MIND, CULTURE, AND ACTIVITY

SEMINAL PAPERS FROM THE LABORATORY OF COMPARATIVE HUMAN COGNITION

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5 What's special about experiments as contexts for thinking

Jean Lave

I have been asked to write about experiments as special contexts for thinking. Experiments might be viewed as exceptional circumstances for problem solving and as unusual social occasions. A great deal has been said by psychologists about relations between laboratory experimentation and everyday activities. Many of the relevant caveats were presented by Wundt (1916). They have been restated, amplified, and added to by Brunswik (1955), Bartlett (1958), Barker (1968), Neisser (1976), Bronfenbrenner (1979), Cole, McDermott, and Hood (1978), to mention only a few appropriate references. To these discussions, I will add an example and a point of view.

The example I have chosen is from my own research among tribal tailors in Liberia. I gathered data on the tailor's uses of arithmetic in their daily routines in the tailor shop and in experimental situations and found that the problem-solving activities of the tailors look quite different in the two settings.

This example serves to illustrate my point of view. Most psychologists' critiques begin with experiments as the normative basis for describing thinking. They then end up treating everyday life as: (a) less demanding than the laboratory experiment (Bartlett, 1958; Case, 1978; Norman, 1975; etc.); or (b) unorganized and only given order by the organizing activity of the mind (this is Barker's (1968) characterization of "most psychologists' views"); or (c) simply, "the residual term which takes on specific meaning as it contrasts with the laboratory." (Cole, McDermott, and Hood, 1978, comment critically about the existing state of the art.) As an anthropologist I started out with an everyday scene as the primary source of information about how people use their heads, and have treated experiments as exotic and narrowly circumscribed events in the lives of the people studied. This point of view leads to questions about how experiments compare with other new situations that might arise in the tailors' mundane work lives.

To compare experiments with mundane social scenes requires a model of those features of everyday situations in tailor shops which might affect the methods tailors used to solve everyday arithmetic problems. I describe below a model of mundane situations and apply this model in a comparison of experiments and everyday situations in the tailor shops.

Background

The research on which this comparison is based stretched over a period of five years. I began by observing in tribal tailor shops, learning the production processes and other routines of tailoring, and studying how apprentice tailors learn their craft. This was followed by a series of experiments on transfer of training which compared the impact of apprenticeship and schooling on performance of more and less familiar tasks. There were two phases to this work. The first set of tasks incorporated problems taken directly from tailoring or school arithmetic. The circumstances surrounding the solving of these particular problems in experimental settings were similar to those found in the mundane setting: that is, the problems were ones the tailors routinely expected each other to solve without help from others. Such problems were viewed by the tailors as challenging previously acquired knowledge or skill. I then invented other, less familiar problems to contrast in specific ways with the problems known to be routine in the shop or school setting. The data for each tailor were analyzed for changes in performance across increasingly unfamiliar problems.

This analysis raised issues which could not be settled with the data from the first set of experiments. As Ginsburg (1977) has pointed out, it is important to compare data on problem-solving processes to draw conclusions about transfer. So on the second set of tasks protocols were collected. Fortunately, tailors learn one set of arithmetic procedures in the tailor shop and a different set in school. This makes it possible to often identify which method tailors were using on a given problem regardless of the setting in which they are solving the problems. The

second round of experimentation also differed from the first in exploring more systematically the formal domain of arithmetic and possible dimensions of transfer of training, including numerical difficulty, mundane/exotic problem content, and ways of presenting problems which required different degrees of decoding work by the problem solver.

The first round of experiments used the tailors' everyday activities as a basis for constructing experimental tasks but did not explore the boundaries of everyday competence. The second round included systematically generated problems, sampled a formally generated problem space, and had the virtues of consistency and representativeness of a formal knowledge domain, but did not grow out of the everyday experiences of the tailors. In the first case it was relatively easy to specify relations between experimental and everyday tasks, but hard to account for relations between my experimental tasks and the tasks of more standard cognitive experiments; in the second round this set of circumstances was reversed.

The results (details in Lave, n.d.) may be summarized as follows: In the experimental situations, those who had learned arithmetic in school as well as in the shop used school-learned problem-solving techniques to proceed through the experimental task. Those who had learned arithmetic in the shop used what could be characterized as a maximum-effort version of shop arithmetic and only a subset of shop arithmetic strategies. Many of the maximum-effort strategies appeared to be invented on the spot.

It appears from these results that the experimental situations were ill-specified ones for the tailors. But they individually filled in the gap between their understanding of the situation and mine. Some did so by reference to their problem-solving experiences in school, some by reference to the shop. Those who used their shop-learned skills as a model felt called upon to produce a version of those procedures which was never seen in the shop. They also omitted many techniques which they would have used in the shop.

After analysis of the experimental work, I was very curious as to how well the experimental data on problem-solving process would generalize to mundane situations. Consequently, in a third round of fieldwork, I observed everyday arithmetic activity in the tailor shops. The results of this work could be summarized as follows: Those who learn arithmetic in the shop use a rich and varied, and a streamlined version of this arithmetic in their work lives in the shop. Those who learn arithmetic in both shop and school (and used school math in the experimental setting) use shop arithmetic in the shop on a day-to-day basis.

Problem

It would certainly be useful to tackle the question of why mundane shop problems and experiments "pulled" such different kinds of behavior from the tailors. What features of everyday life in the tailor shop make it a special context for thinking and account for the special kinds of arithmetic strategies employed there by all of the tailors? Are there differences between critical features of everyday situations and experimental ones which help to account for changes in strategies from one situation to the other?

The model of everyday problem-solving situations

It may be helpful to simply state the main features of the model of everyday arithmetic problem-solving situations. "Situation" as it will be used here includes crucial features of both inner and outer environments of the problem solver, as each shapes the other. Experimental and everyday situations can be compared on these features, using the data on Liberian tailors.

The outer environment: Firstly, in the tailors' lives, certain kinds of arithmetic problems routinely reoccur. Secondly, problem solving often occurs in the context of social interaction or is at least vulnerable to social demands, most of which have higher priority than math. Thirdly, arithmetic problem solving is almost never an end in itself. It is instead an instrumental activity, undertaken in order to arrive at a wide variety of higher-order goals. Finally, it takes place in an environment rich with information for the particular problems which are frequently encountered.

The inner environment: Arithmetic problem solving makes heavy demands on attentional resources; it is effortful. Most arithmetic problems can be solved quickly if all the required information is present, although this condition is not often met.

Comparing mundane and experimental problem-solving circumstances

The outer environment: The first issue is that of routine reoccurrence. Given the repeated occurrence of arithmetic problems in daily life, it should not be surprising that tailors show little difficulty representing problems to themselves. What is problematical in everyday circumstances becomes the input for these problems. Even the information-rich environment of the tailor shop is sometimes not rich enough to permit a tailor to solve a problem at the time he recognizes that it exists. Both the reoccurring nature of problems, and potential difficulties in obtaining new inputs, help to explain why procedures for solving arithmetic problems in the shop very often focus on relations between old and new instances of the same problem.

All of these features of everyday problem solving stand in contrast with the problem-solving tasks presented in an experimental context. One goal in choosing the problems for the experiments was to make at least some of them unfamiliar to all subjects. If the experimenter were successful, any strategy which involved comparing old and new versions of the same problem would be unavailable to the subject. Furthermore, the experiment, as a situation, is a one-of-a-kind occasion. This is not a situation in which it could be said that problems routinely reoccur. Everyday strategies which take advantage of routine reoccurrence will not be effective in the experimental situation. Since there is little time for adaptation of methods during an experiment, experiments are always "learning transfer" situations. Learning transfer is a relatively rare occurrence in everyday life.

Second, the outer environment is peopled; social interaction has very high priority in the tailors' lives. Instrumental activities are lower in a goal hierarchy and require social management in order to compete for resources of attention. Very often in the shop the tailors handle this problem with a fluid, shifting division of labor. A tailor dealing with a customer passes the measuring or other figuring along to some other tailor who solves it and gives him the answer while the first tailor continues to attend to the customer. Checking problem solutions, which in addition to objective results provides reassurance that calculation was properly done, are often social, done in parallel by two or more. (For a similar finding see Kreutzer, Leonard, and Flavell, 1975.) All of this contrasts with experimental circumstances in which problem solving is assumed to be an exclusive engagement between a person and the problem. Social strategies are not permitted.

Third, arithmetic problem-solving, like most of the cognitive procedures which are the target of experimental investigation, is a low-level means employed in everyday life in the service of a wide variety of higher-order goals. In an experimental setting where math problem-solving procedures are the topic of investigation, "solving math problems correctly" is the highest order goal made explicit in the situation. Defining tasks through the practice of "giving instructions" ignores the customarily embedded, instrumental nature of arithmetic activity. More important, it often leads to expectations on the part of the experimenter about what constitutes appropriate (i.e., elaborate, high effort) problem-solving procedures. The same expectations would not be appropriate for problem solving seen merely as an instrumental activity.

The means/end relationship between problem-solving goals and problem-solving procedures has a number of implications. First of all, in the everyday setting in which arithmetic is (only) instrumental, minimizing attention allocated to math makes sense. In experiments, in which solving the problem correctly is a major goal, it makes sense to maximize efforts at problem solving. This is certainly what I observed the tailors doing. Once again the contrast between the two sets of circumstances suggests that procedures appropriate in either one are not appropriate in the other.

Everyday strategies for solving problems include ones which violate many of the usual experimental constraints. In everyday circumstances, standard techniques include simplifying problems, delegating problem-solving work, and rejecting problems. More importantly, it is often useful to compare old and new inputs to a reoccurring problem, note the difference between them, and make a decision vis-à-vis the higher-order goal rather than solve the arithmetic problem (e.g., the eggs are 30 cents higher this week. That's too much. We'll get them somewhere else). This contrasts with the assumption in an experiment that the task must remain fixed; that procedures which involve reframing the task are not permitted.

Higher-order goals in everyday problem solving also vary the precision constraints on the problem solutions. Because of the instrumental nature of arithmetic and other demands on attention, it makes sense to

pay attention to precision constraints. In general people solve problems no more precisely than necessary to meet the higher-order goal for which they are calculating. Attending to precision constraints is a skill of everyday arithmetic that does not much come into play in experimental situations, since solving math problems is the goal. Perhaps the tailors have a default position: Under ill-specified precision constraints and minimal other demands for attention, be as precise as possible. This would help to account for the maximum-effort arithmetic procedures used on the experimental math tasks.

One further implication of the instrumental uses of arithmetic in everyday life has been touched on at several earlier points. Usually the higher-order goals are well enough defined in everyday situations to provide adequate information about precision constraints, error cost and so on. In experiments the goal may seem well specified: "I want you to solve some arithmetic problems." But this takes into account only the instrumental level of the problem-solving activity and not the crucial function of higher-order goals in determining appropriate problem-solving procedures. Viewed in comparison with a higher-order everyday goal, e.g., "getting groceries," goals which would provide comparable precision constraints in experiments are not clear. This confusion may be a serious problem with many experimentally defined tasks.

Inner environment: No matter what the circumstances, mental calculation is effortful and requires heavy attentional resources. It is also a rapid process (most often less than a minute) if all needed information is at hand and if there are not competing demands for attention. At the same time calculation is slow enough to disrupt conversation. All of this applies in experimental settings as well as in everyday settings.

In everyday settings, however, it may take days to solve a given arithmetic problem. Problem solving is subject to interruption and also to absence of information. The contrast between customary speed when problem solving is in progress, and the enormously greater time periods which are often encountered creates difficulties in "problem management," (e.g., holding onto whatever inputs are available, and the problem representation, seeking additional inputs, pushing to assemble them all at once, or storing some and waiting, etc.). These problems are not generally addressed in assessing math skills in experimental settings. In experiments inputs are given and it is generally possible to solve difficult problem-representation circumstances and relatively easier input acquisition circumstances than everyday life provides.

I have not previously mentioned the impact on problem-solving strategies of experience over time in some environments. Change in strategy over time arises as a function of interaction between outer and inner environments. It seems likely that methods used in solving problems (e.g., memorization or interpolation or re-calculation, etc.) are chosen partly in response to experience with the frequency of reoccurrence of different problems in the environment along with the simplest possible extrapolation to the future ("what has happened in the past is what I expect in the future"). (Kahneman, 1973, discusses some implications of this point.)

But tasks and problem-solving methods in experiments have unspecified relations to the extensional domain[1] of everyday life. Experimental tasks are typically selected from domains which bear no specified relationship with everyday tasks and problems. Certainly they are not carefully constructed samples of problems with different (known) frequencies in the domain of actually occurring problems.

Discussion

It could be argued that an important measure of peoples' problem-solving skills is what happens when they are asked to solve new problems in new circumstances. In this frame of reference experiments make sense as a tool for investigation, since experiments present new problems in a new situation. But if this argument is taken seriously it changes the appropriate comparison to make to everyday situations. The appropriate comparison might be other *new* problems which arise in mundane settings, rather than *routine* problems in mundane situations.

One example of a new problem in a mundane setting occurred in a tailor shop. A man came into the shop one day and requested that a tailor make a set of burial clothes. None of the tailors in this shop had made burial clothes before. But all present felt the customer had come to the right place to get a solution to his problem. Bargaining, sewing, the setting, different kinds of clothes, are all familiar. Only the specific item to be made was new, and it could be compared to other closely related types of garments. In short, people's experiences with new situations in everyday lives tend to be a good deal more like previous experiences in

everyday situations than are experiments. It is possible to suggest several ways in which the circumstances of problem solving in new situations are quite differed when experiments and other new situations are compared.

Experiments gain much of their power as tools for investigating cognition from the fact that they are simpler situations than the typical everyday experiences of most subjects. On the one hand, the non-negotiable definition of tasks, the complete presentation of specific tasks is simpler than the fuzzy, often incomplete, unfolding nature of tasks in everyday situations (Cole, McDermott and Hood, 1978). On the other hand, experiments lack specification of higher-order goals which routinely guide the choice of problem-solving method in everyday situations, including new ones. For instance, the burial clothes were extremely simple and also voluminous. No one measured the "customer" and precision constraints on fit were extremely broad, under the circumstances. Yet the goal was there, "make loose-fitting garment x," at the same level as usual, routinely translatable in its impact on sub-portions of the task.

Experiments constitute ill-specified new situations in other, more complex ways. For instance, neither the experimenter nor the subject is likely to know how the situation is related to previous situations in which the subject has been routinely involved. Neither is the experimenter likely to investigate differences between previous problem-solving experiences and activities in the experimental setting. And there is unlikely to be a clear understanding of differences between the distribution of problems-to-solve routinely encountered by subjects, and the experimental tasks as samples from that or some other domain of problems. In the example of the burial clothes, the situation was a slight variant on routinely occurring ones. Previous problems and previous experience solving problems were clearly specified. This was not the case in my experiments.

Experimental situations also differ from other new situations, in the timing of performance demands. In everyday life one would rarely be called on to perform immediately in a new, or ill-specified situation, until one understood "what's going on." Thus, no one in the shop thought of asking an inexperienced apprentice to make the burial clothes, even though several were available, and skilled enough. Only highly experienced masters talked it over and decided on one of their number.

A third way in which experiments differ from most other new problem-solving situations is in the degree of consistency of certain major features of the situation over a series of routine reoccurrences. Experiments often arbitrarily change features of the situation in ways that mundane new situations rarely if ever impose. This is especially true for (a) social circumstances of performance, and (b) means/goals status of the problem-solving procedures under study. Some tasks have a strong social component, others do not. But in everyday life the social features of a daily activity are very likely to remain constant across numerous reoccurrences. Arbitrary change in the social and physical matrix of an activity is not common. It does happen from time to time – occasionally we cook in someone else's kitchen or go grocery shopping with a friend – with predictable performance difficulties. Experiments, unfortunately, very often create this arbitrary change in the social conditions of activity. It is also rare in everyday life that a task which was an end in itself in one setting becomes instrumental in relation to some other end in another mundane context. In everyday situations where this does happen there are very likely to be strong signals to the actor, including clear specification of higher-order goals where appropriate. *Most of the cognitive skills typically addressed in experiments move from instrumental to goal status as they move from everyday situations into experimental ones.* The math activities described earlier are a good example. But memory experiments, perception, logic problems, and most other foci of heavy experimentation suffer from the same arbitrary change. This may help to explain why it is difficult to "see" cognitive skills in everyday settings, a problem emphasized in Cole, McDermott, and Hood.

If the propositions above are acceptable (that both social circumstances and means/goal status are often changed when transported into an experimental context), then a point made earlier becomes even more important. In everyday situations where there are newcomers or novices, there are almost certain to be provisions for induction, temporary peripheral participation, or at least dramatic signals to flag shifts in social or means/goals circumstances. There is likely to be social support for identifying the out-of-the-ordinary features of the situation and adapting to them. Experimental situations seem atypical situations in being impoverished in the social circumstances which lead people to make rapid and successful adaptations in new mundane situations.

Conclusion

If conventional experiments do not masquerade well as "new mundane situations," is there any hope for generalizing from experimental to everyday situations? Actually, the question is an experiment-centric one. It may profitably be revised to, "Is there any hope that we may learn from contrasting performances in contrasting situations?" From my own experience working in Liberia, I would answer in the affirmative. I disagree, however, with the argument set forth in Cole, McDermott, and Hood, about the nature of appropriate generalization. It is argued there (p. 15 and elsewhere) that "the experiment should be treated as a simulation of the properties of the scenes to which we want to generalize." But if any critical features of experiments cum situations contrast with basic features of mundane situations, an ecologically valid simulation of everyday situations is not possible. If context and performance interact, there are almost certainly important features of the situation which won't agree between experiment and mundane circumstances.

It is possible, however, to make predictions about expected *differences* in performances across contexts, given a careful description and analysis of the differences in problem-solving circumstances in some specific mundane setting(s) and in an experimental one. By trying to understand an experiment as an actual experience in the lives of subjects, by focusing on how the circumstances it presents *differ* from those of routine situations, and by successfully predicting performance differences in the separate contexts, theories (rather than experimental results) can become general without automatically becoming invalid at the same time.

Secondly, the notion that rigorous proof of particular kinds of cognitive processing can *only* come from experimental manipulation seems too narrow. If you understand the social organization of a commercial dairy and the division of labor within it, you should be able, like Scribner, to predict who will be good at one kind of arithmetic but not another, and who will solve customer order problems in terms of pints and quarts, and who in terms of cases and half cases. De la Rocha (personal communication, 1980) predicts from a three-stage model of Weight Watchers curriculum, who will carry out new calculations about food servings in one way rather than another; Murtaugh (1980)[2] predicts on the basis of the functional role of a particular food in a person's food management system whether the person will calculate before buying that item in the grocery store. Confining theory testing or theory development to experiments is an excessive limitation on sources of knowledge, and grows out of the model which specifies that the goal of experimentation is to produce a literal reproduction of the target behavior under study. But indirect evidence abounds, including data on the social structure, data on what people do *not* do under certain circumstances, data on what kinds of mental effort people avoid through the use of external inventions or social skills. These can shed light on problem-solving processes with reasonable rigor. Producing rigorous indirect evidence, rather than literally reproducing target behavior, is a useful goal for at least some new exploration of cognitive processes.

Notes

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1. The "extensional domain" of arithmetic problems is the set of actually occurring problems in a given situation.
2. Proposed research: A Hierarchical Decision Model of American Grocery Shopping.

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