Metacognition and spatial development: effects of modern and Sanskrit schooling

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Abstract

According to Flavell (1979, 1987), metacognition consists of both metacognitive knowledge and metacognitive experiences or regulation. Metacognitive knowledge refers to acquired knowledge about cognitive processes, knowledge that can be used to control cognitive processes. As area of research, metacognition has become very important in educational psychology but this domain has only relatively recently given rise to some cross-cultural research. In literature, development of metacognitve knowledge is related to western schooling but some researches showed that metacognitive skills are also developed outside of school. A few of these researches showed a cultural specificity in parents' guidance of children's metacognitive learning (Carr, Kurtz, Schneider, Turner et Borkowski, 1989; Sanagavarapu, 1999) but effects of teachers' guidance or effects of different kind of schooling are rarely examined. The aims of this study was to understand the metacognitive processes of students when they have to solve problems related to spatial notions and to study the influence of two different form of schooling, modern and Sanskrit on the development of metacognitive abilities. We tested 36 children from Sanskrit schools and 36 children from western type schools with some spatial tasks related to everyday cognition and with the MAI (Metacognitive awareness inventory) of Schraw and Dennison (1994) translated and adapted. Since the results showed such a difference between the types of schooling, we also tested the teachers with the COMEGAM, a metacognitive inventory specifically built for testing teachers' awareness of their own metacognition.

Introduction

The domain of the representation of space was especially exploited to interrogate the universality of cognition models but never to interrogate the universality of metacognition. The very few cross-cultural studies on metacognition report some cultural differences (Carr, Kurtz, Schneider, Turner & Borkowski, 1989; Davidson & Freebody, 1988; Sanagavarapu, 1999); this shows that there clearly is a need for more cross-cultural studies in this field. Most of these cross-cultural studies on metacognition used school-related activities. Davidson (1994) regrets that

" There is still a general lack of knowledge about the extent to which people engage in metacognitive thinking and the nature of that thinking in everyday-life setting and on everydaylife tasks particularly if the cultural contexts of those settings and tasks are different from that of classrooms" (p.2).

Thus, by choosing some tasks related to daily spatial activities, we intended to link this study with the topic of everyday cognition (Segall and al, 1999; Schliemann, Carraher, & Ceci, 1997). We also aimed to explore the link between metacognition and spatial concept development and in particular the impact of modern or traditionnal types of schooling on the development of metacognition by comparing at an individual level, the spatial language, the metacognitive and the cognitive performances. Finally, we wanted to find out if some value is accorded to the instruction of "meta" strategies at home and at school.

Our hyposthesis was that the socialisation into Sanskrit cosmology should develop a better knowledge of the spatial orientation system and lead to the use of more geocentric spatial language when solving spatial tasks. Due to the important difference in socialisation of boys and girls in India, it was also expected to find some gender differences in the way boys and girls were going to solve spatial tasks. We took advantage of the existence in Varanasi of a Sanskrit school for girls and of a great choice of Sanskrit schools for boys to compare 36 students of these schools to 36 students attending a Hindi-medium school. The students ages ranged from 13 to 16 and the four samples are similar: 18 girls and 18 boys for both streams of schooling.

Metacognition

Flavell (1979), stated that metacognition is "knowing about knowing". For Schraw and Dennison (1994), it is an ability to reflect, control and understand, in a self-aware mode, one's own learning and cognition. Although this term has been part of the vocabulary of educational psychologists for more than twenty years, because of the lack of a clear definition and the lack of an unified theory of metacognition, defining metacognition is not that simple. But if today metacognition is still a fuzzy concept, there is general agreement among researchers that it can be divided into two general constructs termed: metacognitive knowledge and metacognitive control and regulation. Metacognitive knowledge refers to general knowledge about how human beings learn and process information, as well as individual knowledge of one's own learning processes. Metacognitive experiences involve the use of metacognitive strategies or metacognitives regulation (Brown, 1987). Metacognitve strategies are sequential processes that one uses to control cognitive activities, and to ensure that a cognitve goal has been met. These processes help to regulate and oversee learning, and consist of planning and monitoring cognitive activities, as well as checking the outcomes of those activities.

Research on the development of metacognitive skills has expanded in recent years. For Borkowski and Muthukrishna (1992), most of the major components of metacognition are, or can be, developed and reshaped by carefully planned classroom and homebased learning experiences. These experiences begin early and continue throughout the life-span. Metacognition contributes to learning in several ways (Schraw, Wise & Roos, 1995) but more especially "by helping learners to use their attentional resources more efficiently, to process information at a deeper level, and to monitor their performance more accurately" (p.223). Metacognition could also play an important role in the development of strategy generalization. These last elements show that it is important to study school and every day life activities to determine how students can be taught to better apply their cognitive resources through metacognitive control

How cultural learning contexts influence the developement of metacognition?

We can assume that all humans, regardless of any cultural, sociopolitical, psychological or genetic factors, have the innate hability to engage in a certain type of metacognition. The development of metacognition seems to be linked to the development of cognition (Byrd

&Gholson 1985; Normandeau, 1992) and the effects of schooling seems to be very important for its developpment. Thus, the question is to know if the high levels of metacognition (e.g. Schraw and Moshman's conceptual level) can be developped by people living in different cultural learning contexts and more specially can they be developped by people living in non literated societies (e.g. small hunting and gathering societies living in tribal areas).

The literature on metacognitive development (Freund, 1990; Moss, 1990; Rogoff, Mistry, Gonçu & Mosier, 1993) shows that in order to understand the development of metacognitive self-regulation, one must examine the social and the cultural contexts in which children's problem-solving acitivities are conducted. Vygotsky (1978) argues that the development of self-regulatory abilities originates in cultural-historical processes. They are transferred to the individual through social interactions, more particularly between child and adult (Gauvain & Rogoff, 1989; Moss, 1990; Paris, Newman, Jacobs, 1985) but also between peers. Parent-child interaction has been recognised as an important setting for the emergence of metacognitive abilities. Some studies showed that the nature of the task (Freund, 1990), the age of the child, the sex of the parent and the child (Mullis & Mullis, 1986; Sanagavarapu, 1999) and the parenting styles (Pratt, Kerig, Cowan & Cowan, 1988) can bring variations in adult guidance. Because each culture values aspects and goals of development differently, the cultural context for learning seems also to be significant. Sanagavarapu, Elliot & Relich (1994) and Sanagavarapu (1999) reported cultural variations in maternal guidance of children's metacognitive learning in Australian and Indian cultural communities. Carr, Kurtz, Schneider, Turner and Borkowski (1989) reported cultural differences in metacognition between American and German children, to all appearances, in relation to the difference of teaching styles both at home and at school. The quality of schooling seems also to be very important. For example, Kurtz, Borkowski & Deshmukh (1988) showed that the very little strategic teaching style and the training by hart, both frequently in use in Indian schools, have a very bad impact on the development of abilities linked to metamemory.

Problems with the measurement of metacognition

Today, if metacognition is an important theoretical construct, we are still far from having adequate tools for measuring metacognition (the methods for measuring metacognition still have some serious problems with reliability and validity). Considering the measurement problem and solutions, Schraw and colleagues (2000) suggested to:

- Include observations of metacognitive abilities, which can provide information about strategies, metacognition and motivation in authentic tasks (e.g. reading, writing, or mathematical problem solving).
- Choose suitable cognitive tasks, complex and new enough to let appear metacognitive abilities appear.
- Use an instrument that measures metacognition with psychometric properties like the MAI (*Metacognitive awareness inventory*), on various populations (different ages, ethnic groups and/or having followed different types of schooling).
- Use as many methods as possible with each subject (student) and mix qualitative and quantitative methods.
- Do longitudinal research.

Sanskrit Education

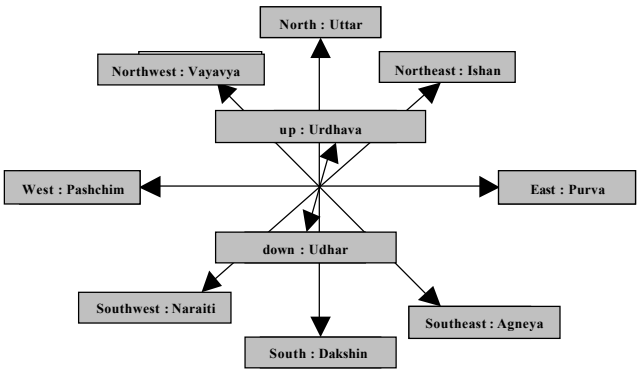
Since the beginning, Sanskrit education was the object of a deep reflection that contributed to the diffusion of Sanskrit during almost three thousand years on the Indian sub-continent (Fillozat, 2002). For example, the educational practices are already discussed in details in the *Upanisads*. If Sanskrit education has been thought of in different manners through the ages, Reagan (2000) and Fillozat (2002) note some constants: the manner in which the knowledge is transmitted from *guru* to disciple or the perpetual research of a tie between intellectual development and spiritual development. The three phases of educational practice described by Reagan (2000) show this tie very well. The first stage *Shravana* is the memorization of texts, techniques, grammar, exegeses and reasonings. This first stage is followed by *Manana,* a stage that implies a reflection on what was just learned; this specific process is more intellectual than spiritual. The second stage is followed by *Nididhayasana*, a stage of meditation that leads to the awakening of consciousness.

Being for the most in a phase of transition, the contemporary Sanskrit schools make still use of certain ancestral techniques of training and of transmission of knowledge. The oral teaching, for example, is strongly privileged. Fillozat (2000) explains this preference while demonstrating that the oral teaching encourages the contact with the master because the difficulty of the memorization by listening requires a constant attention to the master's word. To the contrary, reading encourages isolation and distraction. So, some teachers put a point of honor not to use any books. Besides, the privileged relation between pupil and *guru* is still very strong today (Mishra & Vajpaye, 2004). Finally, the utilization of debates (sãstra) and discussions are still very important in certain schools. Thus, since they are young, students must defend continually what they learned in front of theirs peers and professors. Later, they will do this in public. For Filliozat (2002), this intellectual exchange is conceived like an efficient way to maintain the knowledge acquisition and to enrich it. Research by Lahire (1993) showed that a capacity to take the language as an object of analysis and to use it on a metalinguistic register always leads to success when students are solving school tasks. It is why, our hypothesis was that the constant reflection to what had just been learned (*Manana)* and the practice of the debate in Sanskrit schools was going to encourage the development of a high level of metacognition.

Sanskrit spatial cosmology

This point being already well developped in their communication "Spatial encoding: a comparaison of Sanskrit and Hindi-medium schools" by Vajpayee, Mishra and Dasen, only the specific use of ten directions will be presented in this paper.

Figure 1: the ten directions used daily in Sanskrit schools



In our study, it was expected that this daily use of these ten directions would help Sanskrit pupils when they have to solve some problems related to spatial orientation

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Specificity of the two Sanskrit schools used in this research

These particular schools used in this research have already been described in detail in Broyon (2004); in the present article, we are only going to focuse on their most important specifities. At first, it should be underlined that before arriving in these two particular schools, most of the children followed 4 to 6 years of modern education sometimes even in an English medium school (girls). If we can find a certain number of common points between these two schools, notably with regard to the importance of the Sanskrit teaching and of the religious teaching, numerous differences exist on other levels. This is due in large part to the difference of gender but not solely.

I. Girls' school. Exclusively women manage this institution. The major emphasis of this school is on the learning of the grammar developed by Panini. It is reputed for its Sanskrit courses of very high level and for its teaching of Indian classical music. Seventy girls, of different castes, from social-economic medium to elevated backgrounds, and aged from 6 to 20 years, receive a very strict education without vacations nor visit of their family until the end of their studies. They rarely have an opportunity to escape out the surrounding walls of the school during the first years. These girls come from different parts of the country, speak different languages and communicate exclusively in Sanskrit between them. The school proposes courses from the primary level to the master level. Raised at 4 o'clock everyday in the morning, the girls begin the day while reciting the Vedas and doing rituals around the fire. After breakfast, begins a long day during which some formal courses are dispensed: English, maths, geography, Sanskrit, music and knitting or sewing according to the season. The evening is dedicated to the teaching of religious matters (religious texts, philosophy, traditions, rituals, sacrifices etc.). The teachers and students live as a community, inside the same campus, and they participate in all activities related to school, including domestic tasks. In this school, sports activities are privileged (soccer, badminton, martial arts); the students even receive some military training (with real guns). The only tie of these girls with the outside world seems to be a television, but they only have the right to watch news from time to time.

In this institution, girls receive a global education, as every moment of the day is auspicious for learning. Very little time, which is not distributed and not controlled, remains. In all courses, discussion and debate are privileged. For the teachers of this school, a training followed by good explanation and by an analysis remains in the memory whereas cramming remains like a weight in the brain.

II. Boys' school. The boys' school is established inside of an ashram dedicated to a holy man. This institution is attended by about fifty boys aged 12 to 17 years. All of them are wearing the traditional clothes (*dhoti* and *corta*). They are Brahmins and come generally from the surrounding countryside. The young people are fed and get free accommodations during two years. Because their fathers, priests, peasants or teachers don't have enough money to pay for studies after the primary school, they often attend this establishment for economical reasons. Compared to the girls' school, in this institution, the boys can move more freely and are allowed to leave the compound to go to temple or to go buy things for the director. As soon as they can, the students walk to the nearest Ghat. They are allowed to receive visits and they go home for vacations one month every year.

They get up at dawn, to study *sũtras* and to go to the temple. At the end of the morning, after a long collective prayer, the formal courses begin (Sanskrit, English, politics, mathematics, science, history, geography). Usually, the day ends up by a yoga session. Training of total silence is the first teaching the boys receive when they arrive in this school. Then, teachers teach them the best way to sit down and to listen attentively. In this institution, teachers never give frontal courses. And, cramming for exams, in fashion in a lot of Indian schools, doesn't have a place in this school. In classrooms, all levels are mixed and it is impossible to find a difference between different level students. The students come and go quietly from one class to another. Most of the time, teachers use individual teaching strategies. Nothing is imposed, but teachers are very happy if the young people take themselves the initiative to write what is said during the courses and show it to them. For them, it is a proof that the course is well internalized. The teachers say they are trying to sort out everything that is good in the ancient teaching system to combine it with the good parts of the modern way of teaching. Themes of actuality, for example, are often discussed in class and connected to the ancient texts.

Hindi medium school

The quality level of Hindi medium schools defers a lot from one category of school to another and from one school to another. In principle, private schools, especially English medium schools, are better than municipal or governmental schools. However, when we were looking for schools to do this research, we visited very good governmental schools whereas the quality of certain private or semi-private schools was sometimes questionable: intolerable noise during the courses, absent teachers, big concentration of children in small class rooms, etc. We finally decided to choose a semi-private school with a medium quality level of education when considering the number of pupils in classes, the teacher implication, the teaching of NTIC and the possibility of getting some specific turoring after classes. It also has the advantage to be a mixed school but using single-sex classes.

Methods

The data collection involved thirty-six children (36 girls and 36 boys) in three different schools: one Hindi-medium school and two Sanskrit schools. The multi-method approach included: observation; a problem-based interview (incorporating self-reporting and predictions); questionnaires and video recordings.

Phase 1: students were involved in three tasks, one individual: the road (a) and two group tasks : crocodile and map (b and c).

a) Road task: We used a model on a board (a road constiting of eight segments), some toys being placed along the road; the child is asked to make prediction about his recall (+ recall on reverse road) of the toys and placement on another board of these 15 items along the road.

b) Crocodile task: A sort of cache game. A group of three children plays against three other children. The first group has to decide of an easy location for the crocodile, a toy which is spatialy oriented and to give the best instructions to the second group to find it as quickly as possible.

c) **Map task:** Three children have to draw a map of their school and its surrondings individually. Then, they discuss the results together and draw together a bigger map which is a little bit more complicated.

Phase 2: children were administered the Metacognitive Awareness Inventory (MAI; Schraw & Dennison, 1994) translated and adapted. This instrument is mainly designed to elicit information on the types of strategies used when students are solving problems.

Phase 3: we ask students to answer some questions about the value accorded to the instruction of metastrategies at home and at school. Finally, we interviewed the directors and two teachers in each school about their pedagogy and practices.

Results

The hypothesis concerning the influence of the type of schooling seems to be fully confirmed, especially for the individual task and the MAI. The girls from the Sankrit schools scored better cognitively and metacognitively at the road tasks.

A) Road tasks

I. Cognition

Table 1: Road recall on 15 items (cognition)

SCHOOLS	Mean	N	Std. Deviation
Hindi boys	11.83	18	1.76
Hindi girls	12.28	18	1.27
Sansk. girls	**12.89**	18	**1.18**
Sansk. boys	12.50	18	1.54
Total	12.38	72	1.48

Anova between groups:
F= 1.646
Sig.=.187

Table 2: placement on reverse road

SCHOOLS	Mean	N	Std. Deviation
Hindi boys	11.94	18	2.58
Hindi girls	12.00	18	3.16
Sansk. girls	**12.89**	18	**2.05**
Sansk. boys	12.72	18	2.49
Total	12.39	72	2.58

Anova between groups:
F = .629
Sig.= .599

II. Metacognition

Table 3: [prediction – performance] of recall

SCHOOLS	Mean	N	Std. Deviation
Hindi boys	2.52	18	2.04
Hindi girls	2.58	18	1.32
Sansk. girls	**2.17**	18	**1.09**
Sansk. boys	2.44	18	1.86
Total	2.43	72	1.60

Anova between groups:
F= .233
Sig.=..873

Table 4: [predic-perfo] of reverse road

SCHOOLS	Mean	N	Std. Deviation
Hindi boys	2.78	18	2.11
Hindi girls	3.63	18	2.02
Sansk. girls	**1.50**	18	**1.73**
Sansk. boys	3.80	18	2.60
Total	2.93	72	1.60

Anova between groups:
F = .4.363
Sig.= .007

Beside the task of reverse road, the boys from Sanskrit school scored better cognitively and metacognitively than students from the Hindi medium school. The girls from Sanskrit school did very well at the prediction of the reverse road, which was the last task of this set (Mean: 1.50 items of difference between their prediction and their performance items). Moroever, the girls from the Sanskrit school take usually more time then others students to complete their tasks (individual and group tasks).

Metacognitive Awareness Inventory

About the Metacognitive Awareness Inventory (MAI; Schraw & Dennison, 1994) the students from both Sanskrit schools showed a better perception of their metacognitive knowledge and a better knowledge of their metacognitive abilities.

Table 5: MAI (mean)

SCHOOLS	Declarative knowledge (DK)	Procedural knowledge (PK)	Conditional knowledge (CK)	Planning (P)	Information management (IMS)	Monitoring (M)	Debugging strategies (DS)	Evaluation (E)
Hindi boys	42.11	27.12	28.56	41.00	48.28	35.93	28.94	33.61
Hindi girls	43.50	27.61	27.44	38.33	49.00	39.28	27.67	32.28
Sanskrit girls	**48.67**	**31.72**	**32.61**	**45.44**	**54.44**	**45.76**	31.33	**38.50**
Sanskrit boys	47.50	30.06	30.44	43.61	53.11	40.39	**31.83**	35.83
Total mean	45.44	29.15	29.76	42.10	51.21	40.46	29.94	35.06
Anova between groups	Sig. =.010	Sig.=.003	Sig.=.018	Sig.=.001	Sig.=.047	Sig.=.000	Sig.=.016	Sig.=.005

Information management (IMS) is in first position for all students (but not significant), Declarative knowledge (DK) is in second position, Planning (P) is in the third for boys but in the fourth for girls, Monitoring (M) is in third for girls and in the fourth for boys, Evaluation (E) is in the fifth.

The qualitative analysis of the two group tasks (crocodile and map) is showing a great difference in the way girls and boys solve problems related to spatial notions. For example, to explain to another group where to place the crocodile toy seemed to be very difficult for some girls attending the Sanskrit schools. They focuse on the Agnay corner direction (a direction they use a lot in their rituals), without beeing able to use any other directions, and got completely lost. To the contrary, this task seemed to be too easy for the boys from the Sanskrit school. We have been very surprised of the way these young people manage to solve any kind of problems. They have a great capacity to listen to instructions without interrupting the one that gives them and to solve the problem in a minimum of time. For the map task, the boys used generally more planning and the girls used more debugging. But the group dynamic seems also to have a great influence in the way the problem was solved. Generally, the boys from the Sanskrit schools were more efficient than other students.

Since the results showed such a difference between the types of schooling, we decided to test the teachers with the *COMEGAM,* a metacognitive inventory specifically built for testing teachers' awareness of their own metacognition. This last phase took place this summer (2004).

Discussion and conclusion

We conclude from these findings that the effects of school type are very important when students from traditional and modern stream of schooling are solving task related to spatial notions and orientation. Sanskrit education seems also to have a better influence for the development of metacognitve abilities, for which our hypothesis is confirmed. But, at this stage, it is very difficult to know exactly why the students from these two Sanskrit schools performed better metacognitively. It is probably related to their educationnal practices but which one? It could also be related to the time these children spent to study and/or the importance given by the teachers to the study. It could be related to their self-confidence (especially for the girls). And finally, because all of them spent some time in a modern type of schooling before they came to Varanasi, it could also result from hybridization between the modern and the traditional type.

In India, public and private schools are far from standardized. We can find a big choice of schools and of educational institutions, all of them of different quality levels and using different kinds of pedagogy. This fact doesn't allow us to make any generalisation and we really need to do more comparative studies between these two types of school systems if we want to put them in an appropriate perspective. But, during this study, we perceived that Sanskrit education is a very complex phenomenon and in full mutation.Veer Bahdra Mishra, a very respected pundit of Varanasi, and an hybrid of the two streams of education, declared that Sanskrit education is incapable to enter in competition with the humanist and scientific approach of the modern Indian education (O. Weber et Arte TV, *Sur la route du Gange*, 22 avril 2003). For him, Sanskrit education doesn't prepare children to understand the world that surrounds them. Moreover, the individualized teaching, the practice of concentration and silence, the tie made between actuality and the ancient texts at the boys' school or the use of cooperative learning group, of analysis and discussions as ways of training and the learning of Panini Vyakaran at the girls' school, seems, somehow, to be more suitable to the intellectual development of children than the education dispensed in some Hindi schools (cramming, classes of 50 students and plus, teachers absenteeism, frontal courses, etc.). Researchers should take the opportunity to examine these ancestral practices, adapted and perfected during millennia; to compare them with modern pedagogy could be a very good exercise of decentration.

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