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Socio-cognitive conflict and structure of individual and collective performances

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Abstract

A previous experiment (Doise, Mugny and Perret-Clermont, 1975) has shown that pairs of subjects perform better on a spatial representation task than subjects alone. As a conclusion the hypothesis was put forward that conflicts of cognitive centrations, embedded in a social situation, lead children to coordinate their centrations. The present research was planned to verify several predictions following from this general hypothesis. Results show that indeed more progress takes place when children with different cognitive strategies work together than when children with the same strategies do so, and that not only the less advanced but also the more advanced child progresses when they interact with each other.

INTRODUCTION

As early as 1966, Smedslund suggested the need for a change in the approach to research work on cognitive development. This 'would no longer concentrate on the interaction between the non-human environment and the subject, but on social interaction' (p. 166). It was only around 1970 however that experimental studies explicitly investigating the relation between social interactions and cognitive development started to appear.

The theoretical orientation of these studies, however, varies to a great extent and the resulting hypotheses are thus more or less contradictory. Some emphasize the role of observation and imitation (Murray, 1974, attempts the theoretical integration of social learning and the Geneva approach to developmental psychology). Others insist on the role of reinforcement in vicarious conditioning (Rosenthal and Zimmerman, 1972; Bandura and Walters, 1963). Kuhn, whose approach is more cognitivist, wishes

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to verify Piaget's equilibration model (1974) by experimental means. She does this on the basis of hypotheses concerning the effects of interaction with models of different cognitive levels.

As already pointed out in a previous publication (Mugny, Doise and Perret-Clermont, 1975–76), the majority of these studies are based on a common assumption: the interaction owes its effectiveness to imitation processes. Interaction with a model of a higher cognitive level would seem to be necessary for the subject of lower cognitive level to progress. there is however much divergence between authors as to the 'optimal distance' between the subject and the model.

The Geneva school of developmental psychology, in another approach stresses the role of the internal capacities of the subject in the equilibration of his relations with the environment. The influences of the social factor as such are not one of their current preoccupations, the only exception being the modulations caused by intercultural differences during intellectual development. (Bovet, 1968; Bovet and Othenin-Girard, 1975).

From a sociological point of view, on the other hand, it would be a truism to maintain the social nature of knowledge. Even individual literary works have to be set in the context of social conflicts in which the author is situated (Goldmann, 1966). Other authors (Haroche and Pêcheux, 1971; Doise, Meyer and Perret-Clermont, 1976) show that any evaluation of intelligence must take into account the ideological content implied in the experimental situation.

In view of these different approaches to the problem of knowledge and its acquisition, the task of social psychology is, from a genetical point of view, to define the nature of the relations between the individual and society; this involves studying the interactional processes which result in the construction of knowledge.

This distinctive developmental approach to social psychology is still in its infancy even though we have already obtained several promising results. Thus, we have found (Doise, Mugny and Perret-Clermont, 1975) that contrary to a mechanistic model, cognitive performances cannot be predicted from the previous cognitive levels of group members. In addition, subjects who show progress in conservation task after interaction with another child, use arguments in the post-test which were not produced during the interaction, thus proving the existence of an underlying organizing activity linked to the social interaction.

The cognitive specificity of groups was also found in a task involving the coordination of inter-dependent actions (Doise and Mugny, 1975). This experiment revealed three important facts, showing that not all types of interaction favour progress. This gave us a better understanding of the mechanisms involved. Firstly, it is essential that interaction takes place during the elaboration phase of a notion; secondly, verbal communication during this period is essential to progress; finally, the structure of the group (hierarchical system or relatively decentralized) has a different effect depending on the initial level of the subjects. Centralized groups would seem to be more efficacious for subjects who have more or less mastered a notion but would seem to perturb subjects of lower levels, who seem to benefit more from a spontaneous, homogeneous organization.

Introduction of status differences between children who are still elaborating the notions needed for successful accomplishment of a task, hinders their success. In fact, these status differences inhibit the free comparison of centrations.

We have since shown (Doise, Mugny and Perret-Clermont, 1976) that the simple

conflict of contradictory centrations (both centrations belonging to the same pre-operatory schema) is enough to instigate progress of non-operatory subjects, without then their having imitated a superior model. However, in this experiment, the conflict between centrations was introduced by the replies of an adult collaborator of the experimenter.

The aim of the experiment we present below is a more systematic study of the role of the different socio-cognitive conflicts which arose when previously reported tasks, especially spatial representation (Doise, Mugny and Perret-Clermont, 1975) were carried out by groups. We had found that when a group of subjects carries out such a task without adult intervention, a cognitive restructuration results in a large number of cases. We shall now study the role of the different forms of conflict which arose during these interactions. We shall do this by opposing two children whose problem-solving strategies are not the same.

Before describing the forms of socio-cognitive conflict we studied, we shall briefly summarize the conclusions of previous research; these will be used here as our general hypotheses.

(1) Social interaction is characterized by its constructive nature; this can be seen in the originality of performances produced by a group and of the arguments given during the post-test, as well as in the progress made by individuals after a simple conflict of centrations belonging to the same schema.
Since interaction involves more than simple imitation (which can be considered as a special form of interaction), we expect group performances to be superior to those which could have been foreseen on the basis of the initial levels; in addition, even subjects whose partner is of a lower level will progress.

(2) Socio-cognitive conflict is an important factor in all restructuration, whether collective or individual. Progress should therefore be most apparent when subjects of different cognitive levels actualize different approaches of the same task. It will therefore be necessary to also study the relations between individual progress and the collective performances from which it stems for each of the different forms of interaction.

EXPERIMENTAL METHOD

Seventy-four children, aged from 5 to 7 years, worked in pairs on a representation task. The pairs were constituted on the basis of the pre-test; they consisted either of children having used similar strategies, or of children whose strategies had been different.

Material

We shall briefly describe the material used, a more detailed description having been given in a previous publication (Doise, Mugny and Perret-Clermont, 1975, first experiment). The material which is derived from the 'Trois Montagnes' (three mountains) experiment, described by Piaget and Inhelder (1948) in connection with a study on the awareness of perspectives, consists of a cardboard support onto which are fixed transparent sheets, marked out in millimeter squares, 60 = 40 cm in size. A

clearly visible coloured mark figured on each sheet. This was to serve as a reference point for the orientation of the base, on which a village was to be erected. (The mark was irregular in shape and was set off to one corner of the sheet.)

Two identical sets of three 'houses' made out of Lego completed the material; each house was clearly distinguishable from the others. In addition, a 'door' figured on one side of each house, indicating the front of the house and thus permitting its orientation. The experimenter used one of the sets to make a 'model village' on one of the bases; each house was placed at a previously defined position. The other set of houses was given to the subject who was asked to make an exact copy of the village on a base placed to the left of the subject at an angle of 90° (see Figure 1).

Instructions and items

At all phases of the experiment (pre-test, post-test, interaction), the children were placed facing the base on which was the experimenter's model village (the subjects thus had only a front view, as they could not move around the model). They were then asked to reconstruct the experimenter's village on their own base, which was placed on a table to their left an angle of 90°. The verbal instructions were geared to the child's level: an example was given of a man who, coming out of the lake or from the mountain (the mark) had to find his houses the same on the copy as on the model.

The experimenter's role was reduced to a minimum i.e. to ensure the correct procedure. During the collective phase (interaction), he simply asked the children when they had finished whether they agreed on the result; this was usually the case, even if sometimes the agreement was less a real agreement than a sign of goodwill. A television circuit enabled us to make a complete recording of the interactions.

Two types of item were used: 'simple' or 'complex'. The simple items were, as the name implies, straightforward and involved no rotation of the experimenter's model. In the complex items, on the other hand, the experimenter's base was rotated through 180°, thus displacing the reference mark by the same amount. The compensations the subject had to make to correctly copy the village on his base, whose orientation was fixed, demanded a higher level of spatial representation (see Figure 1).

Two of the complex items were called 'experimental' in that they were not only used for the individual tests, but also during the interaction. Two other complex items called 'generalization' items were only used for the individual tests. Figure 1 shows the

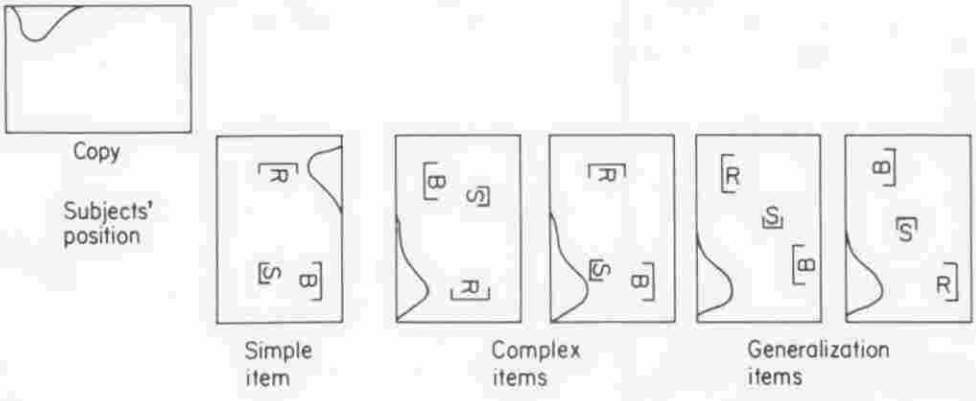

Figure 1.

four complex models. The simple item has been excluded from our analysis as all the subjects accomplished this task without problem.

Thus, an experimental variation is introduced by differently orienting the base of the experimenter's model and that of the copy. The different forms of interaction will enable us to study how the child gradually learns to compensate for this complication.

Experimental measurements

As in the previously mentioned research, two indices were retained. A quantitative index of the deviation of the copy from the model was established for each item. The exact position of each house (to the nearest cm) was noted after each item. This was simplified by the use of the squared paper for the copy. The index was obtained by comparing the vertical and horizontal coordinates (of the two ends of the front side of each house) of the model and the copy. The final index expresses the mean deviation per house. This was obtained by dividing the horizontal and vertical deviations by two. This index enabled us to quantify the performances. But do these performances reflect an organized system which enables the child to solve the problem of the compensations? This was established by another index: the structural index. It was justified mainly because the deviation index did not necessarily distinguish between two different strategies.

Three levels corresponding to the degree of compensation for the rotation, were established for the structural index:

(1) TC: at the most advanced level, the subjects totally compensate for the 180° rotation; this would seem to indicate that their coordination system is sufficiently developed for the type of problem we put to them;

(2) NC: at the lowest level, the subjects offer no compensation whatsoever; the subjects seem to completely ignore the fact that the copy and the model are differently oriented, even though the instructions explicitly stress this point: 'a man coming out of the lake . . .';

(3) PC: at an intermediate level, the subjects partially compensate for the changes in orientation. They are aware of the reference mark but only take into account one of the two relations: they respect the topographical relations of proximity (one of the houses is very near to the mark, another very far from it) but not the left–right relation.

Experimental plan and procedure

The children first did the test individually; they were classed according to which of the above strategies they used. The subjects selected for our study were those who used the same strategy for the two 'experimental' items (the other subjects were eliminated). For the second phase (interaction), the subjects were grouped into pairs; a description of the different experimental situations is given below. The instructions they received were similar to those given for the pre-test, but in addition they were asked to come to an agreement on the correct result ('tell me when you both agree'). The interaction took place one week after the pre-test; a post-test, identical to the first individual test, took place a week after the interaction.

Thus, for the interaction, the subjects were grouped into pairs on the basis of their initial strategies. Several combinations of the three different levels of compensation

were excluded from our study: thus the situation TC × TC (i.e. 2 subjects of TC level facing each other) was considered uninteresting, unless we included more complicated spatial tests. The situation PC × TC was also left out due to a shortage of PC subjects. Theoretically, this was the situation where progress was most probable as the PC subjects would have been faced with partners giving correct answers and it is possible, as Inhelder *et al.* (1974) affirm, that the temporal development curve is exponential. Four combinations therefore remained for the collective part of the experiment:

(1) NC × NC: it was thought unlikely that there would be any conflict between these two subjects since both use strategies which completely ignore the change in spatial relations;
(2) NC × PC: this should be a key situation: either the subjects totally ignore the relations between the different objects or there is partial compensation. Will a higher level of collective restructuration, exceeding the initial levels of both subjects, result from the conflict? Will the PC subject also progress despite his not having had the possibility to imitate a superior model?
(3) NC × TC: the two strategies are totally incompatible.
(4) PC × PC: although the two subjects' strategies are similar and that therefore theoretically there should be no conflict, there is a higher probability of conflict here than in the case of NC × NC, owing to the instability and probable oscillations of the system of partial coordinations.

If we consider the individual performances, we obtained five different experimental conditions. These individual performances were evaluated by a pre-test and post-test, and in particular by the progress made in the interval between the two. In three of the five situations, we studied the NC subjects coupled with PC, TC or other NC subjects; in another two situations, we studied the progress made by PC subjects interacting with NC or other PC subjects. We have not taken into account the TC subjects who did not do the post-test. In fact, their behaviour during the interaction with the NC was remarkably stable

Subjects

Over a hundred children were pre-tested. The main difficulty was to find PC children satisfying our criteria (same partial compensatory strategy at both experimental items). Finally, 74 children took part in 37 interactions. They were grouped as follows: 9 pairs of NC × NC, 11 pairs of PC × NC, 11 pairs of NC × TC, and finally 6 pairs of PC × PC.

Some of the children were not available for the post-test and so our individual analyses covered the following subjects only: 15 NC × NC, 11 NC and 9 PC of the NC × PC situation, 11 NC of the NC × TC situation and finally the 12 PC who had taken part in the PC × PC situation. The NC were aged between 5.4 and 7.1 years, the average being 6 years. The age of the PC subjects ranged from 5.5 to 7.2, the average being 6.3 years. The experimentation took place in the children's school. The subjects of each pair were members of the same class and were of the same sex. They came from the '2ème enfantine' and '1ère primaire' (second infant and first primary) classes of the Geneva school system.

Table 1. Mean deviation index (in cm)

Experimental situations	Experimental phase		
	Pre-test	Interaction	Post-test
NC* x NC	20.07 (15)†	19.00[a]‡ (9)	19.27 (15)
NC* x PC	20.64 (11)	12.23[b] (11)	15.95 (11)
NC* x TC	20.68 (11)	5.73[c] (11)	18.59 (11)
PC* x NC	18.44 (9)	12.23[b] (11)	5.44 (9)
PC* x PC*	18.59 (12)	7.17[d] (6)	11.68 (12)

*Subjects considered for the individual tests; †*n* in brackets;
‡differences between groups obtained by the Mann-Whitney U test: a and b : $U = 19.5$ $p < .025$; a and b : $U = 3.0$ $p < .001$; b and c : $U = 28.5$ $p < .025$; b and d : $U = 13.5$ $p < .10$

RESULTS

Table 1 gives for each of the experimental conditions, the mean deviation indices obtained on the two 'experimental' items by the groups and by the group members at the pre- and post-tests.

Collective performances

The statistical analysis of the differences between the group deviation indices for the various experimental situations shows that the higher the level of the most advanced member of the group, the better the collective performance. In fact, the interactions between two NC produced results very like those obtained at the individual pre-tests; this was no doubt due to the lack of conflict. Similarly, in the situation NC × TC, the collective performances greatly resemble those of the TC at the first individual test. The NC × PC situation is intermediate, the performances being of a slightly lower level than in the PC × PC situation.

Does this mean that a good command of the cognitive compensations required by a specific situation also ensures the command of the social situation? An analysis of the structural index (Table 2) shows that this hypothesis alone is not sufficient to explain all our results.

In fact, in the NC × PC situation, six groups correctly accomplish at least one of the two experimental items i.e. after rotation of the model's base, they respect all the relations between the objects; this was not the case for either of the two subjects at the

Table 2. Structural index of the collective performances

Experimental situations	Number of correct performances on the two complex items of the interaction		
	0	1	2
NC x NC (n = 9)	8	1	0
NC x PC (n = 11)	5	3	3
NC x TC (n = 11)	2	1	8
PC x PC (n = 6)	1	2	3

pre-test. Five groups of the PC × PC situation also accomplish at least one of these items correctly.

These results therefore confirm our earlier results (Doise *et al.*, 1975) regarding the originality of collective cognitive performances, but this time under stricter experimental conditions. They also show however that an interaction is not necessarily conflictual. Thus in the case of two NC subjects, whose strategy is the same, the probability of conflict is very low and consequently, that of collective cognitive progress also. The good performances of the PC × PC situation, theoretically less conflictual than the NC × PC situation, can be explained by the intermediate status of the PC whose strategies tend to oscillate; in this case, the probability of a correct performance is not *a priori* null, as it is for the NC.

Individual performances

Are the effects of the interaction on individual cognitive restructuration in direct relation to the level of the collective performance? In other words, does it mean that the better the group performance, the greater the individual progress at the post-test? If we look at Table 1, it would seem that the relation is more complex, and that the collective performance, however original, does not have a direct influence on individual restructurations. This proves yet again the specific properties of social interaction which are not simply transmitted or transposed as such to the level of the group members studied individually.

Let us first briefly consider results for the deviation index. Among the NC subjects, only those confronted with PC subjects progress significantly ($p < .05$, Wilcoxon test, one-tailed). PC subjects progress in both conditions ($p < .01$, Wilcoxon test, one-tailed), but significantly more so when they are confronted with NC subjects (Mann-Whitney U test, $p < .025$, one-tailed). However, since the deviation index does not necessarily enable us to differentiate between NC and PC performances (one only has to look at the small differences between NC and PC subjects at the pre-test), our analysis will concentrate more on the structural index. Table 3 gives the number of subjects per situation who reach a higher level of performance on the post-test than on either item of the pre-test. It also shows the number of subjects who gave correct replies at both of the complex experimental items.

Table 3. Number of subjects who progress or do not progress (structural index). The number of subjects giving correct replies to both experimental items is shown in brackets

Experimental situations	Progress	No progress
NC* x NC ($n = 15$)	$2^{a\dagger}$ (1)	13
NC* x PC ($n = 11$)	7^{b} (2)	4
NC* x TC ($n = 11$)	1^{c} (1)	10
PC* x NC ($n = 9$)	8^{d} (6)	1
PC* x PC* ($n = 12$)	6^{e} (3)	6

*Subjects taken into consideration for the progress index; †significance levels for the differences (Fischer test): a and b: $p < 0.025$; b and c: $p < 0.025$; d and e: $p < 0.10$.

We shall first consider the progress presented by subjects who were initially NC, at the post-test. When confronted with other subjects of the same level, their progress was insignificant and during the interaction, they readily came to agreement on a false solution. When they interacted with TC subjects, and when the TC led the interaction which usually resulted in the correct solution, the NC made no more progress than in the previous situation. It is only when they are partnered with a PC subject that they make significant progress, becoming capable also of partial compensations. Thanks to the PC, they realize that they have to compensate for the rotation, even if they only compensate for one of the relations (usually the relation 'in front of/behind').
Thus a conflictual interaction does not necessarily help the less-advanced of the two subjects. A clinical analysis of the interactions enabled us to define some aspects which could explain the differences between situations. For example, in the NC × TC situation, the TC entirely dominates the negotiation decision processes and does not explain the criteria used to solve the problem. This is not so in the NC × PC situation where the PC is less dominant. His intermediate status characterized by partial compensations, by his hesitancy, doubts and lack of assurance compared to a TC, means that he tends to make explicit the aspects which he finds problematic (especially the mark); as a result, the NC is allowed a certain influence in the negotiations and final decision. (This also explains to a certain extent why the NC × PC performances tend to be inferior to those of the PC × PC).

Thus, the negotiation or mutual exchanges of influence involve a covariation of cognitive systems and attitudes, making any analysis even more complex. A better understanding of the factors involved would necessitate further research.

The subjects who were initially PC do not benefit either to the same extent from the two forms of interaction in which they take part. The most conflictual situation (facing an NC) results in the progress of most subjects (8 out of 9); but half the PC partnered with another PC also progress. As already mentioned, this situation is more conflictual than NC × NC due to the oscillations in the PC's replies.

Is this progress limited to the experimental items on which the interaction was also based, or does it go further? In order to answer this, we compared the performances on the two generalization items of the post-test of all subjects who progressed on the experimental items with those who did not progress. Is there any improvement between pre-test and post-test on these two items?

It can be seen from Table 4 that half the subjects who according to the structural index improved their performance on the experimental items, also did so on the generalization items this is not the case for those who show no improvement on the experimental items (difference significant at .01). The deviation index also shows this

Table 4. Number of subjects progressing on the generalization items who progressed/did not progress on the experimental items

		Generalization items	
		Progress	No progress
Experimental items	progress	11	13
	no progress	3	31
		($\chi^2 = 8.599$)	

relation between improvements on the two categories of items, the correlation between the two categories being significant for all 58 subjects ($r_{BP}= .51$, $p < .01$). This confirms the relevance attributed to this index. These data show the authenticity of the progress made which, as we have shown, cannot be reduced to a simple process of imitation.

DISCUSSION

The results of this experiment reinforce those of our previous studies on socio-cognitive conflict. They also provide information on the underlying mechanisms.

Thus, the results confirm that collective cognitive perormances are superior to those of the individual, on condition, however — and this was one of our hypotheses — that the interaction be conflictual. When two interacting subjects, using the same strategy, are unaware of the rotation and therefore of the necessity for compensations (NC × NC situation), the interaction is a simple reproduction of the initial performances of the group members. On the other hand, in the other situations which were all to some extent conflictual, the performances often acquired structural characteristics after the interaction which neither of the two subjects had been capable of in the individual pre-test.

The different forms of socio-cognitive conflict also seem to have a determinant influence on the individual progress following the interaction, without however this progress being a direct function of the collective performances. Thus, when subjects of the lowest level (NC) work together with subjects of the highest level (TC), they do not progress even though the group's performance is usually correct. A clinical analysis of this type of interaction, made possible by a video recording, showed that the more advanced subject tends to solve the problem on his own, ignoring the suggestions of the NC. The NC is therefore given no opportunity to coordinate his approach with that of his partner.

On the other hand, when the less advanced subject (NC) is together with an intermediate subject (PC), the characteristics of the interaction are different: the PC, whose system is less stable, is perturbed by the unacceptable solution proposed by the NC, although he does not yet possess the cognitive instruments necessary to solve the problem. While looking for a satisfactory solution, the PC's explicitate their strategy and the problems they face. As a result, they progress, but so do the NCs who are able to take part in the search for a correct solution.

Thus the notion of cognitive conflict, socially created and resolved, helps us to improve our understanding of the mechanisms underlying collective cognitive performances and their repercussion at an individual level. What effects does this have on the various theoretical approaches we examined at the beginning of this article?

The results of our experiment show, in fact, that the defenders of the social learning theory, for whom imitation is an essential development mechanism, need to slightly modify their conclusions. One of their requirements for progress — both from a theoretical and experimental point of view — is that the alternative model be superior and that it be correct (Murray, 1974). But we have shown that on the one hand, collective performances are structurally superior to those of the group members taken individually and that, on the other hand, a non-superior but conflicting model (NC) helps the intermediate subjects (PC) to progress. These results also go against Kuhn's

conclusions (1972); she found that for progress to take place, there had to be a 'short' but positive distance between the model and the subject, a model whose structural level was just above that of the subject being the most efficient.

On the contrary, results which show that a more advanced child (PC) interacting with a less advanced child (NC) makes progress tally with Allen and Feldman's results (1973) on the tutor effect; children who teach other children progress. Zajonc and Markus (1975) invoke a similar effect to explain why on intelligence tests, an only child scores only as well as the last-born of two children and not as well as the first born; they suggest that an older sibling's learning is facilitated when he or she 'teaches' younger siblings. Since an only child and a last-born child have no-one to teach, they do not experience the facilitative effect.

Finally, we would like to remark that if our results differ from those of some of the authors mentioned, this is especially so on the level of our theoretical aims. In fact, it is difficult to conclude that our data are really incompatible, owing to the different experimental methods used by these authors. In our research work, the central idea is still that social coordination of actions facilitates and precedes the individual coordination of actions. The results presented in this article are yet another step towards determining which forms of socio-cognitive conflict facilitate, such progress. We feel that in this way we are contributing to the integration of experimental results, and therefore of theoretical hypotheses, which at first sight seem incompatible.

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RÉSUMÉ

Une expérience précédente (Doise, Mugny, Perret-Clermont, 1975) avait montré que des couples de sujets réussissaient des performances, dans une tâche de représentation spatiale, meilleures que celles de sujets seuls. En conclusion, nous avions émis l'hypothèse que des conflits de centrations, inscrits dans une situation sociale, amenaient les enfants à coordonner leurs centrations. La présente recherche visait à vérifier plusieurs prédictions découlant de cette hypothèse générale. Les résultats montrent ainsi que lorsque des enfants présentant des stratégies cognitives différentes sont amenés à travailler ensemble, ils progressent plus que lorsqu'ils présentent tous deux une même stratégie. D'autre part, un sujet moins avancé, mais aussi un sujet plus avancé, progressent lorsqu'ils sont amenés à travailler ensemble.

ZUSAMMENFASSUNG

Ein früheres Experiment (Doise, Mugny and Perret-Clermont, 1975) zeigte, daß Paare von Vpn eine Aufgabe zum räumlichen Vorstellungsvermögen besser lösen können als einzelne Vpn. Daraus wurde gefolgter, daß Konflikte in kognitiver Zentrierung — eingebettet in eine soziale Situation — Kinder dazu bringen, ihre Zentrierungen aufeinander abzustimmen. Die vorliegende Untersuchung war angelegt, mehrere aus dieser allgemeinen Hypothese abgeleitete Voraussagen zu belegen. Die Ergebnisse zeigen in der Tat, daß größerer Fortschritt erreicht wird, wenn Kinder mit unterschiedlichen kognitiven Strategien zusammenarbeiten, als wenn Kinder mit ähnlichen dies tun.

Darüber hinaus lernen nicht nur die weniger, sondern auch die weiter fortgeschrittenen Kinder, wenn sie miteinander interagieren.