THE QUARTERLY NEWSLETTER OF THE
LABORATORY OF COMPARATIVE HUMAN COGNITION
Michael Cole and William S. Hall, Editors
Jan Russo Cooper, Managing Editor
Center for Human Information Processing
University of California, San Diego
January 1982, Volume 4, Number 1

Taking Away the Supportive Context: Preschoolers Talk About the "Then and There"*

Lucia French
Hampshire College
Katherine Nelson
City University of New York

Recent studies of child discourse have been based primarily on observations of spontaneous, turn-taking conversations in play contexts. However, our analyses of the content of discourse organized around interviews about children's familiar activities (Nelson, 1978; Nelson & Gruendel, 1979, 1981; French & Nelson, 1981, in prep.) indicate that both free play and experimental contexts may underestimate children's communicative competence and the cognitive abilities on which it rests.

The initial purpose of these interviews was to discover how children acquire and represent knowledge about routine events and was undertaken within the script framework initially posited by Schank and Abelson (1977). In general these studies have revealed that preschool children possess a great deal of complex, sequentially-organized knowledge about events that appears to be important to the child's cognitive competence in everyday life. An unexpected outcome of this research was the discovery that in responding to the interviewers' questions about these familiar events, the preschoolers appeared to control semantic and pragmatic devices that were either unobserved elsewhere or were presumed to be beyond the control of preschool children. The language used in the course of describing familiar events is both sufficiently similar across children and events, and sufficiently dissimilar to the language that occurs in unstructured play settings to indicate that we are dealing with a discourse form that reveals competencies quite different from those exhibited in other contexts.

Over the course of these investigations into what children know about familiar activities, approximately 300 middle-class children ranging from 2;11 to 9;5 have been questioned about a number of different activities including getting dressed, going to a restaurant, going to McDonalds, having dinner at home, having lunch at a day-care center, having a snack at camp, having a fire-drill, making cookies, making a camp-fire, having a birthday party, going to the grocery, being at school, and planting a garden. The general method used to elicit descriptions of the activities involved asking a general initiating question such as "Can you tell me what happens when . . . ?" or "What do you do when . . . ?" and then providing follow-up probes such as "Anything else?" and "Can you tell me more?" until the children indicated that there was nothing more they cared to say about the topic. The discourse features to be described here were replicated across studies and, for the most part, were as true of younger as of older children. They therefore will be described in general terms with reference being made to particular studies and to developmental trends only where pertinent.

One point that should be emphasized initially is that, unlike many of the other things that experimenters ask them to do, preschoolers seem to find a request to describe their event knowledge eminently reasonable and easy to respond to. This is somewhat surprising since it seems unlikely that many parents regularly ask children about routine events (although they do often engage in dialogues with their children about *specific* past events which are assumed to be particularly salient).

Decontextualized Speech

Studies of children's knowledge about language ordinarily take one of two forms. Studies of productive language have typically relied upon the child's spontaneous speech--to adults or to other children--in "free-play" settings. Studies of the comprehension of particular vocabulary items have typically relied upon various paradigms that involve the experimenter making a statement that includes the vocabulary item being assessed, and the child *doing* something that can be interpreted as indicating whether he understood the focal word (Tanz, 1980).[1] In either of these contexts, the attention of both participants is usually focused on a set of toys or other objects in the immediate environment and both

*Preparation of this paper was supported by a NICHD #5732HDO7196 post-doctoral fellowship to the first author and NSF grant #BNS 78-25810 to the second author. The data reported here were collected by Lindsay Evans with the cooperation of the Gesell Nursery School in New Haven, Connecticut. We are grateful also to Janice Gruendel for help in the design and execution of the research and to Dawn Smyer for aid in data analysis. A version of this paper was presented at the Boston University Conference on Language Development, October 11, 1981.

Copyright 1978 LCHC

the adult and child tend to talk about the immediate context, that is, about the "here-and-now." While no one has concluded from such findings that adults' speech is limited to here-and-now, there has been a tendency to assume that preschoolers are able to talk *only* about the here-and-now.

The interview data show that when the discourse setting makes it necessary to do so, children as young as 2;11 are quite capable of talking about familiar activities outside the context of these activities and in the absence of external props such as pictorial representations of the context. Furthermore, the reports three- and four-year-old children give of "eating lunch at the day-care center" and "eating dinner at home" do not differ as a function of whether they were questioned about both events at home before dinner or at the day-care center before lunch (Nelson, Gruendel & Hudson, 1980). That is, not only could the children describe "dinner at home" when questioned at the day-care center, but they gave virtually the same description, in both form and content, in that setting as they did in the more "contextually supportive" home settings.

The fact that preschoolers are able to talk about events that are not taking place in the immediate environment when the discourse format makes it relevant to do so is interesting in its own right and contributes to the growing body of revisionist literature showing that preschoolers are not so "cognitively incapacitated" as they have been traditionally characterized (Brown, 1976; Flavell, 1977; Gelman, 1978; Nelson & Gruendel, 1981). Perhaps even more importantly however, "freeing" the preschool child's speech from constraints imposed by talking about the immediate context makes it possible to observe the use of language requiring competencies quite a bit more sophisticated than those ordinarily shown by, and therefore credited to, the young child. These are described in the remainder of this paper.

Generalized Nature of the Accounts

One pervasive assumption about young children has been that their ability to generalize or abstract is limited. However, as can be seen in the sample protocols presented in Table 1, the descriptions provided by even the younger subjects tend to be general in nature; that is, the children tended to talk about "what happens" in general rather than about "what happened" on a particular occasion. In one study, three- and five-year-olds were asked questions phrased in both general terms, e.g., "What happens when you have dinner?" and in specific terms, e.g., "What happened onetime--when you had dinner?" (Nelson & Hudson, in prep.). Although children of each age could respond to questions taking either form, they found it easier to respond to the general questions. Thus young children are not only *capable* of giving general descriptions, but, at least for habitual activities, they seem to find this a more natural way of talking about the activities.

[1]For a discussion of possible reasons for the somewhat counterintuitive finding that between study comparisons show children producing relational terms (such as *before, after, because, or, but* and *if*) appropriately considerably earlier than they appear to *comprehend* them, see French & Nelson, 1981; in preparation.

Table 1

S#2 (2;11)
(What do you do when you get dressed in the morning?)
I go to school.
(Any more you can tell me about getting dressed?)
Just put your tights on and your sneakers on.
(Just put your tights and sneakers on. What else do you do?)
Just put your raincoats on. And then you take them off at school.

S#3 (3;1)
(What do you do when you go grocery shopping?)
Well, you um, pick some food and then go home.

S#7 (3;5)
(Tell me about a birthday party.)
You get, you get ice cream and cake.
(You get ice cream and cake. Anything else you do?)
No.

S#13 (4;0)
Well, you drive and then you go in and eat then that's all!

S#19 (4;2)
(Can you tell me what you do when you have a fire drill at school?)
You walk fast but you can't put your coats on 'cause you need to hurry.
(So you walk real fast and you can't put your coats on, you have to hurry.)
Once when I was having a fire drill, I had a sweater on so I didn't, so I, so I wasn't cold.
(That was lucky, wasn't it? Anything else that you do when you have a fire drill? Anything else that happens?)
We need to walk down the fire escape.
(Umm, that's unusual. Anything else you remember about what you do when you have a fire drill?)

S#42 (5;6)
When you make cookies, well ya, up, make the dough, and you um, get the cookie cutters out and cut 'em and put decorations on. And then put 'em in the oven, and then when they come out, you could eat 'em.

Syntactic-Semantic Correlates of Generalized Descriptions

Several interesting syntactic features were observed as correlates of the generalized form of the children's descriptions. Children frequently used the general or impersonal "you" in their descriptions, as in "you go" or "you put them in the over." They also used the social "we," particularly when talking of group activities. Neither of these pronoun forms is likely to appear in conversations about the here-and-now, but they are highly appropriate and frequent in the discourse setting established by asking children "What happens when . . . ?"

Another characteristic of the generalized descriptions was the frequent use of the definite article to introduce previously unmentioned elements (the teacher, the waiter). The use of "the" rather than "a" indicates that the children believed that the roles introduced were intrinsic to the events they were describing, and the use of the general role term rather than a specific name suggests that they realized that various individuals might fill these roles on different occasions.

A particularly noteworthy syntactic feature was the use of the tenseless or timeless verb form ("you eat," "you go somewhere") by even the youngest subjects interviewed. Sentences containing such verb forms are labeled "timeless" because they do not refer explicitly to the past, the present, or the future. The frequent use of timeless speech in the protocols is of special interest because, although little study has been made of this form, Cromer's (1968) analysis of longitudinal data gathered in free-play settings (Brown, 1973) suggested that timeless speech did not appear until about age four.

Both Cromer (1968) and McNeill (1979) have interpreted the relatively late appearance of this grammatical form as the result of immature cognitive abilities placing a limitation on the development of syntactic competence. Specifically, they hypothesized that it is not until about age four that children attain a level of cognitive competence that enables them to "decenter" from the immediate context to the extent necessary for the use of timeless reference. Our data clearly indicate that children can use timeless speech appropriately as early as their third birthday and therefore apparently have whatever cognitive abilities underlie such speech by that age (French & Nelson, 1981). As virtually all children that we have responses from do command the timeless form, its use cannot be attributed to unusual precociousness.

The frequency and necessity of timeless references clearly varies as a function of the discourse context. Such speech is not required and is apparently nonexistent or infrequent when the speaker's attention and conversation is focused on the immediate context. On the other hand, timeless reference is appropriate and even necessary in the context of describing the general form of routine events, and the three-year-old's underlying competence with this grammatical form may be elicited simply by setting up such a context. It is important to note that in the study of both general and specific dinner/snack reports, even 3-year-olds alternated appropriately between the timeless form for general accounts and the past form for specific accounts (Nelson et al., 1980).

Optional Pathways and Hypothetical Speech

One of the ways in which the reports given by older and younger preschoolers differed was that the older children were more likely to specify alternatives which existed in the general skeletal framework of the events they described. Whereas younger children tended to provide "*and*-linked" *lists* of acts or items which might co-occur, children four and older were likely to mention either alternatives, that is, events or acts which were unlikely to co-occur, or conditionals, that is, events which would occur under certain non-obligatory conditions. Such alternatives and conditionals were frequently marked with either *or* or *if . . . then*, logical connectives considered to be parallel forms in alternation and conditional logic respectively (Ennis, 1976). Some examples of lists, alternatives, and conditionals are shown in Table 2.

Table 2

Lists:

S#4 (3;1)
(Tell me about grocery shopping.)
Get some carrots and meat and celery.
(Some carrots and meat and celery?)
And some lettuce.
(Anything else?)
Uhh, meat.
(And what else do you do?)
Nothing else.

S#8 (3;7)
(What do you do when you go to the grocery?)
I buy, I buy apples and cheese.
(Yeah, and anything else?)
And dessert. And good things that make you big and strong, steak.
(What else do you do when you go grocery shopping?)
Uh. . . .

S#1 (2;11)
(What do you do at a birthday party?)
Eat cake and soda and ice cream and cones. Candy.
(You have all those good things to eat. Anything else that you do at at a birthday?)

S#4 (3;1)
(Tell me what you do at a restaurant.)
Get some soda. Get some french fries. Get some ketchup.
(Anything else?)
Nothing else.

Alternatives:

S#15 (4;0)
And then we buy some stuff and then we go home or go to school or go to Stuart's.

S#37 (5;1)
I sometimes, I put an undershirt on, sometimes I put a slip on. Then I put a dress or pants or shorts or shirt, and then I put a shirt on, whatever, then I put my coat on.

S#42 (5;6)
And um, buckle your shoes or tie 'em.

S#25 (4;7)
Put your clothes on, eat breakfast, go to work or school; that's it.

Conditionals:

S#16 (4;0)
Well, you see, after, if you eat all your food up, ya get dessert.

S#20 (4;3)
Are there strawberry cookies?
(There could be.)
I never cooked them, but I'll try cooking them if my mommy buys it.

S#29 (4;8)
Well, my mom always gets angry with me if I put the wrong things out and she uses them when she's not supposed to use those things.

S#42 (5;6)
Well, sometimes if you're really in a hurry you don't even get your coat or anything on. And runnn. But if you have a little time to get your coat on, you get it on.

S#13 (4;0)
They eat, or you play if they have enough time.

Very little attention has been given on how preschoolers use *if* and *or* in their spontaneous speech. One of our data sets (N=43; age range 2;11 to 5;6) has been analyzed closely for the occurrence of explicit marking (with *or* and *if*) of some items as optional (French & Nelson, in prep.). We have found that *if* and *or* constructions begin to appear at about age four and are relatively frequent by age five.[2] These terms are invariably used appropriately, contrary to the predic-

[2] *If* was used by 8% (1/12) of the subjects between 2;11 and 3;10, by 39% (9/23) of the subjects between 4;0 and 4;11, and by 63% (5/8) of the subjects between 5;0 and 5;6. *Or* was used by none of the twelve subjects between 2;11 and 3;10, by 35% (8/23) of the subjects between 4;0 and 4;11, and by 100% of the eight subjects between 5;0 and 5;6.

tion that might be made on the basis of prior comprehension studies showing inadequate understanding as late as twelve years. The terms also seem to be used more frequently in the interview setting than in the ordinary conversations that young children have with each other or with adults.

We believe that both the correct usage and the frequency of *if* and *or* in our data derive from features of the discourse context established. In experimental settings that attempt to assess children's understanding of relational terms, children must often deal both with somewhat opaque task demands having questionable ecological validity and with stimuli that consist of inherently unrelated propositions on which a relationship is imposed through the use of logical connectives. Such comprehension tasks also often involve a requirement that children "decode" and adopt the speaker's presuppositional framework. In concert, these features of comprehension tasks may *mask* rather than adequately assess preschoolers' understanding relational terms (Tanz, 1980).[3]

Assuming that children are able to use *or* and *if* appropriately, their opportunity to exhibit such competence to investigators is quite limited by the here-and-now focus of the speech samples typically collected. When focused on the immediate context, children's speech concerns their current activities or their plans for the immediate future (Hood & Bloom, 1979) rather than hypothetical or optional alternatives that might have bee, but were not, taken. In contrast, the interview setting frees children from the contextual constraints inherent in talking about the here-and-now and makes the expression of alternatives and conditionals highly appropriate. The discourse setting of script reports thus appears to be a good one for eliciting the spontaneous production of statements containing *if* and *or.*

One domain of contemporary interest for which these young children's productions of *if . . . then* statements has particular relevance is the development of hypothetical reference. The prevailing doctrine for many years has been that preschoolers are incapable of hypothetical thought. While other critics have voiced dissatisfaction with this claim, Kuczaj & Daly's (1979; Kuczaj, 1981) research is the first to systematically consider preschooler's productions of hypothetical statements. Their procedure involved both recording any spontaneous instances of hypothetical reference and asking their subjects hypothetical questions. They found that the frequency of spontaneous hypothetical reference was very low, but that the appropriate use of obligatory forms such as *could* and *would* was substantially better in self-initiated (e.g., spontaneous) than in other-initiated hypothetical reference.

[3]While a case could be made to the effect that "full" understanding of relational terms implies the ability to understand those terms in the absence of contextual support, we feel that a better case can be made to the effect that, as it is typically measured, such understanding involves metalinguistic and logical abilities that are dependent upon but not identical to understanding the natural language meanings of these terms. In addition, investigations which focus only upon whether or not children of a particular age have achieved "full" understanding of such terms fail to address the more interesting developmental question of the course of the acquisition process. For a more further explication of this position, see French & Nelson, in preparation.

In conjunction with the timeless nature of their discourse, our subjects' use of *if . . . then* conditionals result in what appear to us to be *timeless hypothetical statements*, examples of which are presented in Table 3. Although such utterances neither fit into Kuczaj and Daly's (1979) taxonomy of "non-present happenings," nor require explicit marking with *could* or *would*, they nevertheless appear to have a hypothetical status.

Table 3

Timeless hypothetical reference

S#42 (5;6)
Sometimes, if you have a child or a baby, you put it in the cart. And sometimes, sometimes, um, you don't need a cart if you have just a few things to shop for. . . . And sometimes if you don't have the cart you have to carry a person, because it's a baby.

S#37 (5;1)
Well, if they have on here for real, you have to crawl or roll to get the fire out. If the heater was on hot, and it was coming smoke and fire -- everything on fire, you would just get out and cough.

S#38 (5;4)
Buy food, or if you wanna, you return something what you don't want.

S#28 (4;8)
But sometimes Thursday you don't go to school. All you do is just eat breakfast and get dresses if you want, but you could stay in pajamas too.

Our data suggest two further points. First, broadening the definition of hypothetical reference to include timeless references may increase the frequency with which spontaneous productions are observed and thus provide more information on which to base conclusions about the *types* of events to which preschoolers spontaneously make hypothetical reference. Second, the evidence that preschoolers' knowledge of familiar activities includes a representation of alternative pathways suggests that questioning them about such activities, rather than about parents or story characters as did Kuczaj and Daly, might decrease their difficulty in adopting the questioner's "hypothetical framework" (Kuczaj & Daly, 1979) and thus provide a more sensitive assessment of their ability to use the verb forms that are obligatory in the production of temporally referenced hypothetical expressions.

Temporal Structure

Previous reports of this research (Nelson & Gruendel, 1981; Nelson, 1978) emphasized that children almost always reported component events making up the script in correct temporal order. Our careful analysis of over 700 protocols revealed only 19 cases in which children (2;11 to 5;6) violated the correct sequence of invariantly ordered events. These violations were primarily either cases in which subjects mentioned an act twice, first in an incorrect and then in the correct position,or cases in which they gave a conventional rather than temporally correct ordering, as in "I put on my shoes and socks" (French & Nelson, 1981).

The most intriguing aspect of the temporal structure of the descriptions concerns those cases in which subjects recalled an event after the point in their descriptions at which it would have been appropriate to mention it. The rule of discourse specifying that the order of mention of a series of events must ordinarily reflect their order of occurrence makes it inappropriate for a speaker to simply mention such omitted events at the time they occur to him. Instead, he must somehow indicate, through temporal markers or otherwise, where the event fits into the sequence being described. Some examples of such "temporal repairs" are presented below.

S#1 (2;11)
(How do you help your mommy?)
Yeah. She gots something out to bake muffins with. But first she has to buy some things for muffins.

S#17 (4;1)
You know what I do is, I just blow off the candles and eat it. And before I eat it, I just take out all the candles.

S#24 (4;7)
And um, the person will open it. And take off, take off the ribbon before they open it, and they'll find out what's inside.

S#38 (5;4)
You--you can--you sit down and eat ice cream, but first what you do is really play, and then eat ice cream and cake. And then you go home.

These temporal repairs are extremely interesting because they indicate that the children producing them have both an internal representation of the temporal organization of the events and that they are able to move bi-directionally within that representation. Taken together, these two abilities appear to meet Piaget's (1971) criteria for temporal reversibility and thus, according to his theory should not be within the competence of preschool children (French & Nelson, 1981). It is important to note that the likelihood of observing such spontaneous temporal repairs would be very low in either speech focused on the here-and-now or in experimental settings designed to assess temporal reversibility. Although a discourse setting such as this one does not *guarantee* the appearance of such forms, it does permit their expression.

Relational Terms

The terms *before*, *after*, *because*, *if*, *so*, *but* and *or* all function to establish a relationship between two propositions. Comprehension studies have typically shown that preschoolers do not understand these terms, but as both French and Nelson (1981; in prep.) and Tanz (1980) have pointed out, comprehension paradigms often place additional cognitive demands on subjects that are irrelevant to the basic question of whether they know the meaning of a particular term. Although production measures are not without their own problems, contextually and semantically appropriate productions of relational terms often offer compelling evidence that the speaker does indeed understand their meaning.

One problem with relying on spontaneous productions of particular terms to infer understanding is that the frequency of occurrence may be very low. For example, Ford's (1976) four-day attempt to collect naturally occurring productions of *or* in a preschool classroom yielded only three such productions from children (and two from the teacher). There is often little reason to use *if* and *or* in speech focused on the immediate context. Similarly, when conversations concerns the here-and-now, temporal and causal relationships are typically apparent in the extralinguistic context; although it is not *inappropriate* to verbally encode these relationships, it is usually not necessary to do so.

Our interview data contain numerous productions of relational terms. We attribute this frequent production to both the nature of the discourse setting and to the subjects' familiarity with the events they were asked to describe. By requiring subjects to talk about the then-and-there, we removed the possibility of their speech either being limited by or relying upon the extralinguistic context; this apparently increased the appropriateness and thus the frequency of relational terms. However, we do not believe that relational terms would occur with relatively higher frequency in *any* sample of child speech that was not focused on the immediate context, regardless of content. The activities children in these studies were asked to describe were likely candidates for their occurrence precisely because the are temporally-causally integrated units that have both a general structure and offer the possibility of a variety of alternative instantiations. The fact that very young children understand both the temporal-causal structure of the activities and the possibility of alternative actions and objects within them apparently underlies and motivates their use of relational terms. In light of the large body of literature showing that preschoolers tend not to comprehend various relational terms, we were initially surprised by the fact that these children virtually never used these terms inaccurately. Whether this indicates that children simply do not use these terms unless they are certain of their meaning, or whether it has to do with their familiarity with the relational structure of the events is a question for figure study. Support for the latter possibility is offered by anecdotal reports that preschoolers often use relational terms inappropriately when talking about unfamiliar events, and by some data from our lab showing that three-year-olds may use *before* and *after* appropriately when referring to *well-known*, invariant sequences, but incorrectly when referring to arbitrarily established sequences (Carni & French, 1981).

Conclusion

The major findings to date of the research program upon which the present discussion is based are presented in Nelson and Gruendel (1981) and Nelson, Fivush, Hudson and Lucariello (1982). In these papers it is argued that the child's early representations of familiar events are the basic building blocks of further cognitive development. In this paper we have considered the data from a somewhat different perspective than previously, arguing that the discourse setting established by interviewing preschoolers about familiar activities results in a quite different use of language, and thus a quite different picture of the young child's linguistic and cognitive skills, than is obtained by analyzing their ordinary context-bound conversations.

The decontextualized nature of the language we observed is of importance in and of itself and also provides the basis for the other discourse features we noted. That even the youngest children interviewed were able to talk about familiar activities in the absence of a supportive context provides evidence of previously undocumented representational abilities and we suspect that fruitful areas for future research into early representational abilities would include assessing the ability of even younger children and of non middle-class children to engage in such decontextualized descriptions of routine events.

Also noteworthy in light of common assumptions concerning preschoolers' cognitive limitations was the fact that their descriptions indicated that their representations of familiar activities took a general form instead of reflecting a particular episodic experience and included the specification of alternative pathways that could be taken in instantiating an activity. The children's sensitivity to the temporal-causal structure of the activities, and their unusually accurate and frequent production of relational terms were also important feature of these descriptions. All of these factors are relevant to topics of current concern in developmental theory and are particularly interesting in that they demonstrate levels of competence that have gone undetected in research that has relied upon standard means of data collection.

In summary, preschoolers may not be able to tell us too much that we don't already know about such mundane events as getting dressed and eating at a restaurant, but the way they tell us what we already know tells us a lot about them that we didn't already know.

References

Brown, A. L. The construction of temporal succession by preoperational children. In A. D. Pick (Ed.), *Minnesota symposia on child psychology* (Vol. 10). Minneapolis: University of Minnesota, 1976.

Brown, R. *A first language: The early stages.* Cambridge, Mass.: Harvard University Press, 1973.

Carni, E., & French, L. A. *Contextual constraints on preschoolers' comprehension of before and after.* Unpublished manuscript, City University of New York, 1981.

Cromer, R. F. *The development of temporal reference during the acquisition of language.* Unpublished doctoral dissertation, Harvard University, 1968.

Ennis, R. H. An alternative to Piaget's conceptualization of logical competence. *Child Development*, 1976, *47*, 903-919.

Flavell, J. H. *Cognitive development.* Englewood Cliffs, N.J.: Prentice-Hall, 1977.

Ford, W. G. *The language of disjunction.* Doctoral dissertation, University of Toronto, 1976.

French, L. A., & Nelson, K. *Temporal knowledge expressed in preschoolers' descriptions of familiar activities.* Paper presented at the Thirteenth Annual Child Language Research Forum, Stanford University, April, 1981.

French, L. A., & Nelson, K. *Some ifs, ands, and buts about preschoolers' understanding of relational terms.* Manuscript in preparation, City University of New York.

Gelman, R. Cognitive development. *Annual Review of Psychology*, 1978, *9*, 297-332.

Hood, L., & Bloom, L. What, when and how about why: A longitudinal study of early expressions of causality. *Monographs of the Society for Research in Child Development*, 1979, *44*, (6, Serial No. 181).

Kuczaj, S. A. Factors influencing children's hypothetical reference. *Journal of Child Language*, 1981, *8*, 131-137.

Kuczaj, S. A., & Daly, M. J. The development of hypothetical reference in the speech of young children. *Journal of Child Language*, 1979, *6*, 563-579.

McNeill, D. *The conceptual basis of language.* Hillsdale, N.J.: Erlbaum, 1979.

Nelson, K. How young children represent their world in and out of language. In R. S. Siegler (Ed.), *Children's thinking: What develops?* Hillsdale, N.J.: Erlbaum, 1978.

Nelson, K., Fivush, R., Hudson, J., & Lucariello, J. Scripts and the development of memory. In M.T.H. Chi (Ed.), *What is memory development the development of?* In J. A. Meacham (Ed.), *Contributions to Human Development. Monograph Series.* Basil, Switz.: S. Kargar, A. G., in press, 1982.

Nelson, K., & Gruendel, J. At morning it's lunchtime: A scriptal view of children's dialogues. *Discourse Processes*, 1979, *2*, 73-94.

Nelson, K., & Gruendel, J. Generalized event representation: Basic building blocks of cognitive development. In M. Lamb & A. L. Brown (Eds.), *Advances in developmental psychology* (Vol. 1). Hillsdale, N.J.: Erlbaum, 1981.

Nelson, K., Gruendel, J., & Hudson, J. *"What happens" in the child's mind's view: Studies of scripts for familiar events.* Unpublished manuscript, City University of New York, 1980.

Nelson, K., & Hudson, J. *Specific and general memories in preschool children.* In preparation.

Piaget, J. *The child's conception of time.* New York: Ballantine Books, Inc., 1971. (First published in 1927.)

Schank, R., & Abelson, R. *Scripts, plans, goals and understanding.* Hillsdale, N.J.: Erlbaum, 1977.

Tanz, C. *Studies in the acquisition of deictic terms.* Cambridge: Cambridge University Press, 1980.

The Role of Instruction in Memory Development: Some Methodological Choices*

William Gardner
Barbara Rogoff
University of Utah

As Brown (1980) has pointed out, developmentalists know more about what develops in memory than about the life experiences underlying that development. The advantages of the strategic processing of information are well known, and the developmental sequence of memory skills has been mapped--insofar as these skills are visible--in laboratory tasks. But developmentalists know much less about the experiences through which children develop these abilities to monitor and organize their memory performances.

Vygotsky (1962, 1978) believed that in order to make statements about the origins of a cognitive skill and the influences on its development, the skill should be observed during its "zone of proximal development." A skill is in the zone of proximal development when a child has only partially mastered the skill, but can employ it successfully with the assistance of an adult. Vygotsky argued that children develop the ability to regulate their own cognitive activities through social interaction with adults. He called this process internalization. At first children perform new information processing tasks "externally," in conversation and interaction with adults who provide guidance and support. Children then master the new skills by internalizing the guidance that had been provided by the adult. If Vygot-

*Work on this project was supported by N.I.H. Biomedical Research Support Grant no. RR07092 from the University of Utah to Barbara Rogoff.

sky is correct, observing how mothers communicate with children concerning memory skills is essential to our understanding of how these skills are developed.

In this paper we analyze a conversation between a mother and her child concerning the child's memory for items presented in a laboratory task. Our interest is in the *joint* construction by mother and child of a way for the child to remember the arrangement of the items, on which the child alone will be tested. Our analysis will focus on what the mother tells the child about memory, on how she tells it, and on what her conversation partner, the child, contributes to process of telling.

Some Methodological Dilemmas

The analysis is a commentary on a transcript of the mother and child's conversation while preparing for the test. This procedure, unusual in a psychological investigation, was chosen after consideration of other methods. We will recount some of our thoughts on these matters, in the hope that they will be of use to investigators facing similar choices.

Our database is a set of videotapes collected by Rogoff and Ellis (1981) in which mothers prepared their children to take a memory test in a laboratory room which resembled a kitchen. These data were initially collected to explore the direct and interactive effects of the age of the learner (7 vs. 9 years) and the context for the instruction (home vs. school-like tasks) on the teaching strategies of the mothers. Rogoff and Ellis found that mothers use different teaching strategies depending on the age of the learner and the context of the instruction. The logical next step was to examine these teaching strategies in finer detail, and if possible to relate specific "tactical" moves by the mother to particular responses and problems of the learner.

We first considered an event-based scoring method that would assess adult-teaching and child-responding relevant to the adult's regulation of the child's memory activity. The resulting data were to be modeled through bivariate time series procedures which, we hoped, would capture the social interactive qualities of the instruction. Using this intensive statistical modeling, we hoped to discover the means by which the mother managed the cognitive performance of the child.

This approach failed, however, because of what at first sight seemed to be technical problems. We could not develop a coding scheme that was sufficiently fine grained to capture the adaptation of each dyad to the problems it encountered, while still producing large enough frequencies in each code to allow meaningful statistical analyses. This is a common problem in research on social interaction using fine-grained sequential codes. For example, statistical considerations led Martin, Maccoby, Baran, and Jacklin (1981) to collapse 10 infant codes and 13 mother codes into two codes, positive and negative, for each interactant in their sequential analysis of mother-child interaction. Similarly, Bakeman and Brown (1980) were forced to collapse a 120 code scheme to just 4 dyadic states.

Social interaction researchers are not alone in experiencing difficulty in validating theories concerning complex human actions in everyday environments. Epstein (1980) has recently concluded that in personality research

> The traditional solution of attempting to obtain a high degree of control in the laboratory is often ineffective because much human behavior is so sensitive to incidental sources of stimuli that adequate control cannot be achieved (p. 790).

One response to this problem has been to widen the scope of experimental methods to include more environmental sources of stimuli by using person-situation interaction models. This strategy is analogous to the interactive systems models called for by Brown (1980) and Bronfenbrenner (1979). But the multiplication of the number of potentially relevant experimental effects may be without limit because of the complexity of everyday events. Cronbach offers little hope to those who choose this path.

> Once we attend to interactions, we enter a hall of mirrors that extends to infinity. However far we carry our analysis--to the third order or fifth order or any other--untested interactions of a still higher order can be envisioned (1975, p. 119).

Epstein calls for a retreat from the apparent abyss: instead of relating personality constructs to human responses in specific situations or on particular occasions, he suggests researchers average their data over settings and/or occasions.

Epstein's strategy is certain to increase the likelihood of significant F-ratios in research, but the cost will be abandonment of fine-grained analysis of human performances in everyday settings. For our purposes, the aggregation of data on performance over settings or occasions would completely obscure what we wanted to know about metacognitive development: how do an adult and child jointly adapt a cognitive skill to the circumstances of a task in a specific, complex environment. Similarly, we would lose our grasp on the central problem in instruction: the instructors' adaptation of a problem and its context to the knowledge and experience of a given learner (Greenfield, in press; Ratner and Bruner, 1977; Rogoff and Gardner, in press; Wood, Wood, and Middleton, 1978).

These reflections led us to doubt that there were any "technical" solutions to our problems--unless the problem was the technique of coding connected actions into discrete behaviors *per se*. We began to feel that the form which a conventionally operationalized code imposed on our data excluded the most interesting material we could see in the tapes. First, fine-grained sequential analyses are motivated by the assumption that a person's behavior is determined by his or her own and the other's immediately contiguous behaviors. But this assumption did not fit our view of how information is communicated. We believe that an individual's acts are dependent on far more than the immediately contiguous events. As Martin et al. (1981) note,

> It seems likely that as children grow older, their interactions with their parents will be less and less a function of events occurring in the immediately preceding short interval of time, and more a function of events that are remembered and responded to over a period of hours and days (p. 156).

Second, operational codes (sequential or otherwise) force an identical interpretation upon topographically similar acts that occur in widely different contexts. From our own experience, we could see that this is a limitation for research on instruction. In teaching, we work to develop the meaning of initially difficult concepts for students by applying and exhibiting them in several contexts. For example, a Professor might refer to "conservation" in the first and last sentences of a lecture on concrete operations. If we were studying that lecture, it would not be false to code both events as "Reference to conservation." But it would ignore the fact that the second reference should evoke a more sophisticated response from the students than the first reference. From our viewpoint, this would be to ignore what the students are learning and the adjustment of the Professor's depending on what the students have learned.

We came to feel that a fine-grained sequential coding system would miss the essential instructional and cognitive problems faced by the dyads. In particular, it would not give us a way of describing how the interaction changed as the dyad developed a collective understanding of their task. Forms for the representation of the task and its required skills were developed by the dyad over the course of the interaction. This development of common forms of representation became, in turn, the problem to which we addressed ourselves. These considerations led us to explore approaches to social interaction which took the structure of the communication and actions within the interaction as the object of the study. Cicourel (1973) has argued for the need to study the interpretive procedures through which a participant determines the meaning of social events and produces acts which will be recognized as meaningful by others. Moreover, in studying social interaction, the researcher must rely on his or her own tacit command of interpretive procedures to recognize and then make explicit what is going on. Cicourel states that the observer who wishes to understand the meaning of discourse from the perspective of the participants

> cannot avoid the use of interpretive procedures in research for he relies on his member-acquired use of normal forms to recognize the relevance of behavioral displays for his theory. He can only objectify his observations by making explicit the properties of the interpretive procedures and his reliance upon them (Cicourel, 1973, p. 36).

This applied to all observers: a coder in a conventional observational study necessarily relies on interpretive procedures when rating social behavior. But typically, *how* the researcher decides that an action constitutes a discrete event falling under a category in a code is not of interest--except for subsidiary and "technical" reliability concerns. And the question never arises whether the subjects experience the action as being constituted in the researcher's events and categories. The alterative is to focus attention on how the subjects make sense of (and through) their action. As McDermott, Gospodinoff and Aron argue,

> We can use the ways members have of making clear to each other and to themselves what is going on to locate to our own satisfaction an account of what they are doing with each other. In fact, the ways they have of making clear to each other what they are doing are identical to the criteria which we use to locate ethnographically what they are doing (1978, p. 247).

We therefore decided to try to "locate" what our dyads were doing, through intensive ethnographic interpretations of their videotaped and transcribed actions.

An Illustration: The Discourse of One Dyad

What follows is an interpretation of the transcript of a mother assisting her 8-year-old son in preparing for a memory test. The mother is helping her child classify and remember the organization of 18 common grocery items. The experimenters designed the items to fit into 6 common household categories (relishes, starches, baking goods, sandwich spreads, fruit, snacks) to be placed on 6 shelves in a simulated kitchen in our laboratory. The category structure of the items was not given to the mother, but she was allowed as much time as she needed to learn the arrangement of the items on their shelves, and she had a cue sheet showing the items on their shelves. The experimenter told the mother and child that they had just returned from the grocery store and needed to put the items away. After the items had been put away they would leave the room and wait for 5 minutes while the experimenter removed the items from the shelves. Then the learner would return alone and put away some of the original groceries plus some new, similar items on the proper shelves. The experimenter departed and the videotaping began.

MOTHER	CHILD
(sits)	
This should be fun. (stands, looks into grocery bag containing items)	
Okay, now we just got home from the store, okay?	*Yeah*
And we want to have everything in a certain place, so everyone knows where it goes.	

After a motivational comment, "This should be fun," the mother begins by asking her child "Okay, now we just got home from the store, okay?" This is the fictional context provided by the experimenter in her instructions to the dyad; the mother is simply recalling it to the child. This context contains a setting and a starting event as fictional premises for the classification task, the setting being the home kitchen and the starting event arrival home with the groceries. The natural expectation from these premises is that the groceries will be put away. Thus, the context is isomorphic to the classification task of the experiment.

The child confirms his recall (or acceptance, since some learners balked at accepting a lab as a kitchen) of this fictional context. The mother then elaborated the relevance of the grocery placement context for the experimental task, "we want everything to be in a certain place, so everyone knows where it goes." The kitchen context will be useful for the learner's preparation for the test since he could be expected to be familiar with the categorization of kitchen items to some degree. But note that the mother said "so *everyone* knows where it goes." She indicated to the child that the ordering of kitchens is what makes it possible for the members of the family to locate and retrieve items from the common space. Knowing the ordering of kitchens is one of the responsibilities of using them, so that they may be correctly replaced. It would have been more congruent with the actual experimental situation if the mother had said "so *you* know where it goes," since only the learner will be taking a test on the organization of the items. But the mother chose instead to elaborate a fictional goal implicit in the grocery sorting context.

The mother's statements convey metamemorial information when we interpret contextually; "Keep in mind how kitchens are ordered and why they are ordered: so that items may be easily retrieved." The metamemorial information was conveyed to the child through reference to a context where that information was built in.

Having established a context for the classification task, the mother directs the learner's attention to the first shelf (and first category),

MOTHER	CHILD
Okay first of all, lets start with this one. (points to shelf 1) *Okay, let's pretend we're going on a picnic* (points to shelf 1).	

The directive "let's start with this one" focuses the discourse on the first shelf. Then the mother proposes--"let's pretend . . ."--that another fictional context be embedded within the grocery sorting context just established. Whereas the grocery sorting context is isomorphic to the classification task as a whole, the mother has clearly restricted the scope of the new picnic context to the classification of the items on the first shelf.

Notice that although the grocery sorting and the picnic contexts are compatible--it is natural but not obligatory to find picnic items on kitchen shelves--they are not isomorphic. The embedding of one within the other was strongly marked by the mother's announcement of a new level of pretense. What interests us most is the mother's construction of a context for the task. She used but was not governed by the normative schemata for everyday life. The context for meaning was constructed, not automatic.

The mother continues,

MOTHER	CHILD
Okay let's pretend we're going on a picnic (points to shelf 1) *and we'll think: what do we need for a picnic?* (looks into grocery bag of items) *So let's look through here.* (pulls a can of olives out of the grocery bag)	

The mother's use of the first person mental verb "think" is of interest. One component of the classification task is the coordination of a physical search through the learner's knowledge of the relevant category. This pairing of actions is also highly appropriate for the learner when the latter returns alone to take the memory test. The mother models this coordination by pretending (yet again) that she needs to figure out the classification of the items, which she in fact knows, and by labeling her mental and physical actions as she performs them.

The mother proceeds to place three items in the picnic-shelf category.

MOTHER	CHILD
So let's look through here. (pulls out olives from grocery bag) *Uh. . . olives are good for a picnic. So we'll keep all the picnic things here, okay?* (places olives on shelf 1)	(follows mother to shelf 1)
We'll put the olives here. (returns to grocery bags) *Well.* (takes cookies and a can of peaches from a bag and places on a chair) *Let's see, what else do I have just for picnics?* (takes out pickles, displays them to child) *I don't know why, but I think of dill pickles for a picnic.*	*Yeah, sure.*
So you put the dill pickles there, turns and places the dill pickles on shelf 1) *on that shelf.* (points to shelf 1)	*Mmmhm.*
(looks into grocery bag) *And, let's look through here.* (takes peanut butter, muffins, and doritos out of grocery bags and places them on a chair) *Hm. . . those* (doritos) *could go with picnics, I guess we shouldn't take them out.* (replaces the doritos in the grocery bag) *Okay.* (takes ketchup out of a bag) *For hot dogs. that reminds me of a picnic. So that* (places ketchup on shelf 1) *ketchup goes there.*	

Each item is identified as a member of the picnic category as it is placed. The references to *thinking, looking*, and being *reminded* are similarly regular. This pattern suggests that the mother is creating a routine or script, both to structure the rest of the discourse and to train the child in a memory strategy for the upcoming test.

MOTHER	CHILD
All right, we're through with that, (gestures toward shelf 1) *okay? You just glance at that.* (points to shelf 1)	(turns and looks at shelf 1)
If I brought all these things (gestures toward shelf 1) *and I wasn't home, that you'd just put them right back there.* (points to shelf 1) *Okay? So there's olives, pickles, and ketchup just for picnics.*	(unintelligible question)
No, that's just where you're going to put 'em back when you come back and I'm not here. Okay?	(nods)
All righty. . .	

When she has filled the picnic category, the mother marks the completion of this sub-task, "All right, we're through with that"; and prompts the child to study the resulting grouping of the items, "You just glance at that." Two sentences later, she models a rehearsal of the picnic items, "so there's olives, pickles, and ketchup just for picnics." Perhaps to motivate her child's study, between the prompt and the rehearsal the mother asks, "If I brought all these things and I wasn't home, that you'd put them right back there. Okay?" This statement can be translated from the grocery sorting context as a metaphoric description of the memory test. The mother is performing a metamemory function for the child: she provides contextual information about the memory test--that it will be as "If I brought all these things and I wasn't home"--in order to make the child sensitive to his need to study the items. The child is indeed sensitive and asks a question which is unintelligible, but which serves to elicit clarification from the mother. He gets the translation suggested above as an answer. Apparently the mother's point was more effectively expressed through a direct reference to the experimental task than through reference to the fiction that they are arranging a kitchen at home.

Having made her metamemorial points concerning rehearsal, study and the upcoming memory test, the mother moves to shelf 3 and begins classifying items into a new category.

MOTHER	CHILD
Now let's say I was going to fix	

MOTHER	CHILD
dinner, okay?	(nods)
Let me think. (gets up and walks to the grocery bags) *What comes to mind when we're going to fix dinner?*	(follows mother to grocery bags)
(takes a box of macaroni and cheese out of a bag and displays it to the child)	*Macaroni and cheese.*
Yeah, okay (learner interrupts, end of statement lost). . .	(beginning of statement lost) . . .*shelf.* (rubs stomach in a 'satisfied' gesture)
(places macaroni and cheese on shelf 3) *Think out, the shelf closest to the floor,* points to shelf 3) *what you're going to have for dinner.* (returns to grocery bags, takes out a box of rice, displays it to the child) *Some rice. . .That's good for dinner.* (turns, places the rice on shelf 3) *That goes right there, on that shelf for dinner.* (returns to grocery bags, looks into one) *Let's see what else's for dinner. Ooooh, tacos!* (takes tacos out of the bag, displays to the child)	(makes a 'hungry' gesture by rubbing his stomach)
You love those for dinner. (turns and places tacos on shelf 3) *Let's put all of those down for* **dinner** *okay?*	*Mmhmm.* (nods)

Again the mother uses first person mental predicates and routinely labels her coordinated physical and semantic searches. Moreover, the child is now participating in the routine to a greater degree. In particular, he provides dramaturgic support for the dinner context by adding gestures suggesting his desire for the items.

The mother has "written" a script or framework for the interaction. Pragmatically, the script with a contextualized description of the classification task, "sorting groceries after coming home from the store." This is coupled with an announcement of the goal of preparing for the memory test, "sorting groceries when I'm not home." The sorting context provides a basis for a classification subroutine, a pairing of physical and semantic searches which could also serve as a model for the learner's test performance. Semantically, a kitchen taxonomy (Figure 1) has been developed, with starting node, shelf category, and individual item tiers. The overall goal of the discourse could be described as the

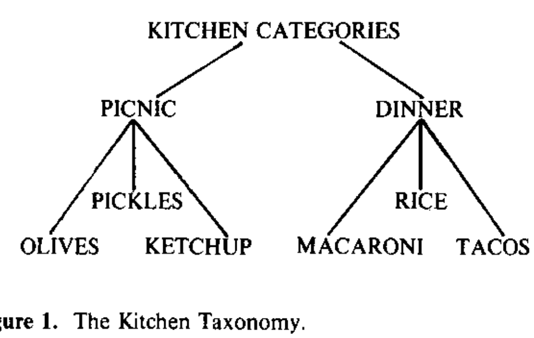

Figure 1. The Kitchen Taxonomy.

writing of the kitchen taxonomy on to the memory of the child, while training him in a routine that could be used with the taxonomy to replace the items on the shelves during the test.

Figure 1, however, represents only a temporary state of affairs in the interaction. The pattern of the semantic context in the discourse is fundamentally modified when the mother shifts to the next shelf/category. To explain this shift we must first discuss Mandler's (1979) distinction between *categorical* and *schematic* memory organization.

Categorical (or taxonomic) organizations are strictly hierarchical, including only superordinating and subordinating connections between elements in the structure. The kitchen taxonomy is an example: the picnic and dinner categories are included within the class of kitchen shelf categories and they are connected only through this superordinating class. In contrast, schematic organizations involve temporal, logical, or causal connections between concepts at the same hierarchical level. For example, the mother develops a schematic linkage between the dinner and desert categories in her shift to the next shelf/category.

MOTHER	CHILD
Let's put all of those down for **dinner**, *okay?*	*Mmhmm.* (nods)
Now let's think, after we've eaten dinner, what do we have? Dessert.	

With "after we've eaten dinner, what do we have?"/"Dessert" the mother elicits the linkage of the dessert shelf to a schematic structure through the child's knowledge of the order of meals in the day.

Mandler argues that schemata are more effective memory structures than taxonomies. The expectations linking schematized categories make a tight structure, in which remembering one item aids memory for the next item in a sequence. A taxonomy of categories, in contrast, is only a system of unstructured lists. Remembering the superordinate category defining the list still leaves the task of remembering the rest of the list.

There would be advantages, therefore, if the shelf categories could be placed in a schematic rather than taxonomic structure. For example, later in the transcript the mother marks the transition from fruit (shelf 5) to snacks (shelf 6) as a schematic shift from lunch (which includes fruit in the mother's scheme) to snacks.

MOTHER	CHILD
Applesauce is fruit, pineapple is fruit, (points to pineapple on shelf 5) *and peaches are fruit.* (points to peaches on shelf 5).*Mmhmm.*	
Okay, that'll be an easy way to remember. Here's lunch (points to shelf 4), *here's fruit* (points to shelf 5, then walks toward grocery bags). *Okay, you've eaten a good lunch, right?*	*Mmhmm.* (walks toward grocery bags)
Now you can have a snack. . .	

Here the mother notices an item that had been misplaced on an earlier shelf. She interrupts herself and discusses its correct placement. Twenty-two transcript lines later she resumes the schematic shift exactly where she has left the matter above.

MOTHER	CHILD
. . .cancel the cookies on that shelf, okay? And there's that blueberry muffin mix. (shuts the cupboard doors, covering shelves 2 and 3, where the misplacement of the items has been repaired) *Okay, so now you've eaten lunch and you say "Mom, may I have a snack?" So let's keep the snacks on the bottom shelf.* (points to shelf 6)	*So I can reach them.*

The planfulness of the mother's discourse--and the importance of the meal schema in its design--is emphasized by the mother's making the transition in the same way despite the substantial interruption.

The memory structure the mother provides for the child is strongly contextualized: for example, the mother says "Now you can have a snack" as they begin shelf 6. At this point in the discourse, however, the child is also actively contributing to the contextualization of the information he must remember. For example, he contributes a justification for the location of the snack category on a bottom shelf, "So I can reach it."

After the transition from the dinner category to dessert, the substitution of schematic for taxonomic order is complete; there are no further references to the grocery sorting context that had anchored the kitchen taxonomy. The structure of the semantic context for the entire discourse is presented in Figure 2.

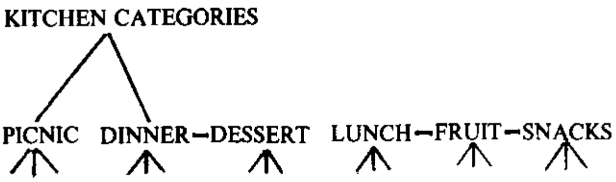

Figure 2. Final Semantic Context.

Although the grocery sorting context is not used after the shift from dinner to dessert, the tiered structure--in which placement subroutines alternate with strategic and metamemorial conversations--is retained. For example, after finishing the classification of the items on the dessert shelf the mother pauses to reinforce the child's awareness of the upcoming memory test and to rehearse his memory for items already classified.

MOTHER	CHILD
So (points to shelf 2) *for dessert we could make a cake or we could have cookies or muffins.* (points to shelf 2) *Now you'll need to put all these back just like this when you come in alone.*	*Okay.*
So top--bottom shelf. (kneels, points to shelf 3) *You remember what's in there?*	*Mmhmm.* (kneels, then scurries toward shelf)
Remember (unintelligible)) *for dinner* (points to shelf 3 as child interrupts)	*Tacos, rice, macaroni and cheese.*
Mmhmm. (taps shelf 2) *Top shelf?*	*Cookies, flour, blueberries.*
Mmhmm. Everything for dessert. And there's the picnic items. (taps shelf 1, then opens its cupboard door for child to see)	*Oliv--okay, olives, dill pickles and ketchup.*

The mother repeats her prompt concerning the memory test, "Now you'll need to put all these back just like this when you come in alone." The mother then asks the child to assess his memory for the contents of shelf 3, "You remember what's in there?" Then she leads him through a rehearsal of the items on the three shelves that have already been classified. Following this, she announces plans for the three final shelves and then begins the placement subroutine for the lunch itself.

Conclusion

We have presented this analysis to illustrate a method for investigating the joint cognitive activity occurring when an adult assists a child in solving a memory problem. The transcript shows a mother organizing her son's preparation for a memory test. She directed his strategic memory actions, such as rehearsal, and provided him with vital metamemorial information. By talking aloud her thoughts as she classified items, she communicated an account of her own strategies and tactics for solving the memory problem. She was concerned to make the memory activity meaningful for the child, and she anchored the meaning both in the context of a family kitchen and in the context of the task demands of the experiment.

Interactions in which the participants jointly accomplish a cognitive performance require that they create and maintain a common framework for the processing of information. When an adult teaches a child, the creation of a mutually intelligible context is essential, since the child's assimilation of new information depends on its compatibility with existing knowledge. Successful instruction structures a context in which the new information is within a child's grasp. We suggest that this is an important process in the internalization of culturally given functions such as memory.

References

Bakeman, R., & Brown, J. V. Early interaction: consequences for social and mental development at three years. *Child Development*, 1980, *51*, 437-447.

Bronfenbrenner, U. *The ecology of human development: experiments by nature and by design.* Cambridge, MA: Harvard University Press, 1979.

Brown, A. L. Learning and development: the problems of compatibility, access and induction. Technical Report No. 165, 1980. Center for the Study of Reading, University of Illinois at Urbana-Champaign.

Cicourel, A. V. *Cognitive sociology.* New York: Free Press, 1973.

Cronbach, L. J. Beyond the two disciplines of scientific psychology. *American Psychologist*, 1975, *30*, 116-127.

Epstein, S. The stability of behavior: II. Implications for psychological research. *American Psychologist*, 1980, *35*, 790-806.

Greenfield, P. M. The role of scaffolded interaction in the development of everyday cognitive skills. To appear in B.

Rogoff & J. Lave (Eds.), *Everyday cognition: Its development in social context.* Cambridge, MA: Harvard University Press.
Mandler, J. M. Categorical and schematic organization in memory. In C. R. Puff, *Memory organization and structure.* New York: Academic Press, 1979.
Martin, J., Maccoby, E., Baran, K., & Jacklin, C. Sequential analysis of mother-child interaction at 18 months: a comparison of microanalytic methods. *Developmental Psychology,* 1981, *17,* 146-157.
McDermott, R. P., Gospodinoff, K., & Aron, J. Criteria for an ethnographically adequate description of concerted activities and their contexts. *Semiotica,* 1978, *24,* 245-275.
Ratner, H., & Bruner, J. S. Games, social exchange, and the acquisition of language. *Journal of Child Language,* 1977, *5,* 391-401.
Rogoff, B., & Ellis, S. The adjustment of instruction by mothers according to context and child's age. Presented at the meetings of the Society for Research in Child Development, Boston, April 1981.
Rogoff, B., & Gardner, W. Developing cognitive skills in social interaction. To appear in B. Rogoff & J. Lave (Eds.), *Everyday cognition: Its development in social context.* Cambridge, MA: Harvard University Press.
Vygotsky, L. S. *Thought and language.* Cambridge, MA: MIT Press, 1962.
Vygotsky, L. S. *Mind in society.* Cambridge, MA: Harvard University Press, 1978.
Wood, D., Wood, H., & Middleton, D. An experimental evaluation of four face-to-face teaching strategies. *International Journal of Behavioral Development,* 1978, *1,* 131-147.

Motor and Mental Abacus Skill: A Preliminary Look at an Expert*

James W. Stigler
Craig Barclay
Patrick Aiello
The University of Michigan

Experts at mental calculation, who are seen as idiosyncratic specialists with highly developed cognitive routines, have attracted the attention of psychologists interested in mental processes (Hunter, 1977). From the perspective of Western psychologists, such skills are highly unusual, and the persons possessing them are inherently interesting subjects for study. By contrast, in Asian countries, particularly Japan and China, rapid mental calculation is not considered unusual. Children are introduced to the abacus at an early age, and intensive training in the use of an abacus often results in superior mental calculation ability.

The abacus is a wooden framed device with columns of beads that can be moved in well-defined sequences to perform arithmetic calculation quickly and accurately. Initially, abacus operation is a motor skill, and is learned very much the way motor skills are learned. Expert abacus operators, however, frequently report that they interiorize a visual image of the abacus. Manipulating the image as they would an abacus, they perform calculations mentally more quickly than they could through the use of the actual abacus. This phenomenon has been documented (Hatano, Miyake, & Binks, 1977; Hatano & Osawa, 1981), but has not, so far, attracted a great deal of experimental study.[1] In this article we present results from a pilot study of an expert abacus operator.

The abacus may enable us to look at some basic psychological questions in a natural context. Acquisition of abacus skill involves a transition from motor to mental representation that resembles the process of "internalization," which is considered by many theorists to be fundamental in cognitive development. While there is a great deal of research which focuses on the nature and function of mental images, almost none has investigated the process by which images are acquired. Investigation of the development and nature of mental abacus computation skills may shed some light on such issues.

In addition to the theoretical reasons for studying the abacus, there appear to be methodological advantages as well. Because of the nature of the abacus, the structure of abacus skill can be described objectively and quantitatively. Consider the analogy of a baseball player who reports that he swings at pitches that he images mentally as a way of practicing his hitting skill. This use of imagery is probably similar to practice with a mental abacus, but it is extremely difficult to study. The investigator has no way of knowing whether the hitter is throwing himself easy pitches or loop-de-loop curves, whether the pretend swing connects for a home run or misses completely, or if the hit is in fact good enough to put the batter on first, second, or third base. With mental abacus, the investigator can set the problem difficulty or type, evaluate the correctness of the calculation, and measure the speed with which it is carried out. Furthermore, it is possible to compare performance on mental abacus with performance on the actual abacus, and perhaps gain some insight into the way in which the skills are related.

In our preliminary study, we decided to work with an expert, since we felt that a description of the expert would provide a basis for future studies on the acquisition process. We focused on addition, and measured speed and accuracy over a fairly large set of addition problems. We were interested in how characteristics of the problem were related to speed of computation, and how this relationship might vary between motor and mental calculation.

We were fortunate to locate an abacus expert willing to volunteer. A Ph.D. in mechanical engineering, she is employed in a research position by a large manufacturing corporation. This woman's expertise resulted from early abacus training and national competition as an elementary school student in Taiwan. Mental abacus calculations were included in this raining, and she won the national championship for both abacus and mental abacus calculation when she was in sixth grade.

We presented our expert with a set of additional problems. A set of addends was constructed of equal numbers of randomly chosen two-, three-, and four-

*Supported by Chin-chan Chu and The Ford Motor Company.

[1] Editors' Note: See G. Hatano, *Cognitive Consequences of Practice in Culture Specific Procedural Skill,* in this issue.

digit numbers. These numbers were then grouped randomly into problems containing two, three, or four addends. The problem set was constructed in six blocks of 60 problems each. Each block contained equal numbers of two, three, and four addend problems. The total set consisted of 360 problems. Problems were written in black ink on 4 x 6 inch plain white index cards, one problem per card, for ease of presentation.

The entire problem set was presented twice on separate occasions, two weeks apart. During the first session, our expert performed the 360 calculations using the abacus; in the second session, the same problems were presented in the same order, but this time the calculations were performed mentally. For both sessions, problems were individually presented to the expert. She was instructed to perform the calculations as quickly as possible without sacrificing accuracy, and to verbally give the answer. Both sessions were video recorded for later coding.

Video tapes were coded for accuracy of solution and calculation time. Accuracy was coded from her verbal answers. Calculation time was measured from the time the problem card was presented to the time she began her verbal response. A manually operated millisecond timer was used, and the total time spent in the calculation of each problem was measured from the video tape three times by the single coder. The reliability of the timing was estimated by correlating the three separate times across the 360 problems for the motor calculations and also for the mental calculations. Pearson's r ranged from .98 to .99 for the six correlations. The dependent measure chosen for analyses was the median of the three times for each problem.

Our first step in the analysis of data was to calculate the error rate. As expected from an expert, the rate was low; out of the 360 problems, she responded with the incorrect answer only four times using the abacus, and five times using the mental abacus. While errors often provide insight into the structure of knowledge underlying a skill, there were too few errors to warrant an analysis in this case. The nine errors occurred on different problems, i.e., never the same for motor and mental computations.

Analysis of variance of response times across the six trial blocks revealed no practice (or fatigue) effects for either motor, $F(5,327)<1.00$, or mental, $F(5,346)<1.00$, calculations. The mean response time per problem was 3199 msec for motor computation, and 2348 msec for mental computation; the time advantage for mental calculation was significant, pairwise $t(324)=22.2$, $p<.001$.

To examine response time as a function of the characteristics of the problems, regression analyses were carried out separately for motor and mental response times, using both number of total digits in a problem (e.g., 23+4568 has 6 digits), and number of addends as predictors. Number of digits was found to be the best predictor of response times. Furthermore, when number of digits was first partialled out, number of addends added no further predictive power. We therefore concentrated on the relation of digits to time. Scatter plots for number of digits versus time are shown for motor and mental calculations in Figure 1. It is apparent that both motor and mental calculation times are linearly related to number of digits in the problem.

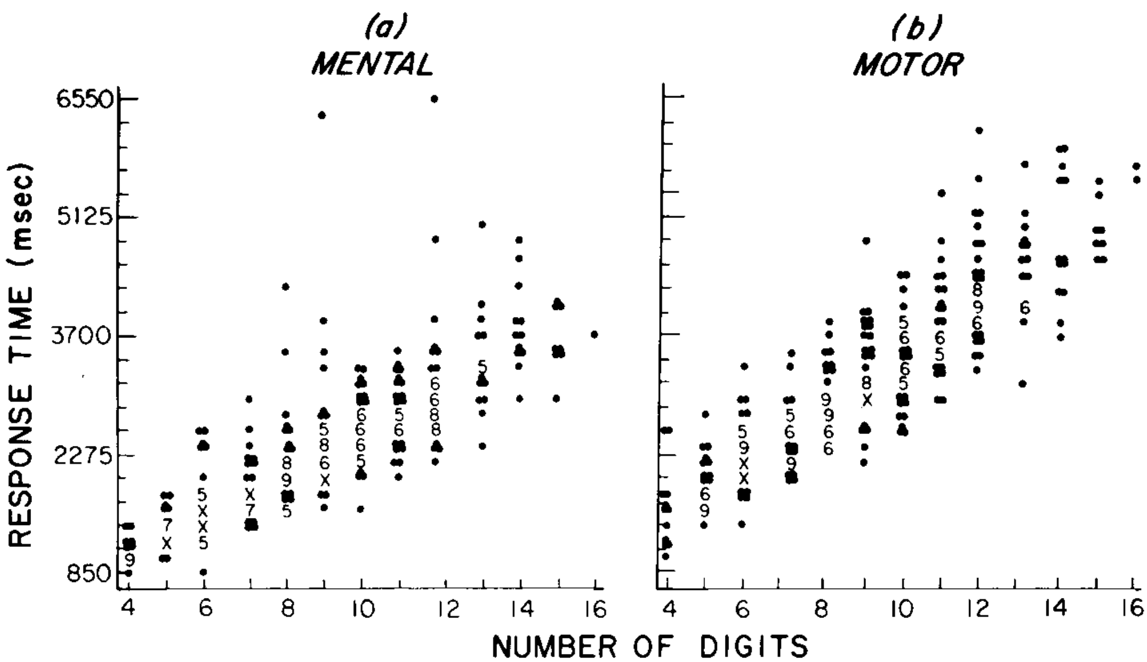

Figure 1. Scatter plot of response time (msec) as a function of number of digits in problem for mental (a) and motor (b) calculations.
(Dots refer to single data points; X's to clusters greater than or equal to 10).

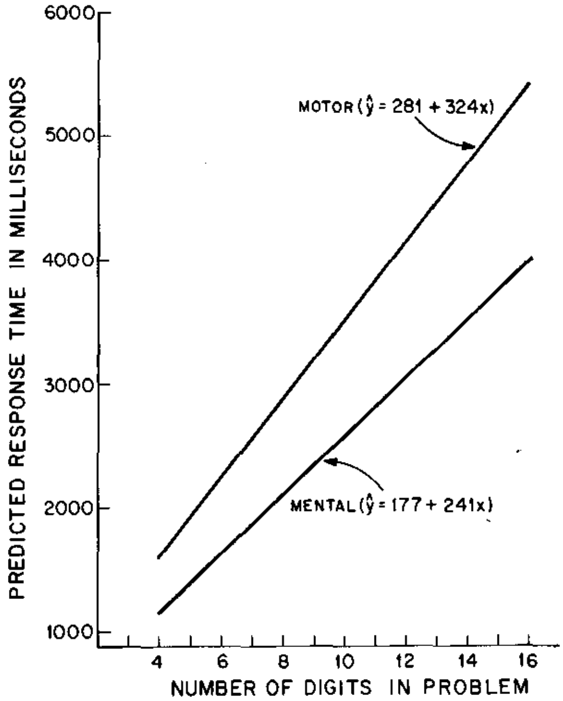

Figure 2. Least squares regression lines for motor and mental data.

In Figure 2 the predicted least squares regression lines are presented for both motor and mental times as predicted by digits. The R^2 statistics for motor and mental times were .79 and .65, respectively. The difference in R^2 could reflect either a difference in goodness of fit, slope, or both between and two regression lines. Further analyses revealed that the slopes differed significantly, $F(1,681) = 39.4$, $p < .001$, but that the standard error of the regression (the standard deviation of the residuals) did not vary reliably between the lines, $F(332,351) = 1.1$, $p > .10$. Thus, both sets of points were fit equally well by linear equations. Analyses also showed no advantage in applying a nonlinear model to either the mental or motor data.

The first finding to be interpreted is that of the difference in slopes between the two regression lines. The fact that both sets of data are fit equally well by a linear regression line suggests that the underlying structure of the skill for both motor and mental calculation may be similar. While calculation time was increased for both motor and mental problems by a constant amount for each additional digit, the increase was reliably less for mental than for motor calculation. If we suppose that calculation time is composed of decision time plus movement time (on the abacus), then it is reasonable to speculate that the time advantage for mental calculation is primarily due to greatly reduced movement time. This interpretation is supported by the introspective observations of the expert. When asked if she could actually see the beads moving on her mental abacus, she responded that she was able to do so during the earlier stages of the acquisition process, but that now the beads appear to make quantum leaps between the intermediate states of the calculation. If it could be shown that mental and motor calculation times are equivalent once movement time is partialled out, then it would be plausible to study mental representation of the abacus via a comparative investigation into the characteristics of physical abacus skill. Unfortunately, we are unable to reliably measure movement time apart from total calculation time.

Also of interest was the finding that number of addends did not have a significant independent effect on calculation times. This is effect means that the size of the number being used, whether tens, hundreds, or thousands, did not influence the speed of calculation. This makes sense in terms of abacus operation, since the procedures used in abacus calculation are carried out one digit at a time. While the horizontal position of the hand must be oriented so as to preserve the proper place value of each digit, the calculation itself does not depend on the place value of the digit. The fact that number of addends had no impact on either motor or mental calculation times provides additional evidence that mental calculation is structurally similar to motor calculation. This finding needs further study using a more variable problem set in terms of both number of digits and number of addends. It also would seem important to compare the effects of number of digits versus number of addends when using different methods of mental calculation.

The present findings are more provocative than they are conclusive. Our research is continuing in three directions: (1) We are currently developing an electronics abacus that will allow reliable measurement of each separate movement and decision time involved in calculation. (2) A computer model is being developed that will simulate the sequence of abacus movements as a tool for aiding in the analysis of data. (3) Experiments are being designed that should aid in making more specific and valid inferences about the nature of mental abacus skill.

References

Hatano, G., Miyake, Y., & Binks, M. G. Performance of expert abacus operators. *Cognition*, 1977, *5*, 47-55.

Hatano, G., & Osawa, K. Digit memory of grand experts in abacus-derived mental calculation. Paper presented at the Annual Meetings of the American Psychological Association, Los Angeles, 1981.

Hunter, I. M. L. Mental calculation. In P. N. Johnson-Laird & P. C. Wason (Eds.), *Thinking: readings in cognitive science.* New York: Cambridge University Press, 1977.

COPYRIGHT: The appearance of the code at the bottom of the page of an article in this Newsletter indicates that the Publisher gives consent for individual copies of that article to be made for personal or internal use. This consent is given on the condition, however, that--for copying beyond the limited quantities permitted under Fair Use (Sections 107 and 108 of the U.S. Copyright Law)--the copier pay the stated per-copy fee (for this *Newsletter*, $1 per article) through the Copyright Clearance Center, Inc., 21 Congress Street, Salem, MA 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

Cognitive Consequences of Practice in Culture Specific Procedural Skills*

Giyoo Hatano
Dokkyo University

An important part of any culture consists of a body of procedural knowledge and the skills necessary for the prompt and accurate execution of that knowledge. These procedural skills are repeatedly performed in production, communication and other areas in daily life, and are acquired by new members through direct observation and/or verbal transmission. Some are universal across cultures, but others are specific to a culture or subculture. Therefore, it should be rewarding to examine by cross-cultural comparison what cognitive consequences are brought about by practice in a culture-specific skill, in order to specify the relations between culture and cognition. Illustrative examples of a promising attempt at this have been seen in previous studies on the cognitive effects of pottery making (Price-Williams, Gordon, & Ramirex, 1969; Steinberg, & Dunn, 1976; Adjei, 1977), tailoring (Lave, 1977), etc.

This paper is divided into two parts. The first part will be a general discussion of problems in the acquisition of conceptual knowledge as distinct from procedural knowledge. In the second, I will derive tentative assumptions about likely cognitive effects of a culturally given procedural skill, with some illustrations from my own studies on abacus operation.

The acquisition of conceptual knowledge in the course of performing a procedural skill

Now let me start with the distinction between procedural and conceptual knowledge. Here I define procedural knowledge as representing a procedure routinely used for solving problems in a domain. It can easily be described by a system of productions, i.e., condition-action pairs. By conceptual knowledge I mean a mental model representing the world involving the object of the procedure. In that world, some "facts," regardless of how they are established, are taken to be true and this truth is believed to be shared by other people, providing a reference group. Thus conceptual knowledge invests with meaning both the entire procedure and its component sub-procedures. It can be approximated by a set of schemata, but unlike meta-procedure or "declarative" knowledge, it is too rich to be completely described by a few statements.

Procedural knowledge is often efficient but only for limited types of problems. This is mainly because the information embedded in it cannot easily be recombined to form other procedural knowledge (Rumelhart, 1979). Except for transfer of training in the classical sense, i.e., through shared components, practice in a procedural skill will not facilitate directly the development of other procedural skills even in the same domain. However, we assume that while practicing a procedural skill (and receiving feedback) people sometimes acquire and/or elaborate the corresponding conceptual knowledge about the object or system dealt with by the skill, find some meaning to the procedure and thus make it generally useful in the domain.

We often make a distinction between the mechanical performance of a procedural skill and performance with understanding. When do we consider that a skill is performed with understanding? It is probably when the performer can explain why it works, or at the least, can judge, in addition to the "conventional" version of the skill, appropriate or inappropriate variations (cf. Greeno, 1980). This judgement gives him some flexibility and adaptability in performance, i.e., s/he can modify the skill according to changes in constraints. Flexibility and adaptability seem to be possible only when there is some corresponding conceptual knowledge to give meaning to each step of the skill and provide criteria for selection among alternatives possible for each step within the procedure. A person may even be able to invent new procedures relying on general conceptual knowledge, which hopefully will meet any constraints imposed. Without the conceptual knowledge, trial-and-error are possible, or purely "empirical" minor adjustments of the procedure. So-called transfer of the procedure is beyond this adjustment. Therefore, we are reasonably sure that one has conceptual knowledge when he has shown invention or transfer, though failure to invent or transfer does not imply lack of conceptual knowledge; generativity may be limited by other factors.

If people ask themselves why a skill works or why each step is needed during its practice, the question will tend to lead them to form some conceptual knowledge about the object or system. It is likely that a farmer, starting with conventional farming skills, acquires much knowledge about plants in a conceptual form in the course of growing rice, corn or any other specific produce. Of course, this conceptual knowledge tends to remain tentative and implicit so long as it is not put to a rigorous empirical test. However, very few of us actually need rigorous scientific knowledge in our daily tasks, and thanks to this tentative conceptual knowledge, an experienced farmer can probably effectively deal with various changes in constraints (e.g., unusual weather, plant disease, etc.), including totally new ones. He may be called an adaptive expert. Likewise, a person with high curiosity can become an adaptive expert in cooking, beginning by preparing food according to a mentor's example or to given recipes, then later modifying the skill depending upon feedback. He can then be quite flexible in his procedure. For example, he will substitute some ingredients which are in season for the original ones prescribed in the recipes. He may even invent some new dishes to add to his repertoire by trying new combinations of ingredients or steps (sub-procedures). A very similar pattern of progress is expected for procedural skills dealing with symbols. For example, some computational procedures are often acquired by rote, practiced a lot, and only later understood in terms of their meaning in the number system.

The process of the acquisition of conceptual

*This is based on the paper presented at the symposium, "Cognitive development: Emerging and re-emerging themes," SRCD meeting in Boston, 1981.

knowledge can be rather straightforward when each step of action reduces the difference between the present and desired states explicitly and immediately. This is a backward problem-solving process. In the usual problem-solving process, people have to find mentally a chain of actions (operators) which reduce this difference. In the formation of conceptual knowledge, people already know that a given sequence of actions can reduce the difference, but have to find out why, i.e., the meaning and/or mechanism underlying each step. Suppose we want to prepare a dish we have enjoyed at a restaurant. If we do not know its recipe, we must proceed by the usual trial-and-error problem solving, but even when the recipe is known, that is, when we know "how," we may still ask why it produces such a taste and/or wonder what role each step of the cooking plays. In so doing, we have begun the process of acquiring conceptual knowledge. When dealing with a complex system where the effect of each step is not visible or it is mediated by other steps, people have to construct, either externally or mentally, a model analogous to the system. They will then "map" actions in the system onto changes in the model. In other words, conceptual knowledge for the former, straightforward case, can be formed by merely simplifying the observed events, while for the latter, complex case, some imaginative construction of the mental world is required. Such examples can easily be found in physics, medical science, etc. In any event, we assume that people can form the corresponding conceptual knowledge through performing a procedural skill, and through that conceptual knowledge they can "invent" other procedural knowledge.

However, this is not always the case. Sometimes, people learn to perform a skill faster and more accurately, without enriching their conceptual knowledge. For example, I suppose, many an amateur farmer has repeatedly grown alfalfa as prescribed, without understanding its nature, the conditions under which it grows best, or the contents of the fertilizer mix. Many of us make pancakes following a recipe, without even trying to understand why it works well. Our lives are full of procedures which we carry out, not for practice, but simply to get things done, and if we repeat them hundreds of times we can become quite skillful at them. However, our skill is useful only as long as constraints are constant, i.e., the same (or similar) set of materials and devices are available. We may become routine experts, but not adaptive ones; we can be outstanding only in terms of speed, accuracy, and automaticity of performance.

What are the differentiating factors between adaptive and routine expertise? Nobody can give us a comprehensive answer, but Piaget (1950) may have given us basic ideas. Though he believed that human beings are intrinsically motivated to understand an object or system, he pointed out that, in order to acquire conceptual knowledge, it is necessary to examine systematically the effects of variations in the procedure upon the outcome. This can be done either by actively manipulating some variables or by observing naturally occurring variations. In other words, one needs a set of data to find which variables go together, and in what manner. Piaget (1952) observed that even a toddler does this by active experimentation in the fifth stage of the development of sensori-motor intelligence. If a procedure consists of several steps, it is first necessary to articulate the entire sequence into steps.

I do not mean that the acquisition of conceptual knowledge is a primarily inductive process. I assume the opposite. The construction/reconstruction of the mental world is essentially deductive in the sense that the learner tries to apply already existing knowledge to interpret the data at hand and incorporate them meaningfully. S/he may not only make predictions using the prior knowledge but also accept conclusions consistent with it quite prematurely. For example, when water in a vessel with a lid did not freeze while water in other vessels did, day-care children became quite convinced that the lid prevented freezing (Inagaki & Hatano, in preparation). This was probably because it is consistent with their "shelter" schema ("Shelter reduces influence from outside"). Thus, they expectedly added the lid to their mental world about water freezing after a single observation.

Studies on "set" (e.g., Luchins, 1942; Luchins & Luchins, 1950), mindlessness (Langer, 1979), and the motivation to know and (Inagaki, 1981, in press) have suggested that some conditions will tend to facilitate this process of conceptual knowledge acquisition and others will tend to inhibit it. Let me give only three examples, each of which is relevant to later discussion.

1) A situation requiring students to modify a procedural skill slightly in order to get the desired outcome, facilitates conceptual change. In other words, if a minor change in constraints makes the original procedure no longer fully effective, the learner is motivated to experiment actively. On the other hand, if there is no change in constraints, and thus no necessity for even minor modification of the procedure, the learner is not motivated to examine variations.

2) When students are required to explain the appropriateness of the procedural knowledge (mostly to others but sometimes to themselves), they often try to select, integrate and elaborate some potentially relevant pieces of prior conceptual knowledge, probably relying on mental experimentation. However, when the procedural knowledge is taken for granted, i.e., there is metacognitive knowledge that the current procedure is the best one, the learner is discouraged from further experimentation.

3) When students are encouraged to pay attention to the nature of the object, i.e., when understanding the object of the procedure is a goal, they are more likely to try to construct conceptual knowledge. However, when the procedure itself and/or its outcome is of primary interest, e.g., when speed of efficiency is emphasized, they are not encouraged to ask why, nor to acquire the conceptual knowledge. Asking why or forming the corresponding conceptual knowledge is regarded as extraneous or even detrimental to efficiency of the performance.

We may say, then, that when asked to modify a procedure slightly, explain why the procedure is appropriate, or understand the object of the procedure, we are motivated to "unpack" the procedure and to find meanings of its components in the imaginative world. On the other hand, not varying the procedure, allowing it to be taken for granted, and placing speed and efficiency above all else will lead us to regard the procedural knowledge as a package and the object or system as a black box.

For example, we should expect farmers to be best motivated to know more about the nature of their crops when the weather changes from year to year, varieties of opinions as to how to cope with this exist, and flexibility based upon understanding is required. They would not be similarly motivated if the weather were stable, they believed their methods had proven to be best, and they were simply accustomed to working hard without thinking.

Cognitive consequences of cultural practice

What then are the likely results of repeated practice in a culture-specific procedural skill? I think that most culturally given procedural skills, unless "disturbed" by factors beyond people's control, are performed rather mechanically without one's asking why, because these skills are taken for granted in the culture. They are applied primarily for purposes of efficiency. Furthermore, as long as people are living in a stable culture, they will not often be required to modify the conventional procedural knowledge. This is exactly the type of situation which tends to inhibit the acquisition of the corresponding conceptual knowledge while a procedural skill is performed.

It is true that in a familiar environment people behave quite effectively without understanding. If they have a rule or algorithm for deciding to use a procedure (this itself is procedural knowledge), they can obtain the desired result without comprehending the nature of the object or system. Thus culture often tells us how to solve problems which are likely to occur in daily life, making trial-and-error unnecessary. However, culture seldom tells why its solutions are right. It usually leaves the issue of understanding to individual enterprise. This is probably because only accumulated procedural knowledge is decisive for maintaining (and hopefully increasing) productivity, a matter of life and death for the people in the culture. In a stable culture, we do not urgently need anything beyond apprenticeship, i.e., institutionalized practice in procedural skills without conceptual knowledge.

Abacus operation, a procedural skill specific to a few Asian cultures, is no exception. Abacus learning facilitates speed and accuracy of computation, but seldom helps students understand the 10-base system, the principles of carrying and borrowing, etc. Thus it shows a limited transfer to paper-and-pencil computation, i.e., another procedural skill for the same goal but with different constraints. We found (Hatano & Suga, 1981) that after-school abacus learning made 3rd-graders' paper-and-pencil addition/subtraction of multi-digit numbers faster and more accurate primarily through shared component skills (e.g., use of the number facts of single-digit addition/subtraction and of complementary-numbers-to-10), but did not improve their understanding of the carrying/borrowing principle. The practice in abacus operation did not greatly reduce "bugs," i.e., the consistent application of a wrong algorithm, in paper-and-pencil computation, though these errors seldom appeared when the children were using the abacus.

However, routine expertise in a procedural skill often produces processes by which the skill can be even more efficiently performed as by-products. People tend not only to excel at a task which they have practiced a great deal with involvement (Cole, 1980), but also to develop special mental devices for performing the task. The art of mnemonics originated by Greek orators is a well-known example of this principle, it again serves to increase productivity. Thus routine experts often show a capacity remarkably different from that of ordinary people on tasks which, though apparently very different, induce these processes. Scribner and Cole (1981) demonstrated that literacies developed and used in different contexts tend to produce a correspondingly differentiated pattern of cognitive competences.

Our abacus experts came to interiorize the operations they carried out using the device and thus could calculate without an abacus as accurately as, and often faster than, with the instrument. Grand experts of this abacus-derived mental arithmetic had a mental abacus of an extended size, on which they could represent a number of many figures. We found that they could reproduce rapidly a series of 15 digits either forward or backward (Hatano & Osawa, 1981). It might be added that their span for Roman alphabet letters or for fruit names was not different from 7 ± 2. Their memory for digits was quite stable, and partially compatible with aural input and oral output. However, they still held digits in working memory, and did not transmit them to long-term memory. By this powerful system of representation, they could mentally calculate a series of large numbers in the algorithmic fashion.

In conclusion, we assume that though practice in most culture-specific procedural skills tends to produce routine experts, with developed special processes involved in their performance, it usually doesn't facilitate development of the corresponding conceptual knowledge, nor competence under a new set of constraints even in the same domain.

This rather "pessimistic" conclusion does not imply that we should pay more attention to the acquisition of procedural skills and less attention to understanding in studies on culture and cognition. Some people try to understand culturally given procedural knowledge and thus posit the underlying conceptual knowledge, which in a sense goes beyond the culture. This also highlights the significance of Piaget's theory in the post-Piagetian era: he was primarily interested in understanding or the underlying structure enabling us to understand, not in successful performance or the correct procedural knowledge per se. It will be a source of profound regret if the American empiricist tradition ignores his great potential contribution in this aspect of the general problem of understanding human cognition.

References

Adjei, K. Influence of specific maternal occupation and behavior on Piagetian cognitive development. In P. R. Dasen (Ed.), *Piagetian Psychology: Cross-cultural contributions.* New York: Gardner Press, 1977.

Cole, M. The present state and future course of cross-cultural studies of cognition. Lecture given at the 44th Annual Convention of Japanese Psychological Association, Sapporo, 1980.

Greeno, J. G. Forms of understanding in mathematical prob-

lem solving. Paper presented at the 22nd International Congress of Psychology, Leipzig, 1980.
Hatano, G., & Osawa, K. Digit memory of grand experts in abacus-derived mental calculation. Paper presented at the 89th Annual Convention of American Psychological Association, Los Angeles, 1981.
Hatano, G., & Suga, Y. Abacus learning, digit span and multi-digit addition/subtraction skills among 3rd-graders. Paper presented at the American Educational Research Association Annual Meeting, Los Angeles, 1981.
Inagaki, K. Facilitation of knowledge integration through classroom discussion. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition*, 1981, *3*, 26-28.
Inagaki, K. Motivation for knowledge and cognition. In G. Hatano (Ed.), *Handbook of cognitive psychology, vol. 4: Learning, development and instruction.* University of Tokyo Press, in press. (in Japanese)
Inagaki, K. *Collective scientific discovery by day care children*, in preparation.
Langer, E. Playing the middle against both ends: The usefulness of adult cognitive activity as a model for cognitive activity in childhood and old age. Paper presented at the conference, "The growth of insight in children," at Wisconsin Research and Development Center for Individualized Schooling, 1979.
Lave, J. Cognitive consequences of tradition apprenticeship training in West Africa. *Anthropology and Education Quarterly*, 1977, *8*, 177-180.
Luchins, A. S. Mechanization in problem solving: The effect of Einstellung. *Psychological Monographs*, 1942, *54*, no. 5 (Whole no. 248).
Luchins, A. S., & Luchins, E. H. New experimental attempts at preventing mechanization in problem solving. *Journal of General Psychology*, 1950, *42*, 279-297.
Piaget, J. *The psychology of intelligence.* New York: Harcourt Brace, 1950.
Piaget, J. *The origin of intelligence in children.* New York: International University Press, 1952.
Price-Williams, D. R., Gordon, W., & Ramirez, M. Skill and conservation: A study of pottery-making children. *Developmental Psychology*, 1969, *1*, 769.
Rumelhart, D. E. *Analogical processes and procedural representations.* CHIP Report No. 81. Center for Human Information Processing, University of California, San Diego, 1979.
Scribner, S., & Cole, M. *The psychology of literacy.* Cambridge: Harvard University Press, 1981.
Steinberg, B. M., & Dunn, L. A. Conservation competence and performance in Chiapas. *Human Development*, 1976, *19*, 14-25.

"The world is full of partial stories that run parallel
to one another, beginning and ending at odd times.
They mutually interlace and interfere at points,
but we cannot unite them completely in our minds.
In following your life-history,
I must temporarily turn my attention from my own. . .
It follows that whoever says that the whole world
tells one story utters another
of those monistic dogmas that a man believes at his risk.
It is easy to see the world's history pluralistically,
as a rope of which each fiber tells a separate tale;
but to conceive of each cross-section of the rope
as an absolutely single fact,
and to sum the whole longitudinal
series into one being living an undivided life,
is harder . . . The great world's ingredients
so far as they are beings,
seem, like the rope's fibers, to be discontinuous,
cross-wise, and to cohere only in the longitudinal direction.
Followed in that direction they are many."

William James, *A Pluralistic Universe*, 1909.

Subscription Form

Name ______________________________

Address ______________________________

______________________________ Zip__________

Please enter my subscription to *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition.*

I am enclosing $ for years at $15.00 per year
I am enclosing $ for years at $10.00 per year (student)

Please make your checks payable to LCHC NEWSLETTER and mail them to:

Jan Russo Cooper
Laboratory of Comparative Human Cognition, D-003
University of California, San Diego
La Jolla, CA 92093

Foreign Subscribers
Please add $5.00
to cover air mail cost.