Progress in Applied Social Psychology, Volume 1
Edited by G. M. Stephenson and J. M. Davis

9

*Interpersonal Coordinations and Sociological Differences in the Construction of the Intellect**

GABRIEL MUGNY†, ANNE-NELLY PERRET-CLERMONT, and WILLEM DOISE

Translated from the French by Alma Dorndorf, University of Bristol, and Diane Mackie, University of Auckland.

INTRODUCTION

Psychosociological experimentation seeks to elucidate the many links which exist between different levels of analysis of the same phenomenon: links which connect functions at the individual level; functions which develop at the level of interpersonal relations; implications of different category memberships and the intergroup relations in which they are manifest; and the influence of the most widely held values in a society (or ideology) (Doise, 1976; Doise, 1978). In this chapter we shall try to distinguish the links which exist between several of these levels in the sphere of the development of cognitive processes which is usually studied at the intra-individual level (if only on account of the individualistic nature of the tests). We will deal first of all with the interpersonal bases of the development of cognitive mechanisms in the child, illustrating experimentally the chain of circular (or spiral) causality which

Most of the research referred to in this chapter was carried out as part of a programme sponsored by the Fonds National Suisse de la Recherche Scientifique, no. 1.343.0.76.
†Authors' address: Faculté de Psychologie et des Sciences de l'Education, Université de Genève, 211 Genève 4, and Faculté des Lettres, Université de Neuchâtel, Switzerland.

connects individual cognitive functions with the interpersonal interactions in which the child participates. Secondly, we will examine this first connection as it relates to differences between social categories via a demonstration that although inter-individual elaboration of cognitive functions is manifest at different times in children from different social categories, the developmental pattern governing them is the same for all social categories.

TRENDS IN THE EXPERIMENTAL STUDY OF THE LINKS BETWEEN SOCIAL INTERACTION AND COGNITIVE DEVELOPMENT

There is no lack of theoretical and experimental work concentrating on the problem of the acquisition of intellectual notions, and essentially of operational notions such as conservation (for a review of this work, see especially Brainerd and Allen, 1971; Strauss, 1972; Brainerd, 1973; Inhelder, Sinclair, and Bovet, 1974). The notion of conflict (in its more general sense) is of importance here, although this concept has been operationalized in widely divergent ways. Thus, a first type of conflict emerges between hypotheses and observations of findings which may disconfirm them creating intellectual dissatisfaction (Lefebvre and Pinard, 1972; Inhelder, Sinclair, and Bovet, 1974). A second type of conflict, studied in depth by the Piagetian school (Inhelder, Sinclair, and Bovet, 1974), arises when different schemata are simultaneously brought into play but are contradictory. To these two very general types of conflicts can be added a third type which is of specific interest to us, i.e. 'socio-cognitive' conflict, where a change in the individual's strategy of responses has its explicit source in a conflict between his initial response and the response strategy of one or several others.

The paradigm commonly used in research into the role of social interaction in cognitive development consists of confronting the subjects, after having evaluated their cognitive levels in a pre-test, with other possible responses to a problem during an interaction phase, in order finally to evaluate any subsequent progress during one or more post-tests. The interaction situations can be categorized according to several criteria: according to the nature of the social situation (e.g. observation of a model or reciprocal interaction between subjects); according to the nature of the partner allocated to the child (e.g. peer or adult); and according to the cognitive level of the responses presented to the child. It can be noted at this point (Mugny, Lévy, and Doise, 1978) that although the interactions between children are studied more frequently than situations where one child merely observes another, the converse is true when one partner is an adult: although adults participate frequently in these experimental paradigms as models to be observed by the child, they do not interact with the child (in the sense of reciprocal exchanges). It is indeed interesting to note that until recently real interactions with the child have been

simply from the interaction of the child with his surroundings in his non-social environment, but that this interaction is always mediated by, and therefore derives its meaning from, his social interactions with his peers and with the adults of his acquaintance. In this sense we are dealing with a socio-interactive approach, which is also a constructivist perspective, since we maintain (with Piaget) that cognition is not a copying process, a passive appropriation, but that it is indeed a construction by the active subject (or, to emphasize the psychosociological perspective, *inter*active subject), which therefore takes place during social interaction.

This perspective, which will now be developed further, is based on an important collection of experiments which for the most part involve a pre-test, test, and post-test procedure. Several experiments employ the same situation, which of course varies according to what we wish to demonstrate, but which is nevertheless based on the same paradigm. The principles of these paradigms are summarized in the Appendix. Four paradigms are presented: *Paradigm I*, spatial transformations experiments: *Paradigm II*, conservation of length experiments; *Paradigm III*, conservation of liquids experiments; and *Paradigm IV*, the 'cooperative game'. The reader is therefore invited to refer to the Appendix to obtain the information which is required for complete understanding of the experiments, but which is too cumbersome to repeat each time one of these paradigms is referred to.

Our basic hypothesis, namely that intra-individual cognitive structuring develops from inter-individual cognitive coordination, led us to develop those ideas both theoretically and experimentally in five directions.

1. The inter-individual elaboration of cognitive strategies initially precedes their intra-individual elaboration. It is evident when considered from a developmental perspective that individual cognitive levels evidenced in the post-test constitute the principal dependent variable; social interaction itself can in effect be considered as of only secondary importance as a dependent variable, even though it is precisely at the level of the inter-individual interaction that the independent variables are most frequently manipulated. However, several experiments have been directly concerned with the evaluation of collective performances. To the extent that the general hypothesis specifies that the inter-individual interactions are beneficial to cognitive development, it is legitimate to suppose that inter-individual coordinations would consequently be superior to intra-individual coordinations in one way or another. This is indicated by several experiments, employing the paradigm of spatial transformations (Doise, Mugny, and Perret-Clermont, 1975; Mugny and Doise, 1978), the paradigm of the conservation of length (Mugny, Giroud, and Doise, 1979), and the paradigm of the cooperative game (Doise and Mugny, 1975; Mugny and Doise, 1979).

The results achieved in an interaction situation cannot be equated with the performance of the better of the partners. This is an important point, and is

ignored as far as the adult partner is concerned even when the latter plays an important part in the child's history. However, one can easily guess than an omission of this kind arises in reality from a very narrow conception of the pedagogic relationship as the social transmission of a cultural heritage, abstracted from all contexts of elaboration, exchange, and cooperation between child and adult.

A similar perspective can be perceived in the too-frequent usage of certain models of response, and in the no less systematic omission of other types of models. In effect, four types of cognitive models can be distinguished, which can be presented to the child in one form or another. Thus, we will use the term *progressive* model to indicate a model of response which is developmentally superior to that used by the child in the pre-test; a progressive model can be *correct* or *incorrect (intermediate)* when we are dealing with a method of solving the problem which mediates between the subject's solution and the correct solution. A model is said to be *similar* when it is based on the same scheme as the child's responses; it may or may not be contradictory to that of the child. For example, two subjects may both incorrectly judge one stick to be 'longer' than another stick in a conservation of length test, but may either agree or differ as to which stick is 'longer'. Finally, we speak of a *regressive* model to indicate that the alternative model is at a cognitively inferior level in relation to the level of which the child is actually capable. Let us then examine the previous research concerning these various types of models (the work carried out by the present authors will not figure at this point of the analysis, since it will be discussed later).

(a) A condition utilizing a *progressive correct model* is integral to virtually all of the experimental designs used, and is in fact very often an essential condition of any demonstration. Moreover, in the majority of cases the effects of such a model appear to be positive. Indeed, children benefit from observation of a correct response model by a peer (J. P. Murray, 1974; Botvin and F. B. Murray, 1975; Cook and F. B. Murray, 1975), or by an adult (Beilin, 1965; Waghorn and Sullivan, 1970; Rosenthal and Zimmerman, 1972; Zimmerman and Lanaro, 1974) as much as they do from observation of a correct response by a peer with whom they interact reciprocally (F. B. Murray, 1972; Silverman and Stone, 1972; Silverman and Geiringer, 1973; Botvin and Murray, 1975; Miller and Brownell, 1975).

(b) Few experiments have studied the impact of a *progressive incorrect* (or *intermediate*) *model*, and, furthermore, their results have in general been inconsistent: J. P. Murray (1974) found that such a model has no beneficial effect, whereas Kuhn (1972), who predicted that children would benefit from such a model, found that they did progress in terms of cognitive development. There appears to exist in fact an optimal 'cognitive distance' between the cognitive level of the model and that of the child, outside of which the child will not progress.

(c) No progress is expected, nor has been found, in the experiments which examine a *similar model* (Kuhn, 1972; J. P. Murray, 1974). Let us note with regard to this point that the models used were in no way conflictual (as is *a priori* the case for the three other types of models) since those used proposed identical responses to those of the subject.

(d) The *regressive model* does not seem to have been studied to any great extent. It can certainly be implicitly assumed that the subject who serves in an experiment as partner to a child at an inferior cognitive level is able to observe reciprocally a regressive model in the latter. However, no progress has been reported by the researchers for the superior child in such cases (although there are indications that such progress may have occurred in F. B. Murray, 1972, and Kuhn, 1972), but the data presented do not allow for conclusions to be drawn. One could also cite the work on the 'tutoring effect' (Allen, 1976) in which, however, the progress is attributed to the *individual* cognitive activity and not to the interaction which is merely the pretext for its appearance. The case of Rosenthal and Zimmerman (1972) is a very special one: they appeal to the notion of the vicarious acquisition of learning in their study of cognitive development from a behavioural perspective, and from this perspective are able to predict a regression of level of performance for the conserving subjects who observed a non-conserving model. The confirmation of this hypothesis is based, however, on an operationalization which continues to present problems (Silverman and Geiringer, 1973; Mugny, Doise, and Perret-Clermont, 1975–76; Perret-Clermont, 1980), particularly the difficulty of differentiating merely compliant responses from some underlying change in cognition.

Taking into consideration all the points discussed and especially when we consider the predominance of correct models in the conditions designed to elicit progress, it seems justifiable for us to conclude that even when social interaction has been introduced as an agent of progress, it has been introduced as an integral part of an approach which postulates, at least implicitly, a process of imitation as a necessary condition for progress to occur.

It was partially in reaction, on the one hand, to a certain domination of individualistic concepts of development and, on the other hand, to a reduction of social interaction to imitation processes, that a new psychosociological perspective of cognitive development was developed. Such an approach was prompted by reflections initiated by the crisis in social psychology; as emphasized by Moscovici (1972, p.141), the task of a new social psychology is partly to develop from 'a bipolar psychology (ego-object) to a tripolar psychology (ego-other-object), a necessary change because it conforms more to reality'.

A PSYCHOSOCIOLOGICAL APPROACH TO COGNITIVE DEVELOPMENT

The central idea of our approach is that cognitive development does not result

one that was already being debated in the 1950s when the findings of authors such as Shaw (1932) or Taylor and Faust (1952) were contrasted with the findings of Macquart (1955) or Faust (1959). It is in fact from the first model of Lorge and Solomon (1955) that we have borrowed the formula enabling us to compare the collective performance with the performance of fictitious or nominal groups, randomly composed according to the probability that one of the partners could discover the correct solution by himself. Indeed, the collective performances exceed this possibility (Doise, Mugny, and Perret-Clermont, 1975).

Another method of demonstrating the cognitive originality of the collective solutions is offered in an experiment using the same paradigm of spatial transformations (Mugny and Doise, 1978). After the subjects had participated in a pre-test, they were divided into those subjects responding correctly or incorrectly; then two groups of two of these latter were formed. One of them was 'inferior' at this task and the other one was 'intermediate', but gave no correct responses whatsoever. Observation of the behaviour during the interaction shows that in the majority of cases these pairs were capable of completing at least one item correctly. It should be remembered that no subject was capable of making these coordinations by himself.

A series of experiments using the paradigm of the cooperative game (Doise and Mugny, 1975) elucidates further the conditions under which the performance of the group is superior to that of the individual. First, it appears that the group is superior essentially in the initial stages of the elaboration of a notion. On this task the group performance is superior to the individual performance when the subjects are about 7 to 8 years old, but is no longer superior when they are about 10 years old (this result is corroborated by some new research on this paradigm; Mugny and Doise, 1979). This indicates that cognitive progress is based on an initial interdependence of actions which decreases to the extent that the individual internalizes his interactively established coordinations.

In a similar way, communication has an essential part to play in the elaboration of a notion. When subjects in a group are prevented from communicating verbally, the collective performances are distinctly inferior to those evidenced in a free communication condition. Once again, this difference is no longer apparent with older subjects. Finally, a similar result is observed for the groups where a hierarchical structure is imposed: the performances of these groups are inferior to those of groups which have been able to interact more spontaneously.

2. Participation in a social interaction can produce individual progress in the partners in the post-tests. Our experimental paradigms, based for the most part on three observation sessions (pre-test, experimental situation, post-test), enable us to elucidate the problem of distinguishing between the quality of the collective performances from the consequent acquisition or learning during

social interaction. Since we maintained, in the work previously mentioned, that the collective performances can be superior to those previously achieved in the pre-test by the same subjects working alone, or by other individuals working alone in a 'control' situation, the comparative study of the individual performances in the pre-test and the post-test should enable us to evaluate the nature of the learning thus produced.

It should be made clear right away that the correlation between any progress evidenced in the post-tests and the progress (compared with performances in the pre-tests) demonstrated during social interaction cannot always be ascertained. In effect, the level attained during the collective activity does not enable us to directly predict the level which will be attained by those same individuals when they next work alone. The psychosociological characteristics of the collective situation and of the interactions which it produces can in fact prevent the child from developing cognitive coordinations at the same level as those on which the collective achievement is based. One can imagine social situations which are too constrained for progress to be even temporarily manifest (Lévy, Doise, and Mugny, in press), or in which such progress is not apparent even when the correct solution has been elaborated during the collective situation. This was the case in one of our experiments (Mugny and Doise, 1978) where the subjects with the correct response imposed it without discussion on the subjects with the incorrect response.

What is the nature of the learning observed when the comparison between the initial abilities of the subjects in the pre-test and the abilities they displayed in the post-test reveals that the individuals concerned have progressed? Are we dealing here with the mere imitation of a pattern of behaviour cumulatively added to the already established behavioural repertoire of the subject? Or can these new abilities be termed 'operations' in the sense that they result from a more general cognitive restructuring of which the individual has now become capable? Three of our experiments were particularly concerned with finding an answer to this question (Doise, Mugny, and Perret-Clermont, 1975; Perret-Clermont, 1980). These experiments relied on the notions of the conservation of liquids and the conservation of number. The analysis of behaviour in the post-tests enabled us to elaborate, in several ways, our theory that the progress achieved as a result of interaction does not result from the simple imitation of a behaviour pattern, but from a much more extensive restructuring of cognitions.

The results of post-tests which included tests of operations other than the one being examined in the experiment show that the subjects' progress tends to become generalized to other, related notions: progress in the elaboration of the notion of the conservation of liquids tends to be accompanied by the acquisition of the notion of the conservation of number, by similar progress in the test for the conservation of matter, and by eventual progress in the sphere of the conservation of length (Perret-Clermont, 1980).

as a cycle of reciprocal causality extending from the collective to the individual and vice versa.

3. In order to produce progress, social interaction should be conflictual. This was the post-hoc hypothesis put forward after an initial experiment on the effects of groups (Doise, Mugny, and Perret-Clermont, 1975, experiment 1). A clinical analysis of the interactions in this experiment seemed to show that the collective performances increased in superiority as a function of the amount of conflict between the partners' responses. It is towards a confirmation of this hypothesis that several new experiments have been directed, introducing situations and variables likely to manipulate directly the existence (or indeed the intensity) of a socio-cognitive conflict of this kind. One piece of research within the spatial transformation paradigm (Mugny and Doise, 1978) utilized an experimental design enabling both the opposition of subjects at different cognitive levels and the juxtaposition of subjects at the same level. The subjects were categorized during a pre-test into three cognitive levels; we shall call them inferior, intermediate, and superior or correct (see Appendix). During a collective interaction phase, two children worked side by side (and thus saw the problem from the same point of view) and had to reach agreement concerning a copy of the village they had to reproduce. In three experimental conditions an inferior subject worked either with a partner at the same inferior level or with a partner at an intermediate level, or with a partner giving the correct response. A final condition opposed two children at the same intermediate level. The results indicated that during the interaction the collective performances were all the better if one of the partners was at a higher level than the other. However, as we have already seen, even pairs in which a subject at an inferior level is opposed to one at an intermediate level succeed for the most part in solving at least one item correctly. None of the members was able to do this individually. Moreover, this experimental condition shows that the progress is produced as much by the inferior subjects as by the intermediate subjects, emphasizing the active constructivist nature of this cognitive elaboration. However, when the inferior subject is in partnership with a 'correct' subject, he does not progress, despite the conflict. It is clear ... ore that although conflict is necessary for the production of progress, it is an insufficient condition. In this specific case the absence of progress seems to be attributable to the nature of the conflict: the superior subject, to whom the solution seemed obvious, actively imposed it on the inferior subject, whereas in the condition with the inferior and the intermediate subjects the latter, unsure of the solution, explained the dimensions which they found problematic in more detail to their partner. The inferior subjects were therefore given an opportunity to be active in the situation and to participate in the elaboration of the collective solution. Finally, when two subjects at the same inferior level worked together, no cognitive conflict was apparent and thus, as predicted, no resulting progress was found. It should be noted that the

condition with two intermediate subjects was more conflictual than was predicted, given that the two participants were at the same level. However, in this case the fluctuation characteristic of the behaviour of intermediate subjects is such that there is some probability of conflict occurring. Other observations (Perret-Clermont, 1980) confirm these different results in other respects.

Progress therefore only appears as a function of inter-individual conflict, where the partners' respective solutions are opposed. We have demonstrated the way in which differences between cognitive levels of partners sharing the same point of view allow a conflict of this nature to be introduced. We further showed (Doise and Mugny, 1979) how a similar conflict can be introduced between subjects at the same cognitive level simply by opposing their viewpoints in the same task of spatial transformations. After the pre-test only the inferior and intermediate subjects were retained for the experimental stage. As was the case in the preceding experiment, two subjects at the same cognitive level were asked to work together, but this time they were not placed in the same position (i.e. did not work side by side) but in positions opposite each other across the table on which the experimental equipment was arranged (so that the level of difficulty of the task was the same for both partners, cf. Figure 1, Item 2). This meant that if the two subjects both wished to use the same incorrect response strategy, a conflict of responses would result. A control condition allowed children to complete the same experimental items alone by successively changing their points of view, thus enabling us to see whether a subject working from successively opposed points of view also experiences conflict. The results show that this is not the case, since different responses may arise from the different points of view, without the child being aware of a contradiction. By contrast, as predicted, significant progress was observed in the collective condition. Thus, the hypothesis of the importance of socio-cognitive conflict in cognitive development is illustrated, in a new way, by a situation which moreover has the advantage of eliminating the modelling effect as an explanation. The two subjects were at the same cognitive level, and were confronted with each other's similar incorrect responses. As was shown in the preceding experiment, it is not necessarily the case that a correct model is also a beneficial model and, furthermore, progress can be achieved without a correct model being presented.

The same effect was observed again using the paradigm of the conservation of length (Mugny, Doise, and Perret-Clermont, 1975–76). In this paradigm a non-conserving child who states that one of the two sticks had grown longer after it had been displaced is told by the adult experimenter that one of the sticks is indeed longer than the other, but that it is in fact the other one, the one not chosen by the child. The child is therefore confronted once again with a model of response involving a similar strategy (the evaluation of length as a function of a topological strategy of over-estimation), but one leading to

contradictory responses. As before, progress was once again produced without the presentation of a correct, or even a progressive, model. And, in effect, socio-cognitive conflict is the only explanation that can be proposed to account for these results.

Two other experiments made use of the same paradigm (Mugny, Giroud, and Doise, 1979). The first demonstrated that the occurrence of progress is linked to intensity of the conflict: the conflict was operationalized in this case by the experimenter's persistence in questioning the child, by means of the similar but contradictory incorrect response. Subjects who consistently opposed the contradictions of the experimenter progressed, until they reached the conservation stage. However, for some subjects a different social dynamic emerged, as it were, to 'counteract' the positive effect on the conflict. These subjects evidenced compliance by systematically accepting the contradictory responses of the adult and did not progress.

The second experiment demonstrates that conflicts also appear spontaneously between children placed on different sides of the table on which the sticks are lying (this ensures a probability for the occurrence of opposed centrations). Moreover, progress was observed in the groups where this conflict appeared but did not appear when the interaction was non-conflictual.

It may be noted that the effectiveness of a socio-cognitive conflict is dependent upon certain social norms, such as assigning larger objects to an adult, and smaller objects to a child. Thus, in an experiment also involving the notion of the conservation of length (in this case, unequal length, Doise, Dionnet, and Mugny, 1978) the experimenter systematically questioned the child's incorrect responses. In one condition the child had to assign one of two bracelets to the experimenter and the other one to himself, the instructions specifying that the bracelets had to fit their respective wrists. In a control condition the assignment was to one of the two cylinders, one small and the other large. One of the contradictions pointed out by the experimenter was between the judgement of length (incorrect for the non-conservers when the configurations were modified, cf. Appendix) and its, often correct, assignment. The results showed that most progress was produced when the socio-cognitive conflict has some direct general relevance, i.e. when the bracelets are attributed to the experimenter and to oneself, rather than to cylinders.

The results of all the experiments described here clarify the conditions under which an interpersonal interaction will produce cognitive progress. Essentially, the occurrence of a conflict of a social nature is necessary. A socio-cognitive conflict is created when the responses to the same situation differ among the members of a group. This conflict can appear between members at the same cognitive level, provided that the responses are given from different points of view or when the centrations issuing from the same reasoning are contradictory. The resolution of this conflict can lead to cognitive progress, notably as a function of the intensity and the social significance of this conflict, and

not significantly less than a correct model!). There is no doubt that it is therefore the nature of the socio-cognitive conflict induced by the presentation of a model which determines whether progress will occur and not the mere presentation of something that can be copied.

Moreover, this last result has also been found in several other experiments. We have shown, for example (Carugati, Mugny *et al.*, 1978), that a socio-cognitive conflict can cause progress even in subjects for whom the task presents no difficulty at all. In an experiment using the spatial transformation task, the orientations of the base of the village to be copied and of those of the base on which it is to be reconstructed were arranged in such a way that the task is made easy for a child in position *X* (Figure 1, Item 1), but is made complex for the subjects in the other position (*Y*). Only one subject was in the easy position, while, according to the experimental conditions, either one or two children were placed in the complex position. As expected, the subjects in position posing a cognitive problem progressed (it is significant that they were able to observe the correct placing of one or more houses at one point or another by the subject in the easy position); but the most striking result is that the subject in the easy position could also progress, despite the fact that for him the solution seemed obvious. In this case, also, only conflictual interaction can account for such progress, all the more so as this progress appeared especially when the subject in the easy position was opposed to two subjects in the difficult position—which increased the probability of conflict (see also Carugati, De Paolis, and Mugny, 1979).

5. As we have already observed, the respective status of the partners plays an important part in the resolution of socio-cognitive conflicts. One of the important variables at this level appears to be status differences between adults and children. Thus, current research (Lévy, Doise, and Mugny, in press) tries to show how different methods of questioning influence cognitive development in different ways, according to whether the source of conflict is a peer or an adult (Lévy, in preparation). Other data examining the concept of 'foreigner' (Jacq, in preparation) showed that subjects understood the reciprocal nature of this notion when Swiss children were confronted with a foreigner, but not when they had to work with a compatriot. Furthermore, foreign children tend to progress more in such a situation, probably because the very fact that they are outsiders renders them more sensitive to the 'injustice' or the 'inferiority' which arises from a failure to recognize the reciprocal nature of the notion. Finally, we may ask whether or not socio-economic or socio-cultural category membership is also likely to be a factor in the process of the elaboration of the cognitive abilities which we have examined in our experiments.

SOCIOLOGICAL AND PSYCHOSOCIOLOGICAL FACTORS

Although we had hypothesized even from our initial experiments that a

relationship existed between the category membership of subjects and the intellectual abilities they developed, this aspect of the work had not been our main focus of attention. However, the compelling nature of some of our findings finally led us to analyse more systematically the effect of social category membership. A comparison of pre-test data obtained from two different schools showed that despite similarity in age and number of years at school, there were more non-conservers among children attending an inner-city school than among the children attending a school in the suburbs. This difference seemed to correlate with a difference in the social background of pupils attending these schools.

This led us to re-analyse the data from two previous experiments carried out in suburban schools (Perret-Clermont, 1980), in relation to the subjects' sociological background, as defined by the socio-professional category to which their parents belonged. This analysis of the two experiments (which deal with the conservation of liquid and of number) was therefore conducted *a posteriori*. Although it is unlikely that this analysis was directly influenced by our expectations (no hypothesis having been formulated as to the nature of this variable's influence and the social background of the subjects being at that time unknown to the experimenters), its validity is however limited. This is mainly due to the fact that since no analysis in terms of category membership had been envisaged, the number of subjects in the different social categories was not always large enough to ensure the validity of significant results. We felt justified, however, in accepting the results of the analysis as illustrative of possible effects and used them in the elaboration of hypotheses which were later largely confirmed experimentally.

As had generally been the case in other studies (particularly Coll Salvador, Coll Ventura, and Miras Mestres, 1974), pre-test results from these two experiments revealed differences in the percentage of children from different social backgrounds who attained the various cognitive levels—in a population of working-class children 40–50 percent were non-conservers, while in a population of similarly aged children whose parents were engaged in middle and higher management only 25 percent were non-conservers. What was of specific interest to us, however, was that the amount of progress evidenced by subjects subsequent to social interaction was such that in the post-test, the percentage of 'low' category children mastering more advanced strategies was similar to the percentage of the 'high' category subjects using them in the pre-test. This recovery seems all the more remarkable when one considers that the 'compensatory' intervention represented by the social interaction lasted no more than 15 minutes. Before investigating further the nature of these differences in the cognitive performances of subjects from different social backgrounds, it was necessary to see if these results could be replicated. In other research involving the conservation of liquid, care was taken to select comparable numbers of children from two dissimilar social backgrounds, one of which was

providing that it is not resolved by prima facie social influence processes, such as compliance (Kelman, 1958) or even obedience. Socio-cognitive conflict therefore leads to collective and/or individual cognitive restructuring when these cognitive coordinations are directly involved in the establishment, maintenance, or reconstruction of an inter-individual relationship, which itself fits into a larger system of relationships and of social norms.

An inter-individual conflict of this kind involves processes at different levels. Thus, the subject is emotionally activated when he is involved in interpersonal conflict, because of the contradictory responses which are made salient to him. He becomes aware of the existence of different centrations, and must come to view his own centration relativistically. We have specified conditions which lead a group member to combine different centrations and to produce new coordinations. This occurs only if the subject is actively involved in the situation. The subject finds himself confronted with cognitive models which, although they do not offer him the correct response, suggest to him some relevant dimensions for a progressive elaboration of a cognitive mechanism new to him.

4. In our experiments we created social situations in which neither the collective nor the individual results could be explained in terms of the processes of imitation. Let us assume, at this point, that the processes involved in a socio-cognitive conflict could indeed be explained within a socio-constructivist perspective. How, then, can we interpret the results obtained with different types of models? First of all, it can be stated that even in the cases where the progress resulting from the imitation of a correct or intermediate model has been accounted for by the cognitive nature of the models on the one hand, and by the intervention of the imitation process on the other, it remains no less true that a conflict of a socio-cognitive nature was implicitly present, or at least could have been so. In our view, it is this inter-individual conflict which is the essential cause of these so-called modelling effects. Thus, we can state, for example, that it is not necessary for a correct model to be presented for progress to occur; this fact seems to have been largely proved. A system of similar but opposed responses can lead the subject to a new cognitive elaboration. Equally, one could assume therefore that even a regressive model would result in socio-cognitive conflict, which in turn would give rise to progress. One of our experiments illustrates just these ideas (Mugny, Lévy, and Doise, 1978).

In the spatial transformation task subjects at the inferior cognitive level were again questioned by the experimenter, who also constructed a copy of the village after the child had completed his. Three different conditions were used. The experimenter's solution was either correct, progressive but incorrect (intermediate), or regressive. Subjects confronted with either the correct or intermediate solution progressed. However, the regressive solution also produced as much progress as the intermediate model (and, it can be emphasized,

termed a high category, where the parents were managers, directors, or have specialized technical skills, while the other was called a low category, where the parents were working class. All the subjects were the same age and had just started school (Perret-Clermont and Schubauer-Leoni, 1981).

All the children were given the same tests in the pre-test, which included a certain number of items from the classic test for conservation of liquid. This enabled us to divide them into two groups: the non-conservers (who had not mastered this notion of conservation at all), and the intermediate and conserving subjects who have either partly or fully elaborated the cognitive operations relevant to the invariance of quantity during successive decantings. Table 1 shows the number of subjects from the two social categories whose pre-test performance manifested the two operational levels just described. The difference in the levels achieved during the pre-test was highly significant, with the 'high' group being more advanced than the 'low' status group.

Table 1 Number of non-conserving (NC) and intermediate (I) or conserving subjects (C) in the pre-test, according to social category

Social category	Cognitive level	
	NC	I + C
Low	78	30
High	20	31

After this pre-test, all the available non-conserving subjects (70 percent of the original sample) took part in social interaction (either with a peer at the same or at a different level, or with an adult who acted as a model), so that any difference in the effect of these collective conditions could be seen. Finally, each subject was again individually post-tested two weeks later, allowing us to note in particular any subsequent change in the operational level demonstrated in the test for the conservation of liquid (see Table 2).

Table 2 Percentages of non-conserving (NC) and intermediate (I) or conserving subjects (C) in the pre-test, high social category, and in the post-test, low social category, all conditions and collective condition NC × C

Social category	Cognitive level	
	NC (%)	I + C (%)
Low, post-test (all conditions, $N = 58$)	53	47
Low, post-test (NC × C condition, $N = 12$)	33	67
High, pre-test ($N = 51$)	39	61

Once again the results confirmed our hypothesis that the post-test performance level of subjects from a 'low' social category would approach the level attained in the pre-test by 'high' category subjects, despite different experimental conditions, whereas the difference in pre-test performance of subjects in the two social categories had been highly significant, the difference between the performance of the 'low' category subjects in the post-test and that of the high category subjects in the pre-test was now only slight.

It should be remembered that these data relate to all 'low' category subjects, not all of whom participated in the collective interaction condition with a conserving peer—the condition more likely to effect progress. When only those subjects from the low category who participated in this condition were considered, it was clear that the percentage of them attaining the various levels at the post-test phase was similar to those attained by the children from the high category in the pre-test. A spatial-transformation experiment involving a similarly adequate number of subjects allowed us to confirm these results: it was clear that the cognitive levels attained in the post-test by children in the low category were equivalent to the levels of the children evidenced in the pre-test by the high category (Mugny and Doise, 1978).

Table 3 Number of subjects attaining inferior (NC), intermediate (PC), and superior (TC) cognitive levels in the pre-test, according to social category

Social category	Cognitive level		
	NC	PC	TC
Low	26	17	20
High	14	19	37

Table 3 shows the number of children in the two social categories evidencing the three possible cognitive levels (see Appendix) in the pre-test. The overall results revealed a distinct superiority in the performance of 'high' social category subjects. However, it should be noted that this difference varied as a function of age. Although for younger children (average age, 5 years and 9 months) no difference in performance was apparent, a marked difference emerged in older children (average age 7 years 9 months), at that very age at which the type of notion under examination is usually acquired.

After this pre-test, the NC and PC subjects participated in one of two experimental conditions. In the first, each individual child constructed a copy of a model village from one point of view and then had to decide whether his reconstruction (which he could change if he thought it necessary) was satisfactory after seeing both it and the model from a different point of view. A situation involving intra-individual conflict was thus possible. In the second condition, two children of the same cognitive level were placed in positions

opposite each other to complete the same task (positions *X* and *Y*, see Figure 1, Item 2), so that a situation involving inter-individual conflict was possible. Table 4 shows the progress achieved by subjects of the two sociological categories in the two conditions. An inferior subject was deemed to have progressed if he used at least one intermediate or correct strategy, while an intermediate subject was deemed to have progressed if he used at least one correct strategy.

Table 4 Number of subjects progressing (+) or not (o) according to the experimental condition and the social category

Social category	Conflict:			
	Intra-individual		Inter-individual	
	o	+	o	+
Low	13	9	6	13
High	8	9	4	10

The results confirmed our psychosociological hypothesis that inter-individual conflict would induce more progress than a situation producing intra-individual conflict. However, when the data from the two sociological categories were considered separately, it was clear that the difference between the two experimental conditions was significant for only the low social category. In fact, an intra-individual conflict situation did not produce significantly less progress than an inter-individual conflict situation for the high category subjects. The results of these experiments seem to indicate that subjects from 'inferior' sociological environments benefit more from social interactions than from individual activity, whereas those from a 'superior' social environment benefit almost as much from the one as from the other. Although its distribution varied in relation to experimental condition, the similar proportion of progress evidenced by members of the two social categories led us to predict that the difference established in the pre-tests, although reduced, would remain (see Table 5).

Table 5 Number of subjects attaining inferior (NC), intermediate (PC), and superior (TC) cognitive levels in the post-test, according to social category

Social category	Cognitive level		
	NC	PC	TC
Low	14	13	36
High	9	9	52

Although the difference between the sociological categories was significant (Kendall's S test, $z = 1.955$ $p < 0.03$), it had considerably diminished in comparison with the pre-test where the value of z was 2.758 ($p < 0.003$). Firm conclusions were not possible however since this result could easily have been due to a 'ceiling effect'—while there was room for improvement in the performance of 43 of the 63 'low' category subjects, this was the case for only 33 of the 70 'high' category subjects.

We therefore compared the post-test performance of the children in the low sociological category with the pre-test performance of the children in the high category. Table 6 shows the percentage of members of the social categories attaining each cognitive level in the pre-test and in the post-test. The raw data are shown in Tables 3 and 5.

Table 6 Percentages of subjects attaining inferior (NC), intermediate (PC), and superior (TC) cognitive levels, according to social category

Social category	Cognitive level		
	NC (%)	PC (%)	TC (%)
Low, pre-test	41	27	32
High, pre-test	*20*	*27*	*53*
Low, post-test	*22*	*21*	*57*
High, post-test	13	13	74

The data fully confirmed the prediction, inferred from the previous experiments, that such a simple exercise (participation in an experimental activity) would result in the children from an 'inferior' social group responding at the same cognitive level in a post-test as had children from a 'superior' social group in a pre-test. Even if we limit ourselves for the moment to a consideration of one specific notion, as has been the case in our experiments, it is obvious that the notion of a social 'deficit' in cognition is no longer straightforward.

Several questions remain unanswered, however. As already noted, our results were necessarily inconclusive because of the large number in the 'high' category who could not 'improve' their already correct performances. Moreover, the proportion of subjects participating in the inter-individual experimental condition, which produced the most progress, was very small. However, it is essentially a matter of ascertaining first whether members of an 'inferior' social group do in fact benefit more from a situation involving inter-individual activity than they do from individual activity, and secondly, whether members of a 'superior' social group do in fact benefit as much from individual as from inter-individual activity. If this proves to be the case, the validity, or at least the generality, of our psychosociological interpretation of cognitive development must be questioned, since it would seem to be applicable only to disadvantaged socio-economic categories where social interactions

Furthermore, a comparison between the behaviour of the subjects during the post-tests and the behaviour of their partners during the interaction emphasizes that any progress evidenced by the former cannot be solely ascribed to imitation. Thus, in an experiment examining the notion of the conservation of liquids, we recorded all the arguments that the conserving children (i.e. those who had mastered the notion in question) gave to their less advanced partners (non-conservers). We were able to observe that during the post-test, these former non-conservers did not limit themselves to repeating the arguments they had heard (all of which they do not always repeat), but that in half the cases they offered novel arguments which they had not been capable of offering in the pre-test. In the same way, it is not possible to explain, by reference to processes of imitation, the progress demonstrated by the subjects who had interacted with their less advanced companions but who did not at that time display the behaviour of which they were finally capable in the post-test. This is particularly the case for the children at the 'intermediate' level who interacted with the non-conserving or 'inferior' subjects in the conservation of number experiment (Perret-Clermont, 1980) and in a spatial transformation task (Mugny and Doise, 1978).

It would therefore seem that these different analyses combine to demonstrate that the learning acquired in social interaction arises from fundamental cognitive restructuring, and goes beyond imitative adoption of situation-specific and 'superficial' behaviour patterns.

Using a series of operational tests and a detailed analysis of the behaviour of non-conserving subjects during the pre-test has, on the other hand, enabled us to show that for each notion examined it is only at a particular stage in the development of this notion (or of the cognitive operations related to it) that the individual is likely to benefit from the social interactions taking place. Thus, we observed that only those children already capable of numerical conservation succeeded in progressing to the conservation of quantities, after having participated in a period of social interaction. In the same way, only those children who were capable of recognizing the equivalence of two series of elements by putting them in one-to-one correspondence and who knew how to 'count' (in the sense of declining the sequence of numbers) were likely to progress subsequent to the social interaction in the experimental stage. This means that in order for the predicted cognitive acquisition to take place, the child should already possess certain 'pre-requisites' which render him capable in some way of playing a significant part in an active confrontation and discussion with his partner. These results support a social constructivist interpretation of development; if the cognitive elaboration of a notion actually occurs in successive stages, each conditional upon the other, these stages would not, however, arise from the simple display of innate, individual potentialities, but from the elaboration of these abilities in previous social interactions. The appropriate model of development should therefore emerge

function to compensate for a 'deficit' (the inability of these children to develop their cognitive mechanisms autonomously). Such arguments (previously discussed by Perret-Clermont, 1980) are invalidated by the results of a final experiment to be presented in detail here, which attempted to deal with the remaining contentious issues (Mugny and Doise, 1979).

The experiment was within the cooperative game paradigm but involved one modification not detailed in the Appendix. All measurements were obtained from the game with the three pulleys but, in contrast to an earlier series of experiments (Doise and Mugny, 1975), the pulleys were set up during the individual pre- and post-tests so that they jammed automatically whenever they were not being directly manipulated. This meant that a subject could not move the marker towards him simply by pulling on one pulley: this could only be done if he first 'let out' either one or both other pulleys and then pulled on his

therwise of course the pulleys jammed, as often occurred if a subject did not coordinate his actions). This automatic jamming did not occur during the experimental phases.

While the pre- and post-test involved subjects manipulating the equipment individually, it was the collective experimental conditions which were of obvious importance, given our previous results. This phase comprised an individual as well as two collective conditions, the results of which were combined as they produced the same effects.

In the first collective condition, two subjects had to work together to move the marker along the circuit. One of the children worked using one pulley, while the other child (who had been instructed not to 'let out' any of his pulleys) manipulated the other two pulleys. In the second collective condition, three subjects had to work together. In these conditions the subjects working together were class-mates of the same age and sex. The experimental phase took place one week after the pre-test, and one week before the post-test.

The children tested came from two very dissimilar social environments within the one southern European country. Ninety-five came from a working-class, immigrant urban school (who are termed the 'low' category) and 95 others were pupils at a private school and came from well-to-do families. The

tension of the subject population to include another age group allowed more detailed analysis than had been previously possible.

In the experimental phase, 23 children from each social group were assigned to the individual condition (8 from each age group, except 7–8 years, where there were 7 subjects), and 72 children to the collective condition (for each age group, 6 groups of two and 4 groups of three children). In contrast to the previous experiments, therefore, a large number of subjects were in the collective condition.

Table 7 shows the median scores for the subjects in the pre-test. It is clear that the performances improved as a function of age. However, the rate of this improvement is not the same for the two social groups. Although the performances

Table 7 Median performance scores according to age and social category in the pre-test

Age	Social category	
	Low	High
5–6 years	−22.5	−18.5
6–7 years	−8.5	+7.0
7–8 years	+9.0	+14.0

were at the same level in the 5–6 year age range, they improved more rapidly in the high social category who achieved a level of performance at 6–7 years of age which subjects from the 'low' social group did not achieve until 7–8 years of age. This confirmed that a considerable number of differences between social groups exist during the initial stages of the elaboration of cognitive notions. It must be emphasized that such differences only became significant at that developmental period when the notions or coordinations under examination are usually being spontaneously elaborated, which in this case is at 6–7 years of age.

The results of the post-tests, as shown in Table 8, allowed us to see whether the interactions in which 72 of the 95 children in each group had participated had led to any significant modification in this situation.

Table 8 Median performance scores according to age and social category in the post-test

Age	Social category	
	Low	High
5–6 years	−33.0	0.0
6–7 years	+23.0	+17.0
7–8 years	+23.0	+28.0

As can be seen, important improvements in performance have occurred within both social groups and in fact the overall difference between the two social groups is no longer significant. (According to the Mann–Whitney U test, the value of z is 1.229 in the post-test ($p < 0.12$), whereas in the pre-test it was 1.934 ($p < 0.03$).) However, a comparison of the individual age groups reveals a significant difference at the 5–6 year old level (where the 'high' category subjects progress while the 'low' category subjects do not) which starts to disappear from the 6–7 year old level on. This shows therefore that not only are differences in performance as a function of social group membership only significant in the initial stage of the elaboration of a notion, but that such differences also actually become less clearly defined during the course of

development. No potential intellectual differences could therefore be said to exist between the members of social categories. If such differences do appear, they may merely be the result of differences between social groups in the amount of and/or the significance accorded to social interactions between children, or between children and adults, with regard to a given notion.

Even though our work is limited in that it deals with only a single notion, rather than several at once, it obviously calls into question the nature of social category differences so frequently observed and alluded to. We will return to this point in the final discussion.

We must look first, however, at the differential effect of the individual and collective conditions at the different age levels in the two social groups. Table 9 shows the average progress made in each condition. It appears that the inter-individual activity condition is not automatically effective but that its effectiveness essentially a function of the stage of development of the notion being examined.

Table 9 Median progress between the pre-test and the post-test according to age, social category, and experimental condition

Social category		Condition	
		Individual	Collective
Low	5–6 years	−8.5	−2.3
	6–7 years	−2.0	+35.3
	7–8 years	+24.0	+19.8
High	5–6 years	−2.5	+10.1
	6–7 years	+8.5	+14.6
	7–8 years	+24.0	+8.6

At an initial pre-elaboration stage in the development of a notion neither individual nor inter-individual activity enables the child to progress, which seems to confirm our belief that there are necessary cognitive prerequisites for progress to occur subsequent to interaction, as discussed above. Thus, neither ndition benefited children of 5–6 years of age in the 'low' category (and one can conjecture that results would be similar for children of 4–5 years in the 'high' social group). At a second stage, which apparently corresponds to the phase at which the cognitive mechanisms necessary for successful completion of this task are first being elaborated, social interaction alone induces progress, whereas individual activity is not capable of doing so. This is apparent in the results of 6–7-year-old children in the 'low' social group and in children of 5–6 years of age in the 'high' social group. Finally, at a third stage, both the individual and the collective activity conditions enable the child to progress, as can be seen in the results of the 7–8-year-old children in the 'low' social group and of the children from 6–7 years of age in the 'high' social group.

The experiment thus confirmed the hypotheses developed from our socio-psychological perspective: social interaction appears to be an essential condition of progress at the initial stage of the elaboration of a notion and, furthermore, it is from this social interdependence that autonomy in development is progressively acquired. Finally, it follows from the data that this progressive acquisition of autonomy, which for both groups is grounded in initial interdependence, develops with a time-lag (of about one year in this case) between the high social group and the low social group. Even though these differences may be obliterated to some extent when the potentialities of the groups are developed, it still remains the case that the social class membership influences the rate of cognitive acquisition; while the experiment enables us to 'de-mystify' the nature of certain social differences, it does not however eliminate the effects of discrimination which occur in other spheres of social organization. Despite this 'de-mystification', we are still unable to account for these differences, and further research on this problem is necessary.

We can now try to draw some conclusions about the interaction between individual cognitive levels, inter-individual processes, and social category membership.

CONCLUSION

As stated in the Introduction, several levels of analysis of the same 'phenomenon' are possible. The research just described suggests that the study of cognitive functions (which at first glance appear to be intra-individual phenomena) cannot be examined independently of analysis at other levels. If this is true, even the notion of the cognizing individual ('le sujet épistémique' in Piagetian terms) becomes an abstraction—an abstraction both from the inter-individual relations which underly the formation of cognitive mechanisms, and from the more general social conditions prevailing in the society in which both individual development and inter-individual relations evolve.

We have in fact demonstrated experimentally that cognitive functions are initially elaborated in inter-individual relationships before being 'internalized' by each individual. The individual, as an autonomous, cognizing subject, does therefore not exist, *a priori*, before any development has taken place. Paradoxically, he is the product of a social interdependence which creates and ensures his subsequent autonomy. Since explanations at the intra-individual level of analysis do not embrace inter-individual social relations, any conception of cognition as a purely intra-individual phenomena is based on an abstraction.

Just such an abstraction is typical in work on cognitive development and provides the underpinning for traditional methodology, on which much of the research which reports the superiority of children from certain social categories and the inferiority of children from other relies. It is not a matter here of

becoming embroiled in the debate concerning the causality of, or the relative contribution of heredity and environment to such differences; our paradigms do not provide, and make no claim to provide, any answer to this question. We proceeded from the simple truth that when the results of only the individual pre-testing are considered, there is ample evidence for a correlation between performance and social category memberships, with members of 'high' social groups performing better than members of 'low' social categories. The originality of our paradigms lay, however, in the introduction of a phase which allowed us to reintegrate the individual with the social context of his development. To achieve this, children from the various social categories were put in a socio-psychological context of development involving social and, more specifically, inter-individual interaction. We were able to demonstrate erimentally the existence of those very processes that our theoretical model suggested would operate in the child. This proper reintegration of the child with the context inducing development, led to a general reduction in, or even the almost complete disappearance of, the cognitive differences between children from different social categories. The potentialities of both groups would thus seem to be comparable, even if their rate of development, particularly at the initial stages of a notion's elaboration, can differ. It follows from these observations that the majority of the research dealing with intellectual differences between social groups and, in particular, that grounded in traditional test methodology, is based on an abstraction which distorts the object being studied. In effect, these tests scientifically create and justify social discrimination; in that it uncovers such inadequacies by demonstrating the interaction between various levels of analysis, social psychological research remains an invaluable tool.

APPENDIX: SOME EXPERIMENTAL PARADIGMS

Paradigm I: The Spatial Transformation Task

very phase of these experiments, 5–8-year-old subjects construct a copy of a model village comprising three or four houses on a base. Every base has the same clearly visible mark as a point of reference for the orientation of the base, presented in the form of a lake, a mountain, or a pool (see Figure 1). The subjects are placed in certain positions from which they may not move, and thus see their own base and the experimenter's village from only one perspective. The items are either simple (Item 1 in Figure 1 is a simple item for a subject in position *X*, requiring only a simple rotation of 90 degrees for successful reproduction of the village), or complex (the same configuration is a complex item for a subject in position *Y*, since, in addition to the visual rotation of 90 degrees, a reversal of the left/right relationship and the front/back relationship is required for the village to be correctly reproduced). Item 2 in

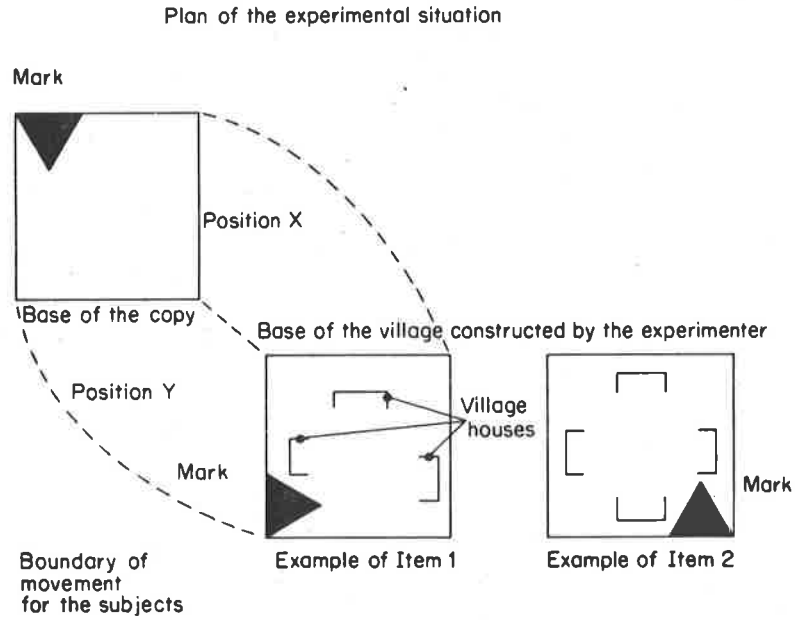

Figure 1. Plan of the experimental situation

Figure 1 confronts subjects in positions *X* and *Y* with the same degree of difficulty. The subject's cognitive levels are ascertained from his pre-test performance on two complex items (Item 1, position *Y*, for example). In general, only those children whose pre-test performances on both items evidence the same cognitive level are retained as experimental subjects.

Three levels are distinguished: subjects categorized as 'inferior' (NC or non-compensating) simply rotate the configuration of houses through 90 degrees, thus making no compensation for the different orientations of the two bases; intermediate subjects (PC or partially-compensating) successfully reverse either the left/right or the near/far dimension but cannot compensate for both; and subjects categorized as 'superior' (TC or totally-compensating) reverse both dimensions and produce a correct model of the village. During the experimental phase and depending on the experimental condition, subjects work either individually or in groups of two or three, and are placed either side by side (i.e. both in position *Y*) or opposite one another (e.g. one in *X*, one in *Y*). Evaluation of individual test performance is based on the better of two items, and progress is deemed to occur when a more advanced strategy (on the NC–PC–TC scale) is used.

Paradigm II: The Conservation of Length

The two different types of experiment reported here both comprised individual pre- and post-testing, with an intervening experimental phase. In the individual tests subjects are tested on the notions of both equality and inequality of length.

(à) *The conservation of equal lengths.* Two sticks of equal length are placed parallel to each other (): children of 5–8 years of age confirm the equality of the lengths of the two sticks. When one of the two sticks is displaced so that the sticks are no longer co-terminous, the responses differ () : non-conservers judge one of the sticks to be longer than the other, focusing on one of the displaced end-points; intermediate subjects either agree that the sticks are equally long but cannot say why, or are undecided; conservers judge the two sticks to be equally long independently of their spatial configuration, and can produce arguments to support their judgement.

In the collective situations, a child and an experimenter (or two children) sit at different sides of the table on which the sticks are placed. When the subject claims that one displaced stick is longer, the experimenter points to the other end of the other ruler and says 'I think this one is longer, you see, it goes further there'. (This response is of course also incorrect but is symmetrically opposed to the subject's.) If the subject complies, the experimenter reminds him of his previous response.

(b) *The conservation of unequal lengths.* The procedure and the category evaluation methods are similar to those for the conservation of equal lengths. Two bracelets of unequal length are placed parallel to each other (): all the children confirm the inequality of the lengths. Then, the longer bracelet is folded so the two bracelets are co-terminous (): non-conservers then judge both bracelets to be equal while intermediate subjects frequently go on judging them to be unequal (but give the incorrect response to the next item). Finally, the longer bracelet is folded again so that its extremities are contained by those of the shortest bracelet (). Both non-conservers and intermediate subjects now judge the longer bracelet to be the one which is actually the shorter as they consider only the relative positions of the ends of the bracelets. The conservers conserve the inequality of the lengths correctly, independently of the configurations they perceive, and can argue to support their judgement.

Subjects participated in an experimental stage between the pre-test and the post-test(s) in which they had to judge unequal lengths. In general the collective experimental condition opposed the subject and an adult collaborator who, after the child had given his answer, responded to each question according to a

pre-established programme of responses intended for the most part to contradict the child's responses.

Paradigm III: The Conservation of Liquids

This paradigm is adapted from the test used by Piaget and Szeminska (1941) for the acquisition of the notion of the conservation of quantities of liquids. The experiment has three phases, in the first of which children (6–7 years old) are individually pre-tested. Each subject has to pour an equal amount of juice into two different shaped glasses so that both he and the experimenter have the same amount to drink. The child's operational level for the elaboration of the notion of the conservation of the liquid, as deduced from his performance, is evaluated according to the criteria defining three specific levels: non-conservers (NC) do not comprehend the notion of conservation and assert that the initial quantity of liquid increases or decreases according to the size of the glass into which it is poured; conservers (C) comprehend this notion and are therefore able to justify the invariance of the quantity judged; and intermediate subjects (I) who oscillate between both these cognitive levels. The level of the subjects in acquiring other operational notions (e.g. matter, number) is evaluated in the same way.

About one week later, in the collective experimental conditions, the children are organized in groups of two or three to share the juice out among themselves using different shaped glasses. The composition of the groups of two or three children at the same or differing cognitive levels differs according to experimental conditions. The instructions given to the subjects specify that they can only drink the contents of their different shaped glasses when they reach agreement that the distribution of the juice is 'equitable' and when they agree that everyone has the same amount to drink. When the partners are at different cognitive levels this produces a certain amount of conflict between the children as the non-conservers justify the amounts they have distributed by reference to the equal 'heights' of the juice in the glasses while the conservers claim that their distributions are fair because they have taken the unequal shapes of containers into account.

About ten days after this, each subject is again individually post-tested to see if any improvement in the level of cognitive development of notions of conservation has taken place. (A second post-test may take place some time later.)

Paradigm IV: The Cooperative Game

The principle of the cooperative game is very simple: a moving part holding a pencil is attached to three pulleys by means of which one or several subjects can move this part along a given path (see Figure 2) with the pencil making the precise course it follows.

Plan of the co-operative game

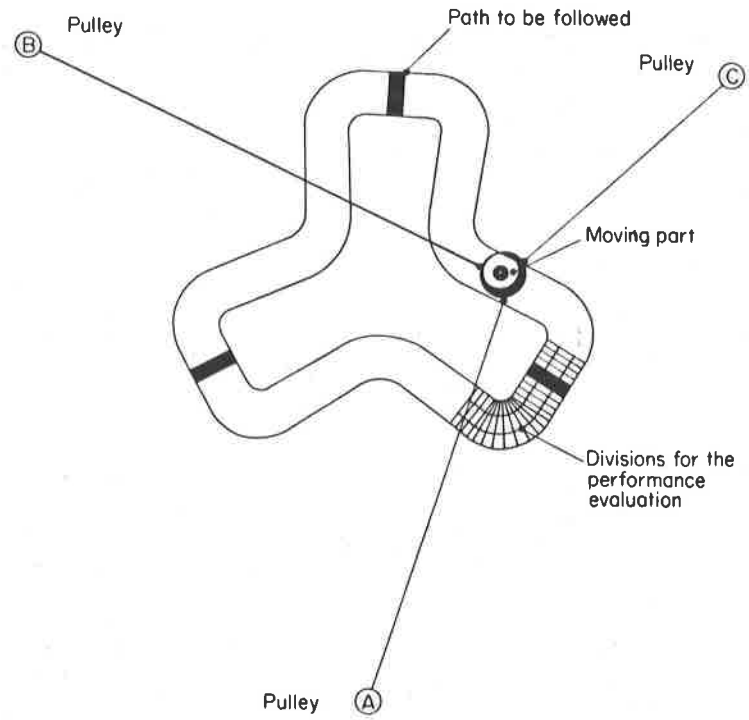

Figure 2. Plan of the cooperative game

This game can be played alone (the subject having to walk around the game in order to manipulate the pulleys), or by two or three children. Individual tests, like collective performances, are evaluated in the following manner. The path to be followed is divided breadth-wise into three equal thirds, and length-wise into units, the circuit being divided into 44, 60, or 180 units, as the case may be. When the pencil mark is wholly within the middle third, this unit is considered to be a successful coordination (score +1); when the mark encroaches on or is in either of the outside thirds the unit is considered as causing average difficulty in coordination (score 0); when the pencil mark is outside the path altogether, the unit is considered as presenting a serious difficulty (score −1). Progress is evaluated in terms of a comparison of pre- and post-test scores.

REFERENCES

Allen, V. L. (1976) *Children as Teachers*, Academic Press, New York.

Beilin, M. (1965) 'Learning and operational convergence in logical thought development', *Journal of Experimental Child Psychology*, **2**, 317–39.

Botvin, G. J. and Murray, F. B. (1975) 'The efficacy of peer modelling and social conflict in the acquisition of conservation', *Child Development*, **46**, 3, 796–99.

Brainerd, C. J. (1973) 'Neo-piagetian training experiments revisited: Is there any support for the cognitive-developmental stage hypothesis?', *Cognition*, **2**, 3, 349–70.

Brainerd, C. J. and Allen, T. W. (1971) 'Experimental inductions of the conservation of "first-order" quantitative invariants', *Psychological Bulletin*, **75**, 2, 128–44.

Carugati, F., De Paolis, P., and Mugny, G. (1979) 'A Paradigm for the study of social interactions in cognitive development', *Italian Journal of Psychology*, **7**, 147–55.

Carugati, F., Mugny, G. *et al.* (1978) 'Psicologia sociale dello sviluppo cognitivo: imitazione di modelli o conflitto socio-cognitivo?', *Giornale Italiano di Psicologia*, **5**, 2, 323–52.

Coll Salvadore, C., Coll Ventura, C., and Miras Mestres, M. (1974) 'Genesis de la clasificacion y medio socioeconomico; Genesis de la seriacion medios socio-economicos', *Anuario de Psicologia*, **10**, 53–99.

Cook, H. and Murray, F. B. (1975] 'The acquisition of conservation through the observation of conserving models', roneo.

Doise, W. (1976) *L'articulation psycho-sociologique et les Relations Entre Groups*, De Boeck, Bruxelles.

Doise, W. (1978) 'Images, représentations idéologiques et expérimentation psycho-sociologique', *Information sur les Sciences Sociales*, **17**, 41–69.

Doise, W., Dionnet, S., and Mugny, G. (1978) 'Conflit socio-cognitif, marquage social et developpement cognitif', *Cahiers de Psychologie*, **21**, 4.

Doise, W. and Mugny, G. (1975) 'Recherches socio-génétiques sur la coordination d'actions interdépendantes', *Revue Suisse de Psychologie*, **34**, 160–74.

Doise, W. and Mugny, G. (1979) 'Individual and collective conflicts of centrations in cognitive development', *European Journal of Social Psychology*, **9**, 105–8.

Doise, W., Mugny, G., and Perret-Clermont, A. N. (1975) 'Social interaction and the development of cognitive operations', *European Journal of Social Psychology*, **5**, 3, 367–83.

Faust, W. L. (1959) 'Group versus individual problem solving', *Journal of Abnormal and Social Psychology*, **59**, 68–72.

Inhelder, B., Sinclair, H., and Bovet, M. (1974) *Apprentissage et Structure de la Connaissance*, P.U.F., Paris.

Jacq, V. (1980) Développement cognitif et élaboration d'une représentation sociale dans différentes situations d'interaction. Doctoral dissertation (in preparation).

Kelman, H. C. (1958) 'Compliance identification and internalization, three processes of attitude change', *Journal of Conflict Resolution*, **2**, 51–60.

Kuhn, D. (1972) 'Mechanisms of change in the development of cognitive structures', *Child Development*, **43**, 833–44.

Lefebvre, M. and Pinard, D. (1972) 'Apprentissage de la conservation des quantités par une méthode de conflit cognitif', *Revue Canadienne des Sciences du Comportement*, **4**, 1–12.

Lévy, M. (1980) 'Necessité du dépassement du conflit socio-cognitif et développement cognitif', Doctoral dissertation (in preparation).

Lévy, M., Doise, W., and Mugny, G. (1980) 'Remise en question, modèle régressif et progrès cognitif' (to be published).

Lorge, I. and Solomon, H. (1955) 'Two models of group behaviour in the solution of Eureka-type problems', *Psychometrika*, **20**, 139–48.

Macquart, D. (1955) 'Group problem solving', *Journal of Social Psychology*, **41**, 103–13.

Miller, S. A. and Brownell, C. A. (1975) 'Peers, persuasion and Piaget: Dyadic interaction between conservers and non conservers', *Child Development*, **46**, 992–97.

Moscovici, S. (1972) *Introduction à la Psychologie Sociale*, vol. 1, Larousse, Paris.

Mugny, G. and Doise, W. (1978) 'Socio-cognitive conflict and structuration of individual and collective performances', *European Journal of Social Psychology*, **8**, 2, 181–92.

Mugny, G. and Doise, W. (1978) 'Factores sociologicos y psicosociologicos en el desarollo cognitivo', *Anuario de Psicologia Social*, **18**, 1, 21–40.

Mugny, G. and Doise, W. (1979) 'Factores sociológicos y psicosociológicos en el desarollo cognitivo: una nueva ilustración experimental', *Anuario de Psicologia*, **21**, 5–25.

Mugny, G., Doise, W., and Perret-Clermont, A. N. (1975–76) 'Conflit de centrations et progrès cognitif', *Bulletin de Psychologie*, **29**, 321, 199–204.

Mugny, G., Giroud, J. C., and Doise, W. (1973) 'Conflit de centrations et progrès cognitif, II: nouvelles illustrations expérimentales': *Bulletin de Psychologie*, **32**, 978–85.

Mugny, G., Lévy, M., and Doise, W. (1978) 'Conflit socio-cognitif et développement cognitif: L'effet de la présentation par un adulte de modèles "progressifs" et de modèles "régressifs" dans une épreuve de représentation spatiale', *Revue Suisse de Psychologie*, **37**, 1, 22–43.

Murray, F. B. (1972) 'Acquisition of conservation through social interaction', *Developmental Psychology*, **6**, 1–6.

Murray, J. P. (1974) 'Social learning and cognitive development: Modelling effects on children's understanding of conservation', *British Journal of Psychology*, **65**, 1, 151–60.

Perret-Clermont, A. N. (1980) *Social Interaction and Cognitive Development in Children*, Academic Press.

Perret-Clermont, A-N. and Schubauer-Leoni, M-L. (1981) 'Conflict and cooperation as opportunities for learning', In: P. Robinson (ed.), *Communication in development*, Academic Press, London.

Piaget, J., Inhelder, B., and Szeminska, A. (1948) *La Géometrie Spontanée chez l'Enfant*, P.U.F., Paris.

Piaget, J. and Szeminska, A. (1941) *La Genese du Nombre*, Delachaux et Niestlé, Neuchatel, Paris.

Rosenthal, T. L. and Zimmerman, B. J. (1972) 'Modelling by exemplification and instruction in training conservation', *Developmental Psychology*, **6**, 392–401.

Shaw, M. E. (1932) 'A comparison of individuals and small groups in the rational solution of complex problems', *American Journal of Psychology*, **44**, 491–504.

Silverman, I. W. and Geiringer, E. (1973) 'Dyadic interaction and conservation induction: A test of Piaget's equilibration model', *Child Development*, **44**, 815–20.

Silverman, I. W. and Stone, J. (1972) 'Modifying cognitive functioning through participation in a problem-solving group', *Journal of Educational Psychology*, **63**, 603–8.

Strauss, S. (1972) 'Inducing cognitive development and learning: A review of short-term training experiments I. The organismic developmental approach', *Cognition*, **1**, 4, 329–57.

Strauss, S. (1974) 'A reply to Brainerd', *Cognition*, **3**, 2, 155–85.

Taylor, D. W. and Faust, W. L. (1952) 'Twenty questions: Efficiency in problem solving as a function of size of group', *Journal of Experimental Psychology*, **44**, 360–68.

Waghorn, L. and Sullivan, E. (1970) 'The exploration of transition rules in conservation of quantity (substance) using film mediated modelling', *Acta Psychologica*, **32**, 75–80.

Zimmerman, B. J. and Lanaro, P. (1974) 'Acquiring and retaining conservation of length through modelling and reversibility cues', *Merill-Palmer Quarterly of Behavior and Development*, **20**, 3, 145–61.