Everyday Cognition: Its Development in Social Context

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Barbara Rogoff and Jean Lave

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8. Social Constraints in Laboratory and Classroom Tasks

Denis Newman
Peg Griffin
Michael Cole

From the perspective of a cognitive psychologist, "everyday cognition" might seem to be a contradictory notion. Psychologists have struggled for a hundred years to overcome the limitations that everyday life places on the ability to make precise statements about the mechanisms of mind. In place of "everyday" cognition, with its wide variety of content, different degrees of familiarity, various ways of dividing up labor, and reliance on conversation as a medium of expression — in short, with its lack of control — psychologists have evolved a set of procedures that are termed "the laboratory." Here the investigator constructs a model system within which it becomes possible to make principled, but limited, claims about hypothetical processes, currently referred to as cognitive processes, that can be said to mediate between states of the artificially created environment and behaviors of the subject.

The key to making claims in the laboratory is the psychologist's control over the task and the conditions under which the subjects undertake the task. In terms of experimental methodology, two kinds of control are necessary. One is obtained by carefully contrasting particular conditions in the model system and by having a sufficiently large number of subjects undertake the same task under the same conditions. This is referred to as experimental design. These design controls presume a practical control over the task, such as the goals of the subject's behavior and the conditions imposed on the subject. The experimenter must be sure, for example, that subjects are actually working on the task they are expected to be working on and that the behavior of the subject, not of somebody else, is what is being recorded.

Whether laboratory settings are used for testing cognitive theories or for administering psychological tests, the cognitive processes modeled in them and the cognitive accomplishments tested are thought of as representing more than esoteric games. No doubt performance in these games counts. Cognitive tests are used not only to predict school success but also to make a wide variety of decisions that influence economic fates. But the constraints on activity used to create model systems render them systematically dissimilar to the systems of activity created in the society for other purposes (Bartlett, 1958; Cole, Hood & McDermott, 1978; Lave, 1980). As a consequence, cognitive theories are weak in just those areas where they relate most closely to practice, namely to those "everyday" cognitive tasks that are significant contexts in our lives.

A number of different strategies are available for attacking the broad problem of specifying cognition in nonlaboratory settings. Each speaks to a different facet of the overall problem. One of them is to examine how behavior occurring in one kind of setting, defined in such terms as its social organization and its participants' goals, compares with behavior in another kind of setting in ways that are productive for cognitive theory and also contribute to educational practice. On this basis, a project was designed to collect data in a fourth-grade classroom on children confronting the "same task" in two different settings. The children's performance in a standard, laboratory-derived task was compared with their behavior in a loosely supervised science activity. The way in which the children confronted and were confronted by these tasks showed that the standard "division of labor" between researcher and subject in laboratory settings tends to obscure an important feature of cognition. When experimenters present a well-defined task to subjects in a standarized way, they have little chance to observe the subjects' formation of new goals or their application of a procedure to new situations.

In comparing the two settings, the study did not assume one setting to be more valid than the other for the characterization of cognition. Rather, both kinds of settings make available for analysis different but important aspects of cognitive activity. It is necessary to integrate the analyses of these different settings in order to construct a cognitive science that is relevant to a general range of human environments for learning and thinking.

Making the Same Task Happen in Different Settings

In a study that was a precursor to the current work, Cole and his colleagues (Cole, Hood & McDermott, 1978; Cole & Traupmann, 1981), set out to locate psychological test-like behaviors occurring in classrooms and after-school clubs. The idea was to analyze the nature of known cognitive tasks when they arise in these nonlaboratory settings. Children were administered a battery of cognitive tasks. They were also observed in their classroom and in their club sessions after school. These settings were searched to find the cognitive tasks occurring there.

In the classroom, activities that psychologists recognize as cognitive occurred quite often. Many times each day the children were seen to be dealing with classification, remembering, and problem-solving tasks. However, when the search began for cognitive tasks in the videotapes of the club sessions, it was difficult to identify any of the cognitive tasks that had been posed for children in the testing session or observed in the classroom. There was an enormous amount of activity at a very high level of noise. Somehow cakes were baked, plants grown, rat mazes constructed, and electric circuits lit without anyone doing anything that a cognitive psychologist could recognize as thinking. Despite systematic observations about how cognitive tasks were organized in the club sessions, so much variability had been allowed into the children's activities, in order not to bias the "discovery" of cognitive tasks in the club, that it was difficult to find any basis for comparison of the "everyday" club with the laboratory settings.

The present study then, in a sense, reversed the earlier strategy. Instead of waiting around for something recognizable as a cognitive task to appear, we made deliberate efforts to find ways to make hypothetical "same tasks" happen in several settings inhabited by the same children. Teachers and club leaders helped to construct a set of activities (one-to-one tutorials, small-group lessons, child-guided work groups), in all of which a particular problem structure was embedded. The project went a step further. It put into those various settings what could be called "tracers." The tracer was a bit of knowledge or some procedure that was taught the children in one of the settings, which was potentially useful if they recognized that they were being confronted with what they considered that same task in the new setting. This set of constraints greatly increased the probability of finding good candidates for analysis and of uncovering how the task was transformed, made easier or more difficult, or avoided entirely under the different organizational conditions.

The term "same task" has been placed in quotes because the sense in which two tasks can ever be considered the "same" is a central question. A cognitive task cannot be specified independent of its social context. Cognitive tasks are always social constructions. Transformations of the social organization of the tasks in the study drastically changed the constraints on behavior, thereby rendering the tasks instantly different according to widely shared ideas of what constitutes a task in cognitive psychology. It was hoped that highlighting the way in which efforts failed to make the "same task" occur in different settings would lead to a clearer specification of the class of social constructions represented by such activities as tests and experiments (LCHC, 1978, 1979).

The original idea in trying to make the "same tasks" happen was to create what are called "problem isomorphs" in cognitive psychology. Problem isomorphs are a set of problems that share an abstract structure but differ in concrete content (e.g. Reed, Ernst & Banerji, 1974; Gick & Holyoak, 1980). In the current study, children were asked at one time to make all the possible pairs from four stacks of differently colored cards and at another time to mix all the possible pairings from a set of four chemicals. In cognitive psychological studies, where problem isomorphs are used to study the effects on a subject's performance after experience with a problem "of the same kind," every effort is made to change only the content of the problem, leaving the abstract form of the procedures, initial conditions, legal moves, and goal unchanged. So in this study the content clearly differed but the abstractly defined goal of "finding all the pairs" remained the same.

The problem isomorph formulation might have worked out fine except that one feature of the task environment was changed which is almost never altered in cognitive psychological research. The chemicals activity departed from the one-to-one social organization of the standard laboratory setting in that groups of children worked together. This change in social organization not only increased the social resources available for solving the problem, thereby making it hard to say who did what, but also changed the source of the problem and thus the nature of the task. In the one-to-one situation the tutor motivated the problem as the one to be done; that is, the children were presented with the task of finding all the pairs of problem elements. In the chemicals situation the children had to formulate the problem for themselves as they began to run out of pairs to mix. This shift in the origin of the task clearly changed the nature of the task so that one would hesitate to call the two versions isomorphs.

Because a task in cognitive psychology is a goal plus constraints on reaching that goal presented by the researcher to the subject, the researcher does a lot of work to formulate a clear task. In everyday situations people do not always have the "advantage" of this kind of help; they often have to figure out what the problem is, what the constraints are, and what the available resources are as well as to solve the problem once it is formulated. In everyday situations people are confronted with the "whole" task, not just the solution part.

This broader conception of the whole task makes it possible to analyze the transformation of a task when it is embedded in different social settings. In order to look for the "same task" happening outside of the laboratory, one has to look for how the work of formulating the task which is done by the experimenter in the laboratory is getting done. This analysis will show that the practical methods of maintaining control in the laboratory lead to ignoring the crucial processes of formulating the task and forming the goal which are often the responsibilities of people in everyday settings.

To make the "same task" happen in two different settings required a task that would have as a solution an easily analyzable and recognizable procedure that the children would not already know. This solution was the tracer. An appropriately simple but exotic task was found among a set that Piaget and Inhelder (1975) used in their studies of combinations and permutations. One of these tasks was aimed at the ability to generate all possible pairs from a set of items, using stacks of differently colored chips. There was an accepted "formal operational" procedure for the systematic solution of this combinations problem, which appeared to be both elegant and beyond the capacity of fourth graders as individual inventions. The combinations task was also useful because Inhelder and Piaget (1958) studied another version of it which involved combinations of chemicals. Since the fourth-grade classroom teacher was already planning a unit on "household chemicals," there was an opportunity to embed this well-analyzed cognitive task into the ordinary course of classroom activities. The task was chosen not to test Piaget's theory or the children's "operational level" but rather for its usefulness as a tracer. Although the project occasionally made use of Piagetian analyses, it essentially took the task outside of the theory that generated it (Newman, Riel & Martin, 1983).

In the one-to-one tutorial situation, which served as the "laboratory" version of the task, each child was invited into the library corner of the classroom by a researcher and was presented with stacks of little cards. Each stack of cards was of a different color and bore the picture of a different television or movie star. Starting with four stacks, the child was asked to find all the ways that pairs of stars could be friends. Specifically, the child was asked to make all the pairs of stars and none that were the same. The child then usually went about choosing pairs of cards from the stacks and placing them in a column.

When the child had done as many pairs as possible, the researcher instituted a short tutorial before doing another trial of pair making. The child was asked to check whether all the pairs had been made. If the child did not invent a systematic procedure for checking, the tutor suggested one, asking, "Do you have all the pairs with Mork" (if Mork were the first star on the left). Then she asked about the next star to the right. These hints were designed to give the child the idea of systematically pairing each star with every other star, so as to see whether this systematic procedure carried over to the next trial at making combinations.

When the checking was finished, the stars were put back in their piles, and a fifth star was chosen. Again the child was asked to make all the possible pairs and none more than once. At this point, many of the children began by making all the pairs with the left-most star. This star was combined with each to its right. Then the second star from the left was combined with each to its right, and so on until all the combinations were made. For children who did not arrive at this particular system of producing pairs, the checking procedure was repeated. But this time the tutor gave as explicit instructions as were necessary to get the child step by step through an entire check.

That is, the tutor asked about each star and its pairing with every other star in a systematic left-to-right manner. In the final trial, the child chose a sixth star and attempted to make all the possible pairs with six.

The tutorial accomplished two things. First, it acted as a pretest of the children in a typical laboratory setting on one version of the combinations task. Second, it taught the children a procedure for determining that they had made all the pairs. The procedure of combining each item with every other item could then act as a tracer in a later task with a different social organization. If the children later used the particular procedure they had been taught, and if it were reasonable to assume that the procedure would not be used except for the goal of finding all pairs, then the children's use of the procedure would be evidence that the child participants had identified the "same task."

Piaget's analysis of this procedure, which he referred to as "intersection," is abstract enough to apply to combinations problems presented in other modes. As he conceived of intersection, the child is coordinating several series of correspondences. This can be understood as treating the single array (e.g. four stars) as if there are two dimensions that intersect. Each item on one dimension is paired with the items on the other dimension in the manner of a matrix (Fig. 8.1). With this matrix conception, choosing pairs follows planfully from beginning to end. All the children have to do is work through the matrix. If the children were just checking if all the pairs were done, it was often just as easy to go, say, row by row, even though checks were duplicated. In the production of pairs where duplication was not allowed, the system of dropouts was

	1	2	3	4
1		1 and 2	1 and 3	1 and 4
2	2 and 1		2 and 3	2 and 4
3	3 and 1	3 and 2		3 and 4
4	4 and 1	4 and 2	4 and 3	

Fig. 8.1. Intersection procedure schema.

usually used so that only the top half, say, was produced. In contrast, children without the conceptual matrix typically make pairs without an orderly pattern or make patterns such as 1 & 2, 3 & 4, 2 & 3, 1 & 4. Without the matrix concept, the children cannot be certain they have all the pairs; they "just can't think of" any more patterns. This endpoint lacks the certainty or sense of necessity found in the intersection procedure.

The intersection procedure is potentially general enough to apply to any number or any kind of items should the structure of the activity make it useful. In cognitive psychology, such an abstract and general structure, usually called a "schema," is considered to be a feature of a subject's internal conceptualization (Abelson, 1981; Rumelhart, 1980). Since this study looked for this "schema" outside of the laboratory, it could not be given an exclusively mental status (Griffin, Newman & Cole, 1981). The search for this schema in the peer interaction setting had to allow that it would be found as much to be mediating social interactions as to be mediating an individual's actions. Even when this tracer was used as a frame for comparison between the two settings, the attempt to locate the "same task" was far from straightforward.

The second setting in which an attempt was made to locate the tracer looked very different from the movie star tutorial. In collaboration with the classroom teacher, a unit on household chemicals was developed. A series of lessons and activities led up to this second version of the combinations problem, which was presented as a special work-table activity. Groups of two and three children went to the back of the room where the teacher supervised science activities, one of which involved making combinations of chemicals. Each group of children was given four beakers of colorless solutions that were numbered for easy reference, a rack of test tubes, and a sheet of paper with two columns marked off on which to record "chemicals" and "what happened." The four chemicals had been chosen so that each pair would have a distinctive reaction. The children did two versions of the combinations of chemicals task a few days apart. A second version closely resembled the original Inhelder and Piaget procedure, but the one discussed here was simpler and its goal more closely matched the combinations-of-movie-stars task.

The written worksheet instructed the children to find out as much as they could about the chemicals by making all the combinations of two and recording the results. After getting a child to read aloud the instructions, the teacher reiterated some safety precautions and directed the children to make all the possible pairs without duplicates. The teacher then sat down at the end of the table and busied herself with paperwork so that she could observe the children without directly supervising them. She intervened on occasion when children ran into difficulty or asked for help, but for the most part the pairs of children worked on their own. It was thus more markedly like a peer group activity with fewer laboratory-like constraints on what was to be done or how to do it than is typically the case in cognitive experiments.

Considerable effort was devoted to making the same task happen in the two settings. Most notably, in both cases the researcher or teacher stated the goal of making all of the pairs at the initiation of the problem. This instruction was not always sufficient to make the task happen, a failure that was significant to the study's findings.

There were some difficulties in getting the task to happen in the chemicals setting. The movie star activity posed far fewer practical problems. The movie star cards were just the right size for placing one pair under another in a neat and accessible column, on the mat next to the child. Once a column was constructed, it was easily scanned and checked, as the cards were brightly colored and the pictures were distinctive. The chemicals were much harder to manage. They had to be transferred from beakers to test tubes, and once a pair was in the tube, no visual record of which ones had been put in was automatically available.

If the children were unable to mix and keep track of the chemicals, they could hardly be expected to attend to the task of getting all the combinations. The solution was to set up an earlier lesson in which the children had to place a solution from a beaker into a test tube and record the results on a form which was to be used later in the combinations-of-chemicals task. The recording paper, as well as the previous instruction and practice on using it, provided not only an "external memory" for each child but also a common reference for the groups who were expected to be working together.

There is no way of measuring precisely the relative difficulty of the two situations. But such comparability is not crucial to the analysis. In spite of the long list of differences between the two situations, in an important way they were the same. In both settings the intersection procedure — the tracer — was potentially useful if the children accepted the researchers' notion of the task. However, the nature of the enterprise required taking some chances. In the chemicals activity the children could not be directed to use the tracer or force the task to happen. The lack of teacher-researcher direction was the crucial difference to maintain. If despite that difference, it was still possible to locate the tracer, this would be an anchor point from which to begin an analysis of the "same task" in two different settings.

Comparing the Two Settings

The project started out assuming that these were problem isomorphs in the ordinary sense. Although this assumption might not ultimately be warranted, the standard approach was pushed as far as it would go to discover how it broke down. The problems that this approach ran into finally forced an alternative analysis.

Once the videotapes were collected, a somewhat naive attempt was made to code the events for occurrences of the tracer. Once coded, they were run through a statistical test to see if performance correlated on the two tasks. For example, if children used the intersection procedure in the movie star task, were they likely to use it in the chemicals task? Or did different children use it in one setting or the other?

The coding of both tasks was designed to spot any instance of a child going through a sequence, like 1 & 2, 1 & 3, 1 & 4, 2 & 3, and so on, in which each item was paired with every other item in a systematic way that could be recognized. The sequence, which could contain duplicates, could be either a complete run-through of the procedure or a fragment of the procedure (e.g. all the 2s: 2 & 1, 2 & 3, 2 & 4). A three-point scale was used, on which "1" meant no fragments of the procedure were found, "2" meant that some fragments of the procedure were found, and "3" meant that the child produced at least one complete run-through of the procedure.

In the movie star task, only 3 children out of 27 started out in the first trial using the intersection procedure. But after the checking tutorial, 17 children used a complete run-through of the procedure, and 4 others used it partially in the second or third trial. In the chemicals task, the coding credited only 4 children with a complete run-through of the procedure, although 8 others did at least one set (e.g. all the 4s). In statistical terms, the conclusion from such a coding approach is a low correlation between performance in the two settings, with 1 child doing a full run-through in the chemicals task but producing only a fragment in the last trial of the movie stars, and 5 children using the procedure in the movie star task but not at all in the chemicals.

These results indicate that in some sense the movie star task was easier, confirming the suspicion that the chemical materials were difficult and unfamiliar. The results were not surprising, given the fact that the intersection procedure was taught just before the second movie star task, a lesson that came months before the chemicals task. But in a more important sense the movie star task was easier. It was far easier to code. For one thing, where to code was known exactly, namely just those testing trials where the children were put on their own to produce the pairs from 4, 5, or 6 stacks of stars. In contrast, in the chemicals activity the intersection sequences were located at various points in the episode in the children's talk about what pairs had, or had not, been done. Also, children were not isolated from sources of help. The intersection sequences which appeared during the chemical task were often collaborative productions which were difficult to code in any but an *ad hoc* way. These differences provided crucial points of comparison. The coder's problems were symptomatic of differences for the participants, including the teacher and researcher, in what the task was and how the work got done.

The chemicals activity presented difficulties from the beginning in locating the tracer, that is, the intersection procedure. There were two kinds of difficulty: knowing where to find the tracer in the course of the children's activity, and knowing to whom to attribute the procedure. It was thought that the children would use the tracer procedure to produce the pairs of chemicals as they had produced the pairs of movie stars in the tutorial. Some of the children would start out with, say, 1 & 2 and proceed to do all the pairs with 1 and so on through the six possible pairs. But this never happened. Instead, the groups of children started with whatever pair was most convenient, or was "thought of first," for lack of a better description. The sequence of pairs either manifested no pattern at all or took on patterns such as doing the middle then the ends. These patterns were not usually produced as part of a single, coherent sequence by the children. For example, one common pattern started with 1 & 2 then 3 & 4 when the two children who were part of the group but working independently each took the two beakers closest to him or herself. When the intersection procedure appeared, it arose in the talk among the children. When the children could not think up another pair that had not yet been done, they would discuss the written record or consult one another's memory.

A group composed of Thomas, Candy, and Elvia provides a good example of this process. At the beginning of the task they settle on a turn-taking order which they maintain throughout. During a turn, one child both mixes the chemicals and records the results. This does not mean, however, that the children work alone; many of the decisions about what to mix and how to describe the result are made after extensive discussion. At each new turn, one child chooses a pair and the other children check it against the record. The sequence of choices follows no apparent order through the six possible pairs, and until the last two pairs the children have no difficulty thinking up a new pair that has not been done. The last two pairs are also arrived at without apparent system but with growing concern about finding more to do.

After Candy's second turn, the six pairs have been done, but Elvia takes an empty test tube from the rack, preparing to mix another pair. With a sigh, Elvia says, "I don't know what color to use now." Thomas suggests 2 & 4, but Elvia finds it on the worksheet. Thomas jokingly suggests 2 & 2, and Candy suggests 2 & 4 again. Thomas thinks of 2 & 1 but finds it has been done. Candy suggests 4 & 2. There is a mild rebuke from Thomas that it is the same as 2 & 4. Elvia comes up with 4 & 3, but Candy finds it has been done. Elvia suggests 4 & 1, and Candy recalls that she did it. At that point Thomas says, "There's no more." Candy thinks of 3 & 1 and Elvia thinks of 3 & 2, but they find both of those on the written record too. Then Elvia suggests 3 & 4. At that point Thomas says, "Wait a minute, 'kay, we got, okay, we got all the 1s." He moves his finger up the record sheet and hesitates when he finds only two of them but then finds the third. Candy says, "All the ones with 2?:2 & 3". She pauses and then says, "They don't have 4 & 1," but Thomas points it out. At that moment the teacher asks, "You have them all?" And Thomas answers, "Yep."

The intersection sequence can be recovered from this interaction. For almost a minute, the three children name off pairs with 4 until Candy moves to 3 & 1, after which Elvia names the other pairs with 3. Then Thomas looks for all the 1s, and Candy suggests looking for the 2s. The order is not "perfect," but as a group they manage to check through all the pairs with each of the chemicals. Usually these checks did not strictly follow the 1 to 4 order but skipped around, partially depending on the order the combinations were recorded on the worksheet. For example, children searched for all the 4s by reading down the worksheet and naming off all the pairs with 4 as they were encountered. This strategy has the advantage of making the search of the record more efficient, although it means the memory load is increased because the children must keep in mind which of the pairs with 4 have been found.

Finding the tracer, the intersection procedure, in the talk among the children as they set about to check their work should not have been a surprise. The tracer was first introduced during the movie star tutorial in the tutor-child checking interaction. The children who used the intersection schema incorporated it as a checking procedure in their production of pairs. They used it in much the same way as they were taught to use it: as a checking procedure.

The second difficulty in the chemicals task was determining who did the procedure. Because the children were not working alone, the procedure could not always be attributed to a single child. In the example of Thomas, Elvia, and Candy the sequence was made up of contributions from all the children, and no child carried out the whole strategy independently. The intersection schema thus regulated the interaction among the children rather than just regulating the individuals' actions.

However, peer collaboration in the chemicals activity did not automatically obscure individual accomplishment. Some children divided the labor in such a way as to make it possible to attribute the schema to an individual. In one case, two boys, Jorge and Mike, who are best friends collaborate closely. Jorge writes down what Mike mixes, and when they exchange turns, Mike records what Jorge mixes. They alternate turns through the six possible combinations, which do not follow any apparent pattern. At that point, Mike takes out a test tube to begin another combination but stops to look over at the record. Mike starts a checking sequence at 1 & 2 and from there continues through the whole sequence, ending with 3 & 4. While he is naming the chemicals, he points to the numbered beakers which remain in a neat array. Jorge, in the meantime, reads the record, finding the combinations Mike is naming. Mike and Jorge divide up the checking roles just as they divided up the roles in producing and recording the chemicals. One deals with the chemicals while the other deals with the written record. Because Mike is the one to name off the sequence of pairs, the schema can be attributed to him. But the schema also regulates the interaction between the two boys. Again, the intersection schema is not just or even primarily an internal knowledge structure. It is also importantly locatable in the interaction among the children. It is, in Vygotsky's terminology, an "interpsychological" cognitive process.

In an important sense the accomplishment of the intersection procedure was always a social accomplishment in the data. The creation in the tutorial of a protected system in which the procedure could be carried out unimpeded was a piece of collaborative social organization. Such organizational support for problem solving is a systematic feature of settings organized for individual assessment. But when individual assessment is the motive for the activity, the organizational efforts tend to go unnoticed because they are background to the data. In the less constrained setting, Mike and Jorge's marvelous bit of organization can be better appreciated.

One thing that the coding neglected to identify in the two settings was the task itself. The tracer was found in most of the movie star sessions and some of the chemical sessions, but what does that say about the existence of the same task in the two settings? The coding of the movie star session assumed that the location of the task was known and that the child's performance on the task was what was being coded. The task was identified with the goal, "Make all the pairs," which was stated by the researcher just before the child began forming pairs of movie stars. The researcher was careful not to give any information until it was clear that the child was not going to make any more on his or her own. The slot between the researcher's instructions and the child's negative answer to the question, "Can you make any more?" provided easy access to the individual child's use of the intersection procedure. It seemed clear that in response to the task of making all the pairs, some children used the procedure or used it partially and some children did not use it at all. The struggle with the chemicals setting, however, led to a questioning of this assumption about the task always being present in the movie star sessions.

When the children started out in the chemicals activity, they clearly were not doing the task. The teacher told them to make all the pairs before they started, but there was no evidence that they were trying to make all the pairs. For one reason, there were other goals that the children were pursuing. For another reason, they were not using the intersection procedure, or apparently any other systematic procedure, for making all the pairs.

The children were doing other tasks than producing all possible pairs. The teacher's instructions at the beginning of the episode stated, but did not emphasize, the goal of getting all the pairs. She emphasized the problem of finding out about the chemicals by seeing how they reacted with other chemicals. The reactions that were produced by different combinations were fascinating to the children, and they were generally interested in the problem of describing the results and writing them down.

Tracy's approach illustrates the common interest in the chemicals themselves. Instead of using the numbers on the beakers, he uses the actual chemical names printed on the beakers. After mixing Chlorox from beaker 2 with copper sulfate from beaker 3, he is excited and describes in detail the blue-green and brown dotted reaction. He appears to want to pursue reactions with "copper." After his partners, who are working together, trade their beaker 4 for his beaker 3, he looks up from the worksheet and objects, "I got copper!" While his partners are attempting to choose their next pair with reference to the worksheet so as to avoid duplication of pairs, Tracy's criterion for choice appears to be interest in a particular chemical.

Children who were not doing the intersection or some other systematic procedure while producing pairs of chemicals were finding the pairs "empirically," according to Piaget. This meant that the children thought up a pair by some means other than the intersection procedure and looked to see whether it had been done. In this case, the children had no way of knowing when they were finished except that they could not think of any more.

Piaget's analysis suggested that a child who was making pairs empirically was doing the same actions, such as mixing pairs or writing the results on the worksheet, but was not doing the same task as a child who knew the endpoint that the researcher had in mind. For the child without intersection, the task was like a request to jump as high as one could. The outcome was an empirical issue and differed for different children. For the child who had the idea of intersection, it provided a definite and general goal to be achieved. In the chemicals activity the teacher's statement of the task goal, "Make all the pairs," was not acted upon. The task, as the teacher and researchers understood it, happened only when the children themselves formulated the goal of finding all the pairs because they wanted to make more pairs.

Tracy's comments about the chemical reactions with copper give a kind of information that was almost never available in the movie star tutorials. The chemicals activity was so loosely constrained that alternative tasks were possible. It was known that the children were not doing the task because they were talking about doing other tasks. In the tutorials, on the contrary, little was allowed other than pair making. Tracy, for example, starts his second trial with five stars by making a row of cards. There is no way of knowing what he might have been trying to do, what his own task was, because he was immediately "corrected" by the researcher and told to make a column of pairs.

The strict enforcement of pair making in the tutorial made it difficult to know whether children were not doing the task of making all of the pairs. Differences in the pattern of pair placements did not stand out as indicating a different goal because they were not accompanied by other behavioral evidence that the children were doing some other task. It was assumed that the children in the movie star activity were all doing the same task but that only some were using intersection to do it.

Piaget's analysis of task performance already implied that some children were not doing his task, which made his analysis somewhat more powerful than other laboratory analyses that cannot distinguish between doing poorly and not doing the task at all. The analytic weakness of the tutorial setting showed up in what Piaget considered to be a transitional level of performance between "empirical" and "intersection," where patterns took place that he called "juxtaposition" sequences, such as doing the ends and then the middle (e.g. 1 & 2, 3 & 4, 1 & 4, 2 & 3, 1 & 3, 2 & 4). He described these sequences as a "search for a system," implying that the child understood the task and was searching for a solution. When such sequences occurred in the tutorial, it was impossible to tell whether or not the child was indeed doing the task. The tutorial design, however, did provide one kind of relevant evidence in that children who made juxtaposition patterns were not significantly faster than "empirical" children in learning the intersection strategy in the tutorial, which suggests that those patterns were not a stage on the way to discovering a solution to the task.

The chemicals activity, however, provided clear evidence that some of these juxtaposition sequences were produced while the children were not doing the task. For example, when Tracy, Leslie, and Rebecca start out, Tracy takes 1 & 2 while Leslie and Rebecca work together on 3 & 4. When they finish their respective mixtures, Tracy offers his 1 for their 3 and mixes 2 & 3, while the girls mix 1 & 4. When the girls finish theirs, Rebecca checks the record and decides to do 1 & 3, so they trade their 4 for Tracy's 3. These trades result in a sequence 1 & 2, 3 & 4, 2 & 3, 1 & 4, 2 & 4, and 1 & 3. This pattern results not from an attempt to create that particular pattern but from trading for chemicals each has not used. In this respect, the unconstrained setting provided better information about task performance than did the laboratory setting. The constraints of the laboratory obscured whether or not some subjects were doing the task.

The original coding scheme must now be drastically reinterpreted. Most of the children in the first and second trials of the movie star task may not have been doing the task at all. Scoring a 1, for no intersection, may not have been a low score; it may simply have been an indication of not doing the task. The coding in the chemicals activity must also be reconsidered. None of the children started out doing the task. For those who finally did, their achievement went beyond the achievement of any child in the tutorial because they discovered the task on their own.

Getting the Task to Happen in Psychology and Education

In both psychology and education there is the need to get people to do tasks which they would be unlikely to confront if left on their own. In both cases an expert must interact with a novice to present the problem and to oversee the methods that are devised for solving it. But the nature of cognitive psychology makes the psychologist's job easier. The psychologist must move the children from not doing the task to doing it when told to do it in the laboratory. The educator must move the children from not doing the task to doing it on their own in everyday life. In everyday situations there is not always an expert getting the task to happen and explaining the procedures. But educators want children to be able not only to solve problems when they are told to do so in a lesson or on a test but also to identify the problems in everyday situations.

Teaching was part of both the movie star tutorial and the chemicals activities. How learning takes place in the course of these interactions is a topic that should play a greater role in psychological research since it may provide an answer to how the task is made to happen in the laboratory situation and also to how the task may be made to happen in everyday situations where there is no teacher.

The movie star activity was designed in part as a testing situation and in part as a tutorial on the procedure to be used later as the tracer. The part of the tutorial devoted to teaching the checking procedure was designed to make use of principles in Vygotsky's (1978) theory of the "zone of proximal development" (Vygotsky, 1978; Brown & French, 1979; Brown & Ferrara, in press; Newman, Griffin & Cole, in preparation). In the procedure used, the tutor started out by giving as much help as the child needed to carry out the systematic check. Where necessary, the tutor asked about every single pair. But as the tutorial progressed, the tutor began giving less and less help until the child was doing the procedure on his or her own. Thus the procedure moved gradually from a location "in" the tutor-child interaction to a location "in" the child.

Following Vygotsky's theoretical formulation, the study assumed that tasks would be found first in the interaction between expert and novice and later in the novice's independent activity, because the novice not only lacked the skills necessary for carrying out a task on his or her own but, more important, did not initially understand the goal. The expert must ensure that the task itself occurred in the interaction between the expert and novice. Teaching in the study not only provided most of the children with the intersection procedure but also gave them the goal of finding all the pairs. That is, it introduced them to the task in such a way that the goal and the procedure were simultaneously internalized in the course of the interaction.

In the movie star tutorial, the children first produced a column of as many pairs as they could, and then the tutor began teaching the checking strategy. The conversation at this point was important. The tutor asked, "How do you know you have all the pairs?" The child usually answered vaguely or, like Tracy, with a hint of frustration, "I can't think of any more." The tutor then asked, "Could you check to see if you have all the pairs?" The child usually said little, and the tutor said, "Well, I have a way to check. Do you have all the pairs with Mork (or the first star on the left)?" From there she proceeded through the checking procedure, allowing the child to take over more and more as they went along.

The tutor's question, "How do you know you have all the pairs?" presupposed that the child was trying to get all the pairs. This may have been a false presupposition, but it was strategically useful (Gearhart & Newman, 1980). The question treated the child's column of pairs as if it had been produced in an attempt to get all the pairs. The teacher then invoked the intersection procedure as a means to fix up the child's "failed attempt to produce all the pairs." In other words, she appropriated the child's pair-making, turning it into an example of how to achieve the stated goal. When their own "empirical" production of pairs was retrospectively interpreted in terms of the intersection schema, children probably began to learn the researcher's meaning of "all the pairs."

This retrospective appropriation process was also seen at the end of the chemicals activity. The teacher always checked when the children thought they had finished and attempted to elicit a rationale for their thinking. Like the tutorial, the teacher was working with a concrete set of already produced pairs which were not necessarily produced by the children using the intersection procedure. In the chemicals task far more than in the movie star activity, the researcher's task completely disappeared from the scene in many cases. The teacher's questions at the end brought the task back to the interaction. Her discussion demonstrated to the children how the work they did could be understood as doing the teacher's task.

In an important sense the tutor and teacher were treating the child's production as if it were a poorly executed attempt to achieve an agreed-upon goal. In education, such assumptions may be a useful way of importing the goal into the teacher-child interaction and, from there, into the child's independent activity. The original coding scheme also treated many of the children's productions as poor strategies for getting all the pairs. In psychology, such overinterpretation can be dangerously misleading. Children are scored as doing poorly when they are not doing the task in the first place.

It is one thing to get tasks to happen when the teacher or researcher and the child are in direct interaction. It is another thing to get tasks to happen in the everyday world over which the teacher or researcher has little or no control. One important difference between everyday and laboratory-style tasks showed up in the chemicals activity.

Take the case of Rebecca, Leslie, and Tracy, who are working together. When it seems that no more combinations of chemicals are to be made, Rebecca looks to the record sheet and begins naming off the combinations following the intersection schema. She does not use the canonical order, however. The first pair on the sheet is 4 & 2. She starts with 4 & 2 and scans the record for the other combinations with 4 and then for the combinations with 3. Within each group (i.e. the 4s and 3s) she names the combinations in the order they appear on the sheet. When she gets to the end, she says, "We're done," and the teacher comes over and asks, "How do you know?" Rebecca repeats her intersection strategy, but this time she speaks more clearly and does the sequence in a stricter numerical order: 4 & 1, 4 & 2, 4 & 3; 3 & 1, 3 & 2, and so on.

The difference between Rebecca's first and second intersection procedure corresponds to a crucial difference in the source of the task. As Lave (1980) pointed out, everyday tasks usually arise from and are constrained by the actor's own higher-level goals. When Rebecca checks the worksheet the first time, it is to establish for herself that all the combinations are done. The order in which she names the pairs follows fairly closely the order on the worksheet she is checking. When she checks the sheet the second time, it is to display for the teacher how she has arrived at her conclusion, and she keeps closer to the canonical order. She answers the question, "How do you know?" rather than trying to find out if more chemicals are to be done.

A "whole task" thus becomes specifically a task considered in the context of the activity or higher-level goals that motivate it. Whenever there is a task, there is always a whole task. But in some settings, like the laboratory, the classroom, or wherever there is a hierarchical division of labor, the higher-level goals may not be under the actors' individual control. In other cases, the actors must formulate the instrumental relation between the goal of the task and the higher-level goal they are primarily trying to achieve. This was what happened in the chemicals activity. The children wanted to mix more pairs of chemicals, so they tried to figure out if they had done them all. Finding all the pairs was not a task which was presented to them by somebody else; it followed from the concrete situation in which they were engaged. In standard laboratory practice, where it is necessary to have as complete control as possible over the goals that the subjects are trying to accomplish, subjects are never called upon to formulate their own goals and so are confronted with only part of the problem — the solution part.

This is not to say that whole tasks are not part of the social interaction in the laboratory. The subject may be very much aware that the researcher has goals which are the reasons for getting the subject to do the task, even though the subject has no part in formulating the task. When Rebecca changes the order of the procedure, she appears to be displaying the procedure for the purpose of the lesson that the teacher is conducting. In short, there is always a whole task, but standard laboratory cognitive tasks are organized into a division of labor such that the subject is confronted only with the solution part.

Education is an attempt to make children able to do the whole task when an appropriate occasion arises. To provide such opportunities as were found in the chemicals activity, where children were allowed to discover a task in the course of doing some higher-level problem, is probably an important kind of experience for children to have if they are going to learn how to apply what they know to new situations. They will not learn to do this if they are always presented with a ready-made task. A teacher's retrospective discussions are also a crucial part of this experience. For the children who did not formulate the task themselves, such discussions were an opportunity to see that a task had been a potential part of the activity.

Conclusions

The effort to make the same task happen in two settings led to identification of two very different ways in which people are confronted with tasks. In one case the task was made to happen by the researcher, who not only stated the goal but also provided training in carrying out the solution. In the other case the teacher stated the goal, but the goal was not acted upon until the children themselves found a function for it in the course of their own activities. This difference calls for analysis in terms of the whole task. That is, any time a task happens, one must ask how it has come to happen. How it was made to happen is not an incidental aspect of the task.

The traditional business of cognitive psychological research has been to identify knowledge and processes in the head of the subject. It is only natural, then, that the subject should be isolated and the part of the experiment during which the experimenter and subject interact, namely the initial instructions or training, should be ignored. But just as the laboratory setting does not have privileged status as a place to study what people can do, "in the head" does not have privileged status as a place to locate schemata. They can also be located in the interaction between the experimenter and subject, or in the interaction among a group of subjects collaborating on a task, or in the interaction between a teacher and a child who is learning to do something new.

A framework that has schemata moving from the interaction to the individual makes the interaction and how it changes over time the central topic of analysis rather than an incidental aspect. Learning a task is accomplished in interactions. The ability to find the same task in everyday settings may also arise in interactions during which the expert turns the child's concrete actions into actions that have a new significance within the interaction. Methods must be developed for bringing those teaching interactions into sharper focus, so as to begin to discover how tasks can move from the classroom to the everyday world.