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Culture and cognition: language and spatial concept development. Theoretical background and overview of research on language and spatial concept development.

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Abstract

In a revived form of the linguistic relativity hypothesis, Levinson (2003) and other researchers in comparative cognitive linguistics have demonstrated that languages may use one or more of three frames of reference (FoR) to describe space: intrinsic, egocentric and geocentric. The dominant choice of frame in the language is shown to determine the non-linguistic modes of spatial encoding. European languages all use an egocentric FoR, while Balinese, Newari, Nepali, and Hindi are among the languages where a geocentric frame is predominant. The study examines how the choice of linguistic FoR and spatial encoding are linked to ecological, cultural, social and neuropsychological features. It takes the perspective of cross-cultural human development (Dasen, 2003; Dasen & Mishra, 2000).

The results of previous studies by our team in Bali, Nepal and India are summarized. They show that the particular form that the geocentric FoR takes (and the language to express it) is linked to spatial orientation systems, themselves congruent with ecology and cosmology. Our research assessed the impact of rural and urban residence and that of schooling.

This introduction to the symposium also presents the methodology that is common to all the studies, in particular the tasks used for language elicitation and for assessing spatial encoding.

Spatial frames of reference (FoR): Theoretical background

Developmental studies carried out in Western societies suggest that children first build up spatial concepts in relation to their own body, following the sequence of topological, projective and Euclidean space (Piaget & Inhelder, 1956). More recent theories of human development propose much the same scheme (e.g. Taylor & Tversky, 1996). This is illustrated in Table 1. The theory that spatial representation is basically built up from the point of view of the human body is still current (Grabowski, 1999; Taylor & Tversky, 1996; Werner & Hubel, 1999). While the ability to use geocentric landmarks varies with age depending on the experimental conditions, in the existing (Western) literature, it never occurs before the child has built up body-related spatial representations. Occasionally there is the suggestion that both of these abilities might develop together, and the choice of reference frame is very much situation dependent rather than a developmental feature, but there never seems to be any complete reversal from the sequence originally described by Piaget.

A major problem with the whole area of spatial concept development is that it has completely relied on research with Western samples (Mishra, 1997). Whether the same sequence of stages of development would hold up in other cultures is not much known. The very centration on the construction of space on the basis of the body could be a bias due to Western individualism.

Table 1 : Spatial frames of reference in developmental psychology and in linguistics.

Piaget & Inhelder, 1956	Topological	Projective	Euclidean
Taylor & Tversky, 1996	Intrinsic : object-centered	Deictic : viewer-centered	Extrinsic : environment-centered
Levinson, 1996, 2003	Intrinsic	Relative, egocentric	Absolute, geocentric

The distinction between these spatial concepts is akin to the distinction at the linguistic level between intrinsic or object-centered, deictic or viewer-centered (relative or egocentric) and extrinsic or environment-centered (absolute or geocentric) spatial terms. In an intrinsic frame, the location of objects is described one in relation to the others. In the relative frame, the description is in relation to a viewer's front, back, left, and right, i.e. it is viewer-centered, and requires knowledge of the viewer's position and orientation in space. In the absolute frame, objects are located according to a co-ordinate system that is external to the scene. Different language

communities preferentially use different reference frames (Levinson, 1996, 2003).

Cross-cultural studies of spatial cognition provide a contrast between the emic and etic approaches (Segall, Dasen, Berry, & Poortinga, 1999). On the emic side we find anthropological descriptions of how space is organized in different cultures (e.g., Gladwin, 1970; Hutchins, 1995; Pinxten, Van Dooren, & Harvey, 1983) that speak little about specific psychological processes and developmental aspects. On the (derived) etic side is the cross-cultural replication of Piaget's theory, using classical "Piagetian" tasks (Dasen, 1993). However, this research neither suggests any reversals in the sequence of stages, nor indeed any culturally specific cognitive processes. The possibility of different developmental pathways, and different developmental end stages, has been suggested (e.g. Greenfield, 1976, Troadec, 1999), but never convincingly demonstrated.

Linguistics and Linguistic Relativism

Does language determine the way one thinks? The issue of linguistic relativity has been revived recently (Gumperz & Levinson, 1996; Levinson, 2003). Cross-cultural research shows that only a weak form of linguistic relativism finds empirical support (Berry, Poortinga, Segall, & Dasen, 2002), and that basic cognitive processes are universal (Mishra, 1997; Segall, Dasen, Berry, & Poortinga, 1999).

It is widely assumed that the coding of spatial arrays for memory will be determined by general properties of visual perception, and that it is natural and thus, universal to conceptualise space from an egocentric or "relative" point of view. Research also indicates that speakers of European languages are used to egocentric encoding; other forms of encoding appear 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 growing doubts about these basic assumptions (Wassmann, 1994). If we have to describe the position of an object or person with respect to another, we achieve this in English by utilising the projective notions of right and left in reference to the body. Some languages do not use the body-centered spatial notions of right and left, front and back. Instead they use fixed, environment-centered or geocentric frames of reference. While in a relative frame, the description of an object or person changes depending on the speaker's body position, in the geocentric frame, the description does not necessarily change with the viewer's change of position.

Such a non-egocentric linguistic coding of a spatial array seems to be incongruent with the perceptual information in fundamental ways, 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 that use exclusively intrinsic or absolute or mixed frames of reference. It is possible to dissociate these influences by carrying out studies with speakers of these languages.

Co-ordinated research in several locations has been carried out by members of the Cognitive Anthropology Research Group (CARG) at the Max Planck Institute for Psycholinguistics, Nijmegen. Levinson (2003) summarizes all this research in a single volume.

Two studies by de León (1994, 1995) in Mexico and among Australian Aborigines show that the overall developmental trend in these two communities, where a geocentric FoR characterizes adult language, seems to go from the egocentric, intrinsic terms to locally geocentric, and in some cases to abstract geocentric terms. This seems to confirm the classical developmental trend even in populations that use an absolute, geocentric system only. However, since relative terms (left/right) are not used at all, the research cannot say much about the relationship between the relative and the geocentric systems. This shows that research is needed in locations where a relative system exists in the language, but is not the predominant one. De León's studies deal only with the development of language. From these, it cannot be directly concluded that cognitive development has to follow the same sequence. Further research is therefore needed, combining the study of spatial language development and the study of cognitive development, which is what we are doing in this project.

Kaja-Kelod: Our first study in Bali

While the CARG group consists mainly of linguists, they have associated other social scientists to their research, in particular anthropologists, and among them a cognitive anthropologist, Jürg Wassmann, who is himself interested in the collaboration between anthropologists and psychologists (Wassmann, 1995, 1997; Wassmann & Dasen, 1994a/b). Dasen joined Wassmann in Bali, Indonesia, in 1994 to study the Balinese orientation system and its importance in Balinese culture (Wassmann & Dasen, 1998). Orientation is geared to the island's central volcano, the dwelling place of the Hindu gods of Bali. Kaja (toward the mountain) is the sacred and pure direction, opposed to Kelod (towards the sea). The axis *kaja-kelod* is in effect a variable direction as one turns around the island. In principle, the axis *kangin-kauh* is orthogonal to it. The entire Balinese cosmology is related to this orientation system: from the human body to the whole 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 distinctions between the left and the right hand.

Wassmann and Dasen (1998) carried out a linguistic survey of the use of spatial terms in Balinese, and examined in detail how the inhabitants of various sites on the Eastern peninsula of Bali use the system, and documented the local adaptations of the system. They discovered 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 the geocentric orientation system.

While the Balinese could use two coding systems, the preference for the absolute system was clear. In the Balinese language, the system of geocentric orientation is so strong that it determines not only the manner of speaking, but also a mode of spatial representation and its commit-ment to memory. Children started with a 'geocentric' notion, which was represented in an 'up to the mountain – down to the sea' orientation to space. While the very young children (4-5 years) used exclusively the geocentric system in their language and in their way of memorising a spatial device, there seemed to be a developmental change towards relative encoding.

This study indicates that in some cultural and linguistic contexts, the sequence of acquisition of spatial knowledge could be reversed, and that different orientation systems and their linguistic encoding might have a significant impact on spatial cognitive development.

Studies in India and Nepal

The development of spatial orientation and its relationship with cognitive performance has been studied in the Indian and Nepalese cultural contexts also. Niraula and Mishra (2001) analysed the development of the spatial orientation system among the Newar children of Nepal, aged 5-12 years, and attending primary schools in the city of Kathmandu and neighbouring villages. They used a pictorial display, and asked children to explore various objects along a path, recall the objects and their spatial locations, and tell the spatial position of various objects relative to other objects depicted in the picture. An analysis was made of the language children at different age levels used to describe the spatial position of objects. The findings revealed that at age 5-6, children could not use geocentric terms (NSEW) to describe the position of objects, by age 8-9, almost 40 per cent of children used geocentric terms and by age 11-12, almost 85 per cent of children did so. There was no evidence of difference between boys and girls or rural and urban children in the use of these terms at different age levels.

An analysis of children's performance on cognitive tasks revealed that geocentric language use was positively correlated with the memory of objects, memory of spatial location of objects along the path, as well as performance on the Story-Pictorial Embedded Figures Test that measures the level of psychological differentiation. These measures generally appeared to be negatively correlated with the use of relative language (LRFB).

In a previous project of our team, we (Mishra, Dasen & Niraula, 2003) worked with 4-14 years old, schooled and unschooled village and city children in India, and mainly Newar mountain children in Nepal (Niraula, Mishra, & Dasen, in press). The impact of schooling was the focus of a paper by Dasen, Mishra and Niraula (2004) and the urban/rural comparison is presented in Mishra and Dasen (in press).

In all these locations we attempted to understand (1) the language that children use to describe space, and developmental changes in these; (2) absolute and relative encoding of spatial arrays following the paradigm developed by the CARG group; and (3) the relationship of language use with performance on spatial cognitive tasks.

One of the assumptions was that cultural features of the groups, including the spatial orientation system and the language that goes with it, will be adaptive to respective ecological settings. Thus, we predicted and found that in the mountains of Nepal, where the obvious feature of the terrain is the slope, people would refer to "up" and "down", and occasionally to local landmarks to describe objects in space. In a village in India, which was located in the flat plains of the Ganges characterized by a complete absence of hills and very few obvious landmarks, use of cardinal directions (NSEW) was the norm. In the city (Varanasi), that provides limited space and a highly congested setting for the organization of activities with narrow lanes requiring several left-right movements in walking, the use of relative (LRFB) terms was expected to predominate in language, and indeed the results showed that both systems were used.

Children's language use was studied with a Route Description Task, and the Piagetian Perspectives Task. "Animals in a Row", "Chips" and "Steve's Maze" tasks of the Nijmegen series were used for elicitation of language and the study of spatial encoding. These tasks are described below. Route Memory, Rotation of Landscapes, Horizontality and Perspectives Tasks were used for the assessment of spatial cognitive development. This research design had a definite advantage over those used in other studies. For example, we were able to record the language used by each child and to relate it to his or her encoding measured task by task. We were also able to examine the particular language used on particular items in relation to the encoding on the same items. In the previous research, the CARG team (and Wassmann & Dasen, 1998 as well) had examined the relationship between language and spatial encoding only at the group level. A linguistic analysis shows that in many societies that have been studied by that team, a geocentric orientation system exists in the culture, is accompanied by a predominance of geocentric language, and goes with a strong trend towards absolute encoding, providing a seemingly strong confirma-tion of linguistic relativism.

In terms of language use, the development trend showed a beginning from the use of "this way/that way" (deictic, often accompanied by gestures or hand movement), through situationally specific landmarks inside of the room and conventional landmarks further removed, to the clearly geocentric ones (i.e. Up/Down in Nepal or the cardinal directions, NSEW). The results seem to indicate that the children use references outside of the display starting at a very early age, but that there is a developmental trend from the use of more concrete landmarks to more abstract dimensions of space.

The analysis of the encoding of simple spatial arrays revealed that the children in the plains of India and mountains of Nepal generally do it in an absolute rather than "relative" frame, which is congruent with the geocentric orientation systems that are prevalent in these locations. On the other hand, there was also evidence for "task specificity" in spatial encoding. More "absolute" encoding was observed if the task could be easily coded in linguistic terms (e.g., Animals), whereas more relative encoding was evident if the task was more difficult to encode linguistically and easier to encode iconically (e.g., Steve's Maze). The results are illustrated in Figure 1. While in Bali (in 1994) all of the 4 and 5 year old children used an absolute encoding, followed by a slight decrease until age 10-11 years, there is an opposite trend of a steady increase in the proportion of items with an absolute encoding in all of the samples in India and Nepal. Given the failure to find the same results in India and Nepal as in Bali, one of the first questions that arises is whether the Balinese data were reliable and could be replicated in Bali itself.

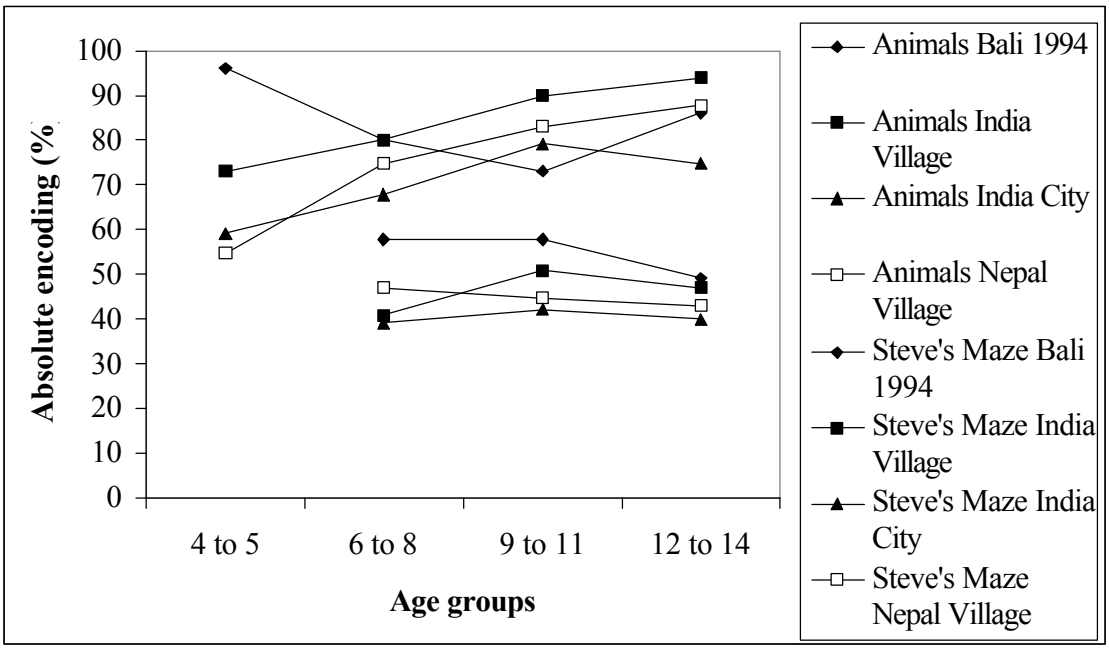

Figure 1 : Results of previous studies (Bali 1994, India, Nepal), absolute encoding for Animals task (3 animals only) and Steve's Maze. (For the Bali 1994, age group 13 includes 12-14 year olds and adults.)

Does the geocentric and egocentric language use, and an absolute or relative encoding have any relationship with the cognitive performance of children? This question was addressed by analysing the relationships of modal language and encoding with performance on a series of Piagetian tasks that assess spatial cognitive development at a more general level. The findings revealed no relationship between absolute or relative spatial encoding and broader aspects of cognitive development. On the other hand, the data did show some correlation between geocentric language use and some of the cognitive development tasks, even when the effect of age and schooling were partialled out. The overall developmental trend indicated slightly more relative encoding in young children, which was replaced by absolute encoding in older children. This trend, however, was not reflected in the modal language used. Children almost never used relative language, except in the city, where it increased with age, while relative encoding decreased with age. This presents another contradiction to the linguistic relativity hypothesis.

Compared to previous research on spatial orientation, our studies in India and Nepal add several features that were not evident in earlier research:

- Developmental data are systematically collected (whereas most previous research was carried out only with adults);
- Data on several spatial encoding tasks are obtained with the same subjects, and various formats of task instructions are being tried out, showing that spatial encoding is task dependent;
- Language production data is obtained with the same individuals as data on spatial encoding, so that the relationship between the two can be tested at the individual rather than only at the group level;
- Our study in India and Nepal includes other spatial concept development tasks, allowing to study the generalisation to the larger domain of spatial cognition.

Cross-cultural psychology as a method is using cultural diversity as a "natural laboratory". When working in one single cultural context (such as is typical of mainstream Western developmental psychology), several variables of interest are often confounded (such as ontogenetic development and schooling, as mentioned above). Using carefully selected samples allows to "unconfound" these variables (Segall et al., 1999). The Indian subcontinent, while sharing the same macro-culture, is so diverse in terms of ecological settings, cultural practices and languages spoken that it allows for perfect cross-cultural research conditions.

While these previous studies answered some questions, many more emerged. We therefore designed a new, still ongoing, multi-site, partly intra-cultural and partly comparative study, the first results of which are presented in this symposium. A summary of the various locations is presented here, and the tasks used in every location are presented. Additional tasks specific to some projects and sample characteristics will be presented in each individual paper.

Research design

Locations

The research is carried out in several locations in India and Nepal, the island of Bali in Indonesia and in Geneva, Switzerland. The research design involves choosing several locations on the main criterion of the prevalence of an egocentric or a geocentric orientation system in language use.

Bali (Indonesia).
In our previous study in India and Nepal, despite the geocentric language used predominantly by children and adults alike, the developmental trend of spatial encoding was found to be from relative to absolute, contrary to what we had found in Bali, where it seemed to be from absolute to relative. It was therefore very important for us to establish whether the Balinese results can be replicated with a larger sample.

Varanasi (India).
As we have established in our previous project, children in Varanasi use a mixed frame of reference. However, some city children use predominantly geocentric language and some predominantly relative language. This is of interest for our study, since we will be able to compare these two sub-groups. In Varanasi, we also compare pupils from a Hindi-medium school to students in Sanskrit schools.

Geneva (Switzerland) : French speaking and bilingual children.
The predominant use of relative terms is characteristic of European languages, such as French, English and Dutch. In Europe, the spatial encoding tasks have been used only with Dutch adults (Brown & Levinson, 1993; Levinson, 2003), and developmental data with a European language is still needed for our study (but see Troadec & Martinot, 2001, for some data on French children). The techniques adapted in India in our previous study need to be used in the same format for cross-cultural comparisons as well as for linking the study to mainstream developmental psychology. In Geneva, monolingual French speaking children are included as well as bilingual children (43% of the pupils in Geneva schools have a language other than French as their first language, usually another European language).

Kathmandu (Nepal) : Monolingual (Nepali) and bilingual (English/Nepali) children.
Nepali children who are fully educated in English (although they are always bilingual with Nepali), attending English medium schools, could be expected to use a relative frame. These are compared to monolingual children in Nepali-medium schools.

Panditpur near Gorakhpur (India) : Village sample using relative language.
The possibility seems to exist to find rural samples in India characterised by the predominant use of relative language. This would provide a challenge to the ecological hypothesis supported in our previous research. In our study, this is attempted in a village near Gorakhpur, but results are not reported in this symposium.

Tasks

The tasks that are used in all parts of our research are described below, while other tasks specific to various parts are described in the separate contributions.

Language production (elicitation)
We record the spontaneous language used in three different situations, the first one involving movement through space, and the two others static displays. When egocentric or geocentric locators are produced, we record whether these are used correctly or not.

(1) Route description. In our previous study, we obtained route descriptions from children by asking them to guide one experimenter, who is blindfolded, to move along a

pathway laid out on the ground. While we have kept this procedure for the current research in Bali, we have adapted it for the other locations to using a model with the same outline (consisting of eight segments) on a board, some toys being placed along the route; the child is asked to guide verbally the experimenter who moves a car along the route.

(2) Perspectives task. Three non-fronted objects are displayed on a board. The child is asked to describe the location of the objects from one position, then, moving around the display, from the opposite side, and then when the display is rotated by 180°.

(3) Spatial encoding tasks. These are described below. On the last two items of each task, the child is asked to tell the reason for his answer, and the language used is recorded.

Spatial encoding tasks

These are tasks initially devised by CARG at the Max Planck Institute of Psycholinguistics in Nijmegen, and are described in Levinson (2003).

(1) Animals in a Row. This task presents the child with four animal models, three of them facing in one direction, and the fourth one placed at right angle to the three others. The child is asked to remember this alignment, and move on to another table with 180° rotation to align another set of the same animals the way they were shown before. Five trials, with animals oriented to right or left are given in a standard sequence, and then two trials with a 90° rotation. The way animals are aligned by the child is coded as indicating an absolute or relative encoding of the display. An innovation compared to our previous research is that we now use four animals instead of only three, which allows for a more valid distinction between intrinsic and absolute encoding (Levinson, Kita, Haun, & Rasch, 2002).

(2) The Chips Task. This task intends to measure visual recognition memory of two-dimensional shapes (small or large, red or blue squares) drawn on cards, two at a time. The child is shown five cards of a series, all with the same orientation, and asked to notice that all of them are similar. Then, one of the cards is rotated by 90°, and the child is asked to tell how it is different from other cards. Following this exercise, the child is presented with a card oriented in a particular direction by the configuration of the two squares, and is asked to remember this orientation. Then the child moves on to another table to choose from a set of four cards set out as a cross, one of them displaying the same spatial orientation as seen before. A series of practice trials are given before moving on to actual testing, which includes five trials with a 180° rotation and two at 90°.

(3) Steve's Maze. This task consists of six 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 can take the child from the end of the drawn path back to the house. The child is asked to remember the path while moving on to another table (with 180° rotation) where three cards are given that show three different path segments. One of these represents a relative solution, another an absolute solution, and the third one an irrelevant choice. Five trials are used.

Research questions

The research questions being specific to each component of the project, they will be presented in each individual paper. Overall, we can refer to a recent paper by Majid, Bowerman, Kita, Haun, and Levinson (2004) reviewing research about spatial frames of reference, in which, quite independently of our research venture, the authors conclude with the following list of "questions for future research":

- *What are the neurocognitive underpinnings for linguistic frames of reference? How much plasticity is there?*
- *How do children learn linguistic frames of reference? And when do linguistic frames of reference begin to influence spatial cognition?*
- *What are the cognitive consequences of being a bilingual in languages that rely on different frames of reference?*
- *Not all rural societies use an Absolute frame of reference, but urban languages appear to use a Relative frame of reference. Why is this?*
- *What mechanisms do speakers of Absolute languages use to keep track of directions in the Absolute frame of reference?*
- *Are speakers of Absolute languages better than speakers of Relative languages at view-independent object recognition?* (Majid et al., 2004, p.113)

It is rewarding to find that our project is designed to contribute partial answers precisely to five of the above questions formulated by experts other than ourselves.

References

Berry, J., Poortinga, Y. P., Segall, M. H., & Dasen, P. R. (2002). *Cross-cultural psychology. Research and applications (second revised edition)*. Cambridge: Cambridge University Press.

Brown, P., & Levinson, S. C. (1993). 'Uphill' and 'downhill' in Tzeltal. *Journal of Linguistic Anthropology*, *3*(1), 46-74.

Dasen, P. R. (1993). Schlusswort. Les sciences cognitives: Do they shake hands in the middle? In J. Wassmann & P. R. Dasen (Eds.), *Alltagswissen - Les savoirs quotidiens - Everyday cognition* (pp. 331-349). Fribourg: Presses de l'Université de Fribourg.

Dasen, P. R. (2003). Theoretical frameworks in cross-cultural developmental psychology : An attempt at integration. In T. S. Saraswathi (Ed.), *Cross-cultural perspectives in human development: Theory, research, & applications* (pp. 128-165). New Delhi: Sage India.

Dasen, P. R., & Mishra, R. C. (2000). Cross-cultural views on human development in the third millennium. *International Journal of Behavioral Development, 24*, 428-434 (Reprinted in R. K. Silbereisen & W. Hartup (Eds.), *Growing points in developmental science* (pp. 266-286). London: Psychology Press, 2002.)

Dasen, P. R., Mishra, R. C., & Niraula, S. (2004). The influence of schooling on cognitive development: spatial language, encoding and concept development in India and Nepal. In B. N. Setiadi, A. Supratiknya, W. J. Lonner & Y. H. Poortinga (Eds.), *Ongoing themes in psychology and culture* (pp. 223-237). Yogjakarta: Kanisius.

de León, L. (1994). Exploration in the acquisition of geocentric location by Tzotzil children. *Linguistics, 32*, 857-884.

de León, L. (1995). *The development of geocentric location in young speakers of Guugu Yimithirr*. Nijmegen: CARG working paper no. 32.

Gladwin, T. (1970). *East is a Big Bird. Navigation and Logic on Puluwat Atoll*. Cambridge, MA: Harvard University Press.

Grabowski, J. (1999). A uniform anthropomorphical approach to the human conception of dimensional relations. *Spatial Cognition and Computation, 1*(4), 349-363.

Greenfield, P. M. (1976). Cross-cultural research and Piagetian theory: Paradox and progress. In K. F. Riegel & J. A. Meacham (Eds.), *The developing individual in a changing world, vol. 1* (pp. 322-333). The Hague: Mouton.

Gumperz, J. J., & Levinson, S. C. (Eds.). (1996). *Rethinking linguistic relativity*. Cambridge: Cambridge University Press.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.

Levinson, S. (1996). Frames of reference and Molyneux's question: cross-linguistic evidence. In P. Bloom, M. Peterson, L. Nadel, & M. Garrett (Eds.), *Language and space* (pp. 109-169). Cambridge, MA: MIT Press.

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

Levinson, S., Kita, S., Haun, D., & Rasch, B. (2002). Returning the tables: Language affects spatial reasoning. *Cognition, 84*, 155-188.

Majid, A., Bowerman, M., Kita, S., Haun, D. B. M., & Levinson, S. (2004). Can language restructure cognition? The case for space. *TRENDS in Cognitive Sciences, 8*(3), 108-114.

Miller, G., & Johnson-Laird, P. (1976). *Language and perception*. Cambridge: Cambridge University Press.

Mishra, R. (1997). Cognition and cognitive development. In J. W. Berry, P. R. Dasen, & T. S. Saraswathi (Eds.), *Handbook of cross-cultural psychology, second edition. Vol. 2, Basic processes and human development* (pp. 143-176). Boston: Allyn & Bacon.

Mishra, R. C., & Dasen, P. R. (in press). Spatial language and cognitive development in India: an urban/rural comparison. In W. Friedlmeier, P. Chakkarath, & B. Schwarz (Eds.), *Culture and human development: The importance of cross-cultural research to the social sciences (in honor of Gisela Trommsdorff's 60th birthday)*. Hove, UK: Psychology Press.

Mishra, R. C., Dasen, P. R., & Niraula, S. (2003). Ecology, language, and performance on spatial cognitive tasks. *International Journal of Psychology, 38*, 366-383.

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

Niraula, S., Mishra, R. C., & Dasen, P. R. (in press). Linguistic relativity and spatial concept development in Nepal. *Psychology and Developing Societies, 17,* xx – xx.

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

Pinxten, R., Van Dooren, I., & Harvey, F. (1983). *Anthropology of space : explorations into the natural philosophy and semantics of the Navajo*. Philadelphia: University of Pennsylvania Press.

Segall, M. H., Dasen, P. R., Berry, J. W., & Poortinga, Y. H. (1999). *Human behavior in global perspective: An introduction to cross-cultural psychology*. Second revised edition. Boston: Allyn & Bacon.

Taylor, H. A., & Tversky, B. (1996). Perspective in spatial descriptions. *Journal of Memory and Language, 35*, 371-391.

Troadec, B. (1999). *Le développement de la pensée chez l'enfant. Catégorisation et cultures.* Toulouse: Presses Universitaires du Mirail.

Troadec, B., & Martinot, C. (2001). *De la variabilité interindividuelle à la variabilité interculturelle: l'exemple du développement de la représentation de l'espace chez l'enfant de Tahiti (Océanie).* Paper presented at the 8ème congrès international de l'ARIC, 24-28 sept., Genève.

Wassmann, J. (1994). The Yupno as post-Newtonian scientists. The question of what is "natural" in spatial description. *Man, 29*, 1-24.

Wassmann, J. (1995). The final requiem for the omniscient informant? An interdisciplinary approach to everday cognition. *Culture and Psychology, 1*, 167-201.

Wassmann, J. (1997). Finding the right path. The route knowledge of the Yupno of Papua New Guinea. In G. Senft (Ed.), *Refering to space* (pp. 143-174). Oxford: Oxford University Press (Oxford Studies in Anthropological Linguistics).

Wassmann, J., & Dasen, P. R. (1994a). "Hot" and "cold": Classification and sorting among the Yupno of Papua New Guinea. *International Journal of Psychology, 29*, 19-38.

Wassmann, J., & Dasen, P. R. (1994b). Yupno number system and counting. *Journal of Cross-Cultural Psychology, 25*, 78-94

Wassmann, J., & Dasen, P. R. (1998). Balinese spatial orientation: Some empirical evidence for moderate linguistic relativity. *The Journal of the Royal Anthropological Institute, incorporating Man (N.S.), 4*, 689-711.

Werner, S., & Hubel, C. (1999). Spatial reference systems (special issue). *Spatial Cognition and Computation, 1*(4), iii-vii.