes (Dasen, 1993).

Studying the spatial orientation system in Bali, Wassmann and Dasen (1996; 1998) found that although in the Balinese language and culture, the geocentric system predominates, the egocentric terms (left/right) also exist. Young children (4–9-year-olds) encoded spatial arrays only in geocentric terms, whereas older children (11–14-year-olds) and adults, while still encoding in geocentric terms more often than in egocentric terms, used the latter occasionally (and more on one task than on the other), and were able to switch from one to the other.

Linguistic Relativism

Does language determine the way one thinks? Not much research was done during the last decades to answer this question, but the issue of linguistic relativity has been revived recently (Gumperz & Levinson, 1996; Levinson, 1996; 2003; Lucy, 1992). Cross-cultural research has shown that basic cognitive processes are universal (Mishra, 1997; Segall, Dasen, Berry, & Poortinga, 1999). Although languages themselves have been shown to conform to many universal principles (Holenstein, 1993), recent research on language acquisition has emphasised both similarities and differences across languages (Mohanty & Perregaux, 1997). Research has indicated that every language allows for the conceptualisation of the surrounding space and communication about it to others. It is widely assumed that the coding of spatial arrays for memory is determined by general properties of visual perception, and that it is natural and, thus, universal to conceptualise space from an egocentric and anthropometric point of view. Further, research has shown that speakers of European languages used egocentric encoding; other forms of encoding seemed to be impossible to them. The egocentric conception of space has been considered as universal and "more natural and primitive" (Miller & Johnson-Laird, 1976, p. 34).

However, there are increasing doubts about these basic assumptions, because they may be ethnocentric (Wassmann, 1994). If one has to describe the position of an object or person with respect to another, this can be done in English by utilising the projective notions of right and left in reference to the speaker's body. Some languages do not use the body-centred spatial notions of left and right, front and back (LRFB) to locate objects, unless these touch the body. Instead they use fixed, environment-centred or geocentric frames of reference such as cardinal directions (NSEW), as in "the child on the West is holding a ball in her left hand". While in an egocentric frame, the description of an object or person changes depending on one's body position (for example, left may become right and vice versa), in the geocentric frame, the description does not necessarily change with the viewer's change of position. Such a non-egocentric description of a spatial array seems to be incongruent with the perceptual information, and the question

is whether these linguistic differences correspond to conceptual differences. We may assume that spatial representations are influenced either by sensory information (which is egocentric) or by language (which may or may not be egocentric). In European languages, that are egocentric, the two are confounded, but there are other languages (Pederson et al., 1997) that use exclusively intrinsic or geocentric or mixed frames of reference in which it is possible to dissociate these influences.

In a study in south India, Pederson (1993) found that Tamil speakers used both geocentric (NSEW) and egocentric (LRFB) systems. While both exist in the language, people in rural areas used the NSEW system, while in urban areas, the LRFB system was dominant, with an occasional reference to local landmarks. Further, both the groups manifested the ability to shift between geocentric and egocentric terminology. In Mexico, de León (1994) noted that Tzotzil children began to master the geocentric system between the ages of 4 and 9 years, in a succession of stages. These stages represent a shift from an egocentric frame of reference, through locally anchored references, to abstract coordinates. In another study with Guugu Yimithirr (GY) aboriginal children in Australia, de León (1995) observed that children between the ages of 6 and 14 years used a geocentric orientation system with no evidence for the existence of egocentric (left/right) terms in the language (Levinson, 1997). Very young children (4 years) used intrinsic words (in, on, off, out) and up/down. Left and right do not exist in the GY language, and front/back are used only in relation to motion, not position. By the age of 7, children used a locally anchored frame of reference, and by 9–10 years, contrasts of terms were built up. However, only 3 out of 26 children had acquired the full fledged system of four GY cardinal terms, and these three children (10–12 years) had learnt it from their grandparents, who emphasised the importance of the traditional form of the language.

In a study in Bali, Wassmann and Dasen (1996; 1998) found that geocentric terms were applied not only to macro space, but also to micro space whenever an object had to be located or a direction indicated. Left and right were applied only to objects in contact with the body, while all other objects were located with a geocentric orientation system using four quadrants along two more or less orthogonal axes, with "up to the mountain—down to the sea" as the main reference. While very young children (4–5 years) used exclusively the geocentric system in their language and in their way of memorising a spatial device, there appeared to be a developmental change towards egocentric encoding. This study indicates that in some cultural and linguistic contexts, the sequence of acquisition of spatial knowledge could be reversed. Thus, the question arises whether different orientation systems, and the corresponding linguistic encoding, have an impact on spatial cognitive development.

These studies cast doubts on the sequence of spatial cognitive development as outlined by Piaget, but they fail to provide an alternative to this theory. Some studies which focused on spatial communication and encoding (Newcombe & Huttenlocher, 2000) suggested that individuals (even children) may have simultaneously available several systems of coding locations that encompass both external and internal references. They may preferentially use these systems depending on the situations and the tasks at hand. This position generally rules out an overall progression from the use of egocentric to geocentric frames of reference in the course of spatial cognitive development, but it does not tell us what frame children would preferentially use to describe and encode spatial features of their environment. Our assumption is that the reference system that is dominant in a given ecological or cultural setting would, to a large extent, predispose children to make use of that system. This means that although children may use other spatial reference systems in dealing with spatial problems, they would show a strong preference for one over the other system.

The present study was conducted in Nepal in which a "geocentric" spatial orientation system was known to exist. It aims at (*a*) understanding the developmental changes in the language that children use to describe space, (*b*) analysing the frames of reference (egocentric vs geocentric) in encoding spatial arrays, and (*c*) examining the relationships of language use, and of frames of encoding, with performance on spatial cognitive tasks.

More specifically, the study was designed to answer the following research questions:

1. What is the spatial language actually used by children of various ages in this setting in Nepal?
2. What are the developmental trends in spatial encoding according to the two frames of reference (geocentric and egocentric)? Does this trend confirm the possible reversal found in previous research in Bali? Is there a significant relationship (controlling for age and schooling) between spatial language use and spatial encoding?
3. Is there a significant relationship (controlling for age and schooling) between spatial language use and/or spatial encoding and spatial concept development? In particular, does using more geocentric language and/or more geocentric spatial encoding favour the development of projective and Euclidean spatial concepts?

Method

Design and Sample

This study, which formed a part of a larger research programme (Mishra, Dasen, & Niraula, 2003) used a sample of 144 children in the age group of 6–14 years. An equal number of schooled and unschooled children were studied, with an equal proportion of boys and girls in each age and school group (Table 1), but this group was not used in the main analyses reported in this paper.

Table 1

Sample Characteristics

	No School		*School*		
Age Groups	*Girls*	*Boys*	*Girls*	*Boys*	*Total*
6–8	12	12	12	12	48
9–11	13	12	12	12	49
12–14	11	12	11	13	47
Total	36	36	35	37	144

The study was done at Bhimeshwor municipality of Dolakha district in the foothills of the Rowaling Himalayan ranges about 135 km east of Kathmandu and connected to the capital city by road. There is tremendous difference in the altitude of the lowest lands (840 m above mean sea level) and the highest peaks (3,549 m). Agriculture is the main occupation of the people; animal husbandry, small cottage industry, business, and government jobs are other economic activities.

The sample of the study represented mainly the Newar ethnic group; the Newari language spoken in Dolakha is somewhat different from that spoken in other parts of Nepal. All children were bilingual and knew Nepali, the language mainly used for testing. There were Brahman and Chetri children also speaking only Nepali, as well as a few children who were bilingual with Tibeto–Burman languages (Sherpa, Thami, and Tamang).

A geocentric reference system, mainly based on an "up-down" orientation, predominates in this region. In day to day interaction, people use a number of words that build a contrast between "up" and "down". The most commonly used words are *undho* and *unbho* to refer to up (towards the mountain) and down (towards the valley). Other expressions are *mathopati* or *masteer* (literally meaning towards the head, in this case the mountain) and *talopati* or *taalteer* (literally meaning towards the foot, in this case the valley). These words are shared by both Nepali and Newari speakers, and by all ethnic groups (such as Tamang, Thami, and Sherpa) who live in this region. Since all activities (agriculture, shopping, and schooling) are organised in a space that calls for upward or downward movement of people, the "up-down" orientation is the most compelling one.

Bhimeshwor municipality has several government and private schools. Despite the availability of schools, the non-school going population comprises 39% of the total population of 5–14-year-olds. Most of the parents of the children in the sample were either illiterate or had only primary education.

Tasks

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

Spatial Encoding Tasks. These tasks were initially developed by the Cognitive Anthropology Research Group (CARG) at the Max Planck Institute of Psycholinguistics in Nijmegen (Levinson, 2003). Hence, they are referred to as Nijmegen tasks.

ANIMALS IN A ROW. In this task the child is shown three animals (chosen from the 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 m away, after 180° rotation, and is asked to align another set of the same animals in the same order as before. Five trials, with animals oriented to the right (downhill) or the left (uphill), are given in the RLLRL sequence.

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

This task is also, repeated at the end of the testing (for children in the age group of 6–14 years) to determine whether the child can shift from one encoding to the other. Depending on whether the child had previously encoded the display in A or R manner, instructions are given 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° of the main direction, so that A encoding is less obvious.

THE CHIPS TASK. 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 5 cards of a series, all with the same orientation, and is told to observe that all of them are similar. One of the cards is then rotated by 90°, and the child is asked to describe how it is now different from the other cards. Following this exercise, the child is shown a card oriented in a particular direction by the configuration of shapes, and is asked to remember this orientation. The child moves to another table (after 180° rotation) and has to choose from a set of 4 cards set out as a cross the one with the same spatial orientation as seen before. One of the cards represents R encoding, another A encoding, and the remaining cards are "distractors". If the child points to one of these, she/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 is given before the actual testing, that includes 5 items.

STEVE'S MAZE TASK. This task consists of 6 pictures of landscapes that depict a house, rice fields, trees, and an incomplete pathway. The child is presented with a picture 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 instructed to remember this route while moving to another table (with 180° rotation) where 3 cards are displayed showing 3 different path segments. One of these represents R encoding, another A solution, and the third one an irrelevant choice (or distractor). If the child points to one of these, she/he is asked to return to table 1, and to try again; the second attempt is the one used for scoring. One item is used for demonstration, another 5 items constitute the test series. The score consists of the proportion of items out of 5 on which the child uses geocentric encoding.

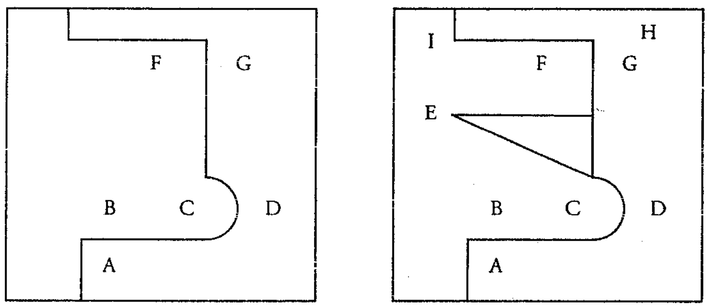
On the 3 spatial encoding tasks, the scores were converted into a so-called R–A gradient, following Levinson (2003). The R–A gradient represents the proportion of absolute items out of 5 items in each task, with D (choice of distractor) counted as half. A higher gradient, therefore, is indicative of a higher tendency towards A encoding; a gradient below 0.50 indicates the predominance of R encoding.

Spatial Cognitive Development Tasks. These tasks are used to assess spatial concept development, and are based on Piaget and Inhelder's (1948/1956) theory. Except for task instructions, accompanied by sufficient training, the tasks were mainly nonverbal. The children are not asked to give extensive explanations of their thinking and no counter-suggestions are used, since these procedures tend to be difficult in cross-cultural research (Dasen, 1975).

REVERSE ROUTE MEMORY. Inspired by the previous work of Gauvin and Rogoff (1989), and Cottereau-Reiss (1999, 2001), in this task a pathway is laid out on the ground, consisting of several segments (6 for children up to age 9, 8 for older children) with right angle turns, set out along the main cardinal directions, and also a diagonal and a circular turn (Figure 1). A number of objects (6 for children up to age 9, 9 for older children) are placed at different points on the route. The child moves along the route, and names each object he comes across. On reaching the end point, in another room, the child is turned 180°, and is asked to describe the way back to the starting point. Then the child is asked to recall the objects that were placed along the route, and to arrange the models of those objects at appropriate locations along a miniature model of the route. The task is scored for the accuracy of the return path description, the proportion of objects correctly recalled, and the proportion of objects correctly placed.

Figure 1

Reverse Route Memory Task (Simple and Complex)



Objects used:

A kettle	B lamp	C water jar
D food carrier	E pitcher	F wok
G bucket	H chair	I stool

ROTATION OF LANDSCAPES. Developed by Piaget and Inhelder (1948/1956), this task was standardised by Laurendeau and Pinard (1968/1970). We used a simplified version of the latter (only 5 items), as in the previous research

by Dasen (1975). Rotation of landscapes is done in three phases. In the first phase (training), two similar landscapes are displayed side by side in front of the child on a table. Attention is drawn towards different parts of the landscape (such as house, river, bridge, and hill), and their location. The E places a doll on one of the landscapes, and the child is asked to put 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, a screen is placed between the landscapes. The child looks at the E's landscape, and on the basis of memory puts the doll on the other landscape exactly at the same place and position as seen before. Five such trials are given. The task is scored in 5 substages, the early stages reflecting the use of topological space only, the middle stages projective space, and the last stage Euclidean space.

HORIZONTALITY. This task was also developed by Piaget and Inhelder (1948/1956), and used among others by Dasen (1975). A bottle half filled with coloured water is placed on a table. The child's attention is drawn to the level of water in the bottle. The bottle is then hidden in a cloth bag and the child is asked to indicate the level of water on the outline of the bottle presented on the record sheet. The hidden bottle is presented in 5 different orientations: 1. right side up; 2. upside-down; 3. on the side; 4. tilted at 45° to the right; and 5. tilted upside-down at 45°. Each time the child has to indicate the level of water on the outline of the bottle.

The task is scored in 5 stages: (*a*) all positions wrong except position 1; (*b*) all positions wrong except positions 1 and 2; (*c*) positions 2 and/or 3 correct and/or some movement of the water drawn for one position among 4 and 5; (*d*) movement of water in positions 4 and 5, but not horizontal; and (*e*) correct for positions 4 and/or 5.

PERSPECTIVES TASK. Inspired by the original work of Piaget and Inhelder (1948/1956), this task was standardised by Laurendeau and Pinard (1968/1970). 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 3 different positions, and to choose among 3 pictures the one that represents what she/he sees. The child is then asked to remain at one position and describe the display from the point of view of the E (i.e., "how the E sees the display") as the E moves to different positions, and to choose from a set of 3 pictures the one that matches the E's view of the display, the E being either opposite to the child, to the right of the child, or in 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 say where the E should move to see the display as depicted in the picture.

The task is scored as the number of correct descriptions on the 4 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 all the tasks that depend on memory (such as, Animals, Chips, Steve's Maze, and Rotation of Landscapes). The child is allowed enough time on each task.

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.

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, consisting of several segments (6 for children up to age 9, 8 for older children) with right angle turns, set out along the main cardinal directions, one diagonal and a circular turn. 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 no objects are placed along the path, and the route description is done before the cognitive part of the task.

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 the 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 given before the cognitive part of the task.

LANGUAGE ON SPATIAL ENCODING TASKS. These include "Animals in a Row", "Chips", and "Steve's Maze". On items 4 and 5 of each task, the child is asked to state the reason for her/his choice, i.e., what she/he did to remember the display. The language used is recorded. This is a departure from the standardised 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 on the last two items of each task was thought to interfere only minimally with the non-verbal aspect of the tasks.

Language Coding Scheme

The language produced on all these 3 tasks was coded using a scheme adapted from Pederson (1993). This is shown in Table 2.

The terms are grouped into the three broad categories—egocentric, projective, and geocentric language. Egocentric references are often called relative because they depend on the speaker's position. The reference to landmarks implies a direction away from the display as well as from the viewer, hence it has 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 the room, and conventional landmarks (CL) that are further and even quite far if they are localities beyond the range of vision.

Table 2

Language Coding Scheme

E	*Egocentric*	
R	Relative	Right, left, in front, in back in relation to the 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*	
T	"Terso"	Nepali word, meaning along a path that is uneven or zigzag
U	Up/down	Up represents the north and east quadrants; down south and west
N	NSEW	Cardinal directions, north, south, east, west
Other		
I	Intrinsic	Next to, near, before, etc. (topological)
D	Deictic	"This way, that way" (usually accompanied by the gesture of a finger or the whole hand)

In the geocentric group, we included "Terso" (T), a Nepali term that was difficult to translate, used mainly by monolingual Nepali speakers (and the two Tamang and Nepali bilinguals) to designate a direction along an uneven path going upwards. We included it here because it indicates a far direction and not a specific landmark, but it could be argued that it also has projective properties. More decidedly, geocentric is Up and Down (U), that refer not so much to two directions but to two half circles (sectors of roughly 180°), "Up" being north and east and "Down" south and west.

The "Other" category comprises Intrinsic (I) references and Deictic (D). The latter corresponds to saying simply, "This way/that way", and is usually accompanied by the gesture of a finger or the whole hand. These gestures are ambiguous in terms of frame of reference: Since a body movement is involved, it could be body related, and could mean "to the right/left"; however, the pointing could also be towards a direction independently of the body. As will be discussed later, D is used mainly by very young children, from whom it is difficult to extract more precise verbal explanations; this question is, therefore, left for future research.

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 3 tasks.

Results

Spatial Language

The proportions of language categories used by the three age groups on language elicitation tasks (combined for Route description, Perspectives, and items 4 and 5 of the 3 Nijmegen tasks on which we asked children to describe how they remembered the display) is presented in Table 3. For this analysis, it is interesting to distinguish all the language categories, while in some of the subsequent analyses it will be sufficient to consider the three broader categories.

Table 3

Proportions of Language Use on Combined Tasks, by Age Group

Language	*E*	*P*		*G*			
Age (Years)	*R*	*SL*	*CL*	*T*	*U*	*N*	*Other*
6–8	03	16	12	07	30	07	26
9–11	02	08	08	11	38	21	12
12–14	03	03	08	11	37	25	13

The most telling aspect of the results was that egocentric language (E) was almost never used, while this would no doubt be the most frequently used category by children speaking European languages. At age 6–8, the use of landmarks (SL and CL) was quite frequent, and Up/down (U), that was dominant reference throughout. Cardinal directions (N) were used mainly by the older schooled children.

In short, this analysis indicated that the spatial language used by the subjects was predominantly geocentric, i.e., it relied on references away from the display. The way this was done changed with age; the younger children often referred to projective landmarks, but Up/Down as a geocentric reference also appeared very early.

However, the change with age of language use was not exactly the same in schooled and nonschooled children (Table 4).

Table 4

Modal Language Use on Combined Tasks, by Age Group and Schooling

	Egocentric		*Projective*						*Geocentric*					
	R		*SL*		*CL*		*T*		*U*		*N*		*Other*	
	NS	*S*	*NS*	*S*	*NS*	*S*	*NS*	*S*	*NS*	*S*	*NS*	*S*	*NS*	*S*
6–8	01	06	15	17	15	09	05	10	39	21	02	13	23	24
9–11	02	02	09	07	10	07	12	09	46	28	08	35	13	12
12–14	01	05	02	04	12	03	16	05	44	30	16	33	09	20
p value					0.03				0.001		0.000			

Notes: NS = nonschooled, S = schooled.

There was not much difference between schooled and nonschooled children in the use of egocentric language; R was used slightly more by schooled children, but the difference was not statistically significant. On the other hand, unschooled children used CL and U, while schooled children used mainly N. In Nepal, the use of cardinal directions is being taught in school, while in India, the NSEW system is traditional and common especially in village settings, including among nonschooled people (see Dasen, Mishra, & Niraula, 2004).

Spatial Encoding Tasks

The results are presented in Table 5, it also includes the data for a group of 4–5-year-olds, for whom the R–A gradient was computed on two tasks, since Steve's Maze was not administered to them.

Table 5

R–A Gradients on Three Spatial Encoding Tasks by Age Group

	Animals	*Chips*	*Steve's Maze*
4–5	0.59	0.42	–
6–8	0.75	0.57	0.47
9–11	0.83	0.64	0.45
12–14	0.88	0.71	0.43
p value	0.03	0.008	–

The R–A gradients by age clearly revealed that the three tasks differed considerably with respect to encoding. On the Animals tasks, most of the encoding was A, even among the youngest age group, but there was a significant increase in geocentric encoding with age. On the Chips task, A encoding was also predominant, although at a slightly lower level, and there was a similar increase in A encoding with age. On Steve's Maze, however, was discernible no age trend, and there was a slight predominance of R encoding.

The effects of schooling were significant ($p < 0.03$) on the Chips task only, with schooled children using more A encoding. The direction of this effect is interesting, since one expected schooling to foster more R encoding.

Since the two modes of encoding coexist, and are triggered by different task demands, the question arises whether children can be induced to change from the spontaneously dominant mode to the other mode. Presenting the Animals task a second time at the end of the testing sessions, and trying to induce the opposite encoding through the set up of the task and the language used for instructions, is an indication of the flexibility with which switching modes is possible. As in the previous research (Wassmann & Dasen, 1996), change was defined as a move from 4 or 5 A encoding to 2 or less, or from 3 to 1 or 0 (and the same for R encoding). The results are presented in Table 6.

Table 6

Frequencies of Children Who Change or do not Change the Mode of Encoding When Incited to do

Age Groups	*Change R to A*	*No Change*	*Change A to R*	*Total*
6–8	4	40	4	48
9–11	2	46	1	49
12–14	3	42	2	47
	9	128	7	144

Overall, most children did not change from their initial mode of encoding, irrespective of the instructions, and contrary to what Wassmann and Dasen (1996) observed, there was no age trend. Another analysis revealed that neither did schooling have an impact on this variable.

Language and Encoding

To examine the relationship between language use and encoding on Nijmegen tasks, partial correlations were computed between the R–A gradients on Nijmegen tasks, and the average proportion of different language categories (see Table 7).

Table 7

Partial Correlations Coefficients between Three Categories of Language Use and Spatial Encoding on Three Tasks, Holding Age and Schooling Constant

	Egocentric	*Projective*	*Geocentric*
Animals	0.03	−0.10	0.07
Chips	−0.25***	−0.14	0.31***
Steve's Maze	−0.08	0.14	0.05

Notes: *p* values: ** < 0.01; *** < 0.001.

The analysis revealed that there was no significant relationship between language and encoding on the Animals task and Steve's Maze. The only significant relationships were seen on the Chips task, positive, as expected, between geocentric language and A encoding, and negative with egocentric language.

While this finding pointed towards linguistic relativism, the link was rather weak, as it was task specific. Other indications contradicted the hypothesis of linguistic relativism. For example, an examination of the three spatial encoding tasks, and the language actually used to explain the behaviour on items 4 and 5, led to the results presented in Table 8 (some items were omitted, such as when a distractor was chosen, or when the explanation referred to shape, as was often the case on Steve's Maze).

As expected, an A encoding was usually explained by geocentric language, except in 15% of the items when egocentric language was used. Interestingly, R encoding was explained by egocentric language in less than one-third of the cases, and more often by geocentric language, the culturally more dominant scheme in this context.

Table 8

Language Used to Explain the Behaviour (A and R Encoding) on Items 4 and 5 of the Three Spatial Encoding Tasks Combined (Proportions)

	Language			Number
Encoding	*Egocentric*	*Projective*	*Geocentric*	*of Items*
G	0.15	0.23	0.62	512
E	0.30	0.18	0.52	216

Cognitive Tasks

The performance on Piagetian tasks (Horizontality, Perspectives, Rotation of Landscapes) and on the Route Memory task significantly correlated with each other, even when age and schooling were partialled out, to the order of 0.17 to 0.33 (except for Perspectives that showed no correlations in any analyses). The tasks also correlated with age, as expected with developmental tasks (0.25 to 0.34 when partialling for schooling), and with schooling (0.20 to 0.22 when partialling for age), but no gender differences were found. Except for the Perspectives task (on which the forced choice among pictures could have led to problems in understanding the task), the Piagetian and Route Memory tasks provided an adequate assessment of spatial cognitive development of a wider range than the Nijmegen spatial encoding tasks.

In order to examine whether spatial language use was related to children's performance on these cognitive tasks, partial correlations (controlling for age and schooling) between various language and cognitive performance measures were computed. Analyses revealed that the use of cardinal directions (N) was correlated in a statistically significant way with performance on Horizontality (0.35), Recall of objects and Accuracy of spatial positions of objects on a route (respectively 0.18 and 0.23), and Rotation of Landscapes (0.15). This analysis substantiated the previous findings (Niraula & Mishra, 2001) that children who used predominantly cardinal directions performed better on cognitive tasks.

The partial correlations (controlling for age and schooling) between R–A gradients on the spatial encoding tasks and the cognitive tasks were in general not significant, except for the correlation between Animals and Reverse Route Memory (0.20, $p < 0.017$), and Chips and Horizontality (0.17, $p < 0.047$). It was concluded that there was little relationship between the type of encoding and wider spatial concept development.

Discussion

These findings demonstrated the effect of ecological features on the use of spatial language by Nepalese children. As mentioned earlier, the terrain consists of such features as mountains, hills and slopes, and living in this terrain involves routine up and down movements. Consistent with this feature, the main orientation system is based on the Up/Down contrast, that does not represent precise directions, but two sectors of 180°. Spatial localisation is, therefore, complemented by the use of salient landmarks (such as houses, temples, hospital, or water sources), or situationally specific landmarks within a room. Older schooled children also used cardinal directions, but this system was not as pervasive as it is in rural India (Mishra, Dasen & Niraula, 2003). While right and left exist in the Nepali and Newari languages, they are hardly ever used to localise objects or in route descriptions.

Overall, the spatial orientation system, and the language used to describe space, were overwhelmingly of the "geocentric" rather than "egocentric" type. Up/down clearly emerged as a geocentric reference, and the use of landmarks, while having projective properties, also referred to directions that were distant from the micro space used in the displays and tasks of the study. Does this cultural and linguistic feature influence the way in which spatial arrays are encoded?

The Animals task induced, as it did in Bali (Wassmann & Dasen, 1998), a predominantly geocentric encoding. As the display consists of three discrete objects, each of which is oriented, the overall pattern is easy to encode in linguistic terms ("They all look Up there"). On the Chips task, the majority of the encoding is also A. Although the objects are discrete, they are not oriented; it is the spatial relationship between the square and the circle that defines the orientation. A linguistic encoding is quite likely on this task as well ("The blue square is Up, the red circle is Down"). However, when confronted with the selection of four such cards set out in a cross pattern, the visual image is likely to predominate, which may explain why A encoding is somewhat less frequent on this task. The visual pattern is even more compelling on Steve's Maze. Here, encoding the path linguistically entails a rather complex route description, while remembering a shape or a pattern of movement (as seen in the case of some children who actually moved their finger or hand) seems to be an easier option (and is more likely to be related to the body).

The overall conclusion on the basis of these findings was that spatial encoding was *task specific*. Despite the overwhelming cultural and linguistic geocentric frame of reference, encoding can be R if the task triggers a visual rather than a linguistic mode. This finding is, of course, not new; the same phenomenon was seen in the study in Bali by Wassmann and Dasen (1998).

On the other hand, changing the instructions and trying to entice children to use the opposite mode of coding from the one they used spontaneously, had very little effect. In Bali (Wassmann & Dasen, 1996), 7–9-year-olds also showed no change on the Animals task when it was repeated in this way, while about half of the 11–15-year-olds and adults did switch (mainly from A to R). Our hypothesis was that schooling and acculturation may be influential in fostering this flexibility. The results presented here did not confirm this hypothesis for Nepalese children: neither age nor schooling had an effect.

An examination of the data at the individual rather than at the group level revealed that the relationship between language use and the frame of encoding was less than perfect; children may encode a situation with a relative frame, but when asked to explain how they did it, they used geocentric language—which could easily be understood in terms of the dominant geocentric adult norm—but also the reverse, i.e., used an absolute mode of encoding explained with egocentric language, a more puzzling (but also less frequent) combination. That individuals say something but do something else, is a common problem in psychology when one deals with attitudes and values, but seems to be equally true in the cognitive domain.

Previous research by the CARG team had examined the relationship between language and spatial encoding only at the group level. A linguistic analysis revealed that in many of the societies studied by the team, a geocentric orientation system existed accompanied by a predominance of geocentric language, and a strong trend towards A encoding. Hence, this pointed to a strong confirmation of linguistic relativism. In this study, we recorded the language used by each individual. This allowed us to correlate: (*a*) the language used by each individual with his or her encoding on each of the three Nijmegen tasks; and (*b*) the particular language used on specific items in relation to the encoding on the same items. On the basis of such an analysis at the individual level, the correspondence between language and encoding was far less impressive.

Unfortunately, there is virtually no western developmental data on the spatial encoding tasks (Nijmegen tasks). Levinson (2003) tested Dutch-speaking adults, and found that their encoding was systematically relative. Li and Gleitman (2002) used the tasks with college students, and observed some absolute encoding under specific conditions, such as testing outdoors. However, Levinson, Kita, Haun, and Rasch (2002) argued that these encodings were probably intrinsic rather than absolute. To our knowledge, only Troadec, Martinot, and Cottereau-Reiss's (2002) study included a sample of French children, but they chose to modify the instructions, and used egocentric language with one sample, and geocentric language with another. Young children followed the frame of reference suggested by the instructions, while older children gave a systematically relative encoding. Besides studies using these specific Nijmegen tasks, there is a substantive body of literature on western children's spatial communication, reviewed by Newcombe and Huttenlocher (2000). All the data suggested that children and adults used exclusively intrinsic and relative frames of reference. It could be expected that older children and adults may use a geocentric frame in some situations, such as in American cities laid out in a grid according to cardinal directions, or in very flat areas such as the Netherlands (Poortinga, personal communication), but to our knowledge this has not been documented by empirical research.

Wassmann and Dasen (1998) reported a very different pattern in Bali. They found more geocentric encoding on the Animals task than on Steve's Maze (the Chips task was not used), and A encoding was found to be quite systematic in the 4–7 years age group. The orientation system in Bali was based on a main "Up/Down" direction (towards the mountain/towards the sea) as in Nepal, but it was quite different in many other respects. For example, in Bali, the direction changed as one turned around a central mountain, while in Nepal, "Up" and "Down" represented stable sectors. Also, language use in Nepal was more varied than in Bali, where situationally specific landmarks and conventional landmarks were not used. In both places, however, even very young children almost never used right and left, and at ages 6–8, the geocentric reference was already predominant and it remained the main one throughout.

Despite similarities in the orientation systems and in language development, the results obtained from Nepal on the spatial encoding tasks differed from those seen in Bali, at least for the Animals task, since there was an increase with age in the R–A gradient, not a decrease, as was the case in Bali.

Another interesting discrepancy with findings of other studies was in terms of language used to describe the display in the Perspectives task. Levinson (2003) argued that people who used geocentric spatial language should describe a display in the same way independently of their position. In this study, children were asked to move around the display, and to describe the objects from three different positions. For example, from position 1, a child could describe the display as "They are all Up" (a kind of edge based response). When moving to the other side of the display (position 2), the same process could produce a different description such as "They are all Down". However, in the Nepalese sample, children who gave such systematic answers were rare. What most children did (74% in position 1, 66% in position 2) was to split the display midline, saying, for example, "These two are Up, that one is Down". It was expected that this would produce the same description from the other side, but that was often not the case. Most often, children used another midline split, and said, for example, "This one is Up, the other two are towards the temple". Some also tended to shift from the midline to the edge, or gave a mixed response (involving both edge and midline positions).

The findings on cognitive tasks are similar to those reported in other studies with Nepalese children (Niraula, 1998; Niraula & Mishra, 2001). Rural and urban Newar children (in the age group of 11–12 years) of the Kathmandu valley demonstrated greater NSEW (N) encoding of stimuli presented in a spatial layout than younger children. This encoding was positively correlated with the memory of objects and their spatial position along the path, as well as performance on Sinha's (1984) Story-Pictorial Embedded Figures Test.

Conclusions

At the group level, the correspondence between the predominant geocentric orientation system present in the culture, the predominant language use and trend in language acquisition, and the mainly geocentric encoding of spatial arrays on at least some of the tasks confirmed the hypothesis of linguistic relativity. However, this was not the case when the data were examined in greater detail at the individual level, and when differential task demands were taken into account. The general conclusion therefore favoured a weak form of linguistic relativism. We agreed with Levinson (2003, p. 214), who distinguished three levels of linguistic determinism: (*a*) constructivism (language introduces coordinate systems unavailable otherwise); (*b*) activation (language favours and exercises one or another system); and (*c*) partial constructivism (language selects among incipiently available systems). He concluded that strong constructivism was not supported by the data, and that the third interpretation was most likely to be the correct one.

Levinson (2003, p. 313) further concluded:

> To sum up, the acquisition data suggests that none of the three frames of reference comes ready-made as a 'natural' conceptual system. Instead, the evidence is that they take time to build, with the earliest frames of reference mastered by about age four. In European languages this earliest frame is the intrinsic system, but in Tzeltal or Tzotzil [two groups in Mexico studied by the CARG team] it is the absolute system. In general, it seems to be that the relative system is the last system fully acquired, and it is clear that this is because of difficulties with the transverse, 'left' and 'right' distinctions.

In Nepal, the earliest frame is also the intrinsic system, but is rapidly superseded by the geocentric (absolute) frame, with the relative frame not assuming much importance in everyday language use nor in spatial encoding, except in some task specific circumstances.

The question arises how these aspects of spatial language and cognitive development would take place in children who are bilingual—with knowledge of a European language, such as English, favouring the relative system, and a language such as Nepali or Newari that favours the geocentric system. We expect to examine this question in our next research project in Nepal.

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