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Spatial Language and Cognitive Development in India: An Urban/Rural Comparison[1]

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Introduction

Within the general framework of cross-cultural research on human development (Berry, Dasen, & Saraswathi, 1997; Trommsdorff, 1993, 1995), this chapter reports on a study of spatial orientation systems in different cultures, the language people use to describe the location of objects in space, how they encode these in memory, and the relationships of these features to cognitive development. An interdisciplinary approach draws on the fields of anthropology, psycholinguistics, and cross-cultural cognitive developmental psychology. We report findings with 4- to 14-year-old children in India ($N = 369$), with a particular focus on the comparison between an urban and a rural group. The field sites were selected taking into consideration how reference to spatial locations is organized in the language as well as in the local cultural practices. In a village in the Ganges plains of India, a geocentric spatial localization system is used mainly with reference to cardinal directions, while in the city of Varanasi, relative references (right/left) are additionally used, although the same language (Hindi) is spoken in both locations. This allows us to test the relationships between ecology, culture, and language, and the encoding of spatial infor-

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mation and performance on some Piagetian spatial tasks, while taking age and schooling into account. The findings support a moderate form of linguistic relativism at the group but not at the individual level.

Theoretical Background

Piaget and Inhelder (1948/1956), and other western developmental psychologists have found that children first build up spatial concepts in relation to their own body, both at the sensori-motor level of action and at the later representational level. Piaget and Inhelder's theory also establishes the developmental sequence of topological, projective, and Euclidean spatial concepts, that has gained wide acceptance in developmental psychology and in linguistics. More recent cognitive development theories use the same typology with different words. For example, Taylor and Tversky (1996) state that theorists of spatial language have distinguished three kinds of reference frames: intrinsic or object-centered, deictic or viewer-centered, and extrinsic or environment-centered. Although there is some controversy about the best terminology, these three frames also correspond, in linguistics, to Levinson's (1996) distinction between relative, intrinsic, and absolute (or extrinsic) frames. Within an intrinsic frame, locations are described in relation to an object's front, back, or sides, and depend on the agreement on the intrinsic orientation of the reference object. In the relative frame, the locations of objects are described in relation to an individual's left, right, front, and back (LRFB); they are viewer-centered and require knowledge of the viewer's orientation. In the absolute or extrinsic frame, objects are located according to a co-ordinate system that is external to the scene, i.e., geocentric. The correspondence between these three schemes is presented in Table 1.

One problem with the area of spatial concept development is that it has almost completely relied on research with western samples. Would the sequence of stages hold up in research in other cultures? Could it be that the very centering on the individual's construction of space on the basis of his or her own body is a bias, due to western individualism (Kagıtçibasi, 1997; Wassmann, 1994)?

Table 1
Comparison between Three Typologies of Spatial Frames of Reference in Cognitive Development and in Linguistics

	Object-centered	Viewer-centered	Environment-centered
Piaget and Inhelder (1948/1956)	Topological	Projective	Euclidean
Taylor and Tversky (1996)	Intrinsic	Deictic	Extrinsic
Levinson (1996)	Intrinsic	Relative, egocentric	Absolute, geocentric

While there is some cross-cultural research on spatial cognition, most of it is not directly relevant to our issue. The situation can perhaps best be described as a contrast between the emic and etic approaches (Segall, Dasen, Berry, & Poortinga, 1999). On the emic side, there are a large number of anthropological descriptions of how space is organized in different cultures, yet few say anything about developmental aspects. For example, the very interesting studies on traditional navigational systems (Gladwin, 1970; Hutchins, 1983; Lewis, 1980) that demonstrate culture-specific, extremely complex and abstract thinking, fail to describe the precise cognitive processes that are involved, and are not developmental. On the etic side is the cross-cultural replication of Piaget's theory, using classical "Piagetian" tasks (Dasen & Heron, 1981; Dasen, 1998b). While systematic cultural differences were found in the rates of cognitive development that could be related to eco-cultural factors, there is no indication from this body of research that there could be any reversals in the sequence of stages, nor indeed any culture-specific cognitive processes (Dasen, 1993; Mishra, 1997, 2001). The only hint at a possible reversal of stages in spatial concept development between projective and Euclidean space comes from a study in Bali, to be reviewed presently.

Spatial orientation in Bali

Following previous efforts to combine the methods of anthropology and psychology in fieldwork in Papua-New Guinea (Wassmann & Dasen, 1994a, 1994b), Wassmann and Dasen (1998) studied the Balinese orientation system, this being an essential aspect of Balinese culture. Orientation is based on a geocentric system of two orthogonal axes, somewhat like cardinal directions, except that the main axis is geared to the island's central volcano, the dwelling place of the Hindu gods of Bali; *kaja*, "towards the mountain," is the sacred and pure direction, opposed to *kelod*, "towards the sea." The *kaja-kelod* axis cannot be translated as north-south, because its orientation changes as one proceeds around the island. Similarly, the orthogonal axis *kangin-kauh* corresponds to East and West, or sunrise and sunset, only in the south of Bali. In order to document the use of spatial terms in Balinese, Wassmann and Dasen (1998) carried out an ethnographic and linguistic survey, examining in detail how the inhabitants of various sites on the Eastern peninsula of Bali use the system. They discovered quite some complexity in the local adaptations of the system. This type of topography-dependent geocentric orientation system can also be found in other languages of South-East Asia and Oceania (Barnes, 1993; Ozanne-Rivierre, 1987; Senft, 1997, 2001).

The entire Balinese cosmology is related to this orientation system: from the representation of the human body to the whole of the universe, from the architecture of temples and villages to the social structure. Children learn the use of the orientation system very early in life, although they also learn the ritually important distinction between the left and the right hand. However, left and right are only applied to the body and to objects in contact with the body; all other objects are located with the geocentric orientation system. In other words, while in European languages, a geocentric system (cardinal directions) is applied only to the macro-space (e.g., for maps, for the outline of some cities), in Bali a geocentric system is also applied to the micro-space, i.e., for the localization of objects on a table or in a room.

In previous research, Wassmann and Dasen (1994a, 1994b) had shown how the linguistic and ethnographic parts of the research are absolutely essential before turning to the use of "induced situations" such as psychological tasks. In Bali, Wassmann and Dasen (1996, 1998) used two spatial encoding tasks based on a simple paradigm developed by the Cognitive Anthropology Research Group (CARG) at the Max Planck Institute for Psycholinguistics in Nijmegen, The Netherlands (Levinson, 1997, 2003). Let us suppose, for example, that three toy animals, aligned and all looking to the left are presented on a table in front of you. You are asked to remember this display, then turn around by 180°, and then place the animals in the same way as they were on the first table. If you orient them to the left, you have used an egocentric (relative) encoding, related to your own body. But, if you are encoding space in the geocentric way, you will orient the animals to the right, keeping the same absolute direction.

This simple task called "Animals in a Row," along with another similar task ("Steve's Mazes," to be described later in the method section), was used with 26 Balinese children aged 4 to 15 years, and 12 adults. In the Animals task, most subjects systematically showed absolute (geocentric) reactions similar to those obtained with the Tzeltal of Tenejapa in Mexico, and contrary to those of a sample of Dutch adults who almost exclusively used relative encoding (Brown & Levinson, 1993, 2000). In Steve's Mazes, Balinese informants made both geocentric and egocentric (relative) choices. This showed that the Balinese could use two coding systems, but clearly prefer the geocentric (absolute) system. In the Balinese language, the system of geocentric spatial reference is so strong that it determines not only the manner of speaking, but is also a mode of spatial representation and its commitment to memory. The results support a moderate form of linguistic relativity: while the very young children (4 to 7 years) almost exclusively used the absolute system in their language and in their way of memorizing a spatial device, there seems to be a developmental change towards relative solutions. This age trend is in contradiction with the developmental theories of Piaget and Inhelder, and others. It was therefore essential to continue the research in similar cultural and linguistic contexts using other spatial development tasks, in order to determine if we will really find a reversal of the developmental sequence described for western children.

The research in Bali, based on a very small sample, can be considered as a pilot study that requires replication. What is needed is a study with larger samples, and other tasks assessing not only spatial encoding but also spatial concept development. Also, having been unable to include a sample of unschooled children, Wassmann and Dasen (1996, 1998) were not in a position to separate the confounded factors of schooling and age. Schooling in Bali takes place in Indonesian, which is akin to European languages in its use of relative terms. Hence, we do not know whether the trend from absolute to relative encoding is linked to age or to schooling or, more generally, to acculturation.

While a replication study in Bali is also being undertaken, the present research program in India is geared to answer some of the questions raised by this pilot study in Bali, with much larger samples and better controls over the language spoken and schooling.

Linguistic relativism

Basic cognitive processes have been found to be universal (Segall et al., 1999; Dasen, 1993; Mishra, 1997), and languages themselves have been shown to conform to many universal principles (Holenstein, 1993), though recent research in language acquisition has tended to emphasize differences as well as similarities across languages (Mohanty & Perregaux, 1997). Speakers of European languages are used to egocentric encoding. Other forms of encoding will appear peculiar or even impossible to them. So much, so that in developmental psychology, cognitive sciences and even European philosophical traditions, the conception of space was considered to necessarily emanate from one's own body, standing in an upright position and looking straight ahead; in the so called "canonical position" (Clark, 1973, p. 34). The egocentric conception of space was also considered universal, because it was "more natural and primitive" (Miller & Johnson-Laird, 1976, p. 34). However, there are growing doubts about these basic assumptions as they may well be ethnocentric (Wassmann, 1994).

Does language constrain the way one thinks? In the middle of last century, Whorf's theory of linguistic relativism enjoyed prominence. But in more recent times the answer to this question has become an emphatic "no." Berry, Poortinga, Segall and Dasen (1992/2002) summarized the empirical data in the following fashion: "In general, we can conclude that there is at best limited support for the linguistic relativity hypothesis at the lexical level, but the last word has probably not been spoken on this issue" (p. 105). The issue of linguistic relativity has been revived by Lucy (1992), and by Levinson and his CARG colleagues (Brown & Levinson, 1993, 2000; Gumperz & Levinson, 1996; Levinson, 1996, 2003). The present research is designed to contribute to this topic, with the particularity of observing language and cognition also at the individual rather than only at the group level.

If one has to describe the position of an object or person with respect to another, we accomplish this in English by utilizing the projective notions of right and left, in reference to the speaker's body. For example: "Two men are standing before me side by side, the man on the right is holding a stick." A viewer taking up a position on the other side of the two men would say: "The man on the left is holding the stick." At first sight this seems obvious and natural, also because the linguistic encoding is congruent with the kind of information provided by the visual, auditory, and haptic senses. But it is not so. Some languages do not use the apparently fundamental, body-centered spatial notions of "left/right," "front/back." Instead they rely on fixed, environment-centered (also called geocentric) frames of reference, such as cardinal directions or related terms. For example, "the man on the West side is holding a stick." In this case, the description does not change with the viewer's change of position.

The question arises 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. Carrying out a study in languages that do not use the egocentric frame of reference, like Balinese or several languages in India and Nepal, will allow us to dissociate the two.

Pederson, Danziger, Levinson, Kita, Senft, and Wilkins (1998) have provided a typology of languages along these lines, distinguishing languages that use exclusively the intrinsic (e.g., Mayan), relative (e.g., Dutch, Japanese), or absolute (e.g., Australian Aboriginal languages; Tzeltal, a Mayan language from Chiapas in Mexico) frames of reference, as well as several mixed cases, such as the Dravidian and Tibeto-Burman languages (Pederson, 1993; Bickel, 1997). However, in several cases, including Balinese and the languages in locations used in our study, the absolute frame is dominant.

CARG members have carried out coordinated research in several locations, working on language acquisition in longitudinal studies with children (León, 1994, 1995), carefully documenting language use in everyday situations and in standardized situations called "space games" (e.g., Levinson, 1991; Ruiter & Wilkins, 1997; Wassmann, 1994, 1997), and by studying the impact of language on spatial encoding through a series of memory tasks (Danziger, 1993), some of which will be described below in more detail. We cannot do justice by any means in this brief review to all of the work carried out by this group (for a summary, see Levinson, 2003).

One study that is directly relevant to our project was carried out by Pederson (1993) in South India. The author provides an interesting classification of subtypes of the absolute, geocentric systems:

- North/south/east/west (NSEW); monsoonwards; towards sunset/sunrise; etc.;
- Uphill/downhill; inland/seaward;
- Conventional landmark, e.g., "towards the headman's house," used to designate distant direction (usually beyond the horizon);
- Situation based local landmark, e.g., "towards the door," used to designate direction in a limited universe of discourse.

Tamil speakers have both a geocentric system (NSEW) and a relative one (LRFB). While both exist in the language, in the rural areas of Tamil Nadu people tend to use the NSEW system and conventional landmarks, while in the urban areas the LRFB system is dominant, with an occasional reference to situation-based local landmarks. However, both groups of speakers have the ability to shift between absolute and relative terminology.

The research reported here is to answer the following research questions, concentrating each time on the urban/rural contrast:

1. What is the spatial language actually used by children of various ages in the two settings?
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 favor the development of Euclidean spatial concepts?

In the study described here, we take advantage of a similar situation in Northern India with Hindi speaking people: we compare two samples, a rural and an urban one, both speaking the same language, yet using (to some extent) different spatial orientation systems. This situation represents a challenge to any strong linguistic relativism theory, though it does allow us to test the hypothesis that those children who use a geocentric language more will also use more absolute encoding (and of course the reverse should hold true for those who use an egocentric language more). We also set out to test the hypothesis that using a more geocentric language and/or spatial encoding may foster spatial conceptual development, in particular of Euclidean space.

Empirical Study in India

In the present study in India, two locations in Uttar Pradesh were chosen because they clearly represent different eco-cultural settings, with spatial orientation systems (and their corresponding language use) adapted to the ecological contexts. We therefore place our research within the eco-cultural framework developed by Berry (e.g., Berry et al., 1992/2002) that has also guided much of our previous research (Dasen, 1998a; Mishra, Sinha, & Berry, 1996; Niraula, 1998; Niraula & Mishra, 2001). According to this framework, individual psychological characteristics are functionally linked to culture that is itself an adaptation to ecological and sociohistorical contexts. In other words, people develop preferentially those skills that are needed in a particular eco-cultural setting.

Sample description

The people in the city and the village chosen for the study speak the same language, Hindi, containing a rich vocabulary of directional terms. However, the use of these terms indicates a clear preference on the part of village people: they use cardinal directions (NSEW) in referring to objects and places in their environment, and when speaking of proximal space. Egocentric terms (LRFB) are very rarely used, and only to refer to objects that are either in contact with 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. Verbal interactions in the community also involve the use of conventional landmarks (e.g., headman's orchard, pond, road, Kali or Durga temple, mosque) known to all people of the village. Interactions with young children in restricted settings (e.g., in a room) may also involve reference to situation based local landmarks (e.g., door, wall, window, and chair), but people refer to various rooms by using cardinal directions (e.g., Eastern room, Northern room).

In the city of Varanasi[2], while the same language, Hindi, is spoken (with minor dialectical variations), and the same NSEW system may be used, it is frequent to use the LRFB system, both for route descriptions, and object localization. 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 tributaries on each side of the town provide some overall guidance, finding one's way in the city requires a close familiarity with it. Further work is needed to ascertain how children become familiar with these surroundings, and how they are induced to use either the NSEW or the LRFB systems.

Hinduism is the main belief system in both locations, conferring special attention to the four cardinal 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. Children attending Sanskrit schools even learn to distinguish eight cardinal directions with their attendant symbolism, however there were no such children in the present sample. The two samples correspond to the features summarized in Table 2.

Table 2
Characteristics of the Two Samples

Urban/rural contrast	Name	Ecological features	Language	Spatial orientation system used by adults
Rural	Roopchandpur	Flat Ganges plain	Hindi	NSEW
Urban	Varanasi	Old city	Hindi	Mixed (LRFB and NSEW)

[2] Varanasi is also called Banaras or Benares.

Table 3
Design and Number of Children in Each Sample

	India, village				India, city			
	No school		School		No school		School	
Age groups	girls	boys	girls	boys	girls	boys	girls	boys
4- 5	4	5	12	11			16	16
6- 8	16	14	10	13	12	13	13	12
9-11	12	13	13	16	12	12	12	12
12-14	12	11	14	15	12	12	12	12
Total	44	43	49	55	36	37	53	52

In each of the locations, we sampled children from age 4 to 14, boys and girls, schooled or completely unschooled, in about equal numbers. This led to a total number of 369 children. The groups of 4- to 5-year-old children were tested with a reduced range of tasks (Steve's Maze, Perspectives and Route memory tasks were not used). The details of the samples are presented in Table 3.

The present study will concentrate on developmental trends in the urban/rural comparison. The effects of schooling have been examined elsewhere (Mishra & Dasen, 2004), and there were no gender differences to speak of. The study reported here is part of a larger design (Mishra & Dasen, 2004) that also includes a sample in Nepal (Niraula, Mishra, & Dasen, in press).

Tasks

The tasks used in this study were divided into three main categories: Spatial encoding tasks, spatial cognitive development tasks, and language tasks.

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 experimenter does not hurry the child, allowing it enough time for each task.

Spatial encoding tasks

These are tasks initially devised by the Cognitive Anthropology Research Group (CARG) at the Max Planck Institute of Psycholinguistics in Nijmegen (Danziger, 1993; Levinson, 2003). Hence, they are referred to as the Nijmegen tasks. These tasks are basically non-verbal, and always start with extensive training to ensure the children's comprehension of the instructions.

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 and being rotated 180°, the child moves to another table approximately 5 meters away. Here it is asked to align another set of the same animals the way they were shown before. Five trials, with the animals oriented to the right or left, are given in the RLLRL sequence; this number of trials is a standard part of the procedures developed by the CARG group, except that they randomize the order of the five trials, which seemed to us unnecessary.

The encoding is deemed "absolute" or geocentric if the animals face in the same geographic direction on table 2 as on table 1, and "relative" 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 a geocentric or egocentric manner, instructions are imparted by using appropriate language to encourage an encoding just opposite to the previous one. To induce egocentric encoding, the table on which the animals are displayed is placed 30° of the main direction, so that a geocentric encoding is less obvious.

Chips. For this task, two-dimensional shapes (small or large, red or blue, and yellow or green, circles or 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 the 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), and is asked 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 a geocentric encoding, another an egocentric encoding, and two other cards function as "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 are given before moving on to the actual testing, which consists of 5 items.

Steve's Maze. This task comprises 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, thereby being shown the route that can be taken from the end of the drawn path back to the house. The child is asked to remember this route while moving (after a 180° rotation) to another table approximately 5 meters away where three cards are displayed showing three different path segments. One of these represents an egocentric encoding, another a geocentric solution, and the third acts as an irrelevant choice (called distractor). If the child points to one of these, she/he is asked to go back to table 1 and 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 consist of the proportion of items out of 5 on which the child uses a geocentric encoding, with D (choice of distractor) counting as ½; following the scheme worked out by Levinson and Nagy (1998), the scores are called R-A gradients. A higher gradient indicates a higher tendency towards geocentric encoding; a gradient below .50 indicates the predominance of egocentric encoding.

Spatial cognitive development tasks

These tasks are used to assess spatial concept development, and are mainly based on Piaget and Inhelder's (1948/1956) theory. Except for the 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, since these procedures were found to be difficult in cross-cultural research (Dasen, 1975).

Route Memory. This task was inspired by the previous work of Gauvain and Rogoff (1989) and Cottereau-Reiss (1999, 2001). 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 one circular turn (see Figure 1). 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, located in another room, the child is turned 180°, and then asked to tell how to go back to the starting point. The child is then asked to recall the objects that were placed along the route, and, based on what they remember, to arrange 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.

Rotation of Landscapes. This task was devised by Piaget and Inhelder (1948/1956) and standardized by Laurendeau and Pinard (1968/1970); we used a simplified version of the latter (only 5 items), as in previous research by Dasen (1975). 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 on a table in front of the child. Attention is drawn to different features in the landscape (e.g., house, river, bridge, hill, etc.) and their locations. 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, based on what they remember, puts the doll exactly at the same place and position in the other landscape. Five such

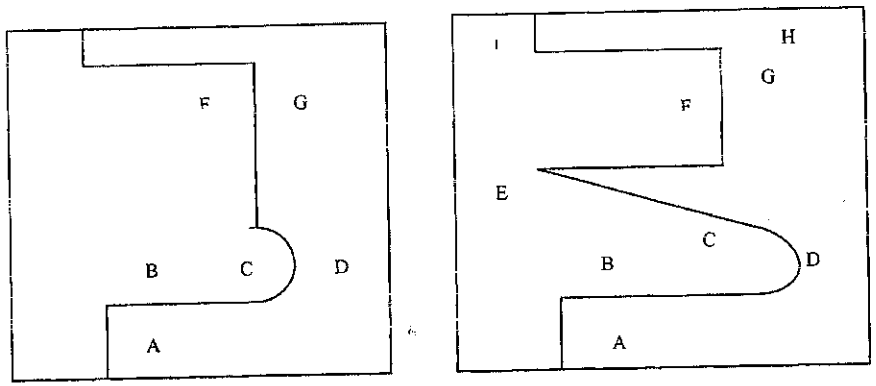

Figure 1: Reverse Route Memory Task (simple and complex). Note: Objects used: A: kettle; B: lamp; C: water jar; D: food carrier; E: pitcher; F: wok; G: bucket; H: chair; I: stool.

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.

Horizontality. This task was also devised by Piaget and Inhelder (1948/1956), and used among others by Dasen (1975). 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°. Each time the child draws the level of water in 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.

Perspectives task. This task was also inspired by the original work of Piaget and Inhelder (1948/1956), and its standardization 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 three different positions, and to choose among three pictures the one that represents what she/he sees. The child is then asked to stay at one position and describe the display from the point of view of the experimenter (E). As E moves to different positions – being either opposite to the child, to the right of the child, or at a diagonally opposite corner –, the child has to choose

from a set of three pictures the one that matches with E's view of the display. 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.

Language tasks

The following procedures were used at the beginning or at 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, along a pathway laid out on the ground, consisting of several segments (6 for children up to age 9, eight for older children) with right angle turns, set out along the main cardinal directions, one diagonal and one circular turn. All verbalizations of the child are tape recorded for later transcription. The path is the same one used for the Reverse route memory task, but without objects placed along the path. The route description is carried out before the cognitive part of the task.

Description of tabletop 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.

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 explain his or her choice, i.e., what she/he did to remember the display. The language used is recorded. This is a departure from the standardized form of these tasks (Danziger, 1993), in which no explanation is asked. This format, however, was also used by Wassmann and Dasen (1998) in Bali; only asking for an explanation in regard to the last two items of each task was thought to minimally interfere with the non-verbal aspect of the tasks.

Language coding scheme

The language produced on all three of these tasks was coded using a scheme adapted from Pederson (1993). This is shown in Table 4.

The terms are grouped into the three broad categories of 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

Table 4
Language Coding Scheme

E	**Egocentric**	
R	Relative	Right, left, in front, in back in relation to speaker
P	**Projective**	
SL	Situation-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**	
N	NSEW	Cardinal directions, north, south, east, west
O	**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)

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 distancing between situation specific landmarks, that are nearby and inside of the room, and conventional landmarks that are further and even quite far if they are localities outside of view.

The geocentric category is represented by the use of cardinal directions. Categorized separately, are the intrinsic (I) and deictic (D) references. The accompanying gestures of the deictic category are ambiguous in terms of encoding: Since a body movement is involved, it could be body-related, and could mean "to the right/left"; however the pointing could also be projective (towards a landmark) or even to a direction independently of the body. As will be seen in the next section, mainly very young children, from whom it is difficult to receive more precise verbal explanations, use D. The interpretation of D is therefore left for further 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 three tasks.

Results

Spatial language

Table 5 presents the change with age of the language used on the three language elicitation tasks, namely Route description, Perspectives and Items 4 and 5 of the Nijmegen tasks (2 tasks for 4- to 5-year-olds, 3 tasks for 6- to 14-year-olds). The developmental trends are highlighted in bold.

Table 5
Proportions of Modal Language Use on Combined Tasks, by Age Group

	Village							City					
Age	R	SL	CL	N	I	D	O	R	SL	CL	N	I	D
4- 5	**0**	27	0	0	0	70	3	**01**	**14**	0	0	3	**82**
6- 8	**3**	39	0	**37**	11	12	0	**18**	**29**	0	**25**	14	14
9-11	**1**	12	0	**73**	8	3	3	**28**	16	0	**40**	10	6
12-14	**8**	6	0	**76**	8	2	0	**55**	4	0	**30**	6	5

Note. R: Relative; SL: Situation-specific Landmarks; CL: Conventional Landmarks; N: Geocentric; I: Intrinsic; D: Deictic; O: Other.

In both samples, it is noticeable that the youngest children (4 to 5 years) predominantly use "this way" and "that way," usually accompanied by a gesture of a finger or the whole hand. The status of this category is inherently ambiguous in terms of absolute/relative encoding: it could be body related since a body movement is involved, and mean "to the right/left," but the movement may also point to a direction that is outside of the display. The latter interpretation is reinforced by the fact that in both samples in India, the very young children also use SL references (i.e., outside of the display, but within the room), a category that is still quite strong at age 6 to 8 years but then diminishes with age. Conventional landmarks (CL) were not used by any children[3].

The main difference in language use between the samples is that the city sample is the only one where a significant number of children use the Relative (R) references of right and left, and this increasingly with age. Geocentric language (N) use increases over age in both samples, and is the major category used in the village after the age of 9.

This distinctive pattern of language use makes sense in terms of the different ecologies. In the village situated in the Ganges plain, the terrain is completely flat, there are no major features such as mountains or hills, in fact, there are hardly any landmarks at all, except different fields or the occasional house or tree. In such ecological conditions, the use of NSEW based on the daily path of the sun (and reinforced by cultural and religious practices) is quite obviously adaptive.

What we find in the city of Varanasi is a mixed pattern: right/left being increasingly used with age as an alternative to geocentric references. The use of relative terms is no doubt linked to the topographical features of the city; it certainly makes more sense to turn left and right in a city, whether driving or walking, than in open

[3] The two groups of 32 4- to 5-year-old children were tested for language use on the Perspectives layout both inside a room and on the flat roof of a house. In each sample, 14 children used at least some SL when tested inside but no CL outside; 21 children in the city and 25 in the village used CL consistently. This contextual effect was statistically significant beyond the .01 level (chi-squared).

countryside. The reference to geocentric cues such as the sun is more likely to be obscured in narrow lanes, which, in Varanasi, are generally not organized in a grid pattern.

Spatial encoding ("Nijmegen") tasks

Table 6 shows the R-A gradients (proportion of "absolute," i.e., geocentric, encoding in 5 trials) over age in the two Indian samples and in the previous study in Bali. With the youngest children Steve's Maze was not used, and the Animals task was performed with two animals only. In Bali, the oldest age group consisted of two children in the age group of 12 to 14 years, and 12 adults.

It is immediately obvious that the three tasks differ consistently in absolute values, but reflect a similar developmental pattern in both Indian samples. On the Animals task most of the encoding is absolute (A), even among the youngest children, this proportion further increasing over age. On the Chips task a similar increase of A encoding with age is noticeable, but at a slightly lower level. If we had only used these two tasks, we might have concluded that there is an overall preference for Absolute encoding, with an age trend from more relative to more absolute. On Steve's Maze, however, there is almost no age trend, and, in fact, there is a slight predominance of Relative encoding.

In Bali, Wassmann and Dasen (1998) similarily found a marked difference between the two Nijmegen tasks used, with almost systematic Absolute encoding on Animals, and somewhat more Relative encoding on Steve's Maze. However, in Bali there seemed to be a trend from complete absolute encoding towards more relative encoding with increasing age and/or schooling; a trend that contradicts mainstream (western) theories of cognitive development. In the present study, this trend was not confirmed; both samples showed a trend opposite to that found in Bali, i.e., slightly more relative encoding in young children and then increasing absolute encoding. This trend however is not reflected in the modal language use, where relative language almost never occurs, except in the city of Varanasi (where it increases with age, while relative encoding decreases with age, in contradiction to the hypothesis of linguistic relativism).

Table 6
R-A Gradients on Spatial Encoding Tasks by Age Group

	India, village			India, city			Bali	
Age	Animals	Chips	Steve's Maze	Animals	Chips	Steve's Maze	Animals	Steve's Maze
4- 5	.73	.50	–	.55	.40	–	.96	–
6- 8	.80	.65	.41	.68	.46	.39	.80	.58
9-11	.90	.70	.51	.79	.51	.42	.73	.58
12-14	.94	.76	.47	.75	.53	.40	.86	.49

We are thus left with the question of whether the results in Bali could be replicated in Bali itself using a larger sample and more tasks, or in other island locations using a similar orientation system. Further developmental research of this kind is also needed in populations where LRFB are not used at all, as well as in those where it is the main reference system. Curiously, except for some small studies with French children (Cottereau-Reiss, personal communication; Troadec & Martinot, 2001), there has been little research carried out with children who speak a European language.

The fact that the instructions can influence the type of encoding was used by Wassmann and Dasen (1998) in Bali to assess the flexibility with which subjects could change from their spontaneous preferred mode to the other. They repeated the Animals and Steve's Maze tasks by changing the instructions, in particular explicitly using relative language for those who had first used geocentric encoding, and placing the table at 30° of the main orientation axis. They found that young children (7 to 9 years) would not change their mode despite prompting, while approximately 50% of the older children and adults would do so easily. In the present study, only 6% of the children in the village and 21% in Varanasi changed their encoding; there was no significant age trend, except that in both samples, among those children who did change, the younger ones (6 to 8 years) changed from relative to geocentric, and the older ones in the reverse direction.

How does the language predominantly used by each child correlate with encoding? In previous research by the CARG group, the correspondence between these two variables was only assessed at the group level, i.e., correlations based on the individual measures of the two variables were not used. In our study, such correlational data is available. Since both language and spatial encoding change with age and with schooling, these two variables were partialled out (see Table 7).

Table 7
Partial Correlations between Language and Encoding (R-A Gradients on Three Tasks) Controlling for Age and Schooling

	Relative (R)	Situation-specific Landmarks (SL)	Geocentric (N)	Intrinsic (I)	Deictic (D)
City (n = 142)					
Animals	-.18*				
Chips	-.23**				-.20*
Steve's Maze	-.18*	.17*		.17*	
Village (n = 154)					
Animals		-.25**	.23**		
Chips		-.24**	.25**	-.19*	
Steve's Maze					

Note. Only statistically significant coefficients are reported: *p < .05, **p < .01 two-tailed.

The pattern of results is quite different in the two locations. In the city, children who use relative language consistently also use more relative encoding (negative correlations with R-A gradients on all three tasks). On the other hand, the expected positive correlations with geocentric language do not occur, while they do so in the village, at least in two tasks out of the three. Since relative language is almost never used in the village, the absence of significant correlations is not surprising. The use of situation-specific landmarks (SL) is negatively correlated with geocentric encoding on two tasks in the village, suggesting that the projective nature of SL is closer to egocentric rather than geocentric space, but this is speculative since it is not replicated in the city. Generally speaking, we can conclude that the correlation between the two variables is weak, much weaker than a strong hypothesis of linguistic relativity would have predicted.

Cognitive tasks
Is there a relationship between modal language use and cognitive performance? The results of correlations between these two domains are presented in Table 8. Since the cognitive developmental tasks evinced, in analyses reported elsewhere (Dasen, Mishra, & Niraula, 2003), significant correlations with age and schooling but not with gender, partial correlations are used, controlling for age and schooling.

The use of cardinal directions (N) is positively correlated to performance on most of the cognitive tasks, and is statistically significant with the simple path in both locations as well as the complex path in the village. The use of relative

Table 8
Partial Correlations, Controlling for Age and Schooling, between the Proportions of the Different Language Categories and Cognitive Tasks

	Horizontality	Perspectives	Rotation	Simple path	Complex path
City (n = 142)				n = 73	n = 113
R	.05	.19*	.08	.01	-.05
SL	-.17*	-.02	-.15	-.21	-.07
N	.13	-.15	.12	.25*	.14
I	-.09	.05	-.22**	-.17	-.11
D	-.19*	-.07	-.18*	-.04	-.16
Village (n = 154)				n = 84	n = 102
R	.11	.04	.13	-.01	-.10
SL	-.21**	-.10	-.19*	-.26*	-.20*
N	.13	.10	.13	.28**	.18*
I	.04	-.12	.00	-.24*	-.05
D	-.14	-.06	-.13	-.28**	-.31**

Note. R: Relative; SL: Situation-specific Landmarks; N: Geocentric; I: Intrinsic; D: Deictic.
*p < .05. **p < .01.

language (R) is not linked to cognitive performance, even in the city (with the exception of Perspectives. But this correlation is most likely spurious, as this task does not correlate with anything else). D, SL, and I tend to be negatively correlated with cognitive performance, particularly in the village sample. These language categories are, as we have seen, typical of younger children. However, in this case, since age was controlled, this finding suggests a developmental pattern in which children who are less advanced in spatial cognitive development (at any given age) also tend to use language typical of children younger than their age. On the other hand, there are no relationships between the encoding on the Nijmegen tasks and performance on cognitive tasks.

Discussion

In relation to the eco-cultural theoretical framework, we have found that the spatial orientation system, and the language that accompanies it, is adapted to the respective ecological conditions. In the flat plains of the Ganges, in rural areas where there is barely a hill and few obvious landmarks, using cardinal directions is the norm. The ecology of the city is more varied, and the processes involved will no doubt warrant a more detailed study; city-dwellers use either relative ("left/right") spatial references or geocentric ones, or a combination of both.

We do not claim that the physical environment is the single determinant for these orientation systems and the accompanying language; ethnology is quick to demonstrate cultural and linguistic diversity within the same ecological conditions. But we argue that it is not possible to distinguish language as a causal factor in relation to cognition, since it does not occur out of a more general cultural context that is itself adaptive to the ecological context. An orientation system based on cardinal directions, such as it occurs in rural India, is completely congruent with Hinduism, and the attached symbolism, as well as with daily routines and practices. The same, of course, is true in Bali (Wassmann & Dasen, 1998). In other words, language comes as a package with other cultural features. Determining which, of language, culture, and cognition, comes first is a chicken and egg problem that does not make much sense in solving.

Children learn the normative adult system and language progressively, and become competent in it by about the age of 9. Before that (in the age group of 6 to 8 years), they may attempt to use the adult system without being able to do so correctly (particularly in the case where cardinal directions have to be learned). They may also use situation based local landmarks (outside of the display, but inside the room) or, when testing is done outside, conventional landmarks. Even younger children (4 to 5 years) tend to say "this way/that way" (D), a fairly restricted linguistic code accompanied by gestures, and one that needs more detailed research, as it may obscure markedly different processes (egocentric and/or geocentric). Whatever the interpretation of D may be, the developmental path seems to be a gradual progression from projective references to immediate surroundings (SL) to an often incorrect use of the geocentric system, until the latter is fully mastered by about the age of 9. This occurs, however, without the use of relative language (R). The latter occurs only in the city, and only with older children.

When a simple spatial array has to be encoded (as in the spatial encoding tasks we used), most of the children do so in an "absolute" rather than a "relative" frame. This is congruent with the geocentric orientation system that is prevalent in both locations. While this finding seems to fit a hypothesis of linguistic relativism at the group level, there are limitations that argue against any strong form of such a hypothesis; e.g., the fact that the choice of spatial frame is partly task-specific.

Task specificity

Indeed, the results show more absolute encoding on Animals, also absolute but to a somewhat less degree on Chips, and more relative encoding on Steve's Maze. This shows that there is no overall linguistic determinant of a frame, but rather that the two frames coexist in every individual, with situational determinants as to which frame is preferentially used.

The fact that spatial tasks are very sensitive to small changes in the display or the instructions has been found repeatedly both in infancy (Acredolo, 1990) and at later ages. Cottereau-Reiss (1999) cites Hatwell (1990) in this respect: "Seemingly minor variations in the content or procedures that do not change the formal structure of the problem sometimes have important effects on behavior, and significantly change the proportion of responses classified as egocentric or exocentric at a given age" (p. 56, our translation). More specifically, the fact that the Animals task results in more absolute and Steve's Maze more relative encoding has been found repeatedly, in Bali (Wassmann & Dasen, 1998), in New Caledonia (Cottereau-Reiss, 1999, 2001), in Nepal (Niraula et al., in press), and in this study in India[4].

One feature explaining this systematic difference could be the ease linguistic encoding, of how many words or sentences are needed to describe the display in order to remember it verbally or iconic encoding can be applied given the subject material. On the Animals task, the display consists of three discrete objects, each of which is oriented, so the overall pattern is easy to encode in linguistic terms (e.g., "they all look East/to the right"). On the Chips task, although the objects are also discrete, they are not oriented; it is the spatial relationship between the two shapes that defines the orientation, and although a linguistic encoding is quite likely (e.g., "The small blue square is North, the big red one is South"), when confronted with a selection of four such cards set out in a pattern (cross), the visual image is likely to predominate. This may explain why relative encoding is more frequent here than with Animals. The visual pattern is of course even more striking on Steve's Maze, where encoding the path linguistically would entail a rather complex route description.

[4] But in the Trobriand Islands, Senft (2000) predominantly found geocentric encoding on four tasks, including Animals, Chips and Steve's Maze, while he found more relative encoding on a task we have not used, the Motion maze task.

Therefore, remembering a shape (or a pattern of movement, as shown by some children who actually move their finger or hand) is more likely and hence more prone to be related to the body.

It has been found repeatedly that the same task can produce quite different results depending on the details of the procedure. Cottereau-Reiss (1999), for example, had the Kanak children in New-Caledonia carry the animals themselves from the first to the second table; this form of the task produced much more relative encoding than the standard format. A recent controversy between Li and Gleitman (2002) and Levinson, Kita, Haun, and Rasch (2002) also illustrates this point. Li and Gleitman (2002) found markedly different results on the Animals task with American students depending on the availability of landmarks in the experimental setting, i.e., when the task was set inside a room with shutters closed, shutters open or outside on the campus, or when a reference object was placed on the table. Levinson et al. (2002) remark that an allocentric encoding is inherently ambiguous as to the frame of reference actually used, which can be either intrinsic or geocentric[5]. Levinson et al. (2002) also remark that a small change in the procedure, such as giving the subject only the three animals on the second table, or four animals out of which to choose the three relevant ones, can change the results considerably. Presumably this results from changing the memory load of the task, and/or attracting attention to the order of the animals rather than only their direction. Levinson et al. (2002) therefore advocate the use of several more complex encoding tasks, such as the Motion-maze task and the Transitivity task (cf. Danziger, 1993).

In a study in Tahiti and in France, in addition to using either the Animals or the Chips tasks, Troadec (Troadec & Martinot, 2001; Troadec, Martinot, & Cottereau-Reiss, 2002) also used different types of verbal induction, and found various effects of eco-cultural setting, age, gender, and task content. In Papeete, Tahiti, older children (10 to 11 years) were more prone to follow either a relative or an absolute induction from the instructions than were younger children (5 to 6 years). Wassmann and Dasen (1998) found a similar age effect in Bali, but this was not repeated in the study in India. In conclusion, the task specificity can be used for a finer analysis of the processes that are involved. Varying the tasks and the task instructions should be done systematically instead of relying on single measures.

Linguistic relativism

Looking at the data at the individual rather than at the group level, one finds that the relationship between language use and frame of encoding is certainly less than perfect; it was found that children may encode a situation with a relative frame, but when asked to explain how they did it, used absolute language, this being easily understood in terms of the dominant geocentric adult norm. However, the reverse was also found: i.e., they used absolute modes of encoding and explained it with

[5] Additional situations would have to be used to distinguish between the two, for example a 90° rotation, or using a two-dimensional array by placing a fourth animal at a right angle with the row of three animals.

relative language, a more puzzling (and also less frequent) combination. That individuals say one thing and yet do another is of course a common problem in psychology when dealing with attitudes and values, but it also holds true in the cognitive domain.

Previous research (such as Wassmann & Dasen, 1998, and by the CARG group) examined the relationship between language and spatial encoding only at the group level: A linguistic analysis shows that in many of the societies that have been studied, if an absolute orientation system exists in the culture it is accompanied by a predominance of absolute language and goes along with a strong trend towards absolute encoding. Hence, there is seemingly a strong confirmation of linguistic relativism. In this study, we have been able to record the language used by each individual, and to relate the dominant language use for each individual to his or her encoding, measured task by task. With such an analysis at the individual level, it can be observed that the correspondence between language and encoding, while not completely absent, is much less impressive.

Another important question was whether the use of geocentric orientation systems and absolute language would only have an impact on spatial encoding in situations (tasks) specifically geared to be sensitive to this feature, such as the tasks developed by the CARG group, or whether it would have an impact on spatial cognitive development at a more general level. Using a series of Piagetian tasks in the area of spatial concept development, we found no relationship between absolute or relative spatial encoding (on the Nijmegen tasks) and broader aspects of cognitive development. On the other hand, the data showed some correlations between modal language use and some of the cognitive development tasks, even when age and schooling are controlled; this is in line with previous research in Nepal by Niraula (Niraula, 1998; Niraula & Mishra, 2001).

Summary

To close, let us come back to our research questions and summarize the findings: The spatial language used by children changes with age in both rural and urban settings from more proximal (deictic and projective) to more distal (geocentric) reference usage, and the latter represents the normative language after age 9 in the village. While egocentric (relative) language is not at all used in the village, in the city its use increases with age.

Despite this increase in egocentric language in the city, the developmental trends in spatial encoding are similar in both locations, with an increase over age of the use of a geocentric frame of reference. Hence, the possible reversal found in previous research in Bali is not confirmed in these two locations in India, despite the existence of a strong geocentric orientation system. Only weak relationships were found between spatial language use and spatial encoding.

There are some significant relationships (controlling for age and schooling) between spatial language use and spatial concept development, but not between the latter and spatial encoding. However, these relationships are not sufficiently strong and systematic enough to conclude with certainty that using more geocentric language promotes spatial conceptual development in general, and Euclidean spatial concepts in particular.

We expect to continue our research by taking advantage of the ecological, cultural, and linguistic diversity in India and elsewhere in order to add more samples – always basing the selection on theoretical considerations – to this comparative research. We also need more data on language acquisition and comprehension at earlier ages, on possible links between the choice of different frames of spatial reference and cognitive style, as well as information as to neuropsychological bases in hemispheric dominance. As Trommsdorff's research has demonstrated throughout her career, in order to be fruitful, the cross-cultural study of human development needs a long-term commitment if we hope to capture the complexity of the interactions between eco-cultural, linguistic and other significant variables.

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