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EMERGING MINDS

*The Process of Change
in Children's Thinking*

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Whose Children Are We Talking About?

My children have never looked much like those described in most theories of cognitive development. I don't mean that they are generally deviant or that they perform abnormally on conservation or class inclusion tasks. They generally seem more or less normal, and on the few occasions when I have presented tasks from the cognitive developmental literature, they have acted pretty much like the children described in the articles.

Where my children are altogether different from the theoretical descriptions is in the variability of their thinking. Cognitive developmental theories generally depict age and thought as proceeding in a 1:1 relation. At an early age, children think in one way; at a later age, they think in another way; at a still later age, they think in a third way. Such descriptions are so pervasive that they begin to feel like reality. Young children are said to form thematic concepts; somewhat older ones to form chain concepts; yet older ones to form true concepts. The reasoning of young children is said to be preoperational; that of somewhat older ones concrete operational; that of yet older ones formal operational. Young children are said to have one theory of mind; somewhat older ones a different, more inclusive theory; yet older ones a more advanced theory still.

The story is the same with characterizations of performance on specific tasks. In descriptions of the development of the concept of living things, 3- and 4-year-olds are said to think that anything that moves is alive, 5- to 8-year-olds that animals—and only animals—are alive, and older children that plants as well as animals are alive. In descriptions of the development of addition skill, kindergartners are said to count from one; first through third graders to count from the larger addend; fourth graders and older children to retrieve answers from memory. In descriptions of the development of serial recall strategies, 5-year-olds are said not to rehearse; 8-year-olds to rehearse in a simple way; 11-year-olds to rehearse in a more elaborate way.

My children's thinking has never looked as neat and clean as these 1:1 characterizations of the relation between age and thought. Each child seems to have diverse ways of thinking about almost everything. As a 4-year-old, my older son explicitly asked whether plants were alive; when I wondered why he asked, he told me that they grew but they didn't move. When she started to add, my daughter would sometimes retrieve an answer from memory and 5 minutes later count

fingers to solve the same problem. When he started calling friends on the phone, my younger son would, after looking up a phone number, sometimes write the number on a piece of paper, other times rehearse it aloud, and other times just try to remember it.

My children's concepts, theories, and reasoning also vary widely. Listening to them talk at the dinner table reveals a remarkable range of ideas, ranging from insightful to incoherent. The same child will first make a clever and penetrating argument, only to buttress the position with a second argument so feeble that it undermines the positive impression created by the first. If our family is at all representative, it seems likely that children's thinking is far more variable than suggested by traditional theories of cognitive development.

This variability implies a second way in which my children's behavior differs from that described in most theories of cognitive development: Unlike the depictions of children within the theories, they must constantly choose what to do. When children are depicted as only having a single way of representing a situation, thinking about a concept, or solving a problem, there are no choices to be made. They are, in a sense, the slaves of their cognitive structures. In contrast, if they possess multiple ways of performing these cognitive activities, then they must choose which one to use in each situation. This is not to say that all, or even most, of the choices involve conscious evaluation of the advantages and disadvantages of alternative courses of action. A great many are made without any apparent conscious consideration. Nonetheless, choices are constantly being made. Each time children try to remember an unfamiliar phone number or solve an arithmetic problem, they must choose how to do so. They also must decide whether to try to argue their way out of cleaning their room or to just do it, whether they should study in advance for the next quiz or cram at the last minute, whether to write a paper on a computer or by hand, whether to talk to a friend about a conflict or to let the passage of time blur the disagreement, and so on. Note that none of these decisions closely resembles the type of problems studied in the field known as "decision making." The "decision-making problems" typically studied within this field are only a small (and I suspect rather unrepresentative) subset of the situations in which children and adults must decide what to do.

My children also dramatically diverge from most theories of cognitive development in a third respect: the omnipresence of change in their behavior. Most theories of cognitive development relegate change to an occasional, and underspecified, role. For example, within stage theories, transitions tend to be brief, rather mysterious episodes during which children ascend from one stable way of viewing the world to a different, more advanced way. Within such approaches, as Flavell (1971) remarked, "the individual spends virtually all his childhood years 'being' rather than 'becoming'" (pp. 426-427). Such depictions are far from unique to stage theories. Regardless of whether the approach describes cognitive development in terms of stages, rules, strategies, or theories; regardless of whether its content centers on problem solving, memory, or conceptual understanding; regardless of whether the children being described are infants, preschoolers, school age children, or adolescents; both classic and contemporary theories typically place static

states at center stage and place change processes either in the wings or offstage altogether.

This makes the theories very different from my own children, who almost never stay still, either literally or metaphorically. They are continually acquiring new concepts, skills, strategies, and frameworks for thinking about the world. The changes were most dramatic early in their lives, when almost every day would bring a milestone. However, they have continued at a high rate throughout childhood and adolescence.

For example, in the last few years, all three children have earned money in a variety of ways, ranging from setting up lemonade stands to delivering newspapers to baby-sitting to buying and selling baseball, football, and hockey cards. Their understanding of these activities, and of more general economic issues, has changed continually as they have engaged in them. From running the lemonade stands, they have learned the importance of choosing a good location, not pricing the product too high, offering discounts for large purchases, and agreeing in advance among themselves how to divide profits. From delivering newspapers, they have learned about the importance of timeliness and reliability, the hidden costs involved in having to go to customers to collect money, and the proper mix of politeness and threats needed to motivate deadbeats to pay their bills. From baby-sitting, they have learned the usefulness of establishing a competitive advantage (in this case by developing a box of special toys and activities to bring to the children for whom they sit), the need to insist on being paid the agreed-upon rate (people have a strangely asymmetric tendency to misrecall the hourly fee), and the advisability of simply refusing to render future services for people who have not lived up to past agreements. From playing the sports cards market, they have learned the importance of acting on new information before the crowd does, of the difference between local and national markets, of the premium commanded by goods of the highest quality, and of the difference between what a book or magazine says something is worth and what people will actually pay for it. These activities have also been instructive about a host of noneconomic issues such as discrimination (parents often prefer girls as baby-sitters), about the value of inside information (professional sports card dealers know about future price increases before others do, and sometimes inform favored customers about impending changes), and about word of mouth (baby-sitting jobs often originate with the recommendations of satisfied customers or other baby-sitters). All of these realizations derive from the children's economic activities, a very small aspect of their lives; many other aspects have, no doubt, led to more numerous and profound changes.

The Mystery of the Immaculate Transition

Suppose that I am right in believing that most theories of cognitive development depict children's thinking as less variable, less demanding of choice, and less dynamic than it really is. Maybe these are mere peccadilloes rather than funda-

mental flaws. After all, might not the gains in simplicity, elegance, and memorability of the theories outweigh the loss in accuracy and completeness entailed in understating the variability and need for choices in children's thinking? And might not the initial focus on static states be a necessary first step toward understanding change?

If this were 1960, 1970, or even 1980, such arguments might be persuasive. As more and more research has been conducted, however, the arguments have become less and less compelling. Simply put, the accumulation of such descriptions has not advanced us very quickly toward what I consider the deepest goal of theories of cognitive development: *to understand the process of change in children's thinking.*

The way in which focusing on static states limits understanding of change has often been recognized, and has been the subject of a number of insightful discussions (Flavell, 1984; Miller, 1989; Sternberg, 1984). To the degree that describing these static states becomes a goal in itself, it diverts attention from the elusive problem of how changes occur. Saying that we cannot understand change until we have better descriptions of thinking at particular points in development also provides an excuse for all seasons, a justification for avoiding the difficult issues involved in hypothesizing and testing mechanisms that could produce the changes.

The way in which underestimating the variability in children's thinking has hindered attempts to understand change is less obvious and has rarely been discussed explicitly. It may, however, be at least as large an impediment to progress. Portraying children's thinking as monolithic at each point in the developmental sequence has the effect of segregating change from the ebb and flow of everyday cognitive activity. It makes change a rare, almost exotic event that demands an exceptional explanation. If children of a given age have for several years consistently thought of a problem in a particular way, why should they suddenly start thinking about the problem in a different way? The process is especially mysterious because the kinds of problems that play central roles within many theories—for example, questions about conservation, balance scales, and purple taxis—cabs—are ones that children rarely if ever encounter or think about outside the laboratory. Thus, it is unlikely to be negative feedback or direct instruction that leads to the change. This leaves us with a paradox: If children have a single concept of x for a protracted period of time, and no external stimulus tells them that anything is wrong with thinking about x in that way, why would they start thinking about it differently? Put more succinctly: What is the cause of such immaculate transitions?

The problem is exacerbated by the large qualitative changes that are often hypothesized to mark successive steps in the developmental sequence. Such depictions make for an appealing story in classroom lectures and textbooks, but also make it difficult to understand how children could ever bridge the gap. Viewing changes in terms of leaps from one understanding to a qualitatively different one may subtly discourage investigators from even trying to account for them. It is hard to imagine mechanisms that would allow a child who initially possessed only holistic concepts to form analytic ones, that would allow a child who could

form only sensorimotor representations to form representational ones, or that would allow a child to restructure a psychologically based theory of biology into a biologically based one. Trying to understand change is inherently challenging and complex. However, in our efforts to describe development as cleanly and dramatically as possible, we may inadvertently have made the task harder than it needs to be.

If there were strong empirical basis for believing that the fundamental changes in children's thinking occur at a few particular times, the problems entailed by underestimating the variability of children's thinking and overestimating the magnitude of the few changes that are recognized might be justified as convenient simplifications. As the database in the field has expanded, however, the assumption of domain-general stage changes has become increasingly untenable. Important changes have been documented at every age. As a result, labeling certain times as the critical transition periods has come to seem completely arbitrary. What constitutes the critical change for cognitive development as a whole: the vocabulary explosion that begins between 18 and 24 months (McCarthy, 1954), the differentiation of categories that occurs between 24 and 30 months (Mandler, Bauer, & McDonough, 1991), the change in understanding of symbolic representations that occurs between 30 and 36 months (DeLoache, 1987), or the change in understanding of the mind that occurs between 36 and 48 months (Wellman, 1990)? It seems likely that the more we know, the less sense it will make to single out some periods as the key transitions in cognitive development as a whole and other periods as ones of stability. Instead, we will want to recognize that all of development is a transition period, with children always thinking in multiple ways, rather than just one.

From this perspective, it is no accident that recent approaches that have emphasized the goal of explaining change, notably dynamical systems approaches (Theilen & Smith, 1994; Theilen & Ulrich, 1991; van Geert, 1991; van der Maas & Molenaar, 1992), connectionist approaches (Changoux & Dehaene, 1989; MacWhinney & Leinbach, 1991; McClelland, 1995; Shultz et al., 1995), symbolic self-modifying systems approaches (Halford, 1995; Klahr, 1992; Simon & Klahr, 1995), and some neo-Piagetian approaches (Acredolo & O'Connor, 1990; Karniloff-Smith, 1992; Kuhn, 1995) all have emphasized both the variability of thought and the continuity of the underlying process of change. Such approaches continue to be in the minority, however. The large majority of research on cognitive development continues to focus on identifying *the* way in which children think about a given topic at a given age and leaves issues regarding change to the future.

Why Do We Have These Problems?

If change is the dominant reality in cognitive development, why have so many efforts been made to divide development into discrete periods punctuated by brief transitions? Oyama (1985) placed this issue in an interesting perspective. She suggested that much of psychology is aimed at identifying *essences*. Are people at

their core aggressive or peaceful, selfish or altruistic, rational or irrational? Is their behavior essentially determined by nature or nurture, heredity or environment, genes or culture?

In the context of developmental research, the goal of such efforts has been to identify the essence at each age. For example, what is the nature of 5-year-olds' thinking, and how does it differ from the thinking of 8-year-olds? The goal has generated many attempts to label the fundamental difference. The 5-year-olds' thinking is said to be "egocentric," "associative," "preconceptual," "wholistic," "undifferentiated," "thematic," and so on. The 8-year-olds' thinking is given an entirely different set of labels, intended both to identify its essence and to distinguish it clearly from its predecessor.

Years of accumulated research, however, have thrown into doubt the existence of such essences. Regardless of the particular essence that has been postulated, exceptions abound. Furthermore, the attempt to identify such essences may have led to a focus on confirming or disconfirming the essence and to a neglect of the specifics of thinking that do not fit neatly into the hypothesized mold. Such exceptions may be critical to the change process precisely *because* they do not fit neatly into the mold.

Oyama's critique has an interesting implication for understanding cognitive development: The separation of stable states from transition periods may result from our attempt to define essences rather than from any underlying reality. Attempting to isolate the essence of thinking at different ages may have led to inaccurate descriptions of children's thinking at particular ages and discouraged serious theorizing about mechanisms (because of the seeming impossibility of describing in detail mechanisms that would accomplish the transition from one essence to another).

These criticisms of theories that posit 1:1 relations between age and thought should not be taken as dismissing their contributions. Attempts to support and refute them have led to impressive demonstrations of both early competence and later incompetence, stimulated creation of increasingly sensitive methods to demonstrate that infants and young children "have" or do not "have" the competence in question, and generally led to an increasingly rich database about development. Rather, the intent of the critique is to question basic assumptions about the nature of cognitive development and to advance to center stage a terribly important issue about which most current theories have little to say—the issue of how change occurs.

The three issues introduced so far—the variability of children's thinking, the need for children to choose among alternative ways of thinking, and the omnipresence of changes in their thinking—are the focus of the remainder of this chapter (and of the book as a whole). In particular, the remaining sections of the chapter examine in more detail how major theories of cognitive development have dealt with these issues, how their inattention to variability and choice have interfered with understanding of change, and how modern evolutionary theory provides a natural framework for thinking about cognitive change in more fruitful ways.

Variability

Fields of psychology are defined in large part by the sources of variability they emphasize. Personality psychology emphasizes variability attributable to individual differences; comparative psychology emphasizes variability attributable to species differences; social psychology emphasizes variability due to interpersonal influences; cross-cultural psychology emphasizes variability due to cultural differences; and so on. Researchers within each field typically describe themselves as interactionists, and many do study interactions among sources of variability. For example, a good number of personality researchers study interactions between individual and situational characteristics (e.g., Carver & Scheier, 1992). Nonetheless, the type of variability that receives the most attention is in large part what defines each field.

Within developmental psychology, variability among age groups is the main focus of attention. The attempt to document such variability is the touchstone of most research in the field. As if obeying the dictum from graduate research methods courses, "maximize variability between groups, minimize variability within groups," most theories of cognitive development have depicted children of varying ages as thinking in dramatically different ways and have relegated to the background variability within each age group. This can be seen in the following brief and oversimplified characterizations of how a number of well-known theories depict age-related changes in thinking. The descriptions do not do justice to the complexity of the theorists' visions, but they should at least be recognizable.

As with so much in the field of cognitive development, Piaget's theory is a good place to start. Piaget depicted children's understanding of various concepts as a sequence of increasingly adequate understandings that reflected their general level of thought and reasoning. For example, 4- to 6-year-olds are described as being unable to understand the conservation concept (Piaget, 1952a). This leads them to think of conservation problems in terms of single static dimensions: relative amount of liquid is equated with relative height of the liquid columns, relative number of objects is equated with relative length of the rows of objects, relative length of objects is equated with relative endpoint in the direction that one of the objects was moved, and so on. After thinking of conservation in this way for several years, children are said to enter into a brief transitional period, marked by cognitive conflict. Following this transition, they arrive at the next, higher, steady state—concrete operational reasoning. At this point, they understand the logic that leads to conservation of number, amount, length, and so on.

Similar characterizations are offered for changes in thinking that occur in other developmental periods. For example, infants younger than 9 months are viewed as not understanding that objects have a permanent existence, as not being able to imitate the actions of other people, and of generally being unable to form enduring representations of objects and events (Piaget, 1952b). Preoperational children, in contrast, possess all of these competencies. Similarly, concrete operations stage children are viewed as unable to understand ratios and proportions, combinatorial possibilities, and chance and probability, whereas formal opera-

