THE QUARTERLY NEWSLETTER OF THE

LABORATORY OF COMPARATIVE HUMAN COGNITION

Center for Human Information Processing
University of California, San Diego

Volume 9, Number 4 October 1987

TABLE OF CONTENTS

Introduction

It is a pleasure for us to be writing an introduction to this Newsletter once again. As long-time readers of the Newsletter know, we started this enterprise together many long years ago, with lots of help from our colleagues at Rockefeller University. Now, thanks to electronic networking, we can work together once again, mediated to tackle the old, old problems that remain the problems of the 1980's no less than of the 1970's. The articles selected by Hall[1] for publication in this issue continue lines of research that were being discussed in this Newsletter at the beginning. The scientific and social contexts, however, have changed. The later Carter years, with their relatively extensive committment to pluralism in America have given way to later years of the Reagan administration. But the scientific problem has remained the same. How can we create a theoretically powerful understanding of the role of culture in human nature that can guide empirical research that confronts the problems of growing up in the late 20th century? One of the key requirements for the success of such an effort is that we come to grips with concepts such as domain, discourse, context, activity system, and ecological validity (to name just a few). Each of the articles here relates to a different aspect of the overall problem.

Jardine and Morgan's paper attacks the issue of mind and context through a critique of Piaget's belief that logico-mathematical operations provide both a theory of mind and a mode for describing mental processes. They argue that in so far as thinking operates through analogies, it is "precisely *not* logical thought;" that is, it does not involve the creation of a univocal *logos* which can be, in principle, stated in just so many words. This very property of words/concepts is what gives psychologists fits when they try to code behavior on line without the benefit of tight experimental procedures to provide the frame. In place of a rigid frame, the Jardine and Morgan view underlines the constitutive and *always in the process of being made* nature of cultural contexts. In place of previously specified scoring schemes, the categories of analysis are likely to be problematic. (See earlier articles by Cole, Hood, and McDermott; Levine, Mehan, Newman, to name a few).

There is a close link between these issues and the problem of ecological validity in psychological research, which surfaces immediately in the article by Capon, Kuhn, and Carretero. As Capon et al. point out, there is great interest these days in attempting to understand something called *practical thinking* in a variety of "everyday" settings (supermarkets, bars, racetracks, etc.). The method that Capon et al. chose to address this problem was to simulate an everyday task (shopping for a skirt) where, they could "constrain the range and complexity of the observed behavior to a manageable level." The result they obtain is that most of the time people simply pick a skirt they like, with no apparent comparison shopping, but some subjects go through a little, or a lot, of narrowing down of choices. They speculate that these patterns of behavior may reflect broad individual differences in personality that would appear in many settings. The Jardine and Morgan paper immediately raises questions about the Capon et al. procedures. With great care, Capon et al. have constructed a rational scoring scheme and applied it to the data. But can the resulting description serve as the basis for the generalizations (about enduring individual differences) they want to make? One obvious next question would be -- what would those women do when they really went shopping?

The work of Lave and her colleagues attempts to answer such questions, but Capon and colleagues feel that unobtrusive observations of real shopping make it difficult to "unravel the complexity of the behavior that was being observed." We are pretty certain that Lave would not agree (perhaps we can include an article from her group soon). Without prejudging that discussion, but on the basis of our own work on the problem of context, activity, and ecological validity, we might suspect that the simulation experiment (for some of the subjects) smells of psychologists, tests, and schools. This "smell" can change the context, reminding the subjects of the proper form of problem solving in school; that is, one should narrow down the choices, be systematic in search through variables, etc. Of course, this supposition could be wrong; but how would we know? We suspect we would have to do detailed work that compared the same people's behavior across settings/contexts. And that route carries with it all the problems of knowing what it means to talk about "same behaviors" in "different contexts" that has been the focus of work at LCHC for some time. Perhaps an issue of the Newsletter devoted to the conundrums of ecological validity would be in order.

The two remaining articles reflect these themes in different ways. Wolters, Fischer, and Zuidema take up the balance beam problem, which has been previously discussed in this Newsletter by Martin, Grossen and Perret-Clermont, and Tudge. One way they characterize the different ways of studying performance on this task as a model system for development is to contrast Kalmykova's interactive, "realistic," classroom-based procedure with Siegler's "independent problem solver" procedure, which embodies the best of laboratory procedures conventionally understood (and, hence, embody the assumptions about rationality which Jardine and Morgan criticize). Note that at the end, the researchers feel they have a cleaner category system, but they are no closer to getting their hands on the mechanisms of change. Martin, on the other hand, could point to social coordination as a key element in change, although her scoring procedure might be criticizable. The constitutive relation between task (text?) and context is again at play, throwing sand in the eyes of psychologists.

The article by Hatano and Inagaki makes no pretence at ecological validity in the normal sense of the term, except in so far as it is a common experience for Japanese school children to be asked strange questions by adults. But the issue of "everyday" versus "laboratory" thinking, cultural context, and the role of analogy in thinking, are all very much in the forefront of this work. Here *reasoning by analogy* and reasoning through a taxonomic, *rationalized system* are involved at different stages and in different contexts of children's lives. The reasoning-by-analogy-with-ego approach begins to interact with the taxonomic biology approach during the school years. A key issue to look for in future research is pinpointed by the authors: How do these two systems interact in the later education, work, and community life of the people who come in contact with both? They also provide a timely warning that science need not be modeled on mechanical rationality, but can be built out of organic metaphors as well ... thus bringing us back to the critique of Piaget with which the Jardine and Morgan article began ... this time with a hint of a number of interesting lines of research to follow if one wants to move from criticizing old masters to a positive program of research.

William S. Hall
Michael Cole

Note

[1] We are grateful to Susan Calkins, Jane Doussard-Roosevelt, Patricia Walker, and Maryann Wzorek of the Developmental Psychology Program at The University of Maryland, College Park who assisted William S. Hall in the review of articles for this issue of the Newsletter.

Analogical Thinking in Young Children and the Use of Logico-Mathematical Knowledge as a Paradigm in Jean Piaget's Genetic Epistemology

David W. Jardine
Department of Teacher Education
University of Calgary

Griffith A.V. Morgan
Department of Family Studies
University of Guelph

What follows is an exploration of the nature of analogy and analogical thinking in young children and a critical analysis of the appropriateness of logico-mathematical knowledge as a paradigm for rationale discourse in Piagetian theory. The guiding hypothesis of this exploratory study is that analogical thinking forms a central feature, not only of the thought of the young child, but that it is a prevalent feature of adult thought and language, (a) as it appears in everyday discourse and (b) as it appears in the discourse of science. This hypothesis speaks directly against certain aspects of developmental theory as formulated by Jean Piaget, wherein scientific knowledge is characterized with reference to the ability to use logico-mathematical operations. Our work, in part, involves a critical examination of Piaget's theory, his understanding of scientific discourse and the place assigned to analogical thinking in the developmental achievement of that discourse.

As a feature of this examination, we wish to take seriously the claim of phenomenological philosophy (Husserl, 1970) that logic and mathematics are grounded in everyday life. And we wish to couple this theoretical orientation to logic and mathematics with Wittgenstein's claim (1968) that the foundation of thought and language usage in everyday life is analogical, involving a notion of "family resemblances" which is not reducible to the notions of explicitness, univocity and methodological reproducibility found in and required by logico-mathematical reasoning.

For us, analogical thinking is a sense-making activity which gathers together elements of meaning, sense, or significance in a way that reveals "similarities" and "correspondences" between these elements while, at the same time, resisting the collapse of these elements into a univocal "common term" (Clarke, 1976). A "common, univocal term" is seen by some authors (Nielsen, 1976) as necessary if an analogy is to have any meaning at all. Contrary to this approach, we are maintaining that the term "analogy," as its etymology entails, should be taken to mean a parallel sense (*ana logos*) which does not intersect in a common, univocal term, but sustains its sense in similarity and correspondences.

Moreover, following Madison (1982), we also suggest that the resemblances or similarities made visible in analogical thinking are not revealed "in spite of differences" (Piaget, 1972) but *in the midst of* and *because of* differences -- analogies reveal a "similarity-*in*-difference" (Clarke, 1976, p. 65). It is this tension between similarity and difference (a tension that will not resolve into either pure equivocation *or* pure "univocation") that gives analogies their powerful and provocative character. Because of this tension, analogies can sustain a multitude of possible interpretations, they can remain something to which we can return again and again, about which we can always say more. It is this ability of an analogy to offer itself to continual interpretation and re-interpretation that leads Madison (1982) to place analogical thinking at the core of human understanding, revealing as it does what Gadamer (1975) described as a movement into, exploration and unfolding of as-yet-undecided possibilities of self-understanding and of understanding the world.

What follows is divided into three sections:
(1) A brief description of a series of observations of a 16-month-old boy of at least average mental ability and reflections on the possible significance of these observations;
(2) An examination of our critical relationship to elements of Jean Piaget's genetic epistemology and the use of logico-mathematical knowledge as paradigmatic of rational discourse in general;
(3) Concluding thoughts on the ironic character of our critical relation to Piaget's work and reflections on the possible pedagogical significance of this relation.

Observations and Their Significance

On a walk with his grandmother, this boy was shown, close-up, a long freight train passing slowly and making its distinctive rhythmic noise. The grandmother said "choo-choo" emphatically and slowly, several times, pointing to the cars in the train as it passed. The child looked alternately and intently at the train and then at grandmother's mouth.

Three days later, he was given a number of egg-carton domes strung together on a string, with knots between. He seized on this with enthusiasm, placed it on the floor and pulled the string behind him, repeating with the same intonation that he had heard earlier, "baw-baw...baw-baw...baw-baw."

Playing with grandfather three days later (who was unaware of the previous developments) he offered him the leading end of the string of egg-carton domes and referred to it as "baw-baw." He persuaded grandfather to move in front of him, pulling the string, while he brought up the rear end like the caboose, chanting "baw-baw...baw-baw..." This game was repeated several times and continued to be repeated over the course of the next several days.

Six weeks later, walking in the snow, the boy came across fresh ski-tracks. While grandfather referred to these as ski-tracks, and invited the child's interest, the child identified the two tracks immediately as "baw-baw" and insisted that grandfather run ahead, between the tracks, while he hung on to grandfather's jacket and ran behind chanting "baw-baw...baw-baw..."

Over an ensuing period of two years, a favorite toy while visiting was a model train which could be hooked in a series. On one occasion, the boy responded enthusiastically to the suggestion that the train ran on tracks which were simply two narrow lines inked on sheets of newspaper. Even later, at 3 1/2 years, when playing on an oriental carpet, he quickly picked out the parallel lines around the edge of the carpet and insisted on running his train on these bands. "Baw-baw" persisted in some form or other until age 4 years as a name for trains, both toy and real.

There are not only several major and persistent play-themes presented in these observations, but a question of how a child, in what is called by Piaget the late sensorimotor/early preoperational stage, organizes his or her cognitive and affective experience. What emerges here also is the critical question of how we, as inquirers into the life of the child, are to go about interpreting this organization and giving it the full credence it deserves. We must ask ourselves whether and/or how the model we choose as a paradigm for the nature and development of organizational ability in children enters into and effects *our* ability to recognize and properly interpret children's abilities in an appropriate manner.

The varied perception of "train" as being a succession of objects strung together, as being a series which had to have a beginning and an end, with one person leading and the other following, the link to parallel tracks in the snow, on paper and on the carpet -- all of this argues for a powerful perception of *analogical relationships*. What is startling here is that this child essentially acted as if he had identified the common factor in a "train" which is reflected, in English, as being a physical railroad (an ordered succession of vehicles on a narrow track), a train or connection of things as in a trail of gunpowder, an object trailing behind one, as in a bride's train, and most clearly expressed in metaphors such as a "train of thought." How did this child grasp the fundamental similarity or connectedness, through but by means of disparate experiences, of a "train?"

Clearly, in attempting to interpret what the child himself "grasped," we must not "read in" too much. We are not claiming that this child was either able to explicate or explicitly aware of all the nuances of sense and significance involved in his activity. Rather, we are claiming that:

(1) This implicit, powerful sense of "connectedness" which the child "recognized" on some level or other, is precisely *not* the sort of thing that lends itself to methodological explication. It is a sense or significance of the world and one's relation to the world that cannot be properly understood under the auspices of the paradigm of explicitness and discursiveness found in logico-mathematical thinking. It is precisely *not* logical thought (which involves univocal *logos* which can be, in principle, stated in just so many words), but analogical thought. This is not to say that one cannot produce, unfold, and explore the multiplicity of meanings and relationships between meanings that form part of an analogy. Rather, it is to say that such production, unfolding, and exploration cannot take as its cue the univocity of meaning (Ricouer, 1970) implied in the essence of logic and the univocity and reproducibility of method implied in how logic goes about producing, unfolding, and exploring meaning (Piaget, 1968), both of which attempt to dispell the tension between similarity and difference in analogies by "solving" (Gallagher, 1977, p. 86) them. Experientially, in the act of understanding an analogy, the tension between similarity and difference is in fact increased, and not dispelled.

(2) Analogical thought, even though it does not orient to explicitness, univocity, and methodological reproducibility, still retains an irreplaceable epistemic content and function. Analogy is a powerful way of voicing something true about the world, even though this truth cannot be discursively said in just so many words, in such a way that one could exhaust, in principle, what an analogy offers us. We suggest that this latter point, the "inability" to discursively voice the epistemic content of an analogy in just so many words, is a matter of *principle* and not a matter of lack of methodological precision, lack of effort, or developmental "incompetence." Analogies essentially resist the reduction to univocity, and it is in this resistance, not in its resolution, that their truth is revealed.

(3) The ability to produce, unfold, and explore the nuances of sense and significance in analogical reasoning itself goes through a developmental sequence which is not simply the handmaiden of logico-mathematical development. One can look at Goldman's (1968) study of children's understandings of religious parables, or Gallagher's (1977) study of the relations between metaphor, analogy, and formal thought. On the other hand, one can also look at Einstein's thought experiments which involved the analogy between relativity theory and travelling in a streetcar, or Rutherford and Bohr's analogy between the structure of the atom and the planetary system (itself perceived analogically by Copernicus and Galileo).

(4) Far from being developmentally supplanted by logico-mathematical thought, analogical thought remains central to the thought and language of adults in everyday life and in the discourse of science itself.

What is reflected in analogical thought is the unexpected capacity to recognize functional and figurative similarities across a wide range of very different situations, and to incorporate and integrate differing aspects or components of experiences, selected for their apparent salience or relevance, into a common theme which knits such experiences together without reducing one to another. This theme becomes a concrete form of organizing the world, organizing one's interactions with others (cf. the boy's interactions with his grandfather), and, whether concretely (through the organization of actions) or "symbolically" (through language), saying something "true" about the integral character of these different situations. The "vehicle" (Peirce, 1960) of the analogy is represented by varying aspects of perception: the real train, the salience of successive units, the relationship of successive visual units to rhythmic sound, the confinement of the train to tracks, etc. The selected features appear to act in "equifinal" (Von Bertalanffy, 1969) ways to integrate one's experience of the world and/or communicate that experience either concretely or in symbols. What is essential here is that this integration of experience and this communication of the integral character of experience can be accomplished, reproduced, refined, repeated, elaborated, extended, and understood without such practices referring back to logico-mathematical thought as somehow paradigmatic of integration and communication. It is in relation to this latter point that we adopt a critical relationship to Piagetian theory, since we fundamentally disagree with the view that "the 'reading off' of experience and of the mechanisms of learning as a function of experience ... is always a function of a logico-mathematical framework, which plays a structuring role" (Piaget, 1971, p. 55).

Our Critical Relationship to Piagetian Theory

Our critical relationship to elements of Piagetian theory does not stem from *the fact that* that theory takes logico-mathematical knowledge as paradigmatic of rationality. Rather, it stems from the effect of uncritically adopting that paradigm as one under which, and in relation to which, one formulates the nature, significance, and place of analogical thought, *both* in children and their development *and* in adults and how they go about thinking about the world.

Jean Piaget built his life's work in genetic epistemology on the perception that children's concepts and operations on the world evolve through specific stages of development and are related to the child's stages of perception and models of organization of experience. Hence, no child makes "errors" in thinking, but rather interprets experiences correctly and efficiently, in relation to his or her existing cognitive organization.

Previous work by the authors (Jardine, 1984) has involved analyses of the theoretical model of rationality that is implicit in Piaget's genetic epistemology. Developmental theory, as an examination of the stages of the child's cognitive development, is organized around and based upon a model of rationality/thought/knowledge which not only takes logic and mathematics as its *telos*, but takes this *telos* of scientific knowledge as something children are "destined to master" (Piaget, 1952, p. 365). At the outset of the project of empirical research as set up by genetic epistemology, then, explicitness (Piaget, 1971, p. 128), univocity (Piaget, 1971, p. 216-217) and methodological reproducibility (Piaget, 1971, p. 80) become the earmarks of the progress of thought in children toward "more inclusive and more stable" (Piaget, 1973, p. 7) forms of cognitive equilibrium. Given such criteria for the nature and development of rationality, it is clear why logical and mathematical thought are taken to be paradigmatic, since they "proceed by the application of perfectly explicit rules, these rules being, of course, the very ones that define the structure under consideration" (Piaget, 1968, p. 15).

Our critical attitude toward the paradigmatic functioning of logico-mathematical knowledge in Piagetian theory is directed to three interrelated phenomena:

(1) The use of logico-mathematically based method as a way of examining the child's thought, its relevant features, and its development. In the child's manner of organizing the world is sought some univocal *ratio*. Some set or sets of "schemata" are sought whose content, functioning, and interrelations become the object of scientific discourse. And this discourse, by its very nature, orients to an explicitness of description and interpretation (Piaget, 1971) *as if* the object of that method lends itself to such explicitness and univocity. That is, the child's conception of the world is, to use Piaget's (1976) term, "reconstructed" under the auspices of *science's need for univocity and explicitness*. Perhaps the child's belief in animism, for example (see Piaget, 1977), and the plethora of analogies that such a belief invokes does not lend itself to the sort of explication demanded by scientific discourse. It is a vast oversimplification to say that the questioner's pursuit of what a child means by certain things he or she says is simply a matter of attempting to better understand what the child thinks. There is operative a model of what it means for someone to be able to give a "good" account of a particular phenomenon that allows

Piaget to accuse the child of being "on the point of reaching the answer" but becoming "victims of the illusions we seemed to find among the youngest" (Piaget, 1977, p. 140).

If we use the following example, features of what we are claiming become somewhat clearer:

"Oh, as I was young and easy in the mercy of his means
Time held me green and dying
Though I sang in my chains like the sea."
(*Fern Hill*, Dylan Thomas)

It is clear, in this passage, that there is no univocal *ratio* to be sought, but a provocative and compelling cluster of metaphors and analogies that *cannot be said in just so many words*, were we to take logico-mathematical knowledge as our cue to interpreting this passage. In such a case, it would be absurd to use scientific discourse as a model for whether this work says anything "true," whether it is meaningful and the like. It would be absurd to hierarchically "rank" such a passage *as if* it meant to speak literally but failed. We are maintaining that there is an equal potential absurdity involved in approaching what are clearly analogical features of children's thought *as if* those features unquestionably lent themselves to the reconstructions demanded by scientific discourse, *as if* the child meant, somehow, to speak explicitly but became "his own dupe, or rather the victim of an illusion in mental perspective" (Piaget, 1976a, p. 141), leading to the "over-determination" of content found in metaphorical and analogical thought, "a phenomenon which we always find in primitive, ill-directed thought. The mind always begins in chaos" (Piaget, 1976a, p. 158).

(2) The adequacy of logico-mathematical rationality as a model, a *telos* for the development of rationality in general. Such use can potentially lead to the misinterpretation of features of the child's thought, interpreting them only insofar as they reveal the stages prototypical of scientific discourse. A pertinent example is that of a child interviewed by Piaget (1977) regarding the nature, origin and locale of dreams. This child maintained that "dreams happen outside me," they are "in front of me," and that dreams "come from the night" and are "caused by the night." These statements are strikingly "true" on an experiential level. They say something about dreams that is not captured by an adult interpretation which insists, as background knowledge for asking the question in the first place, that dreams, "in fact," happen inside the head, and that they don't "in fact" "come from the night," and therefore that the child has produced "exceedingly suggestive deformations of true conceptions" (Piaget, 1977, p. 50). Under the auspices of logico-mathematical knowledge as a model for rationality, "a single truth alone is acceptable when we are dealing with questions of knowledge" (Piaget, 1971, p. 216-217). In short, if the "locale" of the dream is to become the object of scientific discourse, *its locale must be univocal*: it must either be inside the head or outside the head. However much we might, in Piaget's theory, have demonstrated the integrity and viability of the child's conception of the world, however much that theory might insist on the developmental appropriateness of the child believing that dreams are "outside of me" and "come from the night," the status of these beliefs, in the end, is organized around an understanding of the world which demands that the child's conception is a deformation of the "truth" about the locale of dreams.

(3) The use of logico-mathematical knowledge as paradigmatic of scientific discourse itself. Piaget seems, in some sense to confuse or conflate the context in which science is actually accomplished (and the wealth of forms of analogical thought and reasoning that such an accomplishment involves) with the context of justification, wherein giving an account of one's activity *as* scientific requires orienting to univocity, explicitness, and methodological reproducibility in such a way that the actual accomplishment is covered over. Does Piaget's theory give us a model for the development of the possibility of actually being able to *do* science, or does it give us a model for the development of the ability to give an account of one's activity *as* scientific? We suggest that, in certain portions of his work, Piaget falls victim to what Husserl (1970) speaks about when he characterizes the reflections on the "true meaning" of science and its accomplishments as tending to "stop at idealized nature" (p. 50), i.e., as tending not to penetrate into how science is actually accomplished as a feature of everyday life and resting content with an idealized version of scientific discourse as portrayed in logic and mathematics.

Concluding Remarks

It is here that our paper must necessarily take an ironic turn, for if we are to maintain that scientific discourse itself is rooted, both developmentally and contemporaneously, in analogical thought, Piaget's theory *itself* is so rooted. Should we be able, therefore, to make a strong critical case against the elements of Piaget's theory mentioned above, that critical stance is falsified, since it portrays Piaget's theory to be precisely what we then say it cannot be. And, if we do find ourselves caught in this contradiction, it is made all the more ironic since we find, despite the criticisms levelled above, that elements of Piaget's work compel us over and over again to return to it, to re-address it, to re-interpret it, as a powerful, and, it seems, unavoidable part of our understanding of children and their development. In a curious way, Piaget's theory begins to function, for us, in a manner akin to an analogy, sustaining its compelling character without resolving into either wholesale agreement *or* disagreement.

Let us take this claim seriously: genetic epistemology can be taken as a grand analogy for understanding children and their development into adults. Allowing this requires that we distinguish between the Piaget who accomplished the often grand and often painstakingly detailed explorations of genetic epistemology from Piaget the apologist who, in reflections on these accomplishments (cf. Piaget, 1968, 1970, 1970a, 1971), formulates genetic epistemology under the auspices of an outmoded image of *rationalism* (Madison, 1982) which places inordinate weight on explicitness, univocity, and methodological reproducibility. We suggest, in fact, that those texts which count as reflective formulations of the nature of scientific discourse in Piaget's corpus, resist what we see as the consequences of understanding genetic epistemology as a grand analogy for children and their development. In these concluding remarks, we wish to briefly address this resistance and to offer the beginnings of some pedagogical reflections on this resistance.

Jeanette Gallagher (1977) provides a provocative re-formulation of aspects of Piaget's theory, such that parallels are drawn between the classical forms of analogical thought (analogy by attribution, metaphorical analogy of proportionality, and the analogy of proper proportionality) and features of Piaget's work (the structure of classes, the structure of relations, and the INRC groupings, respectively) (p. 86). However, if we are to take genetic epistemology as providing us with a grand analogy for the development of children, this must be pushed one step further. Gallagher suggests that certain aspects of Piaget's work can be formulated as *talking about* analogical thought in its varying forms. To push this one step further, let us suggest that Piaget's work *is* analogical thought in its varying forms and that those elements in the life of the developing child that he speaks about are spoken of analogically.

Formulating Piaget to be *speaking analogically* places the inquirer who is concerned with understanding the life of the developing child in a position which is quite different from the anonymous, pregiven methodological standpoint which aspects of Piaget's work seem to require, aspects in relation to which:

> ... the question of my place in the world, and the question of the place of children in the world, must ... be reconstructed at the outset as questions which can be posed *to* anyone and ... *by* anyone. The question of my place in the world, what I am and can be in relation to children, must be formulated as the question of anyone's place. *Before* the specific details of the Piagetian picture of the world are worked out, my place in the world is already secured as simply "one" of this anonymous "anyone." Such prior securedness in anonymity defines the objective character ... of a Piagetian picture of the world. (Jardine, 1984, p. 237)

The ironic turn which formulates Piaget's theory as an analogy requires that we forfeit those elements of that theory which demand the adoption of a pregiven standpoint from which understanding proceeds. A pregiven, explicit methodological standpoint demands that what follows from the standpoint have a univocal character, since only by having such a univocal character can "objectivity" be guaranteed. In the production, exploration, and unfolding of the meanings involved in analogical thinking, however, there is no pregiven standpoint. Rather, where one stands is precisely what is brought into question. In analogical thinking, the question of where one stands *vis a vis* the entity spoken about is always yet-to-be-decided (Gadamer, 1975), always opening up possibilities of understanding and self-understanding which are yet to be explored. In this sense, analogical thinking involves risk. It doesn't simply involve the fact that we might, *given a prior standpoint,* gain more information about the entity. This, in fact, is no risk at all. It involves the risk, the possibility, that our stand regarding the entity might *itself* change, that the stand we previously took as beyond question (as that *from which* our questioning proceeded) is brought into question.

This, for us, provides the beginning of a compelling metaphor (Kleibard, 1975) for education, since it requires that the relationship between our understanding of children and children themselves is itself analogical. This relationship is itself open to the process of constant interpretation and re-interpretation over the course of teaching, always compelling us to think again about where we stand in relation to the children we teach. And this process of interpretation and re-interpretation resists the collapse of the tension between similarity and difference into a notion of "objectivity" which might wish to possess its object (or, so to speak, to become univocal with its object). It resists what, following Habermas (1971), one could call a "technical" version of education where the child is envisaged as an object whose "education" the teacher can possess through techniques of control, prediction, and manipulation. On the contrary, the notion of analogy lends itself to a more hermeneutic version of education. The similarities and differences between teacher and child are not collapsed into pre-given techniques. Rather, such similarities and differences are sustained in the ongoing production, unfolding, and exploration, over the course of teaching, of "mutual understandings in the conduct of life" (Apple, 1975, p. 126).

References

Apple, M. (1975). Scientific interests and the nature of educational institutions. In W. Pinar (Ed.), *Curriculum theorizing: The reconceptualists* (pp. 120-130). Berkeley: McCutchan.

Clarke, W. N. (1976). Analogy and the meaningfulness of language about God: A reply to Kai Nielsen. *The Thomist* (pp. 61-95).

Gadamer, H. G. (1975). *Truth and method*. New York: The Seabury Press.

Gallagher, J. M. (1977). The future of formal thought research: The study of analogy and metaphor. In B. Z. Presseisen, D. Goldstein, & M. H. Appel (Eds.), *Topics in cognitive development, Vol. 2. Language and operational thought* (pp. 77-98). New York: Plenum Press.

Goldman, R. (1968). *Religious thinking from childhood to adolescence*. London: Routledge and Kegan Paul.

Habermas, J. (1971). *Knowledge and human interests*. Boston: Beacon Press.

Husserl, E. (1970). *The crisis of European science*. Evanston: Northwestern University Press.

Jardine, D. W. (1984). The Piagetian pictures of the world. *Phenomenology and Pedagogy*, 2(3), 224-237.

Kleibard, H. (1975). Metaphorical roots of curriculum design. In W. Pinar (Ed.), *Curriculum theorizing: The reconceptualists* (pp. 84-86). Berkeley: Mc Cutchan Pub. Corp.

Madison, G. B. (1982). *Understanding: A phenomenological-pragmatic analysis*. Westport, CT: Greenwood Press.

Nielsen, K. (1976). Talk of God and the doctrine of analogy. *The Thomist* (pp. 32-60).

Peirce, C. S. (1960). *Collected papers* (Vol. 1). Cambridge, MA: The Belknap Press of the Harvard University Press.

Piaget, J. (1952). *Origins of intelligence in children.* New York: International Universities Press.

Piaget, J. (1968). *Structuralism*. New York: Harper & Row.

Piaget, J. (1970). *Main trends in interdisciplinary research*. New York: Harper & Row.

Piaget, J. (1970a). *The place of the sciences of man in the system of sciences*. New York: Harper & Row.

Piaget, J. (1971). *Insights and illusions of philosophy*. New York: Meridian Books.

Piaget, J. (1972). Principles of genetic epistemology. Cited in Gallagher, 1977.

Piaget, J. (1973). *The psychology of intelligence*. Totowa: Littlefield, Adams & Co.

Piaget, J. (1976). *The child and reality*. London: Penguin Books.

Piaget, J. (1976a). *Judgement and reasoning in the child*. Totowa: Littlefield, Adams & Co.

Piaget, J. (1977). *The child's conception of the world*. London: Palladin Books.

Ricouer, P. (1970). *Freud and philosophy*. New Haven: Yale University Press.

Von Bertalanffy, L. (1969). *General systems theory: Foundations, development and applications*. New York: Braziller.

Wittgenstein, L. (1968). *Philosophical investigations*. Oxford: Blackwell's.

Editors' Note

E. Goody's article, "Why must might be right? Observations on sexual herrschaaft," published in the April issue of this volume of the Newsletter (pp. 55-76), was written for a roundtable for anthropologists and historians on "Herrschaft as social practice" in Bad Hamburg, West Germany, 1983. It will appear (1988) in *Herrschaft als soziale Praxis*, Alf Lüdtke (Ed.), published by Vandenhoeck & Ruprecht, Gottengen, West Germany.

Shopping Styles and Skills: Everyday Cognition in a "Noncognitive" Task

Noel Capon
Deanna Kuhn
Mario Carretero
Columbia University
University of Madrid

Dissatisfaction with traditional concepts and measures of intelligence (Sternberg, 1984; Cole, Hood & McDermott, 1978) and a growing enthusiasm for investigating human functioning in nonlaboratory settings underlie a new wave of research on intelligence in practical, real-world settings (Rogoff & Lave, 1984; Sternberg & Wagner, 1986). Very little is known about the ways in which people behave intelligently in real-world activities or about the nature and extent of individual variation in practical intelligence. The most obvious place we might look for people to exhibit intelligence in a real-world setting is in their professional or vocational roles and, indeed, a majority of the studies of practical intelligence have been devoted to the investigation of intelligence in work-related settings and roles (Frederiksen, 1986; Scribner, 1984; Sternberg, 1985; Wagner & Sternberg, 1985).

In the present study, we investigate practical intelligence outside a work setting. How and to what extent do individuals display intelligence in simple, everyday activities common to most people and how great is individual variation in this regard? The investigation of practical intelligence in a nonvocational setting is particularly important from a life-span developmental perspective (Baltes, Dittman-Kohli & Dixon, 1984; Dixon and Baltes, 1986). Intelligence in the workplace is confined to a particular context and segment of the life span and may depend on specific acquired knowledge and expertise that are hard to separate from intellectual operations themselves. From a developmental perspective, it is important to know not only the extent of inter-individual variability in levels of functioning but also the extent of intra-individual variability in performance of the same intellectual task at different points across the life span (Kuhn, Pennington, & Leadbeater, 1983).

The everyday task we chose to investigate in the present study is one which is not thought of as intellectually demanding but in fact is likely to involve a good deal of cognitive processing -- selecting an item of clothing to purchase from a clothing store. There is an existing literature on consumer behavior, but for the most part researchers in that field have followed the tradition of social and cognitive psychologists and have based their work on laboratory tasks that involve symbolic stimuli and are not intended to reflect the subject's activity as it occurs in a natural context. The few researchers undertaking studies of shoppers in a natural setting have relied on a nonintrusive observational methodology and as a result have found it difficult to unravel the complexity of the behavior that was being observed (e.g., Bettman, 1979; Lave, Murtaugh, & de la Roche, 1984). In designing the present study, we wished to constrain the range and complexity of the stimuli encountered by the subject and, thereby, reduce the complexity of the observed behavior to a manageable level, while at the same time preserving the naturalness of the shopping situation.

As we shall rely primarily on a think-aloud methodology (Ericsson & Simon, 1984), we wished to eliminate retrospective justifications of habitual consumer choices (such as might occur frequently in a grocery store) and focus on verbal reports of concurrent cognitive processing (which, Ericsson & Simon [1984] contend, is essential for appropriate use of the think-aloud methodology). For this reason, we chose a particular set of items (specially tailored women's skirts) that would be new to subjects but nevertheless come from a general product class, women's clothing, with which the subjects would be familiar.

Subjects in the present study were lower SES Hispanic women of a wide age range (median age was 45) from a church group in a large urban environment. The women were not highly educated: Slightly over half had less than a high school education and the others had a high school diploma. In choosing this population, our intent was to study subjects who were unlikely to be functioning at high levels with respect to traditional academic intelligence and who, for the most part, had no special vocational expertise, but who, nevertheless, would be highly experienced and possibly skilled in the activity that was to be the focus of our investigation.

Could we locate and record the intelligence exhibited in this familiar activity? Would individual differences be observed? The first, critical step in being able to answer these questions is to define what would

0278-4951/85/7-40 $1.00 © LCHC

constitute intelligent performance in such an activity. In the present study we consider and investigate a number of potential indices of intelligent performance. One simple one is consistency: Would the subject make the same or a very similar choice on a second occasion? Another of the potential indices is made possible by our asking subjects in a separate task, following the simulated shopping session, to rate (according to preference) each of the four dichotomous dimensions on which the skirts vary, as well as to rate each of the skirts themselves. We can then ask the extent to which the subject is able to take into account and integrate her dimension preferences, both in the ratings of the skirts and in the selection task itself or, more generally, how consistent selection, skirt rating, and dimension rating performances are, both with each other and across time. A third potential set of indices comes from the talk-aloud behavior in the simulated shopping session itself: To what extent does the subject display strategies that optimize correct choice (i.e., choice of the skirt she really did most like) and/or efficiency in the selection process?

The consistency criterion which is emphasized in our analysis is particularly salient considering the existence of stereotypes about lower SES, less educated individuals as consumers. Though there exists no systematic evidence in support of it, the stereotype is that such individuals are likely to behave in an impulsive way: Rather than weigh all of the dimensions of the objects they are contemplating and integrate their preferences with respect to these dimensions into an overall evaluation of the object, the stereotype suggests that the individual is more likely to fix on a single dimension of the object, ignoring others s/he in fact cares about equally or to base selection on only a global impression of the object, with no analysis of its dimensions. In either case, the stereotype implies that the individual has not necessarily selected the object s/he "really" prefers, and consistency in choice over successive occasions is expected to be low.

The present work allows us to examine whether there is any validity to such a stereotype and, more broadly, to investigate the strategies subjects do use and the extent and nature of individual variation in this respect. In work preceding the present study (summarized in Capon, Kuhn, & Carretero, in press), we investigated consistency between object and dimension ratings with respect to a trivial product and found that these consistency ratings were moderately related to established measures of cognitive ability. (Such "partial overlap" with established ability measures, it should be noted, is probably the best outcome one can expect in studies of practical intelligence. If the new measures correlate very highly with established measures of mental ability, the argument can be made that they are "nothing but" alternative measures of those abilities; conversely, if the new measures show no such correlation, a question might be raised regarding their validity.) In the present study, we go on to examine this consistency and subject's strategies more generally in the case of both a product and a task that resemble more closely those encountered in everyday life. In a recently completed study, which we shall describe briefly, we establish that the strategies identified in the present study are general across different kinds of products.

Method

Subjects

Subjects were 41 Hispanic women, members of a Catholic church in a lower SES urban neighborhood in a large eastern city. All spoke Spanish as their first and primary language and spoke little or no English. All interviews were conducted in Spanish by the third author. Subjects ranged in age from 18 to 69; median age was 45. Two subjects had no formal education; 21 had completed elementary school, 17 had completed high school, and one had some college experience.

Procedure

The session took place in a specially outfitted room in the church where the subjects were members. The setting was designed to simulate as far as possible the conditions a woman might encounter in choosing a skirt for purchase in a clothing store. The room contained a clothing rack, on which the skirts hung, a full-length mirror, adequate overhead lighting, a table, and several chairs. The 24 skirts were hung on hangers in random order on the rack. The subject was free to move skirts along the rack, to reorder them on the rack, to remove them from the rack for examination, and, if desired, to try them on.

The skirts had been tailored by a skilled seamstress especially for the study. They were of a quality that might be found in a medium-priced clothing store. The 24 skirts represented all possible combinations of one trichotomous and three dichotomous dimensions: color (navy, tan, green), fabric (polyester, corduroy), front pockets (present or absent), and hem ruffle (present or absent). The skirts were all of an identical, average size.

The subject was told that the purpose of the study was to learn about how women select clothing. She was then engaged in a few minutes of casual conversation with the interviewer as a warm-up. The three segments of the study -- skirt choice task, skirt rating task, and dimension rating task -- were always conducted in that order. Though order effects could exist, this constant order was chosen so as not to risk contaminating the main task (skirt choice), on which protocol analysis is based.

Skirt selection. The subject was shown the rack of skirts and told that she was to select the skirt that she liked best, just as she would if she were buying one in a store. She was told that she should take as long as she liked and that it was important to choose carefully for at the conclusion of the study a drawing would be held (like the raffle drawings sponsored frequently by the church) and the winning three women would each receive the skirt they had chosen, custom made in their size.

The subject was also told that a major purpose of the study was to find out what she was thinking as she made her choice and that she should therefore speak all of her thoughts aloud as she was making her choice. It was explained that what was said by her and the interviewer would be recorded on a small tape recorder, which was located unobtrusively above the skirt rack. If, during the choice task, verbalization ceased for more than a few seconds, the interviewer asked, "What are you thinking now?" In addition to the taped record, the interviewer kept a written record of the skirts examined and any other nonverbal behavior by the subject.

Skirt rating. Once the skirt choice had been completed, it was explained to the subject that she would now be asked to indicate how much she liked each of the skirts. A 40-inch cardboard scale, divided into equal intervals numbered 1-20 was displayed, the end points of the scale were labeled in Spanish) "No me gusta" ("Don't like at all") and "Me gusta mucho" ("Like very much"). The subject was told that if she liked a particular skirt very much, she should point to the segment numbered 20 at one end of the scale, if she didn't like a skirt at all she should point to the segment numbered 1 at the other end of the scale, and if she felt neutral about the skirt she should point to one of the middle segments (10 or 11). The more she liked a skirt, the interviewer explained, the higher the number she should point to and the less she liked it the lower the number she should point to. The subject was given practice with a variety of soft drinks until it was clear that she understood and was comfortable with the scale.

The subject was then asked to rate each of the 24 skirts, presented one a a time in a random order. When all 24 skirts had been rated, the subject was asked to rate the skirts a second time, "to make sure."

Dimension rating. The subject was then asked to rate each of the four dimensions of the skirts, first with respect to preference and then with respect to importance. Preference was measured in two different ways. First the subject was asked which of the levels of a dimension she preferred, e.g., polyester or corduroy. For color, all three binary preferenced were solicited. Second, for each level of the dimension, e.g., polyester and corduroy, the subject was asked to indicate how much she liked that level, utilizing the rating scale apparatus described above. The subject was then asked to indicate how important each dimension was in her evaluation of the skirts, utilizing the same rating scale apparatus but with end points, "No importante" ("Not important") and "Muy importante" ("Very important").

Replication. Approximately six months later, 29 (71%) of the subjects returned for a second session during which the entire interview was repeated.

Results

Skirt selection

Half of the transcribed verbal protocols from the skirt selection task were examined as the basis for construction of a coding scheme, which was then applied to all of the protocols. In developing the coding scheme, an iterative process was used in which a trial scheme was constructed, a portion of the protocols coded, the scheme revised, and the process repeated. The result was a microscheme that classifies each evaluative judgment made by the subject. Results of the microscheme coding were then used as the basis for global classification of subjects, as reported below. An evaluative judgment was chosen as the most coherent unit of analysis, rather than each individual utterance.

Table 1

Microscheme Coding of Evaluative Judgments

Single-alternative evaluations	
Global	This skirt is pretty.
Global with qualification	I like this skirt except for the pockets.
Unidimensional	I don't like the color of this skirt.
Bidimensional	
Additive	The color and pockets are nice.
Compensatory	I like the color but not the pockets.
Tridimensional	
Additive	The color and fabric are nice and I like the ruffle.
Compensatory	I like the color and fabric but not that ruffle.
Multiple-alternative evaluations	
Global*	*
Unidimensional	I like the color of these skirts.
Bidimensional	
Additive	I don't like the polyester or ruffle on these.
Compensatory	I like these tan skirts but not the pockets.
Tridimensional	
Additive	I like the color and fabric of these and the pockets are nice.
Compensatory	I like the color and fabric of these but not the pockets.
Simple comparative evaluations	
Global	I like this skirt better than that one.
Unidimensional	This is a better color than that one.
Bidimensional	
Additive	This is a better color and fabric than that one.
Compensatory	This has a better color but that's a nicer fabric.
Tridimensional	
Additive	This one's a better color and fabric than that one and it has ruffles.
Compensatory	They're both a nice color but I prefer the fabric and ruffles on this one.
Multiple-alternative comparative evaluations	
Single-to-group	
Unidimensional	I don't like this skirt as much as the blue ones.
Bidimensional	I like this skirt's color and fabric better than those over there.
Group-to-group	
Unidimensional	I like the polyester skirts better than the corduroy.
Bidimensional*	*

*Did not occur

Such a judgment could consist of multiple utterances, for example, "I like this skirt--the fabric is nice and the color is good on me." After construction of the scheme was completed and applied to all protocols, half of the protocols were selected randomly for independent coding by a second coder. Percentage agreement for identification and coding of an evaluative judgment was 91%.

The object of the coding scheme was to assess evaluative judgments with respect to the apparent complexity of the cognitive operations involved. An initial dichotomy that was examined, therefore, was whether a subject's judgment pertained only to a single skirt or whether it pertained to a set of skirts that the subject had grouped together on some basis. In the former case, which we shall refer to as a single-alternative evaluation, the subject made a judgment regarding a single skirt, either globally or with respect to one or more of its dimensions. Evaluations involving more than one skirt we observed to be of three types. In one, which we shall refer to as a multiple-alternative evaluation, the subject identified a set of skirts based on one or more dimensions and made an evaluative judgment of the set as a whole. In the other two, the subject either compared two skirts to one another (a simple comparative evaluation) or a set of skirts to another skirt or set of skirts (a multiple-alternative comparative evaluation). Each of these judgment types was also examined with respect to another aspect of complexity, the number of dimensions of the skirts taken into account and whether these dimensions were integrated in an additive manner ("I like both the color and the ruffles") or a compensatory manner ("I like the color but not the ruffles"). These distinctions are summarized with examples in Table 1.

Overall, 414 evaluative judgments were identified, an average of 10 per subject. The majority of these, 306, were single-alternative evaluations (shown by all 41 subjects). There occurred only 29 multiple-alternative evaluations, 52 simple comparative evaluations, and 10 multiple-alternative comparative evaluations. Notable, then, is the fact that though subjects had been instructed to think aloud as they went through the process of selecting a skirt, most of the time they simply expressed judgments about individual skirts, with no indication of how these judgments related to selection.

We did, however, observe a transition point in the protocols of some subjects. Towards the end of the protocol, after a number of evaluative judgments of one or more of the types described had been made, some subjects verbalized a restricted choice set of specific alternatives from which selection was to be made. They then proceeded to make a choice from among this restricted set. Of the 41 subjects, 18 (44%) displayed this two-phased approach. For 16 of the 18, the restricted choice set consisted of only two alternatives; for the other two, it consisted of three alternatives. During phase two, over half of the evaluations (53%) were simple comparative; the remainder were single-alternative and no multiple-alternative evaluations occurred. During phase one (the only phase for 23 of the subjects), in contrast, most evaluations (81%) were single-alternative and other types were infrequent.

Global classification of subjects is presented in Figure 1, in the form of a tree diagram. Phase-one behavior is portrayed in the top half of the diagram and phase-two behavior in the bottom half. The number of subjects falling into each classification is shown. The first and second branchings yield four groups: those who (in their phase-one behavior) showed only single-alternative evaluations, showed some simple comparative evaluations, showed some multiple-alternative evaluations, and showed both simple comparative and multiple-alternative evaluations. As reflected in Figure 1, most subjects who showed one of these two types of more complex processing also showed the other, and presence of simple comparative evaluations without multiple-alternative evaluations as well was particularly rare.

The third branching refers to the type of single-alternative evaluations used: No more than unidimensional, some bi-dimensional, and some tridimensional. Presence of bi- or tridimensional evaluations did not differ significantly as a function of presence of multiple-alternative evaluations or as a function of presence of comparative evaluations. The final branching distinguishes those subjects who showed some compensatory evaluations from those who did not. There was a weak but nonsignificant trend toward more frequent occurrence of compensatory evaluations among multiple-alternative subjects.

Only the first two branchings were related to phase behavior. As reflected in Figure 1, subjects showing multiple-alternative but not comparative evaluations were highly likely to display a second, restricted-choice phase; subjects showing both types of

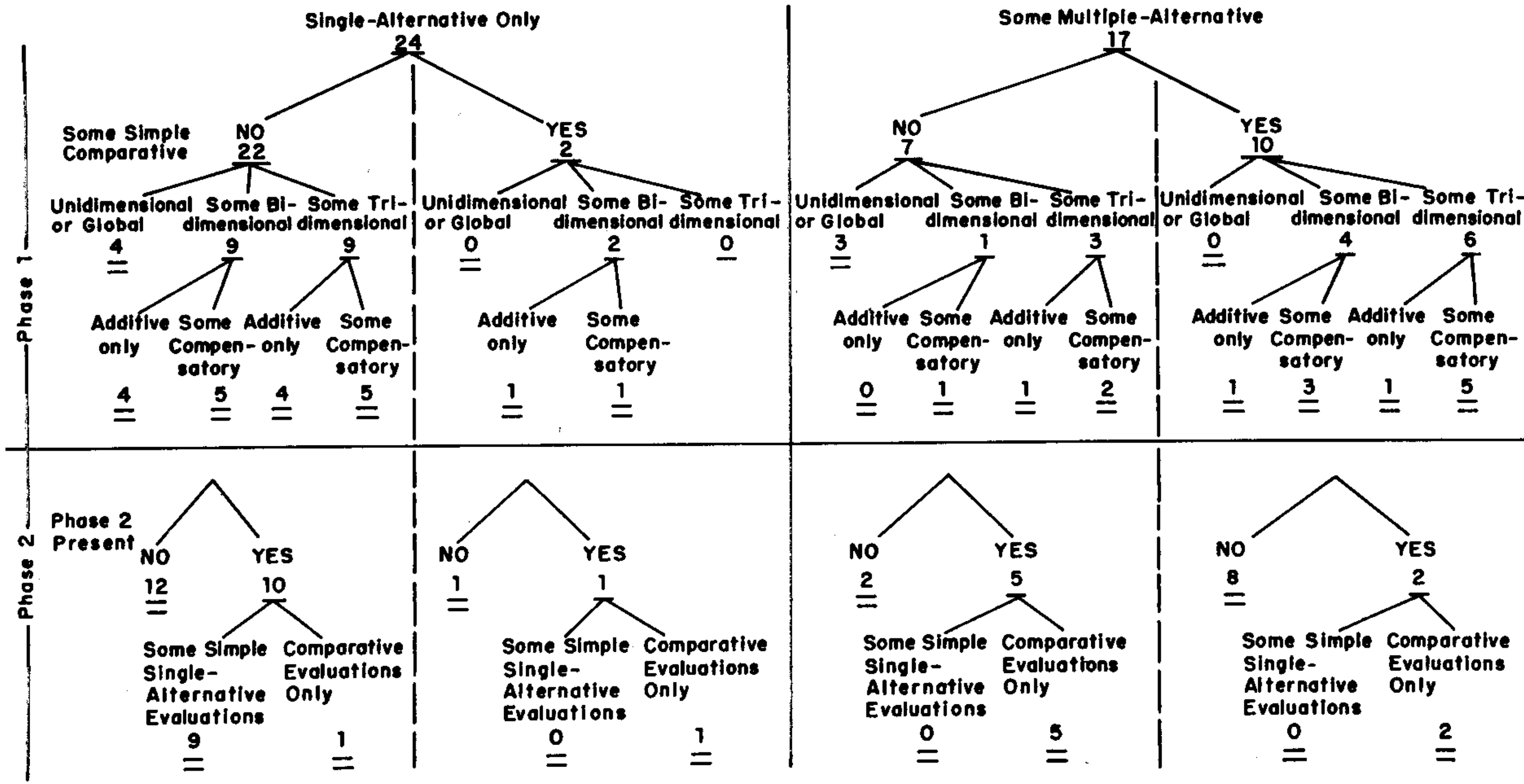


Figure 1: Patterns of performance on skirt selection task

more complex processing were unlikely to do so; and single-alternative subjects were about equally likely to do so or not. Differences also appeared with respect to type of phase-two behavior. Among the 18 subjects who showed a second phase (final branching in Figure 1), half made only comparative evaluations during the second phase, while half also made single-alternative evaluations during the second phase. As reflected in Figure 1, subjects showing exclusive comparative evaluations in the second phase were much more likely to be in the multiple-alternative group: All seven subjects in this group showed exclusive use of comparative evaluations during phase two, whereas only 2 of 11 (18%) of the single-alternative group did so (Fisher test, $p < .01$), suggesting that the second-phase behavior of the multiple-alternative group was different in quality and may have been more skilled or efficient. A further difference suggestive of this conclusion pertains to the degree of similarity among the alternatives which comprised the second-phase choice set. The implication of a choice set in which the alternatives differ on few dimensions compared to one in which they differ on multiple dimensions is that the subject's first-phase behavior has been more effective in narrowing down the alternatives. Two of five (40%) of the multiple-alternative-without-comparisons group and two of two (100%) of the multiple-alternative-with-comparisons group had a single dimension level difference in their phase-two choice set, contrasted to only 3 of 11 (27%) of the single-alternative group. Finally, all subjects in the first two groups constructed a phase-two choice set of only two skirts, which they then chose between.

Another aspect of behavior on the selection task that was examined was the relation between skirts examined and the skirt chosen, i.e., did subjects show a tendency to choose the first skirt examined, the last skirt examined, or a skirt in the middle of the examination sequence? One subgroup of subjects chose proportionately more polar skirts (those examined first or last) than would have been expected by chance ($X^2 = 5.44$, $p < .05$). These were the 13 single-alternative subjects who did not show a second phase (see Figure 1). The distribution for all other subgroups did not differ significantly from chance. Eight of the 13 single-alternative single-phase subjects chose the first skirt examined, three chose the last skirt examined, and the remaining two did not choose a polar skirt.

Finally, total number of skirts examined and total time taken in the selection process differed across subgroups. The multiple-alternative-without-comparisons subjects examined the fewest number of skirts (mean of 4.0) and took the least time (mean of 4 minutes 39 seconds). These were the same subjects who, while displaying only multiple-alternative and no comparative evaluations in phase one, were highly likely to show a second phase and, furthermore, one that appeared to be highly efficient. Subjects who examined the largest number of skirts (mean of 12.5) and took the most time (mean of 7 minutes 30 seconds), in contrast, were the multiple-alternative-with-comparison group. These subjects displayed both comparative and multiple-alternative evaluations in their phase one behavior and were unlikely to display a second phase. Intermediate were the single-alternative subjects (whose phase-two behavior, recall, if they did display a second phase, appeared not as efficient as that of the multiple-alternative subjects): They examined a mean of 7.6 skirts and took a mean of 5 minutes 51 seconds. The difference in number of skirts examined by these three groups was significant, $F(2,38) = 3.66$, $p < .05$), with only the two extreme groups differing significantly in post-hoc comparisons (Tukey test, $p < .05$).

Skirt and Dimension Ratings

Each of the subject's skirt ratings was treated as an independent judgment to be entered into an analysis of variance for that subject, following the procedure used by Anderson (1970, 1973). Each ANOVA included the four factors: fabric, color, pockets, and ruffles. The two replications of the 24 unique skirts provided the error term. A classification of subjects according to the pattern of effects found in their individual ANOVAs revealed a considerable range of information integration patterns. Including both main and interaction effects, 13 subjects took all 4 dimensions into account, 13 took 3 into account, 6 took 2 into account, 8 took 1 into account, and 1 subject displayed no effects.

In the dimension ratings, of the 41 subjects, 39 indicated a preference of one level of a dimension over the other(s) for all 4 dimensions, the remaining 2 subjects indicated preferences for 3 of the 4 dimensions. Subjects showed considerable consistency between object ratings and their explicit dimension preferences, expressed directly in the dimension ratings. Of the 38 subjects who exhibited main effects in their ANOVAs, 25 exhibited dimension preference scores that were consistent with all of their main effects. Of the remaining 13 subjects, 10 had only a single dimension preference score inconsistent with a main effect. Subjects thus overall showed considerable ability to integrate dimension preferences into preference ratings of the objects. However, despite the considerable consistency between the implicit preferences for levels of the skirt dimensions revealed as main effects in the ANOVAs and the preference scores obtained directly from the dimension ratings, there were far fewer significant right-direction main effects in the ANOVAs than there were non-zero preference scores for dimensions, 71 versus 158. In other words, subjects did not take into account in the skirt ratings all those dimensions of the skirts with respect to which they had preferences.

Consistency Across Tasks and Time

Subjects were divided into two groups based on their performance on the rating tasks: strong and weak integrators. Three criteria were employed, all of which had to be met for a subject to be classified as a strong integrator: (1) Integration of preferences for at least two dimensions was demonstrated by the appropriate significant effects in the subject's ANOVA; (2) Fifty percent or more of all dimension preferences resulted in right-direction main effects in the subject's ANOVA; (3) No dimension preference resulted in a wrong-direction effect in the subject's ANOVA. Application of these criteria produced 16 subjects who were classified as strong integrators and 25 who were not. A strong relationship was found between this dichotomy and the groups developed based on the choice task. Of the 24 single-alternative subjects, just 5 (21%) were strong integrators. Those subjects who showed some simple comparatives or a second phase (Figure 1) were no more likely to be strong integrators. In contrast, 6 of the 10 (60%) multiple-alternative-with-comparisons and 5 of the 7 (71%) multiple-alternative-without-comparisons subjects were strong integrators. With the two multiple groups collapsed, this association was significant.

Other measures of consistency were also moderate to high. A set of analyses was undertaken to investigate the degree of consistency exhibited by subjects within and across the skirt choice, skirt rating, and dimension rating tasks, both within and across the two sessions (six months apart). In each case, comparisons were made between the single-alternative, multiple-alternative-with-comparisons and multiple-alternative-without-comparisons groups. The correlation between the first and second replications of the skirt rating task were uniformly high, with the lowest coefficient for any individual group in either session, .61. The two within-session across-task measures were the relationships between skirt choice and dimension preferences and between skirt choice and skirt ratings. The former consisted of the mean number of preferred dimension levels (obtained directly from the dimension ratings) that were present in the chosen skirt, i.e., if the subject indicated a preference for corduroy over polyester in the dimension-rating task, was the skirt chosen in the choice task corduroy? Consistency was uniformly high on this measure, a mean of over three in every case. Consistency between skirt choice and skirt ratings was measured by the proportion of times that the skirt selected in the choice task was also the most highly rated skirt in the rating task. Once again there was high consistency, overall 79% and 88% agreement for the first and second sessions respectively.

The three across-session measures were each derived from within-task comparisons, one each for the dimension rating, skirt rating, and skirt choice tasks. The dimension-rating measure consisted of the mean number of dimensions (of four) for which the preferred level (e.g., corduroy over polyester) was the same across sessions. The skirt-rating measure was the mean of the four possible correlation coefficients between the first and second replications of the skirt-rating task at the first session and the first and second replications of the skirt-rating task at the second session. The choice measure consisted of the mean number of dimensions of the chosen skirt for which the preferred level (e.g., corduroy) was the same at both sessions. The skirt-rating measure was the mean of the four possible correlation coefficients between the first and second replications of the skirt-rating task at the first session and the first and second replications of the skirt-rating task at the second session. The choice measure consisted of the mean number of dimensions of the chosen skirt for which the preferred level (e.g., corduroy) was the same at both sessions. All of these measures of consistency were high for all three groups. There was somewhat greater variability across groups in the last two measures, but these differences were not statistically significant. All subjects, then, performed all of the tasks with considerable consistency.

Global Strategy Types

Results of the choice task allowed us to classify subjects into four overall groups.

Single-alternative evaluation without comparisons. The 12 subjects in this group (see Figure 1) showed the minimal form of behavior consistent with the task demand to examine the skirts and choose one. They examined a number of skirts, on average about a third of them, and made evaluative judgments about each one as it was examined. No more complex judgments were expressed either comparing skirts to one another or evaluating a set of skirts grouped together on some basis. After a series of single-alternative evaluations, the subject chose a skirt, almost always the first or last one examined.

Single-alternative evaluation with some comparison. The 12 subjects in this group likewise examined about a third of the skirts and showed a predominance of simple single-alternative evaluation, but they also showed some comparative evaluations, either during the first phase itself (n = 2) or confined to a second, reduced-choice phase (n = 10). This second-phase behavior, however, differed from that of subjects in the multiple-alternative groups: Subjects continued to make single-alternative, as well as comparative, evaluations of the skirts in the second-phase reduced choice set (in contrast to multiple-alternative subjects whose second-phase behavior was confined to comparative evaluations) and, furthermore, the reduced choice set itself was different, likely to differ on more than one and sometimes as many as three or four dimensions. Subjects in this group, relative to those in the first group, thus showed evidence of having imposed some higher-order strategic framework on the task, either in explicitly comparing skirts to one another or in constructing a reduced choice set, but the variability among the two or three skirts in the reduced choice set suggests that this effort may not have been particularly effective.

Multiple-alternative evaluation with phase-one comparison. The 10 subjects in this group, unlike those in the two previous groups, showed evidence of having imposed a higher-order strategic framework on the task by implicitly grouping skirts together on the basis of some defining feature, usually one or more of the four dimensions on which they varied, and making an evaluative judgment of them with respect to the defining dimension(s). Subjects in this group, however, mixed these judgments with simple comparisons of one skirt to another. They rarely constructed a reduced choice set and were the slowest of all groups in making a selection, examining the most skirts in the process.

Multiple-alternative evaluation with no phase-one comparison. The higher-order strategic framework imposed on the task by the seven subjects in this group consisted during phase one exclusively of multiple-alternative grouping and evaluation with respect to defining dimension(s). Most then used these evaluations as the basis for construction of a reduced choice set, differing on one or, at most, two dimensions, from which the selection was made. This reduced choice set never contained more than two skirts and only comparative judgments were made once the reduced choice set had been constructed. These subjects examined the fewest individual skirts and completed the selection process most rapidly. It thus appears as if they imposed a framework of higher-order strategies on the task with a greater degree of success and efficiency than did subjects in the preceding group.

Generality of Strategies

In a dissertation by Martin (1987), the present study was replicated using two different products, sweaters and coffee mugs, with each subject encountering both products (in counterbalanced order across subjects). Martin also manipulated the product array to be either random (as in the previous work) or hierarchical, i.e., arranged in a matrix. This manipulation had no effect on performance. Martin's study does, however, show the strategy types described above to be general across these two kinds of products: Subjects tended to be classified as showing the same type for both products. This finding, however, still leaves unanswered a number of important questions about these types, which we consider below.

Discussion

The results of this study provide evidence of intelligent performance on the part of all of the subjects examined but also evidence of significant individual variation. All subjects showed intelligent performance with respect to consistent selection of an identical or very similar skirt on two separate occasions six months apart and also with respect to consistency in their ratings of the skirts, both within and across sessions, in their ratings of the dimensions and in the relations between skirt choice, skirt ratings, and dimension ratings. Where notable individual variation occurred was in the relation between skirt and dimension ratings, i.e., the extent to which a subject integrated her dimension preferences into preference judgments regarding the skirts themselves and, most important, in the think-aloud behavior exhibited in the selection task. Examination of the protocols from the latter suggested the four different groups of subjects described above.

To what extent is it valid to regard the four preceding types as constituting an ordinal scale with respect to intelligent performance of the activity we observed? Alternatively, are they better regarded simply as different styles of carrying out a common, everyday activity, some more analytic in nature, perhaps, but not necessarily less effective? An argument can readily be made for the last of the four types described as the most intelligent, efficient way to execute the task: Items are grouped conceptually based on the dimensions in terms of which they vary and this categorization is used as the basis for narrowing the original set down to those having the preferred characteristics.

Arguments in favor of the second alternative, however, also can be made. Subjects in the first two groups, who did not show categorization by dimension, were no less consistent than subjects in the latter groups with respect to choice of skirt on the two separate occasions. One could argue that since they chose the same skirt, or nearly the same skirt, on the second occasion, it must have been the one they indeed liked best and who, therefore, is to criticize the way they went about selecting it? One might in fact make the even stronger argument that one-by-one examination of individual skirts reflects a "configural" approach that is the most intelligent and, indeed, only feasible way of carrying out the task in the case in which the subject's dimension preferences are highly interactive, i.e., preferences regarding one dimension are conditional on the value of other dimensions. The limiting case of such a configural approach, of course, is the one in which all four dimensions interact and each unique combination of dimensions therefore must be judged as a separate entity.

Diminishing the likelihood of this "configural" interpretation, however, is the fact that if subjects in the first two groups indeed had such configural, or interactive, preferences, they did not display them in the skirt rating and dimension rating tasks. No subject expressed any difficulty in making simple preference judgments for each of the dimensions in isolation from the others (as would be reflected, for example, in judgments such as "Blue is a better color but only in the corduroy skirts."). More important, subjects in the first two groups rarely displayed more than a single two-way interaction effect in the skirt rating task, fewer on the average than the number of interacting effects displayed by subjects in the two latter groups. It is unlikely, then, that their preferences were configural to an extent that would have made it difficult for them to engage in evaluation by dimension.

The temporal consistency argument is also vulnerable to a counterargument that subjects' consistency in this regard may have been attributable not to any consistency in the selection process itself over the two occasions but to the subject's memory of having selected a particular skirt on the first occasion. In other words, the act of making the initial choice may have been salient enough for subjects that they remembered their choice on the second occasion and felt constrained to reaffirm it. To the extent this possibility is correct, then second-occasion process is constrained by first-occasion choice, in which case the replication no longer provides a pure assessment of the consistency with which a particular process yields the same choice on repeated occasions.

Temporal consistency of choice, then, may not be the most valid indicator of the consistency with which the subject carried out the task. A more process-sensitive assessment of consistency, it can be argued, may be found in the consistency between dimension ratings and skirt ratings. In their ratings of the individual skirts, subjects often failed to integrate all of the dimensions on which they expressed preferences in a way consistent with those expressed preferences. Differences in this regard, we also found, were related to the differences observed in the skirt selection task: Subjects in the two single-alternative-evaluation groups in the skirt selection task were unlikely to show successful integration of their dimension preferences in their ratings of the skirts.

Results of the skirt and dimension rating tasks, then, support the interpretation of an ordinal ranking of the groups formed on the basis of the skirt selection task, with the initial groups regarded as displaying less skill or efficiency than the later ones. In rating the individual skirts, subjects in the first and second groups did not exhibit the interaction effects that would have justified configural, item-by-item processing, nor was their performance likely to reflect integration of all of their dimension preferences in a consistent way.

What this interpretation does not tell us, however, particularly if one discounts the configural possibility, is very much about how these subjects *did* accomplish selection of a skirt. Though subjects in the first of the four groups described above exhibited only a series of evaluative statements regarding individual skirts, something presumably determined the selection the subject made. At one extreme, it might be argued that the subjects who appeared less skilled in fact engaged in similar kinds of categorization and comparison processes as did subjects in the latter groups and that this processing dictated choice, but the process was not accessible to the subject and, therefore, did not appear in the think-aloud protocol. The likelihood, however, that this assertion is correct in any strong form is diminished by the facts that (a) subjects in the first group, who showed only single-alternative evaluations, typically chose the first or last skirt examined; and (b) subjects in the second group who showed construction of a restricted choice set (second phase) typically constructed a set that differed on several dimensions. In other words, what additional performance indicators were available suggested that the selection process of these subjects differed substantially from that of subjects in the third and fourth groups.

Study of individual protocols also supports this interpretation. Characteristic of subjects in the two single-alternative groups was a long series of single-alternative evaluations, often global in nature. For example, one typical subject said about four successive skirts on the rack, "This one is very nice; this is nice, too; I like this one too; this one is very pretty." Two-phase single-alternative subjects then typically turned to a comparison of two skirts, from which they ultimately chose one, but the basis for focusing on these two was not clear, i.e., it was not clear that all others had been consciously eliminated as less desirable. One subject, for example, began the second phase by saying, "Well, these two, I like them very much because they are very similar, except one has pockets and the other doesn't." (In fact, the only commonality between the skirts was color; they were of different fabric, one had pockets and no ruffles, and the other had ruffles and no pockets.) She then chose one of the two, saying, "Well, I like this one very much so I would like to buy it." Single-alternative subjects who did not show a second phase simply chose one of the skirts examined, usually the first or last. One such subject, for example, chose the first skirt she had examined, saying: "I think that I'm not going to continue looking because I'm almost decided and I don't have too much time so I would buy this one because my idea was to buy a simple skirt for the Spring."

These protocols thus appeared very different from those in which the subject went through a systematic evaluation of the skirts by dimension and then chose the skirt that had the combination of favored dimensions. Nevertheless, it is still fair to say that we cannot be certain of the extent to which the individual differences observed in this study reflect differences in the access subjects have to their cognitive processing, i.e., their metacognitive functioning, versus differences in the cognitive processes themselves. Most likely, both are involved in the differences observed in the present study. The distinction is of course an important one that deserves careful consideration in all studies of everyday cognition.

Two general points are worth making in this regard. First, types of cognitive and metacognitive processes probably covary to some extent, i.e., some kinds of cognitive processes are more likely to be accompanied by metacognitive access than are others. Second, individual variation in metacognitive functioning with respect to real-world cognitive tasks is likely to be as important and is as worthy of study as is individual variation in cognitive processes themselves. To know how one does something, i.e., to have cognitive control over the process, is likely to be an important aspect of cognitive functioning in real-world activities. In the present case, it is significant that subjects in the first group and, to a considerable extent, the second group as well had a great deal to say about individual skirts themselves but little or nothing to say about how they selected one skirt over the others.

What can be said more broadly about the individual variation observed in this study? The comparison and categorization operations absent in some protocols and present in others are very simple ones that are within the competence of adult subjects from the population sampled. It is unlikely, then, that fundamental differences in competence are involved. Subjects most likely differed, rather, in their disposition to actively impose the organizing structure these operations offer when the narrow task demands could be met without doing so.

We believe it likely that the differences observed reflect broad cognitive/personality styles that characterize an individual's approach to a range of activities. In this respect, they no doubt relate to a number of other style constructs, described in previous cognitive style and personality literature, having to do with analytic versus holistic or linear approaches. A fundamental issue in studies of cognitive style has always been whether it is valid to impose any order on the styles identified, regarding one as more advanced or desirable than another. The task investigated in the present study might be regarded as one with respect to which it is particularly difficult to regard any approach as better than another. The choice itself of a particular skirt rather than the others cannot be regarded as better or worse than another choice would have been. No skirt was better than any other in any objective sense. We must presume that each woman chose the skirt she liked best. How can a researcher impose value judgments on the way she went about it?

We deliberately chose to study a task that involved a relatively inconsequential choice for the subject, as we wanted to examine an activity that she engaged in often. One need only change the item being selected, however, say to an insurance policy, and the variations in approach that we have identified take on a much different tone. The existence of subjects showing the more analytic types of processing is as important in its implications as is the existence of subjects showing the simpler linear types. Subjects who approached the task in a highly analytic way showed no tendencies to differ in age or amount of education from subjects who did not. The fact that the sample as a whole represents a restricted range with respect to educational attainment and traditional academic intelligence supports the view that intelligent behavior may be evident in other than traditional academic domains and warrants being searched for and examined in those domains.

The individual variation we observed also assumes considerable significance from a life-span development perspective, in particular with respect to the issue of maintenance of cognitive skills in later years. In other work involving only the rating tasks (Capon & Kuhn, 1980; Capon, Kuhn, & Gurucharri, 1981; Capon & Davis, 1984), we have investigated performance among age groups from kindergarten children through the elderly and found that the proportion of subjects who show a high degree of consistency in integrating their dimension preferences in their ratings of the objects themselves rose during childhood and was constant across adulthood, dropping only slightly among the elderly. Subjects using more analytic approaches, then, may be highly likely to maintain them into old age, which suggests that the kind of activity examined in the present study may represent a fruitful domain in which to investigate the cognitive skill of the elderly as well as the general issues raised by the question of practical intelligence.

Note

The authors acknowledge the support of the Redward Foundation in conducting this work.

References

Anderson, N. (1970). Functional measurement and psychological judgment. *Psychological Review, 77*, 153-170.

Anderson, N. (1973). Algebraic models in perception. In E. Carterette & M. Friedman (Eds.), *Handbook of perception*. New York: Academic Press.

Baltes, P., Dittman-Kohli, F., & Dixon, R. (1984). New perspectives on the development of intelligence in adulthood: Toward a dual-process conception and a model of selective optimization with compensation. In P. Baltes & O. Brim (Eds.), *Life-span development and behavior, Vol. 6*. New York: Academic Press.

Bettman, J. (1979). *An information processing theory of consumer choice*. Reading, MA: Addison-Wesley.

Capon, N., & Davis, R. (1984). Basic cognitive ability measures as predictors of consumer information processing strategies. *Journal of Consumer Research, 11*, 551-563.

Capon, N., & Kuhn, D. (1980). A developmental study of consumer information processing strategies. *Journal of Consumer Research, 7*, 225-233.

Capon, N., Kuhn, D., & Carretero, M. (in press). In J. Sinnot (Ed.), *Everyday problem solving: Theory and applications*. New York: Praeger.

Capon, N., Kuhn, D., & Gurucharri, M. (1981). Consumer information processing strategies in middle and late adulthood. *Journal of Applied Developmental Psychology, 2*, 1-12.

Cole, M., Hood, L., & Mc Dermott, R. (1978). Ecological niche picking: Ecological invalidity as an axiom of experimental cognitive psychology. Unpublished manuscript, University of California, San Diego, and Rockefeller University.

Dixon, R., & Baltes, P. (1986). Toward life-span research on the functions and pragmatics of intelligence. In R. Sternberg & R. Wagner (Eds.), *Practical intelligence: Nature and origins of competence in the everyday world*. New York: Cambridge University Press.

Ericsson, K. A., & Simon, H. (1984). *Protocol analysis: Verbal reports as data*. Cambridge, MA: MIT Press.

Frederiksen, N. (1986). Toward a broader conception of human intelligence. *American Psychologist, 41*, 445-452.

Kuhn, D., Pennington, N., & Leadbeater, B. (1983). Adult thinking in developmental perspective. In P. Baltes & O. Brim (Eds.), *Life-span development and behavior, Vol. 5.* New York: Academic Press.

Lave, J., Murtaugh, M., & de la Roche, O. (1984). The dialectic of arithmetic in grocery shopping. In B. Rogoff and J. Lave (Eds.), *Everyday cognition: Its development in social context (pp. 67-94).* Cambridge, MA: Harvard University Press.

Martin, E. (1987). *Consistency in individual consumer choice strategies.* Unpublished doctoral dissertation, Columbia University.

Rogoff, B., & Lave, J. (Eds.). (1984). *Everyday cognition: Its development in social context.* Cambridge, MA: Harvard University Press.

Scribner, S. (1984). *Studying working intelligence.* In B. Rogoff & J. Lave (Eds.), *Everyday cognition: Its development in social context (pp. 9-40).* Cambridge, MA: Harvard University Press.

Sternberg, R. (1984). *Beyond IQ: A triarchic theory of human intelligence.* New York: Cambridge University Press.

Sternberg, R. (1985). Implicit theories of intelligence, creativity, and wisdom. *Journal of Personality and Social Psychology, 49,* 607-627.

Sternberg, R., & Wagner, R. (Eds.). (1986). *Practical intelligence: Nature and origins of competence in the everyday world.* New York: Cambridge University Press.

Wagner, R., & Sternberg, R. (1985). Practical intelligence in real-world pursuits: The role of tacit knowledge. *Journal of Personality and Social Psychology, 49,* 436-458.

Editors' Note

In order to cover rising costs for printing and mailing and to reduce the losses the Newsletter incurs, we have found it necessary to change the subscription charge.

Beginning with Volume 10 (January, 1988) the annual fee will be increased to $20.00. Also, we are increasing the postage fee for foreign mailing to $7.00 a year.

We have not changed the subscription rate since 1982, so (a) we really need it and (b) it will not become a habit!

Balanced Measurement of Cognitive Development: A Discussion on Methodological Problems with the Balance Scale

Miriam Wolters
Coen Fischer
Johan Zuidema
Department of Developmental Psychology
University of Utrecht

Balance scale tasks are used in research projects with different aims. They are used to study cognitive development and knowledge acquisition (Inhelder & Piaget, 1958; Siegler, 1981; Wilkening & Anderson, 1982), and to study the relation between cognitive development and education (Kalmykova, 1981). In this Newsletter, Martin (1985) and Tudge (1985) reported using balance scale tasks to study the relation between children's cognitive performance and the social context in which problem solving occurs. Martin and Tudge relied on procedures and categorizations designed by Siegler. The aim of this article is to comment on Siegler's method in using the balance scale as an instrument to measure cognitive performance, particularly in the light of Kalmykova's work. Siegler works within an information processing tradition, Kalmykova in a Vygotskian tradition.

Siegler and Kalmykova Compared

There are large differences between the procedures used by Siegler and Kalmykova. It is not possible, therefore, to compare the two procedures on every aspect. We will compare just a few aspects, which we feel most clearly show the differences between the two. Since Kalmykova's work is not translated in English, we will discuss her theoretical background in more detail.

Psychologists in the USSR, working in a Vygotskian tradition, try to create experiments in realistic situations. That is why Kalmykova performs experiments in schools. Also, for realism, Kalmykova chooses the balance scale, since it has close connections with everyday life in the Soviet Union. Students see balance scales being used in stores, markets, etc. By choosing the balance scale, problems which arise

0278-4351/85/1-33 $1.00 © LCHC

when using artificial material are prevented. A realistic situation also means that students should receive feedback. Feedback is given to students in Kalmykova's experiments by showing the result on the scale itself or by turning over a test-item card with the answer.

Siegler's subjects receive no feedback. They are very limited in their actions. During the test, they are allowed to say left, right, and balance, that is all. This seems to be an unnatural situation. In ordinary life, children can experiment and ask questions, etc. It is possible that Siegler's findings are partly an artifact of this limited scope of action. Perhaps children would use rules differently or even change rules, if they were less constrained.

The problem of giving or not giving feedback is not just a procedural detail, but goes back to a different theoretical background. Psychologists working in a Vygotskian tradition distinguish at least two developmental levels: An actual developmental level as determined by "independent" problem-solving, and a level of potential development, determined through problem-solving under guidance and with feedback provided. This distinction was offered by Vygotsky in the 1930s as a way to attack the use of IQ tests in the USSR at that time. His argument was that IQ tests resulted in a picture of completed development only, information that is of little use in an instructional situation.

The distance between the level of actual development and the level of potential development is called the zone of proximal development. When a realistic situation is created, feedback is given, help is available, and subjects are taken beyond the actual developmental level into the zone of proximal development. In Vygotskian terms, Siegler, by not giving feedback and not helping the subjects, is measuring just the level of actual development of his subjects.

Apart from feedback there is a second aspect in which the two procedures differ, i.e., orientation. Orientation is an important activity, acknowledged by most developmental and educational psychologists in the USSR. If a student does not learn to orient himself to the relevant features of objects and/or situations, there is a danger that, while the accomplishment of a task may be correct and accurate, the process itself remains unstable. If a student does not learn to orient himself properly, his performance will decrease if there is just a small change in conditions. A student understands a problem when he is able to trace mentally the relevant features or relations in the problem situation. In other words a student understands a problem when he has oriented himself to the relevant aspects or relations in the problem situation.

In her procedure, Kalmykova stimulated the orienting activity by using cards with test-items (see Figure 1). For some items, the card is used together with the scale; for other items, the question is answered by using the card only.

No. 1	No. 14
5 cm -------1 w 5 cm -------1 w	5 cm ------- 1w 20 cm ------- 4w
(+)	(-)

Figure 1: Examples of Kalmykova Test-item cards. The top row gives the data for one arm and the bottom row for the other arm. The (+) or (-) indicates whether the scale will balance or not.

The purpose of the items using only the card was to stimulate orientation, i.e., to make students pay attention to the relevant aspects of the problem, weight and distance. In other situations there is a possibility that students are distracted by irrelevant aspects of the apparatus, the experimenter, etc.

Unfortunately, the layout of the card that Kalmykova chose is flawed. Instead of putting the distance and weight for one arm on one side of the card, she put the two distances on the left and the two weights on the right (see Figure 1). This is very confusing, because the card does not perceptually represent the situation on the scale. It is not just confusing but also has a disadvantage which Kalmykova apparently overlooked. The student confronted with those test-item cards encounters a large amount of "nice" number configurations. He knows these configurations from his mathematics lessons: the multiplication tables. We have calculated that, in 75% of all the test-items, the attention of the student is drawn to multiplication tables. So, in 75% of all items the ability to do multiplication is an interfering factor, even though the items were constructed to avoid measuring this ability. A replication of Kalmykova's research in the Netherlands showed that this danger is very real.

In summary, Kalmykova's procedure has several positive hallmarks of educational research in a Vygotskian tradition. Her investigation took place in schools, under relatively normal conditions. This means that the investigation has more relevance to education, but is (partly) therefore less strict when looked at from a methodological point of view. Siegler's research is methodologically strict, but it is difficult to see the usefulness of this research for educational purposes. Both procedures have their advantages and disadvantages. Siegler's study is methodologically strict, which is an advantage, but no feedback is given during the test, which is a disadvantage. In Kalmykova's study feedback is given, and orientation on relevant aspects of the task is stimulated. Both of these are to be considered advantages; the latter, however, turned out to be a disadvantage because of badly chosen layout for the cards.

The Usefulness of the Balance Scale

The balance scale has a number of technical advantages. The apparatus is not too complex and can easily be taken to schools. Test items that can be made for the balance scale range from very easy to very hard. This allows the formulation of items for subjects of varying ages, items they can really chew on, without finding them impossible to solve. It is often true that items subjects have to solve in a test have no connection with daily life. Here, too, the balance scale offers advantages. Children have met a lot of appliances which use the same principles as the balance scale. What child has never played on a seesaw? That children have no experience with the actual balance scale is an advantage to the investigation. Interference from learning-effects can be avoided. Learning-effects can be systematically varied during the experiment. Children know the principles of the balance scale, inverse proportionality and equilibrium, from their own experience, often without being aware of it. These principles, appearing in varying shapes, are important to children, at school and later. There are many practical uses of inverse proportionality. Examples vary from a pair of nutcrackers to the counterweight of a crane.

On a mental level it is also important that a student can handle inverse proportional relations and equilibriums. In all kinds of situations it happens that factors which are farther from the center "carry more weight" and have a larger influence on (the disturbances of) the equilibrium.

As a last advantage we want to mention the attractiveness of the instrument. Children like to work with a balance scale and motivation problems often encountered when using paper and pencil tasks are avoided. We may therefore conclude that the balance scale is a very useful device to investigate cognitive development. With simple means one can make interesting items.

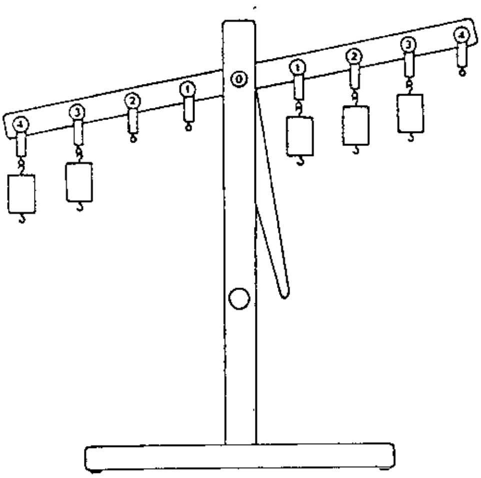
An Alternative Method

Knowing this, we set out to develop a method in which the advantages of Siegler's and Kalmykova's procedures are combined and the disadvantages left out. Kalmykova's contribution to the alternative method is mostly theoretical, while Siegler supplies us with a sound methodological basis. We designed a series of items and checked to see if Siegler's rules would still fit when we changed the design procedure by stimulating orientation and giving feedback.

We have to take care that students optimally orient themselves. So, the material is designed to optimize orientation: Different functional parts of the balance scale have different contrasting colors. The weights can easily be counted (see Figure 2). We prefer the weights to be of equal color and shape, because the subjects will then take them to be equal (which they are). From the investigation by Siegler, we know that of the two factors "weights" and "distance," weight is the psychologically dominant one. To orient the subjects to distance as well, we put large large numerals above the hooks on the beam of the balance scale. Another way to orient students to the law of the balance scale was to show them that there are degrees of imbalance. This was done by making sure that for equal differences in torque between the left and right arm of the balance scale, the inclination of the beam (the two arms) is the same, whatever the number of weights hanging from the beam.

The second important aspect is feedback. After each item feedback is given by showing the effect on the balance scale. In general the items start easy and get more difficult each time.

Subjects. We selected 104 students from the first to the fifth grade of two elementary schools in two small towns. Their ages varied from 6 years to 11



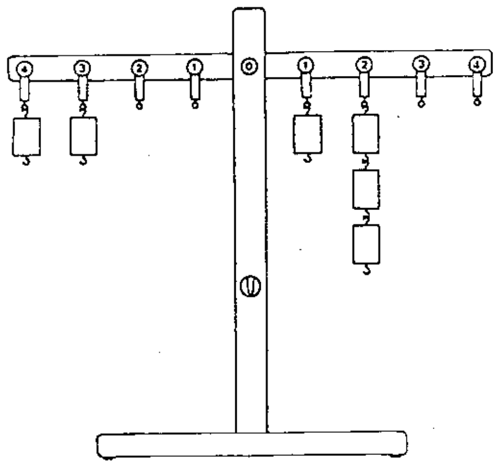


Figure 2: The balance scale apparatus

years. Each grade supplied roughtly the same number of boys and girls. "Average" pupils were selected by their teachers.

The balance scale. The balance scale has a beam with a total length of 85 cm. On each side are four positions at intervals of 10 cm from the center point, on which weights can be hung. These positions are numbered 1 through 4 from the center point, in large (20 mm) red numerals on white circles. The color of the support is white, the color of the turning part (the beam and the pointer) is red. The wooden weights are 80 gm each, with a diameter of 4.5 cm, and a length of 6.5 cm. The color of the weights is blue. From the back of the apparatus a pin can be stuck through both the support and the pointer, so that the beam cannot move. The balance scale is constructed in such a way that the turning points of the weights and the axis are on one line. This means that for equal differences in torque between the right and left side, the inclination of the beam will be equal, whatever the total number of weights hanging from the beam.

Procedure. At the start of the session the purpose of the experiment is explained to the subject by way of three very simple examples (notation: 0001-0000; 0001-2000; 0020-0200, cf. Figure 2). After this the subject is offered items with the following procedure. The pin is stuck in the balance scale. The experimenter hangs the weights on the beam and asks, "Will the beam go down on this side, on that side, or will it not go down at all?" The subject answers and finally the pin is drawn out so that he can check his prediction. No time limit is used.

The order of the items has been chosen so that a subject will make an incorrect prediction after as many correct predictions as the rule that is used allows. This order is: balance item (B), weight item (W), distance item (D), conflict-weight item (CW), conflict-distance (CD), conflict-balance (CB). For classification of rule use, we do not take into account the predictions which are offered after an incorrect one. After all, after an incorrect prediction, the subject receives feedback and sees something he does not expect. He might use this to change his hypotheses about the law of the balance scale and might then change his rule.

Since we give feedback after an item is presented, we have to classify the rules that the subjects use differently than Siegler does. For classification purposes the prediction patterns subjects can use have been clustered in nine types. (See Table 1.) Each of the prediction patterns is an indication of one of Siegler's rules or an indication of "no rule" (rule 0).

Table 1

Answer Pattern and Rule-Classification

Type	Test item	Prediction Pattern
		1 2 3 4 5 6 7 8 9
B	1100-0011	- + + + + + + + +
W	0110-0210	? - + + + + + + +
D	0120-0021	? ? l b + + + + +
CW	1000-1200	? ? ? ? - + + + +
CD	0030-0011	? ? ? ? ? l b + +
CB	0011-0010	? ? ? ? ? ? ? - +
Rule		0 0 0 1 3 2 3 3 4

Key:
+ = Correct prediction
- = Incorrect prediction (two possibilities!)
b = Balance (but incorrect)
l = Left (but incorrect)
? = This prediction does not influence rule-assignment

We will now show how each pattern in Table 1 is an indication of rule 0 to 4.

Pattern 1: The first item is predicted incorrectly. All subjects that use a rule will correctly predict this item. In consequence, the subject is assigned rule 0.

Pattern 2: The first item is predicted correctly, the second item incorrectly. Again, all subjects that use a rule should predict the second item correctly; the subject is assigned rule 0.

Pattern 3: The first two items are predicted correctly. For the third item "left" is predicted, whereas "right" would be the correct prediction. No subjects that use a rule can make this prediction, therefore the subject is assigned rule 0.

Pattern 4: The first two items are predicted correctly and for the third item "balance" is predicted. Rule 1 users should predict this, whereas rule 2, rule 3, and rule 4 users should predict "right" (correct). Therefore, the subject is assigned rule 1.

Pattern 5: The first three items are predicted correctly. In that case the subject may be a rule 2, 3, or 4 user. The fourth item is predicted incorrectly. Rule 2 and rule 4 users should predict this item correctly, therefore the subject is assigned rule 3.

Pattern 6: The first four items are predicted correctly, but for the fourth "left" is predicted, whereas "right" would be the correct prediction. The subject is assigned rule 2. N.B.: More correct items lead to a lower rule than in pattern (5).

Pattern 7: The first four items are predicted correctly, but for the fifth "balance" is predicted. A rule 2 user would predict "left" (incorrect), a rule 4 user would predict "right" (correct), therefore the subject is assigned rule 3.

Pattern 8: The first 5 items are predicted correctly, the sixth incorrectly. The subject is assigned rule 3.

Pattern 9: All items are predicted correctly. The subject is assigned rule 4.

The small number of items entails the danger that by chance a wrong classification may occur for those subjects who do not use a rule or those who use rule 3. Siegler's model does not predict statements of subjects who do not use a rule (rule 0) nor can it predict what rule 3 users will predict for the conflict items. The probability that someone who does not use a rule is, by chance, classified as a rule-user is for rule 1: 1/27; for rule 2: 1/243; for rule 3: 23/729; for rule 4: 1/729. The probability that someone is, by chance, classified as a user of any of the four rules is 2/27. The probability that a rule 3 user is by chance scored as a rule 4 user is 1/27. Thus, the overall probability that a subject is incorrectly classified is small.

The items were selected so that math ability would not interfere with understanding the balance scale task. Care was taken that the product of weight and distance (the torque) on either side never exceeded 10. In fact, the average torque is less than 5. Even when using such small numbers, we were able to construct enough items for each type. It is to be expected that not even the younger subjects will experience math problems.

Results. The question was: Does Siegler's rule model fit when the procedure is changed, i.e., feedback is supplied? In Siegler's experiments (cf. Siegler, 1976, p. 495) about 10% of the subjects could not be classified as using a rule. The results of our alternative procedure shows that out of 104 subjects, 7 subjects could not be classified as using one of the four rules (rule 0). The complete results are shown in Table 2.

Table 2

Results

Grade	Rules					Mean	s.d.
(N)	0	1	2	3	4		
1 (19)	3	10	3	3	0	1.32	.92
2 (22)	1	6	10	4	1	1.91	.90
3 (21)	2	7	5	5	2	1.90	1.15
4 (21)	1	6	10	3	1	1.71	1.76
5 (21)	0	3	9	6	3	2.43	.90
1-5 (104)	7	32	37	21	7	1.89	1.02

Problems of Validity and Reliability

The alternative method has some advantages over the method Siegler used. With this alternative method, however, it is still not possible to gain insight into the thought-processes of the subjects which play a part in the development of rule use. How do subjects change from one level to another? And what about the difference between two levels?

Within a rule, there are psychological issues on which the method gives no information. What problem-solving strategies are used? We noted that there are differences in the way rule 4 users solve an item. One student, for example, calculates the item 1100-0300 as 1x4+1x3=7; 3x2=6, therefore the left side goes down. Most students however, do not multiply, but reason as follows: 4+3=7; 2+2+2=6, therefore the left side goes down. The results are the same, but the way in which these results are reached is different.

Moreover, items considered to be of one type can address different aspects of a student's thinking. To illustrate, consider examples of "conflict-balance" (items are 0003-0010, 0011-0010, and 0022-0020). The first item can be solved by multiplication, the second by addition, the third needs both addition and multiplication. There are students who can solve the first item where only one position on each arm is occupied, but cannot solve the other two items. Apparently, when the number of occupied positions changes, the problem changes.

Subjects will not always solve the items by Siegler's rules, even when the results (i.e., the error patterns) correspond with the rule model. For example, several subjects see immediately that "1211-2211" (conflict-balance) allows "1111-1111" to be subtracted, leaving "0100-1100."

Differences in thought-processes may arise from differences in problem-solving strategies. Where the younger students restrict themselves to regularities in the behavior of the balance scale, older students might try to understand why the scale behaves the way it does and reflect on their own problem-solving processes. Then they might notice more aspects, from which it may well be harder to draw regularities.

Conclusion

The alternative procedure for measuring rule-use has some advantages over the procedure originally used by Siegler. The advantages correspond with two procedural aspects: feedback and orientation. Some of the difficulties Martin (1985) and Tudge (1985) experienced might have been prevented, had they used the alternative method presented in this article. Tudge especially had difficulties assigning rules using Siegler's method. He needed finer degrees of differentiation and a method to distinguish between stable and transitional rules. The transitional rules were characterized by the fact that a certain amount of guesswork is involved. There is a possibility that Tudge would not have had to use transitional rules when feedback was provided.

References

Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence*. Basic Books.

Kalmykova, Z. I. (1981). *Produktivnoe myslenie kak osnova obucaemosti*. Pedagogika: Moscow.

Martin, L. M. W. (1985). The role of social interaction in children's problem-solving. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 7*(2), pp. 40-46.

Siegler, R. S. (1976). Three aspects of cognitive development. *Cognitive Psychology, 8*, pp. 481-520.

Siegler, R. S. (1981). Developmental sequences within and between concepts. With commentary by S. Straus, S. Levin; with reply by the author. *Monographs of the Society for Research in Child Development, 46*(2), Serial no. 189.

Tudge, J. (1985). The effect of social interaction on cognitive development: How creative is conflict? *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition*, *7*(2), pp. 35-40.

Wilkening, F., & Anderson, N. H. (1982). Compassion of two rule assessment methodologies for studying cognitive development and knowledge structure. *Psychological Bulletin*, *92*, pp. 215-237.

Everyday Biology and School Biology: How Do They Interact?

Giyoo Hatano
Dokkyo University

Kayoko Inagaki
Chiba University

In this paper we will discuss how young children's "everyday biology," acquired primarily through contact with animals and plants in daily life, and school biology, systematically taught in school, interact to result in lay biology that ordinary adults have. First, we will demonstrate that young children, before being taught in school, can often accurately attribute anatomical/physiological and mental properties to animals and plants and predict animate objects' reactions to novel situations. Their "biological" inferences seem to rely on transferring knowledge about human beings but checking it against specific knowledge about the target object. We will then specify in what sense we claim that their body of knowledge constitutes a biology. Next, we will show limitations of this everyday biology. Though it is generally adaptive, it may lead children to generate some overattribution (personifying) errors, (i.e., they transfer knowledge about human beings too far) as well as underattribution errors.

Older children and adults have learned school biology. We define it as a body of knowledge in school curricula and textbooks, summarized and edited from research findings in scientific biology. Attributions and predictions about an animal or plant in school biology should be based on knowledge about category membership of the target animate object and knowledge about that category. Hierarchically organized knowledge about biological categories (e.g., vertebrates, mammals, primates, chimpanzees) is expected to enable mature students of school biology to control precisely the attribution of a variety of animate characteristics.

How do these two biologies, everyday and school biologies, interact? Is everyday biology totally replaced by school biology or does it still play a role when adults talk about biology? Our developmental data suggest that the shift from everyday to lay adult biology is continuous and incomplete: As children grow older, their biological inferences become more and more constrained by higher order categorical knowledge, but do not reach the pure category-based inferences dictated by school biology.

Young Children's Personifying "Biology"

Since Piaget's assertion (1929), many people have believed that young children are animistic and personifying. Animistic means labeling inanimate objects "living," attributing characteristics of animate objects (typically humans) to inanimate objects, and making predictions or explanations about inanimate objects based on knowledge about animate objects, again usually represented by human beings. Personification means the extension of human attributes to any non-humans. Thus, animistic reasoning can be regarded as personification of an inanimate object.

Animistic and personifying tendencies have been taken as signs of immaturity, reflecting the fact that young children have not yet differentiated between animate and inanimate objects (Piaget, 1929; Laurendeau & Pinard, 1962). However, a number of investigators have recently asserted that even young children have acquired the knowledge needed to differentiate between humans, typical non-human animate objects, and inanimate ones. In fact, Gelman, Spelke, and Meck (1983) found that even 3-year-olds almost always correctly attribute the presence or absence of animate properties, such as "have eyes" or "walk," to a person, cat, doll, and stone.

This assertion sounds reasonable, not only because it is supported by the data, but also because it is harmonious with our zeitgeist: Young children are so competent that they can understand basic concepts and use effective procedures before schooling (e.g., Gelman, 1979) and people tend to excel at a task they practice a lot in daily life situations without schooling (e.g., Scribner & Cole, 1981). Young children have certainly learned considerably from their direct experience of raising animals and plants as well as from their indirect but relevant experience with reading, picture books, and television programs.

However, even assuming that young children have acquired a fairly rich knowledge about animate objects, two questions remain to be answered. First, how can they infer an animate object's unobservable attributes or its reactions to situations that they have not yet observed, without more or less formal categorical knowledge in biology? It is very unlikely that they have learned specific details of each animate object, since even adults have not. Second, why do young children make personifying and animistic remarks fairly often, even if they do so not as often as Piaget claimed? Gelman, Spelke, and Meck (1983) assert that young children are seldom animistic in thinking, unless they are induced to answer in the "play mode." Although this play-mode explanation may be true for animistic responses which are induced in a dialogue with an adult in less naturalistic situations, it must still be a partial answer, because observant early educators have reported that young children make spontaneous animistic or personifying responses quite seriously in daily life. For instance, after accumulated experience with cultivating flowers, a 5-year-old girl stated, "Flowers are like people. If flowers eat nothing, they will fall down of hunger. If they eat too much, they will be taken ill." (Motoyoshi, 1979). Here the girl mapped the relationship between humans and food to that between flowers and water, quite seriously.

In order to answer these two questions we would like to propose that, though young children have acquired enough knowledge to enable them to differentiate fairly well between humans, typical non-human animate objects, and inanimate objects, they apply their knowledge about human beings to other animate objects or even to inanimate objects when they have to infer an object's unknown attributes or reactions. This is probably because they do not have rich categorical knowledge in biology and, thus, have to rely on analogy in inferences. Since they are intimately familiar with humans while necessarily novices in most other domains (Carey, 1985), they can most profitably use their knowledge about humans as the "base domain" for making analogies. Their personification (in other words, person analogy) may lead them to accurate predictions for animate objects phylogenetically similar to humans. It can also provide justification for a variety of experiences, sometimes even with phylogenetically less similar objects like flowers, as in the example cited in the preceding paragraph. Young children may have learned these heuristic values to some extent through their prior contacts with a variety of animate objects.

The analogies young children make may involve structurally inaccurate mapping and induce biased reasoning: When the relation between humans and food is mapped into that between flowers and water, the role of fertilizers or nutriments in the soil in the flowers' life and growth is neglected. Children may carry analogy beyond its proper limits and produce false inferences, as revealed in typical examples of so-called animistic reasoning. However, we would assume that even young children can generate an "educated guess" by using personification as analogy in a constrained way. Animistic errors and/or overattribution of human characteristics to non-human animate objects should be regarded as negative by-products unluckily produced by this process of reasoning which is basically adaptive in nature. It must be very hard to judge accurately how far each specific human attribute can be extended.

What constraints do children impose on their personification as analogy? First, we would expect *differential application*, i.e., the closer the target object biologically to a human being, the more often will the child will recognize similarity and, thus, apply personification. Even young children can recognize an animate object's similarity to humans in terms of its phylogenetic affinity (Inagaki & Sugiyama, in press). This differential application of personification tends to reduce both erroneous over- and underattributions, to the extent that children's criteria of judging similarity correspond to those of adults or biologists. Although analogy itself does not presuppose similarity in objects or attributes between the target and base domains, heuristic values of analogy will be greater when the two sets of elements are similar than when they are not, at least where the analogy does not hold perfectly, as in the biological world.

The second constraint which operates after the children have tried personification is *factual check*. Even young children know some specific, observable facts about various objects and, thus, they may be able to use this knowledge to check the plausibility of the prediction reached by personification. For example, we would expect that if personification leads them to predict that a tree runs to avoid damage, they should reject this prediction on the basis of their knowledge of trees. This constraint tends to make personification as analogy more and more accurate, as children accumulate specific pieces of biological knowledge.

Young Children Use Person Analogy in a Constrained Way

We (Inagaki and Hatano, 1987) investigated whether children as young as 5-6 years of age could make educated guesses by using constrained personification. More specifically, in Experiment 1, we studied whether young children would often use the person analogy when it was appropriate and, in Experiment 2, whether they would refrain from using it, when inappropriate, in the light of their specific knowledge about the target objects.

In the first experiment, 80 children of 5-6 years of age were asked to predict and explain a rabbit's, tulip's, or stone's reactions to novel situations concerning four biological phenomena: no water intake, too much water, inevitable growth, and spontaneous recovery. Example questions were as follows: "What will happen with X if we give it glass after glass of water day and night?" (Too much water); "Suppose someone is given a baby X and wants to keep it forever in the same size, because it's so small and cute. Can he or she do that?" (Inevitable growth). The same set of questions were asked about a human.

Children's answers were coded in terms of the reasonableness of the prediction. All types of predictions that more than a quarter of the "control" college students also made were considered reasonable. Therefore, reasonable in this study meant adult-like. For a tulip in the "too much water" situation, for example, children's predictions implying some damage (e.g., die or any other ill health) were classified as reasonable, whereas those suggesting no damage or a beneficial effect, like "Giving it glass after glass of water will make the flower bigger and bigger, prettier and prettier," were classified as unreasonable.

Responses to the question for the target (a rabbit, tulip, or stone) were also scored in terms of whether they were personifying responses. Two types of such responses were identified: *explicit personification*, which was operationally defined as a child's describing the reaction in person-relevant terms that are almost never used by adults for the target object (e.g., "thirsty" for the tulip, "birthday" for the rabbit or tulip) or justifying his or her prediction by referring to a person ("just as a human does"); and *implicit personification*, which was scored when the child's prediction and explanation for the target were essentially the same as those for a person (e.g., [for a person] "No, we cannot keep the baby in the same size forever, because he takes food. If he eats, he will become bigger and bigger and be an adult; [for a tulip] "No we can't. Because if we don't water it, it will wither, but if we water it, it will become bigger and bigger"). These personifying responses were supposed to reflect the use of the person analogy, i.e., stating what a person is likely to do (or what is likely to happen to a person) in the situation and replacing a person with the target object with some minor adjustment in expressions.

About two-thirds of the children at least once gave explicit or implicit personification in replying to these four questions for a rabbit or tulip, though they did not give personification for a stone. For example, one of the children answered to the inevitable growth question, "No, we cannot keep it [the baby rabbit] forever in the same size. Because, like me, if I were a rabbit, I would be 5 years old and become bigger and bigger." In addition, these personifications tended to be associated with reasonable predictions. In the "too much water" situation, for example, a majority of the children relying on personification predicted that the tulip would wither or die, while the children not using personification answered that it would grow bigger and bigger by giving glass after glass of water day and night.

The second experiment was conducted in order to confirm that children would not transfer knowledge about human beings to any object or situation indiscriminately, but checked the plausibility of the prediction inferred through personification by using specific knowledge about the target object. Other novel situations, where a rabbit or tulip responded quite differently from a person, that is, where the person analogy was misleading, were presented. Very few of the children relied on personification to generate unreasonable predictions in these cases. Let us give an example: "Suppose a woman buys a rabbit (or a potted tulip). On her way home she drops in at a store with this caged rabbit. After shopping she is about to leave the store without the rabbit. Then, what will the rabbit do?" In this situation none of the children used personification for a tulip. A very small number of children used it with the rabbit's actions which were almost within the animal's behavioral repertoire such as a rabbit's struggling in a cage to signal that it is being left behind. The children seemed to refrain from relying on personification by using specific knowledge about the target object, such as "A flower doesn't walk," or "A rabbit doesn't speak." A majority of them aptly predicted the target's reactions in these situations.

Thus it is suggested that young children can and often do use constrained personification as a means to generate an educated guess. Through daily life experience and before being taught in school, young children may have formed a kind of "theory" or system of inferences which can produce fairly consistent and plausible predictions. Carey (1985) also suggests that young children possess a sort of "theory," or "naive psychology" in her terminology, to generate consistent attributions of animate properties or inferences about bodily functions; children decide whether the target objects have certain properties, such as bones or breathing, by inductively projecting from the knowledge that human beings have them.

Biology or Behavioristics?

Can we assert, from the data by Carey (1985) and Inagaki and Hatano (1987), that young children have a form of biology? We think "Yes," while Carey (1985) believes "No." How are these contrasting answers generated? Both studies reveal (1) that, consistent with the findings of Gelman, Spelke, and Meck (1983), even young children have acquired the knowledge needed to differentiate between typical animate and inanimate objects and (2) that they apply their knowledge about human beings to other animate objects in a constrained way to make attributions or behavioral predictions. The major difference between our viewpoint and Carey's lies in the appraisal of children's causation and in the definition of biology.

Carey (1985) claims that young children make predictions and explanations based on their intuitive psychology, i.e., on intentional causality. Applying mechanistic causality to the workings of the body becomes possible only around age 10. In other words, younger children do not accept that our bodily functions are independent of our intention to operate the body machine and are executed without intention of the responsible organs. They do not admit either the inevitability of growth or death for any living thing, because they lack the knowledge that biological processes which produce them are autonomous.

Carey (1985) also claims that young children do not have biology because they are "totally ignorant of the physiological mechanisms involved" (p. 45). They know that input (e.g., eating too much) is related to output (becoming fat or upsetting the stomach), but nothing about what mediates them.

On the first issue of causality, we think our data suggest that at least 6-year-olds have a notion of non-intentional, though non-mechanical, causality which might be called "vitalistic causality." As to the second issue, that of young children's ignorance of physiological mechanisms, we do not disagree with Carey. However, we believe, this does not imply that they do not have any form of biology.

Let us discuss the second issue first: What do we have in our mind as a prototype of biology? In order to find an answer we will look at the history of endogenous biology. The modern Western science of biology is fairly new; it has a history of a few hundred years at the longest. However, this does not mean that non-Western people or Western people before the origin of modern biology did not have shared conceptual knowledge explaining a variety of biological phenomena, which might properly be called endogenous biology in those cultures and at those times.

In Japan, for example, endogenous science before the Meiji restoration (and the beginning of her rapid modernization), which had evolved with medicine and agriculture as its core, included a lot of biological knowledge. It was not mechanistic and atomistic, but vitalistic and holistic. In that science the human body was considered to be the prototype of other living things and also of nature as a whole. Shoyeki Ando, one of the distinguished scholars in that tradition, claimed, "the human body is a micro-cosmos, as the cosmos is a macro-human" (Yasunaga, 1976). Medicine and agriculture were considered to be alike, because both of them tried to enhance organisms' healthy vital force (*ki* in Japanese) to overcome unhealthy forces. Bodily functions were interpreted in terms of vitalism. For example, the stomach digests in order to send the vital force absorbed from food to other body parts.

We think that this science is close to the prototype of endogenous biology. It should be noted that this was a science, not a technology, because it involved more than procedural knowledge, i.e., more than an empirical collection of input-output relations and the "how to" based on them. It had some explanations that were understood in common by people who were involved and that were used in dealing with novel situations. Those explanations were based on the vitalistic causality, i.e., "X influences Y through giving vital force." Though it is clearly different from the mechanistic causality of our modern physics, it is not identical to intentional causality. According to this endogenous biology, the workings of the human body as well as of all nature are governed, not by individual intentions, but by more or less autonomous laws of vital force.

The last argument is related to the first issue of young children's causality. As shown in the preceding section, 5 to 6-year-olds well recognize that growth is beyond our control or intention; a baby rabbit grows, not because it wants to, but because it takes food. Our recent interviews with kindergarten children revealed that almost all of them knew that we cannot "direct" our stomach to digest quickly when plenty of delicious food is served or we cannot resist drowsiness even when an attractive television program is on. In other words, they understood that something inside the body is not fully subject to the intention of our mind. Did they attribute the working of an organ to its intention? They seldom did. Usually they did not ascribe consciousness to the stomach. "Energy or nutrition comes out when food enters the stomach," one of the subjects asserted.

In conclusion, we fully agree with Carey that young children do not possess the modern science of biology, but we would like to claim that they have another form of biology, which is differentiated from psychology. They seemed to rely on non-intentional causality, probably a version of vitalistic causality.

However, it is true that, in our contemporary society, there are limitations of this everyday biology of young children and of people who have not been influenced by modern Western science. One is, as Carey (1985) aptly pointed out, the lack of explanations in terms of physiological mechanisms for an organism's material exchange with the environment (e.g., nutrition, respiration), circulation of materials within its body, its growth and death, etc. The children seldom seek exact explanations for what is going on within the body of a living organism. Another is the lack of a coherent perspective, based on which animate objects are grouped meaningfully so that deductive attribution of properties from higher order categories is controlled systematically. In other words, they have a kind of natural history but their classification tends to be based on the appearance of objects. Young children's personifying biology must suffer from these limitations, which will be discussed in the next section.

When is the Person Analogy Misleading?

Though the use of constrained personification is adaptive in nature, it is not always advantageous. There can be situations where the target in fact reacts differently from humans, but the prediction reached by relying on personification does not seem implausible to children. For example, personifying predictions like "A tulip will feel pain from the prick of a needle" will probably be compatible with their knowledge about the plant, because, as Johnson and Wellman (1982) suggested, young children think that an object can have cognition, feeling, or sensation without a brain, though biologists deny the presence of such a sensation among plants. Therefore, young children will erroneously accept such predictions generated by personification.

Thus our study (Inagaki & Hatano, 1986) was designed to better conceptualize the advantages and disadvantages of personification. Sixty kindergarten children were asked to predict and explain either a rabbit's, grasshopper's, or tulip's reactions to three types of novel situations, two of which were almost the same as those used in Inagaki and Hatano (1987) described above, that is, the "similar" situations where the reactions of the target were essentially similar to those of humans (e.g., inevitable growth) and the "dissimilar/contradictory" ones where a person could make observable, uniquely human reactions and, thus, the person analogy would lead to predictions contradicting children's specific knowledge about the target (e.g., left behind). The third type newly introduced in this study included situations where a person would reveal mental reactions while the target would not, but young children were expected to transfer analogically from a person to the target ("dissimilar/compatible" situations). An example question of the third type was, "Suppose a grasshopper is raised in a small cage. One day someone puts a large cage next to this small one. Then, does the grasshopper think something?" If the subject answers "Yes," ask, "What does it think?" Parallel questions about a human were also asked to the same children.

It was hypothesized that children would rely on personification fairly often in both the "similar" and "dissimilar/compatible" situations, because their predictions reached by personification would not contradict their specific knowledge about the target in the these situations; however, we hypothesized, they seldom would rely on personification in the "dissimilar/contradictory" situations. Futhermore, their personifying predictions would be reasonable more often than their nonpersonifying ones in the "similar" situations, whereas they would be unreasonable in the "dissimilar/compatible" situations.

Results supported our hypotheses. Although almost none of the children used personification in the "dissimilar/contradictory" situations, a majority of them relied on it in both the "similar" and the "dissimilar/compatible" situations. In addition, though their answers based on personification produced reasonable predictions more often than nonpersonifying ones did in the "similar" situations, using personification in the "dissimilar/compatible" situations led to unreasonable predictions. Out of the 20 children, 18 made either explicit or implicit personification in the two "dissimilar/compatible" situations for the grasshopper, 15 for the rabbit, and 18 for the tulip, respectively. About 98% of these predictions obtained through personification were unreasonable from the adults' perspective, while only 21% of the nonpersonifying answers were so. Examples of the children's answers that rely on personification follow: "The grasshopper also feels excited as a person does," "The grasshopper will think, 'I would like to enter the large cage' in the same way that a person would open a door of a small house and enter a large one," "The tulip wants to move to the large pot from this small one, because it can enjoy good scenery there."

This study confirmed that young children did use personification in a constrained way (i.e., with factual check) and that their constrained person analogy can be regarded as a form of plausible reasoning. However, it also revealed that there are situations where personification is misleading in the sense that it produces overextensions of human properties. Overextension occurred in situations dealing with mental phenomena, such as feeling or thinking.

Inference based on similarity to people in everyday biology is likely to produce underextension errors as well, especially for those animate objects which, though apparently dissimilar to people, are fairly close phylogenetically. We found that about 70% of the kindergarteners believed that a snake did not excrete. More than 90% of the children of ages 4 and 5 rejected breathing as an attribute of plants and 50% of the 4-year-olds did so even for a pigeon and grasshopper (Inagaki & Sugiyama, in press). We interpret this to mean that when the target animate object is judged not similar to a human, young children tend to answer "No" to an attribution question (e.g., Does it breathe?) without checking its other related property, for example, whether the target has the organ for that attribute (whether it has a lung or gill).

In order to eliminate such over- and underextension errors and make correct predictions and attributions for every object, it seems necessary to go beyond the limitations of everyday (i.e., "personifying") biology. If children have acquired the physiological knowledge that in order to feel pain an object must have a central nervous system with receptors, they will not accept a prediction that is based on its similarity to people, i.e., plants feel pain. If children have acquired the categorical knowledge that eating, excreting, and breathing are fundamental functions to sustain any animal's life, they will infer with confidence that a snake must excrete, even when they have not yet observed it excreting or even if it seems to have no openings to excrete from. However, the construction of such knowledge probably requires the learning of school biology.

Ideal Type of School Biology

What we mean here by school biology is a body of knowledge represented in school curricula and textbooks. It overlaps scientific biology being investigated by biologists in the field, but is not identical to it, because the former is edited for school children. Contrary to everyday biology, school biology consists of hierarchically organized knowledge.

What is taught to pupils as school biology? According to the course of study for elementary and secondary school children issued by the Japanese Ministry of Education, pupils are expected to learn through direct observation of living things found nearby that all living things have bodily systems and ways of living which have been adapted to their environments. Students are also taught about the human bodily system and such functions as digestion and respiration as mechanisms to sustain life.

These two major topics of school biology taught at Japanese elementary and junior high schools (i.e., explaining the correspondence between ways of living and body structures/functions from an evolutionary point of view with respect to a variety of animate objects and describing, at a physiological level, biological processes underlying the life of animate objects) are not covered by everyday biology. Though everyday biology may include a lot of piecemeal knowledge about ways of living and body structures/functions of animate objects, evolution or adaptation to the ecological niche is not readily grasped in it. Likewise, though the workings of some of our visceral organs (e.g., a heart, stomach, etc.) are perceivable and understandable in terms of vitalistic causality, the physiological parts that they play in a human body are not readily comprehensible in everyday biology.

Though school biology is represented in the course of study in its purest form, there are some live experts who have internalized it almost completely; they are the college students who major in biology at teacher training courses to become elementary or secondary school teachers. We found that these students could easily classify various animals into biological categories and make inferences about their properties, probably relying on their categorical knowledge.

Thus, as children learn school biology, they are expected not only to become able to attribute an animate object's characteristics and predict its reactions more accurately using these additional pieces of knowledge, but also to become systematic in using the categorical knowledge they have in order to make inferences. They may constrain more and more their inferences based on the target object's similarity to a human by using biological categories. They may come to attribute properties to the target animate object in a deductive manner by relying on higher order categories (e.g., "The grasshopper is an invertebrate, so it must have no bones"). Biological categorization (i.e., grouping animate objects in terms of structures and functions of their bodies) becomes more compelling when children have learned the physiological mechanisms which are carried on in the body parts and the evolutionary perspective emphasizing that phylogenetic affinity is reflected in bodily characteristics. To put it differently, students gradually acquire metacognitive knowledge about the usefulness of higher order categories through the learning of school biology. Let us discuss in the next section our major findings about changes in the children's biological inferencing as revealed in a cross-sectional developmental analysis.

Constraining Biological Inferences by Categorical Knowledge

Inagaki and Sugiyama (in press) examined systematically how attribution of properties changes developmentally from preschool to lay college students. They divided properties into anatomical/physiological (e.g., have bones or breathe) which are more or less directly taught in school biology and mental (e.g., feeling happy or feeling pain) which are not directly dealt with there. For the anatomical/physiological properties, they predicted, as Carey (1985) found, that attributional patterns would change from similarity-based to category-based with age. (Similarity-based means attributing an animate property to the target object according to its similarity to people; category-based means attributing by relying on higher order biological categories.) For mental properties, however, they predicted that even adults would still in part make similarity-based attribution. They also predicted that there would be an intermediate attributional pattern (using their terminology, constrained similarity-based attribution) in between the two contrasting patterns of attribution, between younger children and adults for anatomical/physiological properties and between older children and adults for mental properties.

Twenty subjects each from five age groups participated, that is, 4-year-olds, 5-year-olds, second graders, fourth graders, and college students. The college students had not had formal training in biology, botany, or zoology. Eight phylogenetically different objects (a person, rabbit, pigeon, fish, grasshopper, tulip, tree, and stone) were used as targets. These were perceived, in another sample, as different in similarity to people in the order given.

The subjects were individually asked questions about four anatomical/physiological, three mental, and three observable properties for each of the eight objects. Questions about three observable properties (e.g., having eyes) were included to confirm that no developmental differences in attributional accuracy were found concerning these properties. In fact, subjects in all age groups had almost equally accurate knowledge about them.

For each of the seven unobservable property questions proportions of "Yes" responses to the eight target objects were computed in each age group.

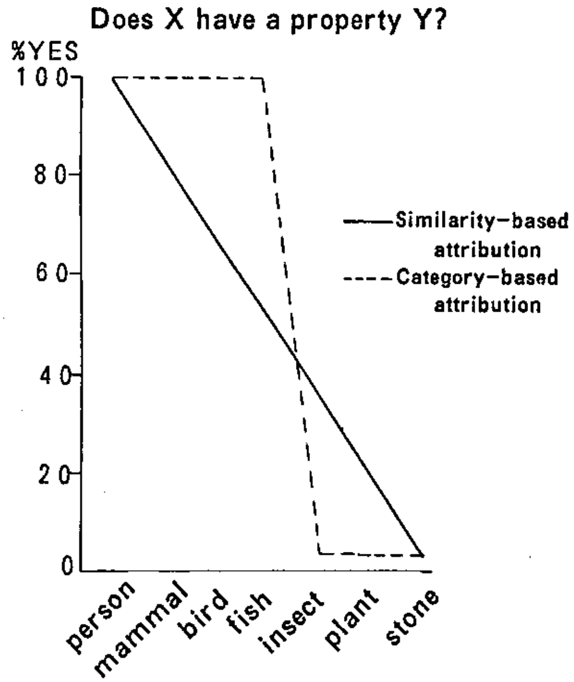


Figure 1: Attribution Patterns.

When these objects are arranged on a continuum according to their phylogenetic affinity to a person, a profile of the category-based attribution will be a pattern consisting of a big gap (decline) with two flat parts before and after it (the dotted line in Figure 1); a profile of the similarity-based attribution will be a gradually decreasing pattern from a person to a stone (the solid line in Figure 1). Thus, by examining whether there existed a big gap and whether the proportions of "Yes" responses for the two sets of objects located before and after the gap were "flat," the investigators could classify the attributional patterns of each age group for each property into category-based, similarity-based and intermediate (constrained similarity-based), using a set of operationally defined criteria.

For the anatomical/physiological properties there was a progression from the use of similarity-based attribution among 4-year-olds to that of category-based among adults, as expected. An intermediate pattern of attribution was observed: One among 4-year-olds and two among 5-year-olds, second graders, and fourth graders. For mental properties, subjects in all age groups mostly used similarity-based attribution. Adults and fourth graders showed one intermediate pattern each.

The above findings obtained through group data analyses were confirmed by another experiment using individual data analyses. In this experiment each of 20 5-year-olds and 20 college students was asked to attribute two anatomical/physiological properties and two mental properties to 25 animate objects, in addition to a person and a stone, five members of each belonging to the categories of mammals, birds, fish, insects, and plants. After the property questions, they were required to classify the above 25 objects into five categories. Only subjects who classified most of them correctly were included in the analyses. The results indicated that 5-year-olds relied on similarity-based attribution for both anatomical/physiological and mental properties, while adults made category-based attribution for the former properties but still in part relied on similarity-based attribution for the latter.

We have recently conducted a preliminary study to examine the developmental shift in biological inferencing by presenting pairs of animals, belonging to the same categories, but differing in similarity to people. Thirty-three second, 34 fourth, 41 sixth graders, and 26 college students participated in this study. They were asked about two anatomical/physiological, two mental, and two observable properties for each of the 10 animate objects. Of these 10, eight could be paired in terms of biological category: an elephant-a mouse (mammals), a penguin-a swallow (birds), a tortoise-a snake (reptiles) and a mantis-a dragonfly (insects). The remaining two, an octopus and a shellfish, were treated as fillers, because they were phylogenetically not very close, though both were mollusks. Based on the subjective similarity rating data from another group of 26 college students, the former of each pair was supposed to be more similar to people than the latter. After all property questions, subjects were required to find animals of "the same kind" among the 10 objects. Category-based attribution will generate an identical set of responses to both members of the pair, while similarity-based attribution may induce different attributions even within the pair, more specifically, more "Yes" responses to the more similar member of the pair.

The following three were the major findings:
1) Proportions of correctly finding these pairs increased as they became older (40.2, 47.8, 76.2, and 90.3%); 2) When they could find biologically correct pairs, their

attributional responses were mostly identical within the pairs at any age level, but within-pair inconsistency decreased further as they became older (9.4, 8.2, 7.3, and 6.1%);
3) When the responses differed within the pairs among subjects who recognized correct pairs, younger children gave significantly more "Yes" responses to the members more similar to people, while adults did not do so for anatomical/physiological properties. On the other hand, for mental properties subjects in any age group gave more "Yes" responses to the members more similar to people, though a statistical significance was found only among second graders.
The above results were interpreted as suggesting that though there is a shift from similarity-based toward category-based attribution, this shift is continuous and incomplete even in adults.

A reaction time experiment conducted in collaboration with H. Morita revealed that even college students relied on similarity to some extent not only for mental properties but also for anatomical/physiological ones in the situation where quick responding was required: 1) They made more "Yes" responses to the member of the pairs that was more similar to people than the other member; 2) Their "Yes" responses tended to be quicker, while their "No" responses tended to be slower, to the more similar member than the less similar one when their responses were identical within pairs.

What Does the School Provide?

The findings reviewed in the preceding section strongly suggest that, as children learn school biology, their ways of inferencing in fact change from similarity-based toward category-based. In other words, we attribute the observed developmental shift in biological inferences to the learning of school biology. More direct evidence for this attribution can be obtained by a number of research strategies.

As one of these strategies, a series of learning experiments examining how children's personifying biology interacts with school biology in instruction and how it is modified through instruction are in progress. We hope to find not only that school biology is learned meaningfully by being assimilated into the existing knowledge of everyday biology, but also, as claimed by Vygotsky (1962), that school biology reorganizes everyday biology by adding physiological mechanisms and the evolutionary perspective, so that the reorganized body of knowledge can effectively be used as the basis for answering a wider variety of biological questions.

References

Carey, S. (1985). *Conceptual change in childhood.* Cambridge, MA: MIT Press.

Gelman, R. (1979). Preschool thought. *American Psychologist, 34,* 900-905.

Gelman, R., Spelke, E., & Meck, E. (1983). What preschoolers know about animate and inanimate objects. In D. Rogers (Ed.), *The development of symbolic thought* (pp. 297-326). New York: Plenum.

Inagaki, K., & Hatano, G. (1987). Young children's spontaneous personification as analogy. *Child Development, 58,* 1013-1020.

Inagaki, K., & Hatano, G. (1986, October). *When does personification help and mislead?* Paper presented at 28th Annual Meeting of the Japanese Association of Educational Psychology, Fukuoka, Japan. (In Japanese).

Inagaki, K., & Sugiyama, K. (in press). Attributing human characteristics: Developmental changes in over- and underattribution. *Cognitive Development, 3.*

Johnson, C. N., & Wellman, H. M. (1982). Children's developing conceptions of the mind and brain. *Child Development, 53,* 222-234.

Laurendeau, M., & Pinard, A. (1962). *Causal thinking in the child.* New York: International Universities Press.

Motoyoshi, M. (1979). *Watashino Seikatuhoikuron* [Essays on education for day care children: Emphasizing daily life activities]. Tokyo: Froebel-kan. (In Japanese).

Piaget, J. (1929). *The child's conception of the world.* London: Routledge & Kegan Paul.

Scribner, S., & Cole, M. (1981). *The psychology of literacy.* Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1962). *Thought and language.* (E. Hanfmann & G. Vakar, Trans.) Cambridge, MA: MIT Press.

Yasunaga, T. (1976). *Ando Shoyeki.* Tokyo: Heibon-sha. (In Japanese).

Editors' Note

In the October issue of each volume, we have a cumulative index feature. It has gotten too long. So, we have a "quasi-cumulative index" in its place. From now on we will cover only five years back. So, this year's index starts with 1982.

The early years were good ones, though. If you want a copy of the last full cumulative index as it was published last October (including even the early days of ICHD), send a stamped self-addressed large envelope and your request to our usual mailing address.

CUMULATIVE INDEXES

ARTICLES PUBLISHED IN THE *LCHC NEWSLETTER* FROM JANUARY 1982 THROUGH OCTOBER 1987

(Code: Author/Date/Title/Issue and Pages)

(Back issues of the *LCHC Newsletter* are available for $5.00 an issue or $20.00 per volume. Send orders to: *LCHC Newsletter*, The Laboratory of Comparative Human Cognition, X-003, University of California, San Diego, La Jolla, CA 92093.)

Goody, Esther. (1987, April). Why must might be right? Observations on sexual herrschaft, *9*(2), 55-76.

Griffin, Peg, & Mehan, Hugh. (1983, January). Introduction to this issue, *5*(1), 1-2.

Grossen, Michele, & Perret-Clermont, Ann-Neely. (1984, July). Some elements of a social psychology of operational development of the child, *6*(3), 51-57.

Hatano, Giyoo. (1982, January). Cognitive consequences of practice in culture specific procedural skills, *4*(1), 15-18.

Hatano, Giyoo, & Inagaki, Kayoko. (1987, October). Everyday biology and school biology: How do they interact?, *9*(4), 120-128.

Hatano, Giyoo, & Newman, Denis. (1985, July). Reply and response, *7*(3), 95-99.

Heap, James L. (1986, July). Achieving displays of computer literacy: Unfolding Cunningham and Paris' findings, *8*(3), 105-108.

Hedegaard, Mariane. (1986, April). Two approaches to thinking and knowledge acquisition, *8*(2), 58-63.

Hoffman, Sandra Josephs. (1985, July). Play and the acquisition of literacy, *7*(3), 89-95.

Holquist, Michael. (1983, January). The politics of representation, *5*(1), 2-9.

Humphries, Tom. (1986, April). Planning and evaluating culturally sensitive post-secondary educational programs for deaf people, *8*(2), 71-75.

Hutchins, Edwin. (1983, January). Myth and experience in the Trobriand Islands, *5*(1), 18-25.

Hutchins, Edwin. (1986, April). Mediation and automatization, *8*(2), 47-58.

Hutson, Barbara, & Thompson, Diane. (1985, April). Moving language around on the word processor: Cognitive operations upon language, *7*(2), 57-64.

Inagaki, Kayoko, & Hatano, Giyoo. (1983, January). Collective scientific discovery by young children, *5*(1), 13-18.

Jardine, David W., & Morgan, Griffith, A.V. (1987, October). Analogical thinking in young children and the use of logico-mathematical knowledge as a paradigm in Jean Piaget's genetic epistemology, *9*(4), 95-101.

Jensen, Minna Skafte. (1986, January). Types and versions in ballad tradition: The oral poet's use of the potentialities of variation, *8*(1), 18-23.

John-Steiner, Vera. (1984, July). Learning styles among Pueblo children, *6*(3), 57-62.

Kelly-Byrne, Diana, & Sutton-Smith, Brian. (1983, October). Narrative as social science: A case study, *5*(4), 79-83.

Klingler, Cynthia. (1986, October). The self-regulatory speech of children in an additive bilingual situation, *8*(4), 125-131.

Koivukari, Mirjami. (1984, July). Rote or comprehension: Does a teacher get what s/he wants? *6*(3), 67-70.

Laboratory of Comparative Human Cognition. (1982, April). Microcomputer communication networks in education, *4*(2), 32-34.

Laboratory of Comparative Human Cognition. (1982, July). A model system for the study of learning difficulties, *4*(3), 39-66 (Special Issue).

Laboratory of Comparative Human Cognition. (1983, October). Paradigms and prejudice, *5*(4), 87-92.

Lancy, David F., Cohen, Herb, Evans, Barbara, Levine, Nancy, & Nevin, Mary Lou. (1985, October). Using the joystick as a tool to promote intellectual growth and social interaction, *7*(4), 119-125.

Larsen, Mogens Trolle. (1986, January). Writing on clay: From pictograph to alphabet, *8*(1), 3-9.

Levin, James A. (1982, April). Microcomputers as interactive communication media: An interactive text interpreter, *4*(2), 34-36.

Levin, James A., & Souviney, Randall. (1983, July). Introduction to this issue, *5*(3), 45-46.

Levy, Elena. (1987, July). A Vygotskian perspective on discourse: From complex to concept, *9*(3), 100-105.

Lucy, John A. (1985, October). The historical relativity of the linguistic relativity hypothesis, *7*(4), 103-108.

Martin, Laura M. W. (1985, April). The role of social interaction in children's problem solving, *7*(2), 40-45.

McDermott, R. P. (1985, January). Wisdom from the periphery: Talk, thought and politics in the ethnographic theater of John Millington Synge, *7*(1), 1-6.

McLane, Joan B., & Wertsch, James V. (1986, July). Child-child and adult-child interaction: A Vygotskian study of dyadic problem systems, 8*(3), 98-105*.

McNamee, Gillian Dowley, & Harris-Schmidt, Gail. (1985, January). Narration and dramatization as a basis for remediation of language disorders, *7*(1), 6-15.

Michaels, Sarah. (1983, April). Influence on children's narratives, *5*(2), 30-34.

Michaels, Sarah. (1985, July). Classroom processes and the learning of text editing commands, *7*(3), 70-79.

Middleton, David. (1987, January). Some issues and approaches, *9*(1), 2-5.

Middleton, David. (1987, January). Dance to the music: Conversational remembering and joint activity in learning an English Morris dance, *9*(1), 23-38.

Minick, Norris. (1986, October). The early history of the Vygotskian school: The relationship between mind and activity, *8*(4), 119-125

Moll, Luis C. (1984, July). Editor's note. *6*(3), 51.

Moll, Luis C. (1984, October). Editor's note. *6*(4), 75.

Mordkowitz, Elliott R., & Ginsburg, Herbert P. (1987, April). Early academic socialization of successful Asian-American college students, *9*(2), 85-90.

Nelson, Katherine. (1987, July). Discussion, *9*(3), 116-117.

Newman, Denis. (1982, April). Perspective-taking versus content in understanding lies, *4*(2), 26-29.

Newman, Denis. (1985, April). Functional environments for microcomputers in education, *7*(2), 51-57.

Olson, David R. (1982, October). Consequences of schooling, *4*(4), 75-78.

Padden, Carol, & Markowicz, Harry. (1982, October). Learning to be deaf: Conflicts between hearing and deaf cultures, *4*(4), 67-72.

Punamäki, Raija-Leena. (1987, April). Psychological stress responses of Palestinian mothers and their children in conditions of military occupation and political violence, *9*(2), 76-84.

Riel, Margaret. (1983, July). Education and ecstasy: Computer chronicles of students writing together, *5*(3), 59-67.

Rosa, Alberto, Ochaita, Esperanza, Moreno, Enrique, Fernandez, Emilio, Carretero, Mario, & Pozo, Juan I. (1984, October). Cognitive development in blind children: A challenge to Piagetian theory, *6*(4), 75-81.

Roter, Armonit. (1987, July). The concept of consciousness: Vygotsky's contribution, *9*(3), 105-111.

Schneider, Phyllis, Hyland, John, & Gallimore, Ronald. (1985, October). The zone of proximal development in eighth grade social studies, *7*(4), 113-119.

Schousboe, Karen. (1986, January). Panis et circensen - Orality and visuality in medieval Denmark, *8*(1), 10-17.

Schudson, Michael. (1987, January). Preservation of the past in mental life, *9*(1), 5-11.

Scollon, Ron. (1983, July). Computer conferencing: A medium for appropriate time, *5*(3), 67-68.

Scribner, Sylvia. (1984, January/April). Introduction to this issue, *6*(1 & 2), 1-4.

Scribner, Sylvia. (1984, January/April). Cognitive aspects of work, *6*(1 & 2), 4-5.

Scribner, Sylvia. (1984, January/April). Cognitive studies of work, *6*(1 & 2), 1-50 (Special Issue).

Scribner, Sylvia. (1984, January/April). Practical problem-solving on the job, *6*(1 & 2), 5-6.

Scribner, Sylvia. (1984, January/April). Product assembly: Optimizing strategies and their acquisition, *6*(1 & 2), 11-19.

Scribner, Sylvia. (1984, January/April). Pricing delivery tickets: "School arithmetic" in a practical setting, *6*(1 & 2), 19-25.

Scribner, Sylvia. (1984, January/April). Organizing knowledge at work, *6*(1 & 2), 26-32.

Scribner, Sylvia. (1984, January/April). Technical note: Frequency effect in retrieval of job-related knowledge, *6*(1 & 2), 34-37.

Scribner, Sylvia. (1984, January/April). Toward a model of practical thinking at work, *6*(1 & 2), 37-42.

Scribner, Sylvia, Gauvain, Mary, & Fahrmeier, Edward. (1984, January/April). Use of spatial knowledge in the organization of work, *6*(1 & 2), 32-34.

Scribner, Sylvia. (1987, July). On reading Vygotsky, *9*(3), 94-96.

Shotter, John. (1987, January). Remembering and forgetting as social institutions, *9*(1), 11-19.

Speidel, Gisela E., Gallimore, Ronald, & Kobayashi, Linda. (1983, April). Facilitating transfer of learning: The influence of environmental setting, *5*(2), 40-43.

Stigler, James W., Barclay, Craig, & Aiello, Patrick. (1982, January). Motor and mental abacus skill: A preliminary look at an expert, *4*(1), 12-14.

Sugarman, Susan. (1983, April). The development of inductive strategy in children's early thought and language, *5*(2), 34-40.

Tudge, Jonathan. (1985, April). The effect of social interaction on cognitive development: How creative is conflict?, *7*(2), 33-40.

Ure, M. Celia Dibar, & Colinvaux, Dominique. (1985, January). New results on the reasoning of unschooled adults, *7*(1), 27-29.

Van der Veer, Rene. (1985, October). The cultural-historical approach in psychology: A research program?, *7*(4), 108-113.

Vaughn, Billy. (1985, October). Computer networks and education, *7*(4), 131.

Waller, Marguerite. (1987, January). Commemoration: Making family history as a family event, *9*(1), 48-50.

Wertsch, James V. (1987, January). Collective memory: Issues from a sociohistorical perspective, *9*(1), 19-22.

White, Sheila J. (1987, July). Lost for words: A Vygotskian perspective on the developing use of words by hearing-impaired children, *9*(3), 111-115.

Wolters, Miriam, Fischer, Coen, & Zuidema, Johan. (1987, October). Balanced measurement of cognitive development. A discussion on methodological problems with the balance scale, *9*(4), 114-120.

Zinsser, Caroline. (1985, July). For the Bible tells me so: Teaching children in a fundamentalist church, *7*(3), 86-89.

Zukow, Patricia G. (1984, July). Folk theories of comprehension and caregiver practices in a rural-born population in central Mexico, *6*(3), 62-67.

ANNOTATED BIBLIOGRAPHIES PUBLISHED IN THE *ICHD* AND *LCHC NEWSLETTERS* FROM JANUARY 1982 THROUGH OCTOBER 1987

(Code: Author/Review Date/Title/Reviewer/Issue and Pages)

ARTICLES PUBLISHED IN THE WORK-IN-PROGRESS SECTION OF THE *LCHC NEWSLETTERS* FROM JANUARY 1984 THROUGH OCTOBER 1987

(Code: Author/Date/Title/Issue and Pages)