



# Cross-cultural research on spatial concept development

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## Abstract

I will first review cross-cultural research in the area of culture and cognition, with particular focus on the development of spatial concepts. I propose that the formulation best covering all empirical data is in terms of «cognitive style», i.e., spatial cognitive processes are universally available to all humans, but there are preferences for some spatial frames of reference over others. These cultural differences are under the influence of a number of eco-cultural variables. The second part will illustrate this general conclusion by research on the development of the «geocentric» frame of spatial reference, initially studied by Levinson (*Space in language and cognition: explorations in cognitive diversity*, Cambridge University Press, Cambridge, 2003). This is a cognitive style in which individuals choose to describe and represent small-scale tabletop space in terms of large-scale geographic dimensions. In Indonesia, India, Nepal and Switzerland, we explore the development with age of geocentric language as well as geocentric cognition, and the relationships between the two, as well as the environmental and socio-cultural variables that favor the use of this frame (Dasen and Mishra, *Development of geocentric spatial language and cognition*, Cambridge University Press, Cambridge, 2010).

## The cross-cultural study of cognition and cognitive development

Cross-cultural psychology attempts to overcome the Western ethnocentrism inherent to mainstream psychology. It draws attention to the fact that psychological theories that have been established empirically only on a minute fraction of humanity (mainly first-year university students in Europe or USA) cannot ipso facto be considered to be universally valid. By taking the existing theories and methods and testing their validity elsewhere, it is gradually able to establish if cognitive processes are really universal, and how they are used in specific cultural contexts. Cross-cultural psychology (often in the form of what is called “cultural psychology”, “indigenous psychology” or «culture sensitive psychology») also studies psychological phenomena that originate in particular cultural contexts. The «geocentric» frame of spatial reference is one such process that would never have been studied in Europe or North America, because it is basically unknown there.

Cross-cultural psychology can also be used as a sort of quasi-experimental laboratory in order to “unconfound”

variables that are intrinsically linked if one carries out research in a single setting only. For example, in developmental psychology, if all children go to school and move up in the grades at about the same age, the variables of ontogenetic development (chronological age, maturation) and the effects of schooling are confounded. If we want to be sure that a particular developmental trend is really linked to age and not only to schooling, we should compare schooled and un-schooled children (e.g., Mishra and Dasen 2004).

For several decades starting in the 1970s, «culture and cognition» was an important theme in cross-cultural psychology, including developmental aspects (e.g., Berry and Dasen 1974). Although it is no longer in fashion, we have a serious amount of empirical data that allows us to draw some general conclusions. My own contribution has been mainly inspired by my training in Geneva with Jean Piaget, followed by a gradual immersion in ethnographic fieldwork (cf. Dasen 2017). This has included studies with children among Australian Aborigines, Inuit in Canada, Baoulé in Côte d’Ivoire, Kikuyu in Kenya, Yupno in Papua New Guinea, and finally children in Bali, Indonesia, India, Nepal and Switzerland in the research on spatial frames of reference (FoR) summarized below.

I conclude from my own results as well as those of others (for reviews see Dasen 1972, 2007, 2011; Segall et al. 1999—and I don’t know of any that would seriously

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contradict this even in more recent research) that Piaget's theory of sensorimotor intelligence and concrete operations is indeed universal at the structural level: the substages described by Piaget, and the type of reasoning these represent, are found everywhere and in the same succession. On the other hand, there are cultural differences in the rate of development of particular concepts, depending on whether these are valued and fostered or not in daily activities in any particular setting. These differences can be compensated by appropriate operational training procedures, which show that they are quite malleable. In some cases, children have the underlying competence for a particular concept, but cannot display it without some help in their performance on tests.

## Cognitive styles

In their research on culture and cognition, Cole et al. (1971, p. 233) came to the following conclusion: "Cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another". Again, there is no more recent cross-cultural research I know of that contradicts this conclusion. Dasen and Mishra (2010, pp. 13–14), however, reformulated it slightly: "Cultural differences in cognition reside more in *cognitive styles* than in the existence of a process in one cultural group and its absence in another".

Cognitive styles can be defined as "an individual's preferred and habitual modes of perceiving, remembering, organising, processing, and representing information" (Dörnyei 2005, p. 125), or even more generally as "one's preferred way of processing information and dealing with tasks" (Zhang and Sternberg 2006, p. 3). Messick (1976, as quoted by Kozhevnikov 2007, p. 464) defined cognitive styles as «stable attitudes, preferences, or habitual strategies that determine individuals' modes of perceiving, remembering, thinking, and problem solving». In other words, we speak of a cognitive style when a set of cognitive processes are all potentially available, but some are preferentially used rather than others, and when different individuals (or different groups) react differently to a cognitive problem (task, test, experiment, etc.) in some systematic way even though they have the same underlying cognitive capacity or competence. They "choose" to react in this particular way under the influence of a variety of factors such as their age, gender, previous experience or socialization. This "choice" may of course be quite unconscious. An important aspect of cognitive styles is that there is no value judgment attached, i.e., it is not inherently "better" to choose one style rather than another, except that a particular style may be more adaptive in a particular environment (Berry et al. 1982).

Cognitive styles have been very popular in developmental and cognitive psychology, particularly in the 70s to 90s. This is less so today. In 1997, Sternberg and Grigorenko (1997) asked «Are cognitive styles still in style?». My answer is: not really, at least not within these older frameworks, but we can reuse the concept slightly differently. Cognitive styles used to be defined as a stable personal characteristic, a psychological dimension-like personality, leading individuals to acquire and process information in a particular way. Psychologists usually defined one single bipolar dimension, on which individuals were considered as having one style or the other depending toward which extremity they were leaning. The common statistic was a median split, or else individuals near the middle of the dimension were purposely ignored.

The best-known cognitive style is psychological differentiation also known as field dependence and field independence (Witkin 1978; Witkin et al. 1962; Witkin and Goodenough (1981)). It is the cognitive style which attracted most cross-cultural studies [from Witkin and Berry (1975) to Mishra and Berry (2018)]. There are several tests supposed to measure this style, and in theory they should be highly correlated, but most studies show that this is not always the case. Another issue is whether or not the two opposites on such a dimension are really mutually exclusive. It seems that this is not necessarily the case; some individuals seem to be flexible, being able to adapt their style to the situation. While cognitive styles are supposed to be value free, each style being adapted to a particular environment, being able to show flexibility is possibly the best outcome. I will come back to some of these issues in the discussion.

The research program I am going to present briefly deals with the cognitive style of using a geocentric vs egocentric frame of spatial reference (Dasen and Mishra 2010; Dasen et al. 2018).

## Spatial language and frames of reference (FoR): the geocentric versus egocentric cognitive style

According to Levinson (2003), three frames of reference can be used to describe the location of objects in a restricted, so-called tabletop space: intrinsic, egocentric (sometimes called relative) and geocentric (absolute). This corresponds roughly to what Piaget and Inhelder (1956) termed topological, projective and Euclidean space, or according to Taylor and Tversky (1996), space centered on the object, on the person and on the environment. In the intrinsic/topological frame, which seems to be universal and develops very early in children, objects are situated in reference to each other (next to, near, inside, to the nose of the car, etc.). The egocentric frame uses the point of view of the speaker, using mainly right and left, and is favored in many languages, including

Arabic, Bantu languages, Indo-European languages and Japanese. The geocentric frame makes use of distant geographic features (to the mountain/sea; uphill/downhill) or coordinates (cardinal directions NSEW) to speak about local table space, including inside a room. In Bali, for example, Bahasa Indonesia tends to use the egocentric frame: «put the knife to the right and the fork to the left of the plate», while traditional Balinese uses a geocentric FoR: «put the knife toward the mountain and the fork toward the sea» (Wassmann and Dasen 1998, 2006).

Levinson's team has designed a number of tests that allow to determine which frame of reference is being used for spatial representation (which we call spatial "encoding"). To give an example, in the test called «Animals in a row», the informant is presented with three toy animals aligned on a table, all three looking in the same direction. The experimenter says «Look at these animals. You will have to remember them and put them in the same way on the other table», the second table being placed at some distance and with a rotation of 180° (or 90°). If the animals were looking right on the first table, and the informant aligns them also to the right after turning around, s/he is using the egocentric FoR. The geocentric mode corresponds to «The animals looked to the mountain on the first table, they also look to the mountain on the second».

Two other tasks we used in our research, also devised by Levinson (2003) and his team, are «Chips» and «Steve's Maze». In the former, the experimenter shows a card with two geometric shapes, for example a small circle above a larger one, and asks the informant to find the same card among a choice of four (each with a different orientation) on the second table, after a 180° or 90° rotation. In the latter, the informant is shown an outline map with an incomplete path on the first table, and a choice of complementary paths on the second (one representing an egocentric solution, one a geocentric one, and a third irrelevant option). Each test consists of at least five items, the score being the proportion of items in which the geocentric FoR is used.

Levinson's (2003) team also systematically used spatial language elicitation tasks in order to record spatial language in standardized conditions. Most languages allow the use of all three frames of reference, but show a preference for one or the other. Thus, in Euro-American societies, the geocentric frame is often used for travel over large distances but never spontaneously inside of a room, where the egocentric frame is used exclusively. Levinson (2003) and his team of anthropological linguists has found a number of languages in which the preference for the geocentric frame is very strong, for example in some Mexican languages, in Aboriginal Australia and Austronesian islands, as well as in India and Nepal. In general, the same preference is also reflected in non-verbal spatial encoding. Levinson (2003) therefore opts for a strong version of linguistic relativism,

i.e., he concludes that it is language and only language that determines cognition. However, this is not fully supported by the findings in cross-cultural psychology (cf. Berry et al. 2011). Furthermore, most of the research of this team was carried out with adults; we were interested in developmental aspects, in particular when and how children learn to use a geocentric FoR.

In a review of the psychological literature on spatial FoR, Dasen and Mishra (2010, p. 37) noted that the geocentric frame should not be confused with the «allocentric» one, on which most of the research is concentrated:

A distinction is often made between "egocentric" and "allocentric" reference frames with respect to encoding of spatial information in experimental studies. Egocentric is defined as a "body-centered" or "viewer-centered" frame, a frame in which one's body is used to remember the location of objects (e.g. the cup is left of me). In contrast, the "allocentric" is defined either as an "object centered", or "environment-centered" or a "landmark-centered" frame. In all these instances, reference is made to something that is external and not linked to the body for encoding spatial information. These studies have been carried out generally within closed rooms, where the allocentric cues include the color of walls, and some objects either hung on the wall or placed somewhere in the room. ... It may be noted that the way the allocentric frame has been conceptualized in these studies corresponds to Piaget's topological spatial frame, or what Levinson (2003) calls an "intrinsic" spatial frame of reference. The focus is on how objects are encoded either in relation to each other or to some local features of the display. Hence, it is not surprising that studies report quite an efficient use of an allocentric frame by children much earlier than the use of an egocentric frame.

Since 2010, there has been an important new body of research on the allocentric frame, both with young children and non-human primates (e.g., Haun et al. 2011; Li and Abarbanell 2018; Ribordy et al. 2013; Rosati 2015; Shore 2012). I will not take space to review it because my main interest is specifically with the subset of geocentric space, about which there is hardly any new research.

## A cross-cultural developmental research program on geocentric spatial language and cognition

Our research started with a mainly ethnographic study in Bali, Indonesia, where we tested 38 children (4–14 years) and some adults (Wassmann and Dasen 1998, 2006). In Bali, the traditional orientation system is distinctly geocentric,

the main contrast being «to the mountain» and «to the sea». Some years later, Ramesh Mishra and I organized a large-scale research program in India and Nepal. Keeping to the age range of 4–14 years, we were able to test 545 children (191 in a village in India, 178 in the city of Benares and 176 in a village in Nepal), each sample being stratified with equal numbers of boys and girls, and schooled and completely unschooled children. In this part of India, the dominant orientation system is based on cardinal directions (NSEW), which is used almost exclusively in rural areas, while in the city, egocentric references are used as well, particularly when giving directions. In our rural Nepalese setting, on the Himalayan slope, the traditional orientation system is based on two sectors of 180°, uphill and downhill, more precision being given by using local landmarks.

In a third part of this research program, we were able to organize a large-scale study in Bali, with two main samples (4–12 years), 72 children in a city and 98 in a nearby village. We also returned briefly to the village of the first study, testing 33 children aged 4–8 years. We then continued research in India and Nepal. In the city of Benares, we tested 155 pupils of Sanskrit schools and 221 in a Hindi school, in the age range 11–15. The Hindi school was a semi-private school in which Hindi is used as the language of instruction, English being taught as a second language. The Sanskrit schools train boys (and one of them girls) in Sanskrit language, history, geography, literature and Hindu religion, meditation and yoga. Some of the pupils are expected to become Hindu priests. Sanskrit has the particularity of using ten named cardinal directions, and many of the rituals are strictly oriented according to this geocentric system. In Nepal, we pursued the question of bilingualism, in particular the situation where the school language favors the egocentric frame. We tested 400 pupils aged 4–12 in Kathmandu, half of the sample in government schools where teaching occurs in Nepali (which favors the geocentric frame of cardinal directions), and half in private schools where English is the language of instruction. We also replicated the study in Geneva, Switzerland, with 75 children (4–12).

In all the locations, the tasks had the same format, although local adaptations were made (e.g., in the familiarity of the toy animals). Extensive pre-testing was carried out to ascertain the appropriateness of the tasks and the instructions, always presented in the informants' preferred language. The verbal instructions avoided any spatial language that might give a cue to one frame or the other. The details of the methodology and results can be found in Dasen and Mishra (2010).

In all of the locations mentioned above (except Geneva), we found a distinct preference for the geocentric FoR in both language and cognition, more in rural than in urban settings, increasingly with age, sometimes starting very early, such as (at least) age 4 in Bali and rural India. In these cases, a

majority of very young children choose mainly a geocentric frame in both language and encoding, and the proportion then rises further to attain almost 100% after age 9. We hesitated to interpret this finding as a reversal of stages, since European children start with the projective (egocentric) frame and master the Euclidean (geocentric) one only later. However, we prefer to speak of a «different path of development, from geocentric to more geocentric, with the egocentric FoR as a secondary possibility throughout» (Dasen and Mishra 2010, p. 313). We further concluded: «This is also why an interpretation in terms of cognitive styles seems more appropriate: the dominant style is geocentric, but under some circumstances (...) the egocentric style may take over.» (p.313)

In all locations used for this study, all three FoR were theoretically available in the local language, but a clear preference for the geocentric one emerged, more or less, depending on various individual and eco-cultural variables, except for children in Geneva who used the egocentric FoR almost exclusively (Dasen and Wassmann 2008). Children showed a greater preference for the geocentric FoR under the influence of various socialization practices. Generally speaking, the geocentric FoR was linked to a cluster of variables indicating a respect for the local «traditional culture». It was stronger in rural settings, or for city dwellers if they had more contact with rural areas or had migrated from there. Schooling in itself had no major effect (except in rural Nepal where schooled children used the cardinal directions taught in school). Practicing Hindu religious rituals fostered the geocentric FoR. In Varanasi, India, this was confirmed strongly by a study in Sanskrit schools (Vajpayee et al. 2008). Bilingualism had contrasted effects depending on circumstances. In Bali, where teaching occurs in Bahasa Indonesia, children using Indonesian at home and preferring Indonesian in the testing situations acquired the geocentric FoR much later than those immersed in the local Balinese language. For our study in Kathmandu, Nepal, we therefore expected children in private schools where teaching occurs in English to favor the egocentric frame more than those taught in Nepali. That prediction turned out to be false, most likely because the Nepalese teachers were teaching (and no doubt using) the geocentric FoR (in this case cardinal directions) even in English. In Geneva, where 60% of the children were bilinguals, this variable had no effect, because all of the languages used in their families (such as Portuguese, Spanish or Arabic) give preference to the egocentric FoR.

Another finding that supports the idea of cognitive style and goes against the hypothesis of strong linguistic relativism is task specificity: different cognitive tasks triggered the geocentric FoR differently, even though they were structurally similar. Furthermore, our informants would sometimes choose one FoR in their behavior on a task (i.e., encoding), but justify it verbally by the other frame, without being

aware of the contradiction. When there was such a mismatch, it was usually in the direction of a non-dominant choice of encoding explained by normative language. In other words, language is more likely to conform to the social norm than cognition.

Generally speaking, looking at the correlation coefficients (partialled for age) between the language and cognitive measures, these were much lower than expected if language were to determine cognition. The partial correlations are to the order of .30, which is statistically significant at the .01 level, but in fact explains only 10% of the common variance. In structural equation models (Amos) produced for each location showing the impact and relations of different variables, the best fit was achieved without a direct link between geocentric language and geocentric cognition.

Our overall conclusion is that the egocentric versus geocentric spatial FoRs are a cognitive style, i.e., both frames are potentially available in the languages of the locations used in our study, but which one is actually used depends on the situation and on a series of eco-cultural variables. Is this formulation in terms of «cognitive styles» really the best choice?

## Discussion

Is the egocentric/geocentric cognitive style in spatial cognition strictly a bipolar dimension or is there always some flexibility? or is this flexibility restricted to some individuals? One way to look at flexibility is task specificity. Systematically, in every location (except Geneva), one of the tasks (Steve's Maze) elicited more egocentric encoding than the two others. This was no doubt due to the «task demands», namely in this case a more iconic rather than linguistic memory encoding. This finding is similar to the low inter-task correlations found in the research mentioned above. If the reactions of an individual were systematically the same for all tasks, it would mean that using a given FoR is a defining part of that individual, an aspect of “personality” that is sufficiently stable to generalize across all situations. Some of our subjects were indeed more likely than others to use one frame systematically. In one part of our research in Varanasi and Kathmandu, we attempted to select subgroups of systematic geocentric and egocentric speakers and encoders. However, this proved more difficult than expected. In fact, it was impossible to find systematically egocentric persons, and while the geocentric ones were more numerous, often they were systematic for language or for encoding, but not for both. So, while our effort to maximize differences by selecting subsamples was not successful, this very fact confirmed that any individual may “choose” one frame or another, for at least some situations and under certain

circumstances. It also illustrates the finding that language and cognition do not necessarily always follow the same FoR.

Another way to look at flexibility is the possibility to influence an individual's choice either by manipulating the testing situation, in particular the instructions, or by using explicit training. If the choice of FoR really is a cognitive style in the way we conceive it, one would suppose that it should be fairly flexible, i.e., that a change in instructions and/or a change in the setup of the tasks should induce a change in the choice of frame. Similarly, training paradigms (such as used by Haun et al. (2011) with non-human primates and very young children) should show easy training effects.

In our first study in Bali, we used a change in instructions plus change of setup for Animals and Steve's Maze, giving explicit cues to the opposite choice than the one given spontaneously. One-third of the subjects changed their choice on Animals and more than half on Steve's Maze. The flexibility increased with age: the 6–8-year-olds showed no or little change, the older ones and adults much more.

In our second study in India and Nepal, we used the paradigm on Animals only. Overall, 24 percent of the children followed the counter-suggestion, somewhat more (34%) in the city. This is no doubt due to the fact that there were more spontaneous egocentric answers in the city, and a change to geocentric is easier because that represents the linguistic and cultural norm. However, there was no age trend, and we concluded that «the hypothesis that children get more flexible with age is not confirmed in this study» (Dasen and Mishra 2010, p. 129).

I now think it was a mistake not to pursue this issue, and we should have used such a paradigm using counter-suggestions or training particularly in our study in Geneva, since there, we found that all the children, at all ages we tested, used only the egocentric FoR (Dasen and Wassmann 2008). Is this in contradiction with the notion of cognitive style? Would Geneva children be able to change to a geocentric choice? Unfortunately we can't be sure, but there is interesting research by Troadec (2007) and Courrèges (2011) and Courrèges and Troadec (2009) that suggests that they would. In a study with French preschool children and with children aged 6–11, as well as adult students, these authors used three experimental conditions: without spatial references in the instructions, with egocentric and with geocentric (or at least allocentric) references. Furthermore, they used counter-suggestions systematically.

Not surprisingly, the majority of answers were overall egocentric, but there was an interesting age trend with the geocentric induction: 40% of the young children (6–7) responded to the geocentric induction in the instructions, 70% of the older children, but again only 30% of the adults. The young children do not accept counter-suggestions at all,

the older ones at 40% and adults at 70%. The latter nevertheless do so often with a comment, saying “yes, that is possible too, but the more correct solution is left and right”. The authors interpret their findings as follows: Both frames are “basic” in cognition, i.e., potentially available as early as age 3, but language and culture provide an “override”, which is strictly egocentric in French. Young children are unable to link the two representations flexibly, but this flexibility/complexity increases with age.

Note that these authors actually used local landmarks (such as «to the courtyard»), which is certainly allocentric but only on the verge of a geocentric FoR. I think, however, that similar results would be obtained using fully geocentric references. Nevertheless, it is undeniable that the performance of the children in Geneva and in France represents a challenge to the concept of cognitive style, i.e., it is pushing the limits of its definition: One could argue that the cognitive process for using a geocentric FoR simply does not exist. Similarly, Levinson (2003) mentions languages (in aboriginal Australia and the San in Southern Africa) that apparently do not have words for the egocentric FoR.

In conclusion, there is still scope for further research. We decided to study the geocentric FoR precisely because it is an understudied cognitive process that needed a cross-cultural ethnographic and psychological approach. We hope and believe that this research adds an interesting, even if somewhat marginal, dimension to the mainstream of research on spatial cognition.

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