

## **Social interaction and the development of cognitive operations**

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### **Abstract**

*This paper presents two experiments to support the general hypothesis that the coordination of actions between individuals promotes the acquisition of cognitive coordinations. The first experiment shows that two children, working together, can successfully perform a task involving spatial coordinations; children of the same age, working alone, are not capable of performing the task. The second experiment shows that subjects who did not possess certain cognitive operations involved in Piaget's conservation of liquids task acquire these operations after having actualized them in a social coordination task.*

How do the cognitive operations controlling the interaction between the individual and his environment develop? The two research studies which we present here suggest that social psychology can help in answering this question. These operations do not develop only when the individual interacts with the objects of his physical environment. We present the hypothesis that the development of cognitive operations is facilitated when several individuals are required to coordinate their actions on the environment. This thesis lies at the crossroads of several lines of thought and research, the most useful for our purposes being the 'theoretical' approach of Piaget and the more 'practical' approach of certain educational psychologists.

Piaget often underlines the importances of social factors in the child's cognitive development. 'Human intelligence develops in the individual in terms of social interactions too often disregarded' (Piaget, 1971, pp. 224-225). Indeed, according to Piaget, '... cooperation is the first of a series of forms of behaviour which are important for the constitution and development of logic' (Piaget, 1950, pp. 162-163).

In his *Etudes sociologiques*, Piaget constructs a model which demonstrates that

the structures of intellectual operations are identical to the structures underlying social interactions involving values and exchanges of ideas (Piaget, 1965, pp. 49-53, 90-99, 100-171.) In this model, the equilibrium of these exchanges implies, apart from a common scale of values or a common language, a 'conservation' and a 'reversibility', that is, the possibility of coming back to propositions or validities previously recognized, of recognizing that what is a debt for one is a credit for the other and of taking into consideration as well what one or the other asserts.

The identity of form of cognitive operations in the individual with the structures for the exchange of assets and ideas is such, for Piaget, that he considers it impossible to establish a causal link between the progress of 'social logic' and the progress of 'individual logic'. 'Since both sorts of progress go hand-in-hand, the problem seems without solution, except to say that they constitute two inseparable aspects of a single reality at once social and individual' (Piaget, 1965, p. 158). We intend to take up the empirical study of this question again, one which has been dropped by the Geneva school, by putting forward the hypothesis that social interaction does indeed exercise a causal effect on cognitive development.

The educational current of thought which interests us is that which seeks to go beyond the model of the transmission of 'know-how' by insisting on the fact that teaching must aim at an active reconstruction of the science in the student. Freinet (1969) has already put forward the thesis that this would be most easily achieved when students carried out their work jointly. The same conviction is shared by certain Italian educational psychologists (Cecchini, Tonucci *et al.*, 1972) who are engaged on research into the effect that jointly carried out work has on children. Their main thesis is that the intensification of social relationships among children from disadvantaged backgrounds succeeds in making up for the handicap these children experience in comparison with children from more advantaged backgrounds. Traditional teaching accentuates this handicap. Teaching which favors children working together should eliminate it.

The research studies which we are going to describe are aimed at clarifying the links between social interaction and the realization of cognitive structures, which are postulated by the two approaches already mentioned. The first experiment, in particular, tries to show that certain forms of social interaction which allow individual children to coordinate their actions with the actions of other children results in cognitive performances which are better structured than those obtained in an individual situation. The second experiment is designed to show that cognitive modifications occurring in a situation involving social interaction are internalized and can later be re-activated by the individual child in a situation marked by the absence of interaction between equals.

### **Experiment 1 (carried out by G. Mugny)**

Numerous studies in social psychology have been concerned with the problems of the differences between individual and collective performances (e.g., Moscovici and Paicheler, 1973). The early conclusions of these studies were very varied. Depending on the criteria and the tasks involved, groups were more successful or less successful than individuals and sometimes equally successful. Significant progress in this field was made when the effect of the structure of the group interaction was studied in relation to the task structure. Nevertheless, there seems to be room to reconsider the problem of the comparison between individual and group from a developmental point of view, *which poses the problem of which factors affect cognitive development*. Supposing that it were possible to show that children at a certain level of development were unable to perform successfully on a task involving a certain specific cognitive structure unless they had the opportunity to coordinate their actions with those of others, would that not be an indication that some kind of interindividual coordination favors the coordination of the same actions by the individual? It is understood that such a verification in no way 'proves' the thesis that social coordination is necessary for an individual to attain 'operational thought'. It constitutes only the first stage of such a 'proof'. The experiment which would enable us to reach this stage must meet certain requirements. Above all, it is necessary that the best performances in a social interaction situation cannot be explained solely by the laws of a combination in that a group would succeed when one of its members was capable of solving the problem. From these considerations we derive the two chief predictions to be tested in this study:

- 1) Two children who are required to coordinate their actions attain cognitive performances superior to those of children facing the same task on their own.
- 2) This superiority is significantly different from the superiority that would be apparent if a single member of the group were sufficient to account for its performance.

### *Method*

#### *Subjects*

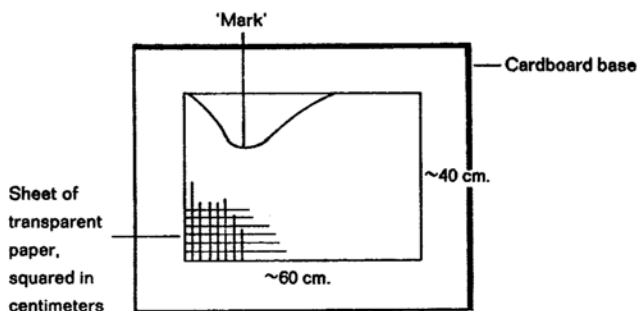
The population studied was taken from a school in the suburbs of Geneva. Sixty boys and girls took part in the experiment. They came from two classes of the 'deuxième enfantine' (second infant), with an average age of 5.9 years, and from two 'première primaire' (first primary) classes, with an average age of 6.8 years.

### *Test material*

The test material, improved after a pilot study, was derived from the Trois Montagnes (Three Mountains) experiment, described by Piaget and Inhelder (1956) and involving a study of awareness of perspective in a task of spatial representation.

The apparatus consisted of cardboard bases, onto each of which was attached a sheet of transparent paper, marked out in millimeter squares, about  $60 \times 40$  cm. On each sheet, in the same place, a clearly visible colored 'mark' was drawn, to serve as a point of reference for the orientation of the base. The 'mark' was an irregular shape and was set off to one corner of the sheet (see Fig. 1).

Figure 1. *Base for the construction of the model village and for the copy*



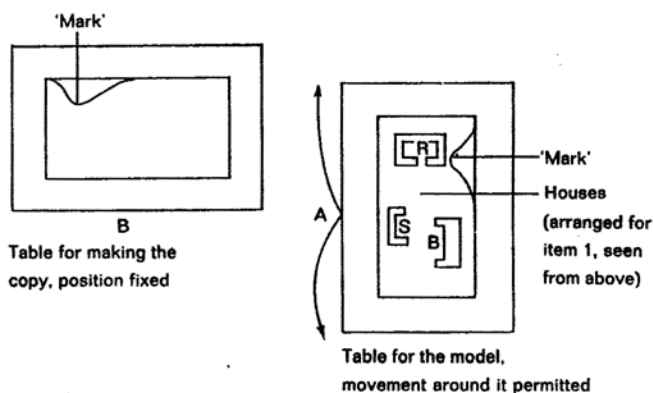
Two sets of three houses made of Lego completed the apparatus. The houses were clearly distinguishable from each other. A door indicated the 'front' of the house. The houses were named according to their shape, a ranch (R), a small house (S) and a big house (B). The experimenter used one of the sets to make a model 'village' by placing each house at a precisely defined position on the base. The other three houses were given to the subjects for them to make a copy of the 'village' on an identical base.

### *Instructions and procedure*

The subjects were placed facing a table on which was the experimenter's model 'village' (see Fig. 2A). They were given their set of houses and told to reconstruct the 'village' on the other base, which was placed in a table set at an angle of 90 degrees to their left. It was made clear to the subjects that they were permitted to move around the model (without touching the houses), but that they must

remain in front of the table while making the copy, and without turning the base (see Fig. 2B).

Figure 2. *Placing of subjects relative to the tables for the model and for the copy*



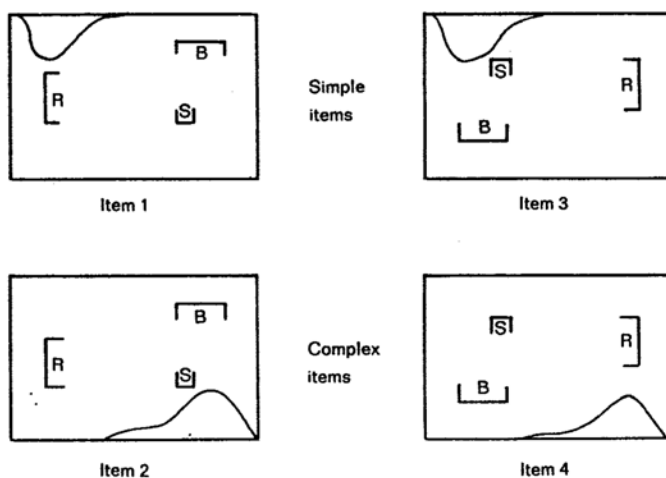
The instructions were geared to the children's level and referred to 'the man coming out of the lake [the 'mark'] who had to find his houses the same on the copy as on the model'. The instructions were repeated and clarified if necessary to ensure that they were fully understood.

Since we wished to compare a social interaction situation involving the maximum possible spontaneity with a situation as individual as possible, we tried to eliminate the 'active' role of the experimenter to the maximum extent. Otherwise it would have been difficult to check the effect of cognitive activation (through requests for supplementary information, counter-suggestions, etc.) and the effect of cognitive structuring (the influence on cognitive growth of the internal logic of an interview situation) which could have interfered with the central processes of dyadic interaction and cognitive isolation. The role of the experimenter was thus limited to ensuring the correct procedure. A television circuit made it possible to avoid taking detailed notes on the spot.

### *The items*

Four items were used, two deriving from the definition of two 'villages' (i.e., from the relative position of the houses). Two others were obtained by modifying the relative position of the houses and the 'mark' of the first two items (see Fig. 3). Each model 'village' was presented on a base where the 'mark' was at the top on the left (as for the copy) or at the bottom on the right (with a rotation of 180 degrees with respect to the copy). The composition of the two sets of four items is shown in Figure 3.

Figure 3. *The four models as seen from position A (cf. Fig. 2)*



The items were classified as 'simple' or 'complex', depending on the structure of the transformations they required. The subjects had to make the copy from position B (Fig. 2) and could do this for the simple items by making a simple rotation through 90 degrees of their copy of the model. For the complex items, this rotation had to be combined with an imaginary inversion of the copy or with a copy obtained by going round to the other side of the model to observe it. The subjects were all given the items in the same order (Fig. 3).

### *Experimental situations*

#### *Individual situation*

The subjects worked at the task alone. Apart from giving instructions, the experimenter did not communicate with them at all.

#### *Collective situation*

The subjects were taken in groups of two children of the same sex and from the same school class. They were asked to work together and to come to an agreement.

In both situations the subjects were instructed to let the experimenter know when they thought they had completed the task. For each age level, 10 subjects were studied in the individual situation and 20 others (ten groups of two) in the collective situation.

### *Experimental measurements*

An index of the deviation of the copy from the model was established. First, the exact position of each house (to the nearest centimeter) was noted after each item. This was simplified by the use of the squared sheet of paper. The index was obtained by setting up vertical and horizontal coordinates (in centimeters) of the two ends of the 'open door' side. Thus for each house it was possible to calculate an index of the deviation of the copy from the model, by taking the difference between the coordinates for the copy and those for the model, the index expressing the total horizontal and vertical deviations, divided by two.

The structural index consisted of the number of houses correctly placed with respect to the position and orientation of the door opening. While less precise than the other index, this was expected to give a more exact idea of the spatial operations which are not linked to the operation of measurement. However, it was expected, and a pilot study had shown, that the two indexes would be strongly linked. The measurements were made after each item while the children played as they liked with a construction game.

### *Results*

#### *Deviation*

As expected, the simple items (1 and 4) showed less deviation than the complex items (2 and 3) (see Table 1). Thus it seemed reasonable to simplify the analysis by adding together the items in the same category. A three factor experiment with repeated measurement on one of the factors (Winer, 1962) made it possible to

test our hypothesis (see Table 2). From the results it was clear, on the one hand, that age made no difference and, on the other, that the differences between the two categories of items were highly significant. Above all, it was clear that the groups of children gave performances superior to those of children on their own. For the interaction of factors  $A \times C$ , the results showed that the differences between situations were only apparent for the complex items, social interaction bringing no benefit for the simple items but improving performance on the complex items.

Table 1. *Mean of indices of deviation*

Experimental situation*	Item 1	Item 2	Item 3	Item 4	Mean for simple items (1 + 4)	Mean for complex items (2 + 3)
I2	11.55	28.95	31.95	8.45	10.00	30.45
I1	5.10	30.35	29.20	14.15	9.62	29.77
G2	6.25	23.70	17.10	13.30	9.77	20.40
G1	4.15	17.35	14.15	13.70	8.92	15.75

\* I - individual situation; G - collective situation;  
 2 - deuxième enfantine, (second infant); I - première primaire (first primary)

Table 2. *Analysis of variance of deviation\**

Source of variation	df	Mean square	F	Level of significance
Between subjects	39	—	—	—
Situation (individual/collective) A	1	639.9	15.11	$p < .001$
School level B	1	94.4	2.23	
$A \times B$	1	1.0	0.02	
Error between subjects	36	42.33		
Within subjects	40			
(Simple/complex items) C	1	4527.7	25.44	$p < .001$
$A \times C$	1	886.1	4.97	$p < .05$
$B \times C$	1	1.7	0.00	
$A \times B \times C$	1	43.1	0.24	
Error within subjects	36	177.9		

\* The indices for items 1 + 4, 2 + 3 were added together.

### *Structural index*

This index gives the number of houses correctly placed and oriented for the two different categories, the index of total success being 6. In this case, too, the



age factor made no difference (see Table 4), so Table 3 was simplified by giving only the means of factors A  $\times$  C (situation and item category).

Table 3. Means of structural indices\*

	Simple items	Complex items
Individuals	4.75	1.30
Groups	5.05	3.30

\* The indices for items 1 + 4, 2 + 3 and for the two age levels were added together.

Table 4. Analysis of variation for the structural index

Source of variation	df	Mean square	F	Level of significance
Between subjects	39	—	—	—
Situation (individual/collective) A	1	2.11	4.358	$p < .05$
School level B	1	0.11	0.232	
A $\times$ B	1	0.31	0.644	
Error between subjects	36	0.48		
Within subjects	40	—		
(Simple/complex items) C	1	17.11	38.886	$p < .001$
A $\times$ C	1	1.51	3.435	$p < .10$
	1	0.01	0.028	
A $\times$ B $\times$ C	1	0.01	0.020	
Error within subjects	36	0.44		

An analysis of variance identical to that used for the deviation index (see Table 4) confirmed the latter's results (although the interaction A  $\times$  C was of lesser significance). In consequence, it is not precision (of the measurement, which appeared in certain groups only) which fundamentally distinguishes the performance of individuals and groups; it is indeed the system of spatial transformations which underlies the performances.

Could the success produced by social interaction be simply a by-product of the fact that with two children there is a higher probability that one of them would be of a high enough level to succeed independently of the other? To answer this question, it is possible to calculate the number of successes that would be expected in a group (assuming an equivalent sample) as a function of individual successes which here only go up to three in number. (It concerns subjects achieving at least *one* success without error from the point of view of the structural index and this for the two complex items only.) The formula of Lorge and Solomon (1955) was used, according to which  $p_g = 1 - (1 - p_i)^n$ , where  $p_g$  is the probability of group success,  $p_i$  the probability of individual success (as a function of the sample) and  $n$  is the number of individuals. This formula shows that for

the hypothesis that the success of a single individual is sufficient to account for the group performance; 5.5 groups should give a correct performance on the complex items at least once. Now 14 groups give such a performance, so the result cannot be attributed to this effect. Indeed, the difference between the frequency observed and the frequency according to the hypothesis of the formula described is highly significant ( $X^2 = 12.86$ ;  $df = 1$ ).

Another result shows that social interaction produces different effects. This concerns the progress made by individuals and groups on the items. The groups should make more progress than the individuals for two reasons. First, it is more probable that two individuals whose actions interfere with one another rather than one individual acting alone would discover and integrate a new aspect of the problem. Moreover, an individual can concentrate successively on different aspects of the task which remain uncoordinated. In contrast, in a group different points of view, at first not integrated, might later reappear simultaneously in the actions of the two members and so require a better integration.

In order to show whether groups would show more progress than individuals, we have, after detailed analysis, distinguished two categories of performance which reflect different strategies. The distinction between these categories rests on the placing of house R and the block of houses, B and S. X performances include all the correct solutions and those where R is correctly placed but B and S reversed, as well as cases correct except for errors in the orientation of the houses (evidence of final difficulties). Y performances include the cases where there is a simple rotation of 90 degrees (the solution not taking into account the change in position of the 'mark'), as well as the cases where R is placed according to this simple rotation of 90 degrees but where B and S are reversed, this appearing to indicate an intermediate level. The results are given in Table 5.

Table 5. *Frequency of attainment of various levels in the different experimental situations\**

Levels attained		Situation	
Item 2	Item 3	Individual	Collective
x (stabilization +)	x :	5	9
x (regression)	y :	1	2
y (progress)	x :	2	6
y (stabilization —)	y :	12	3

\* Level x indicates a higher level, level y a lower level.  
Test of exact probability on the last two lines.  $p < .025$

The patterns which are particularly interesting are the Y - Y and the Y - X; a test of the exact probability (Fischer) is significant ( $p < 0.025$ ) and confirms that the groups show more progress, leading to a better structuring of perspectives, than the individuals of whom the large majority develop little or not at all. This is shown notwithstanding the fact that there are as many small changes, especially in orientation of the houses, within category X as there are in category Y.

This first experiment thus shows clearly that under certain conditions social interaction leads to more complex structuring than does individual action. But is the effect of the interaction internalized at the individual level? The second experiment attempts to answer this question.

### **Experiment 2 (carried out by Anne-Nelly Perret-Clermont)**

While the preceding experiment has enabled us to verify the existence of a significant difference between individuals and groups of children engaged in certain coordinations of operations, this second study is more concerned with the possible effects of social interaction on the organization of operational coordination in the individual child. It thus concerns the problem of the internalization of the coordinations originally produced in a social situation. It is concerned with finding out whether, beyond memorization of the operations set into play in the group action, the internalization of these operations leads to an understanding of the concepts employed which is structurally more elaborate. The child would reveal this understanding by using explanations which involved valid and explicit arguments which he had not previously heard of and which are pertinent to the attainment of operational thought.

Piaget's classic task on the decanting of liquids (Piaget and Szeminska, 1952) was adapted for this study. In this task, the authors demonstrate that the quantities are not realized to be constant straight away but that the concept of their conservation develops progressively according to a precise intellectual mechanism. This task has the advantage of having been used by Sinclair (1967) in her studies on learning terms comparing quantities, in an experiment which is considered again here.

Sinclair had found that children who had a concept of conservation expressed themselves in a different manner from pre-operational children. She then looked to see whether modification of the verbal patterns of the non-conservers would be followed by a change in their behavior at the operatory level.

Sinclair gave her subjects a pretest to determine their operational level, using

the task of decanting liquids. The second session was designed to give verbal training (use of vector, of differentiating terms and of bi-partite structure). This training was continued in the third session, which ended in a posttest identical to the pretest. The three sessions were spaced between three and seven days apart. A month later, the children were given a second posttest as a check. In view of the results, Sinclair concluded that children trained in correct understanding of certain verbal expressions concerning conservation in no way improved their operational grasp of conservation.

A different problem is posed here. If verbal learning does not help the understanding of conservation at all, what will be the effect of a collective performance of the task both by children who understand conservation and by those who do not? It will be shown in the section on method that the task of decanting liquids can easily be transformed into a collective task of a specific character, namely sharing. The hypothesis is that learning will be facilitated for a non-conserving child who has to pour out equal shares for two children who are conservers, in the particular situation where the use of non-conservation would harm the interests of the conserving children. The conservers would help the first child to produce a 'correct' coordination of the different aspects of the situation so as to enable him to carry out his task fairly.

### *Method*

#### *Subjects*

The experimental subjects were Geneva schoolchildren from the première (first primary class), aged 6 and 7, with equal numbers of boys and girls.

#### *Test material*

This consisted of a set of transparent laboratory glasses of different shapes: three identical glasses A, A' and A'' (graduated chemist's glasses of 250 ml. capacity), a glass C, wider and shorter than glass A, a glass D, taller and narrower than glass A, an opaque bottle containing fruit juice and some straws.

### *Instructions and procedure*

#### *Experimental situations*

(1) *Pretest.* The child sits at a little table with the experimenter (E) who invites him to play a game with juice. The child is told that he can drink the juice after the game if he wishes. E then follows the classical procedure using glasses A, A' and C, encouraging the child to explain his replies and offering him contrary

suggestions. At the end of the experiment, E gives the child a straw and asks him whether he wants to drink from glass A or glass C. E then asks him to explain his choice. The responses to the pretest are then divided into three categories according to operational level: conservers (C), intermediate (I) and non-conservers (NC). The criteria used are those described by Piaget and Szeminska (1952) and also used by Sinclair (1967).

Criteria: First stage - absence of conservation (NC). A child at this stage who sees the same quantity of liquid in identical glasses has no difficulty in recognizing their equality. Yet if this liquid is poured into different shaped glasses the child believes that the quantity of liquid increases or lessens as a function of the size of the container.

Second stage - intermediate response (I). These children have intermediate reactions. From time to time they assert that the quantity is conserved but without seeing any physical or logical necessity for it. These children waver between coordination of the relationships involved (height and width of the glasses) and submission to the evidence of their perceptions.

Third stage - conservation necessary (C). The child asserts straight away that the quantities of liquid are conserved, independently of the number and nature of pourings carried out. As reasons for this conservation, they give the following explanations: identity, compensation and reversibility.

(2) *Social situation.* This phase of the experiment took place, on average, fifteen days after the pretest. Three children (in general coming from different classes but all being 'première primaire' pupils) were brought together in the experimental room. The children (S1 and S2) were conservers (C) on the pretest, the third child (S3) a non-conserver or intermediate (NC or I). S3 is seated at the head of the table with S1 and S2 on either side of him, facing each other. The experimenter tells them that they are going to play a game with juice that is a little different from the one they played the other day. Glass A is given to S1, glass D to S2. E gives the opaque bottle to S3 and asks him to pour out some juice for S1 and S2 in their respective glasses 'so that they both have the same to drink and they are both equally happy'. E adds that S3 must ask for the approval of S1 and S2 when he has finished. It is only when all three have agreed that the sharing is fair that S3 is given an equal amount of juice in A'' and all three may drink. E also places glass A' in front of S3, telling him that he can use it if it is of any use to him.

This social interaction situation lasted about 10 to 15 minutes. The role of the experimenter was to keep the conversation going without expressing her own opinion. Sometimes she rephrased the children's comments, especially in the case

of a shy child or of a non-conserver who did not seem to be listened to by his companions.

(3) *Posttest 1.* A week after the social situation the NC or I subject was put in the same situation as in the pretest, with the same method of questioning and evaluation. However, the material also included glass D as well as A, A' and C. This allowed the E to question the child about new kinds of pouring (for example, comparing A poured into C with A' poured into D). The classification of responses was carried out using the same criteria as in the pretest.

(4) *Posttest 2.* A second posttest, identical to the first, took place about a month after the first.

#### *Control situation*

The control group was made up of twelve subjects, boys and girls of the same age and the same class in school as the experimental subjects. These subjects were given a pretest and then posttest 1, with the same time interval between the two sessions as those in the experimental situation.

#### *Results*

Table 6 enables the comparison of the subjects' levels on the pretest with that of posttest 1; 24 of the 37 children progressed on the scale NC - I - C, which represents progress for 64.8 % of the subjects.

Table 6. *Operational levels of the subjects on the pretest and on the first posttest*

Levels on posttest 1	Experimental situation		Control situation	
	NC on pretest	I on pretest	NC on pretest	I on pretest
NC	11		9	
I	9	2	1	1
C	8	7	0	1
Totals	28	9	10	2

The comparison of the progress of non-conserving children exposed to a social situation with that of the control group children who were only exposed to the pretest and posttest 1 makes it possible to show that the simple factor of maturation

tion had little likelihood of being alone responsible for the high percentage of progress ( $X^2 = 5.70$ ;  $df = 1$ ;  $p < 0.01$ ; one-tailed).

Is this progress lasting? The analysis of the results of posttest 2 shows that: fifteen subjects maintained progress made between the pretest and posttest 1; eight subjects even progressed between the two pretest; four subjects regressed to their pretest level, at the time of the second posttest.

Progress thus seems quite stable. On the other hand, the fact that eight subjects even progressed between the first and second posttests seems to signify that the acquisition of cognitive operations is an active and relatively slow process. This has been similarly brought to light by recent research on learning (Inhelder, Sinclair and Bovet. 1974).

In order to verify if such an active process does indeed intervene, a qualitative analysis of the subjects' replies at the time of the posttests was made. Are their performances simply reflections of the discussions experienced in the social situation? It seems that this is not the case. Among the 23 subjects who had given conserving performances (21 C on posttest 2, to which are added the two C from posttest 1 who regressed to I on posttest 2), thirteen had introduced one or more arguments in their explanations which had not appeared in the social situation. Among these new arguments were three arguments of identity, seven arguments of compensation and seven arguments of reversibility. It should be pointed out that as the identity argument was very frequently given by C children in the social situation, it had only a small probability of appearing as a 'new argument' in the posttests.

These results give clear support for the hypothesis that the interaction experienced in the social situation does indeed favor the elaboration of the operational structure of the individual child.

If this situation thus opens up possibilities of cognitive structuring for the subject, the problem is to know which characteristics of the social situation are responsible for it. Is it the presence of two other children which facilitates decentration by allowing the subject to envisage different points of view more easily? Or is it 'the conflict of communication' (Smedslund, 1966) arising from the confrontation between subjects of different cognitive levels which makes the subject aware of the contradictions of his own mode of reasoning? Or perhaps the fact that C children are in a majority allows them to impose their opinion on the NC child who is often less sure of himself?

These questions open the way to new research. However, a preliminary analysis of the children's discussions in the social situation hints at the results for it appears that among the most effective discussions for the progress of NC or I children are those in the course of which the C children defend their own point

of view in a consistent and coherent manner (73 % progress). In contrast, if one of these children has shown NC or I behavior, even momentarily, then the social situation becomes less effective (50 % progress). These observations indicate the importance for the NC child of not simply being put in the presence of equals and interacting with them but of being confronted by partners who defend a different mode of reasoning in a stable manner.

### **Conclusion**

The two experiments that have been described meet the requirements of the first steps in the verification of the hypothesis that the development of 'operational thought' is facilitated when several individuals are required to coordinate their actions.

In the first experiment, it was possible to show that groups do indeed reach levels of structuring in their performance which individuals cannot attain. The second experiment then showed that cognitive structures formed in a social situation are internalized and reactivated in situations characterized by a different kind of social interaction.

The next step is a more detailed analysis of the mechanisms by which social interaction affects cognitive structuring. The hypothesis of 'cognitive conflict experienced and resolved socially' will continue to be used in our future research. The interaction of two children on a given task presents the opportunity for systems of action and representation centered on different aspects of a task to be confronted with each other and to become coordinated. Whilst one child working alone at a given task can remain enclosed in an egocentric approach, it should be more difficult for two children with different points of view to agree to a non-decentered approach, especially when these points of view are mutually exclusive. It is towards the verification of this hypothesis that our present research is directed.



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## Résumé

Cet article présente deux expériences illustrant l'hypothèse générale que le fait pour des individus d'effectuer entre eux des actions coordonnées favorise leur acquisition d'opérations (*coordinations*) intellectuelles. La première expérience montre comment deux enfants qui travaillent ensemble, peuvent réussir une épreuve de coordination spatiale; des enfants du même âge travaillant seuls sont incapables de réussir cette épreuve. La seconde expérience montre comment des sujets qui ne possèdent pas certaines opérations intellectuelles qui entrent en jeu dans l'épreuve de conservation des liquides de Piaget, peuvent acquérir ces opérations en les actualisant dans une épreuve de coordination en groupe.

## Zusammenfassung

Es werden zwei Experimente beschrieben, die die generelle Hypothese unterstützen, daß das gemeinschaftliche Durchführen von Handlungen den Erwerb kognitiver Koordinationsfähigkeit fördert. Das erste Experiment zeigt, wie zwei zusammenarbeitende Kinder erfolgreich eine Aufgabe zur räumlichen Koordination durchführen können, wogegen Kinder gleichen Alters, die allein arbeiten, nicht in der Lage sind, eine solche Aufgabe zu lösen. Im zweiten Experiment werden Vpn, die die kognitiven Operationen zur Lösung von Piaget's Aufgabe zur Volumenkonstanz zunächst nicht beherrschen, befähigt, diese Operationen durchzuführen, nachdem sie die Operationen in einer gemeinsam durchgeführten Koordinationsaufgabe aktualisiert haben.