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Integrating Basic and Applied Developmental Research: A New Model for the Twenty-First Century

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Until recently, basic and applied research agendas in the field of child development have followed separate paths. One reason the two have not merged is that the objectives of basic and applied research are often seen as incompatible. In this paper, we argue that researchers can simultaneously achieve the objectives of advancing basic knowledge and addressing applied problems within a single research program. We provide a framework for this perspective by first looking back at historical trends of basic and applied developmental research and then looking forward at potential new approaches for integrating basic and applied research. We use our own research on perception of affordances and unintentional childhood injuries to illustrate how researchers might implement these strategies for integrating basic and applied research. We conclude by discussing how we might extend this integration further to include nontraditional classes of application.

INTRODUCTION

In his editorial welcome to the *Journal of Applied Developmental Psychology* two decades ago, Edward Zigler (1980, p. 1) remarked that "researchers have tended to array themselves on one side or the other of the basic-applied distinction as if their paths by definition diverged and an uncrossable chasm gaped between them." Although initial progress has been made in bridging this gap, researchers generally have not embraced the idea of integrating basic and applied developmental research, particularly in the field of cognitive development. One reason for this hesitation is that the objectives of basic and applied research are often seen as incompatible. The goal of applied research is to provide information that will help solve problems that have immediate practical consequences for children, regardless of whether this information has particular relevance for understanding processes of development. In contrast, the goal of basic research is to provide information about processes of development, regardless of whether this information has relevance for solving particular problems of practical significance. But are the objectives of basic and applied developmental research necessarily incompatible? Although applied and basic research are traditionally seen as distinct, we argue that researchers can simultaneously achieve the objectives of advancing basic knowledge and addressing applied problems within a single research program. This paper lays the groundwork for a new model of developmental research by outlining strategies researchers can use to integrate basic and applied research issues.

BASIC AND APPLIED RESEARCH

Past and Present

The scientific study of child development grew out of practical concerns for the welfare of children. Much of the momentum for the child development research movement can be traced to Mrs. Cora Bussey Hillis, a wealthy housewife living in Des Moines, Iowa (Bradbury & Stoddard, 1933; Cravens, 1993). After raising a younger sister and several of her own children, some of whom died in childhood, Hillis became interested in promoting the welfare of children. She set out to accomplish what was then a novel idea: establishing an academic research station to study children's normal development. Numerous attempts to convince officials at the nearby Iowa State University in Ames failed. Hillis then turned to the University of Iowa in Iowa City. She approached the University of Iowa President Thomas H. MacBride and Dean Carl E. Seashore. Together, the three founded the Iowa Child Welfare Research Station (Bradbury & Stoddard, 1933; Cravens, 1993). The goal of the Station was to build "a body of solid factual knowledge that would benefit children and enable both parents and child specialists to work more effectively" (Sears, 1975, p. 19). Scholars from a broad array of fields, including psychology, pediatrics, anatomy, nutrition, and education, joined to establish a science. With the monetary backing of the Laura Spelman Rockefeller Memorial fund, a number of similar child research stations were founded

at universities across the country, including the University of California at Berkeley, the University of Minnesota, and Yale University.

Soon after the first child welfare research stations were opened in 1924, the Committee on Child Development (CCD), an organization within the National Research Council and the predecessor of Society for Research in Child Development (SRCD), was founded as the first national association of child development researchers (Smuts, 1985). Through the early years of the CCD and SRCD, their missions and activities paralleled those established at the Iowa Child Welfare Research Station. Along with psychologists, scholars of pediatrics, nutrition, anatomy, sociology, and anthropology worked together to solve developmental problems facing normally developing children (Rheingold, 1985). The applied research concerns of SRCD continued into the 1940s, particularly as society members sought to do research to contribute to the war effort.

Over time, however, research trends changed. Much of the work in child development in the last half century has been directed toward basic research issues. Why and how did this shift away from applied research and toward basic research occur? Starting in the late 1940s and early 1950s, experimental child psychology dominated developmental research. Experimental child psychology emphasized carefully controlled experiments designed to answer theoretically motivated questions. Heavily influenced by a behaviorist perspective on learning and motivation in animals, researchers studying children sought to extend such models to learning and motivation in children (Kendler & Kendler, 1970; Spiker & Cantor, 1973). This focus on carefully controlled experiments played an important role in turning the study of child development into a rigorous science, but it also marked a movement away from addressing issues relevant to the welfare of children, particularly in the domains of cognitive and perceptual development (see Robins, Gosling, & Craik, 1999; Sears, 1975).

More recently, the pendulum has swung back toward applied developmental research, often as an outgrowth of basic research. As in the early years of child development research, developmental psychologists are increasingly conducting research with collaborators in applied fields such as law, nursing, pediatrics, and education. *The Journal of Applied Developmental Psychology* has grown rapidly and publishes research on applied issues across a variety of domains of development. Researchers in the domain of social–emotional development, however, have largely led the way in integrating basic and applied developmental research. In a recent special issue of *American Psychologist* devoted to applications of developmental science, all but one of the articles involved applications of social–emotional research (Hetherington, 1998). One prominent example of such integration in the domain of social–emotional development is the effect of day-care on early social–emotional development (e.g., Belsky & Rovine, 1988; Lamb & Sternberg, 1990; NICHD Early Child Care Research Network, 1997). Researchers have used attachment theory as a framework for understanding the effects of day-care on infants and young children, particularly with respect to issues involving turnover of day-care providers, multiple day-care settings, and timing of entry into day-care.

Although research integrating basic and applied issues in cognitive development is more scarce, one influential example is the study of children's eyewitness memory (e.g., Ceci & Bruck, 1993; Goodman & Schaaf, 1997). Related work examines children's memory for past events involving sexual touching (e.g., Baker-Ward, Gordon, Ornstein, Larus, & Clubb, 1993; Greenhoot, Ornstein, Gordon, & Baker-Ward, 1999; Ornstein et al., 1998; Saywitz, Goodman, Nicholas, & Moan, 1991; Steward & Steward, 1996). Another example of cognitive development research integrating basic and applied issues is work on children's unintentional injuries (e.g., Lee, Young, & McLaughlin, 1984; Plumert, 1995; Plumert & Schwebel, 1997; Schwebel & Plumert, 1999). This research has focused on identifying cognitive and perceptual factors that may put children at risk for unintentional injuries.

The movement toward applied research has restored some balance to the field of developmental psychology. The division between basic and applied developmental research persists, however, particularly in the field of cognitive development. Typically, developmentalists continue to identify themselves as applied scientists or basic scientists, but rarely as both. To bridge this gap, a new vision of developmental research is warranted, one that integrates basic and applied research. Below, we outline strategies for achieving this integration and then provide a fledgling example of this new vision of developmental research. We focus on the field of cognitive development because it has lagged behind in this movement toward integrating basic and applied research.

Strategies for Integration

There are at least three approaches for integrating basic and applied research. Two of them serve as starting points for the third. One starting point is for basic scientists to discuss the implications of their research findings for applied issues. For example, researchers have suggested that basic developmental change in representational ability should be considered when

questioning young children about alleged sexual abuse incidents (DeLoache, Miller, & Rosengren, 1997) and when considering children's suggestibility before trials (Welch-Ross, Diecidue, & Miller, 1997). Uttal, Scudder, and DeLoache (1997) have also suggested that young children's difficulty with using three-dimensional objects as symbols may impede their ability to benefit from manipulatives in math learning.

A second starting point for achieving integration of basic and applied research is for applied scientists to ground their research in basic developmental findings and theory. Many applied developmental psychologists see this as a central part of their research. In fact, it was a goal embraced early by the editorial board of the *Journal of Applied Developmental Psychology* (Sigel & Cocking, 1980; Zigler, 1980). Shumow's (1998) recent study on the effect of parental involvement in children's homework completion is one example of this type of research. This study extended basic research and theory on parental scaffolding to the practical problem of how to improve children's mathematics skills. Another area of inquiry that illustrates how researchers use basic theory to guide applied research is the field of child clinical psychology (see Cicchetti, 1984; Serafica & Wenar, 1996; Tryon, 1990). Research on child abuse, for example, has used Bronfenbrenner's (1979) ecological model to understand the complex interplay among multiple risk factors including the individual, the family, and other broader contexts such as neighborhoods and schools (Emery & Laumann-Billings, 1998).

The strategies of discussing the implications of basic research for applied issues and grounding applied research in basic theory represent important steps forward because they promote exchange of ideas between researchers from both sides of the basic–applied distinction. There are drawbacks to these strategies, however. Specifically, there usually is little crossover in the actual research conducted. In other words, the research tends to be either basic or applied, but not both. This limits the extent to which research from either side can inform the other.

Recently, a third strategy for integrating basic and applied research has evolved from these initial starting points: basic research conducted in the context of an applied problem. This strategy often involves investigating the role of basic psychological processes in some type of problem behavior. For example, Ornstein and his colleagues (Baker-Ward et al., 1993; Greenhoot et al., 1999; Ornstein et al., 1998) have studied the development of memory abilities in the context of children's eyewitness testimony. Likewise, Plumert and her colleagues (Plumert, 1995; Plumert & Schwebel, 1997; Schwebel & Plumert, 1999) have examined children's ability to judge affordances in the context of unintentional injuries. In this work, they have examined basic developmental changes in children's judgments of affordances and have assessed how individual differences in the accuracy of these judgments are related to individual differences in injury proneness. We examine this work in more detail below. The advantage of this approach is that the research provides information that is directly relevant to both basic and applied developmental issues.

Both the strategy of discussing the implications of basic research for applied issues and the strategy of grounding applied research in basic theory serve as ideal starting points for conducting basic research in the context of an applied problem. That is, one can progress from a program of basic research to one that incorporates research on relevant applied issues, or one can progress from a program of applied research to one that incorporates research relevant to basic issues. Ultimately, this model of research may evolve into an integrated program of research that moves flexibly between basic and applied developmental issues. Below, we consider the evolution of our own research as an illustration of integrating basic and applied cognitive development research.

An Example of Integration: Unintentional Injuries

Children and ATVs. Our research on children's unintentional injuries began with a phone call from the Consumer Product Safety Commission (CPSC; Pick, Plumert, & Arterberry, 1987). The CPSC was in the process of investigating the ability of children to ride all-terrain vehicles (ATVs) safely. There was considerable evidence to suggest that ATVs pose a serious danger for children. Epidemiological evidence supported their claims: of approximately 85,000 ATV accidents in 1985, almost half involved children under 16 years of age. As part of their investigation, the Consumer Product Safety Commission wanted scientific evidence concerning the age at which children could operate ATVs safely. Our task was to provide them with such information based on our review of relevant research on children's perceptual, motor, cognitive, and social development. In short, they wanted us to discuss the implications of basic research for an applied problem with significant real-world implications. As a starting point, we were able to examine a large number of epidemiological reports detailing the circumstances of ATV-related injuries sustained by children under 16 years of age.

Consider the following example, which illustrates several of the factors typical of ATV incidents that we pursued in our literature review.

> Case study: A 10-year-old boy was knocked unconscious when he flew over the handlebars of the three-wheel all-terrain vehicle that he was driving down a slope at approximately 30 miles per hour. According to the report, the boy indicated that he was accelerating at the same time he was pressing the throttle lever with his hand and depressing the brake pedal with his foot. As he was traveling the last 100 feet, he felt the rear wheels of the ATV bouncing and he experienced difficulty steering the ATV.

Fortunately, the boy was held overnight in the hospital and did not appear to sustain any permanent injuries. Examples such as this helped us form hypotheses about what characteristics might play a role in children's ability to operate ATVs safely. Guided by our hypotheses, we scoured the available developmental literature to find information relevant to these hypotheses. The end result was a lengthy document summarizing risk factors related to children's ability to operate ATVs safely and recommending possible minimum-age requirements for operating ATVs (Pick et al., 1987).

Real-world versus laboratory settings. The task of using basic research findings to draw conclusions about an applied problem was more difficult than we anticipated. One problem we encountered was that it was often difficult to draw parallels between children's functioning in experimental settings and their functioning in real-world settings. In particular, the types of tasks children confronted in the laboratory were often very different from the types of tasks they confronted when performing a complex, real-world activity like riding ATVs. For example, most of the research we used to draw conclusions about the role of perceptual-motor factors in ATV riding was based on very simple laboratory tasks in which the relevant stimuli were specified for participants. In the laboratory, the person generally knew ahead of time exactly what stimuli to search for. The response or possible responses were also quite delimited and usually very simple. For example, a research participant might be instructed to wait for a dot to appear on a screen and to push a button when that dot appeared. In contrast, children riding ATVs confront multifaceted stimuli requiring complex responses. We reconciled this disparity between laboratory and real-world settings by concluding that children's performance in the rich, complex setting of ATV riding was likely to be significantly worse than their performance in the impoverished, simplified setting of the laboratory.

Another problem we encountered was that we were limited to generating hypotheses; we could not test them. Our report consisted of our "best guesses" about the difficulties that children of particular ages were likely to encounter when riding ATVs. As scientists, we found this quite frustrating. We hesitated to make many definitive claims about minimum-age requirements for operating ATVs because we did not have the opportunity to empirically test those claims. For example, we thought that children below the age of 13 or 14 would have difficulty comprehending the manuals that accompanied ATVs. However, it was difficult to make a strong argument about comprehension difficulties without a direct test of our hypothesis.

Developmental factors in unintentional injuries. Despite these problems, our experience examining the implications of basic research for an applied problem played an important role in stimulating our thinking about applied research. First, it drew our attention to the problem of childhood injuries. Unintentional injuries are the leading cause of death in children under age 18 (National Safety Council, 1998; Rodriguez & Brown, 1990). Approximately 22,000 children and adolescents die each year in the United States as a result of drownings, poisonings, electrocutions, falls, pedestrian injuries, bicycle collisions, and choking on foreign objects. Second, we discovered that very little is actually known about the psychological causes of unintentional injuries, particularly about how immature cognitive and perceptual skills may contribute to unsafe behavior. Clearly, a better understanding of the underlying factors that contribute to the occurrence of injuries is needed to help design effective prevention strategies (Brooks & Roberts, 1990; Peterson & Mori, 1985; Roberts, 1986).

One idea stimulated by thinking about ATV riding was that children's ability to evaluate their level of skill in relation to the demands of the task may play an important role in unsafe behavior (see also Lee et al., 1984). According to J. J. Gibson (1979), adaptive behavior within the environment depends upon perceiving affordances, or the fit between one's own physical characteristics and the properties of the environment in which actions take place. For example, to bicycle across a road safely children must evaluate their own level of bicycling skill in relation to the demands of the situation. In the case where cross-traffic does not yield, children must wait for a sufficient gap between vehicles before crossing. To determine whether the gap between two vehicles affords crossing, children must accurately judge the size of the gap in relation to the time it will take them to bicycle across the road. If children either overestimate the time it will take the car to reach the crossing line or underestimate the time it will take them to bicycle across the

road, they may choose a gap that is insufficient for safe crossing.

Basic cognitive skills in applied contexts. These ideas formed the basis for a subsequent program of research integrating basic and applied issues (Plumert, 1995; Plumert & Schwebel, 1997; Schwebel & Plumert, 1999). Very generally, the goal of this research was to examine basic developmental changes in children's cognitive skills in the context of an applied problem. From the perspective of basic research, these studies were designed to examine (1) developmental changes in children's ability to judge affordances; and (2) factors that play a role in children's ability to judge affordances. From an applied perspective, these studies examined whether individual differences in the tendency to overestimate one's physical abilities were related to injury proneness. Several basic research findings emerged from this program of research. Most notably, we found that 6- and 8-year-old children often overestimated their physical abilities. We also found that 8-year-olds benefited more from practice with performing activities than did 6-year-olds, and that children who watched a peer fail to successfully perform a set of physical activities were more conservative in their judgments of their own ability to perform those same tasks. Moreover, we found that highly active, approach-oriented, and undercontrolled children were more likely to overestimate their physical abilities than were their less active and more controlled counterparts. From an applied perspective, we found that 6-year-olds who greatly overestimated their physical abilities also had a history of more unintentional injuries requiring professional medical attention, as did 6-year-olds who were rated by their parents as active, impulsive, and undercontrolled.

The idea that children may engage in unsafe behaviors because they overestimate their physical skills in relation to the demands of the situation made intuitive sense when we embarked on this program of research. However, it was contrary to the view that people are quite good at perceiving the fit between their own physical characteristics and the demands of the situation (Gibson, 1979; Warren, 1984). Much of the research, in fact, had shown that adults are generally quite accurate in perceiving affordances (e.g., Carello, Grosofsky, Reichel, Solomon, & Turvey, 1989; Warren & Whang, 1987). The results with infants and children were more mixed, however. For example, McKenzie and colleagues (McKenzie, Skouteris, Day, Hartman, & Yonas, 1993) found that although infants made appropriate adjustments to their movements in their attempts to reach toys, they very often attempted to reach toys that were well out of reach. They noted, in fact, that many infants would have fallen while trying to grasp objects that were well out of reach had they not been restrained in their infant seats. Likewise, Adolph (Adolph, 1995; Adolph, Eppler, & Gibson, 1993) found that although walking infants were more cautious about descending than ascending slopes, they overestimated their ability to go up and down slopes. McKenzie and Forbes (1992) also found that 9- and 12-year-old boys consistently overestimated the height of steps that they could climb.

Despite findings showing otherwise, there was a general bias toward the view that infants and children are fairly accurate at perceiving the fit between their own physical abilities and the demands of the situation. The situation appeared quite different, however, when viewed through the lens of an applied problem. The idea that children sometimes make mistakes in judging the relation between their physical capabilities and the demands of the situation revealed a new way of viewing affordances. Our findings suggest that perceiving the fit between one's physical characteristics and the demands of the situation is a learning process that unfolds over time. As such, it is likely to be influenced by a number of factors including experience and even temperament. Children are most at risk for making errors (and possibly injuring themselves) when they are learning a new skill or are in a new environment. Moreover, children who are active, impulsive, and approach-oriented may be at even greater risk because they enjoy trying new activities and exploring new environments.

Although we started our research program by thinking about how basic research can inform an applied problem, it is clear that thinking about an applied problem can also inform basic research. Researchers in other areas have reached similar conclusions. Ceci and Bruck (1993), for example, outline work in the area of children's eyewitness testimony and demonstrate how the research not only has helped to identify the veracity of child witness reports under various conditions but also has extended theoretical descriptions of memory development. These types of observations suggest that basic and applied research have much to offer each other.

CONCLUSIONS

The balance between basic and applied research has shifted over time. Early work focused on applied issues surrounding problems of child welfare. After World War II, researchers moved away from applied issues and turned instead to carefully controlled experiments designed to test theoretically motivated questions. More recently, renewed interest in applied issues suggests a new model for research in the next

century, the integration of basic and applied research. Although this approach is in its infancy, it promises to be an important part of the research arsenal. In advocating this approach, we are not suggesting that developmental researchers give up their basic research interests and turn instead to applied problems, or vice versa. Instead, we are suggesting the potential for change in how we view the objectives of developmental research. The objective of an integrated research program is to understand behavior in terms of both basic developmental processes and practical, everyday functioning. Within this framework, researchers' programs can move freely between basic and applied research. Thus, at times the research might focus exclusively on a basic or on an applied problem, and at other times the research might address basic and applied problems simultaneously. We find this new approach particularly appealing because consideration of applied issues can inform basic theory, and consideration of basic research can guide applied questions. Knowledge about the basic processes of child development can be expanded while solving problems of practical significance.

Our focus thus far has been on integrating basic research with a particular class of application: understanding the etiology of a problem behavior. The applied goal of our research on children's unintentional injuries, for example, is to examine what factors might put children at risk for injury. Likewise, the applied objective of research on children's eyewitness testimony is to understand why children might have difficulty recalling events. In some sense, however, one might question whether these types of issues actually fall under the rubric of applied research. Rather, one might see them as investigations of basic processes across a continuum of normal and problem behavior (or across a continuum of artificial and natural situations). Clearly, understanding problem behavior can provide insights into normal behavior. However, there are at least two other kinds of application that deserve consideration: *diagnosis/prediction* and *treatment/intervention.*

Typically, researchers interested in integrating basic and applied research stop short of doing studies on diagnosis or intervention. On the basic–applied continuum, diagnosis and intervention are often viewed as too applied. That is, researchers find it difficult to see how a diagnosis or intervention study might contribute to issues of basic science. But can such classes of application inform basic research? Consider again unintentional childhood injuries. Using information about the basic processes underlying unintentional injuries, it should be possible to predict which children are most at risk for injury and to design interventions to decrease their risk of injury. By actually carrying out the diagnosis and treatment work, one can provide additional tests of whether the original hypotheses about the basic processes underlying unintentional injuries are accurate. In other words, diagnoses and treatments based on faulty assumptions about the basic processes should not work. Below we consider other examples of how one might extend the integration of basic and applied research even further by considering these two other classes of application.

The goal of diagnosis is to identify the current state of affairs, usually when this is not obvious without special assessment. For example, behavioral orientation measures or evoked potential measures are useful for assessing auditory function in young infants. The practical application of such assessment is obvious if infants with hearing dysfunction can be identified at an early age. Concomitantly, such assessment could shed light on basic orientation and habituation processes. Another example of diagnostic application comes from basic research on infant habituation and dishabituation. There is recent evidence that individual differences in performance in habituation tasks predict later intellectual functioning (Bornstein, 1989; Bornstein, Slater, Brown, Roberts, & Barrett, 1997; McCall, 1994; see also Rose, Feldman, Futterweit, & Jankowski, 1998). This raises the basic research question of why functioning on these tasks at very early ages predicts performance on school-age tasks that are, superficially at least, so very different. Another important and interesting predictive application is the fact that monocular deprivation in infancy (caused by crosseyedness) can lead to permanent impairment in binocular functioning. Research examining binocular functioning in older children and adults who had corrective surgery at different ages and at different intervals after the onset of the ocular problem suggested an optimal time for the corrective surgery (Aslin & Banks, 1978; Banks, Aslin, & Letson, 1975). Surgery at a younger age did not cause better subsequent binocular functioning, but, importantly, later surgery resulted in a decrement in subsequent functioning. These results lead back to basic questions concerning physiological development of vision in children.

Typically, once a problem has been diagnosed, interventions are designed to ameliorate the problem area. Research on the interaction of psycholinguistic speech production research and clinical speech therapy in communication disorders provides a good example. Linguists and psycholinguists have identified a relatively small number of phonetic features, or distinctive features, that distinguish all the words or syllables of the languages of the world. The partic-

ular distinctive features used vary from one language to another, but a relatively small subset seems to capture most of the meaningful sounds of any language. Although psycholinguists debated exactly what the correct set of distinctive features was, the basic scientific theory that there were basic differences in phonetic features suggested an intervention to correct certain types of speech impediments. For example, a child might have systematic difficulties in speech production in which he or she is unable to distinguish between unvoiced and voiced sounds (i.e., there is no distinction between sounds like /p/ and /b/, /t/ and /d/, /s/ and /z/, and so on). If voicing were really a psychologically meaningful feature, perhaps training the voicing distinction in the context of one pair of sounds would lead to generalization in all contexts where voicing was critical; practically, it might be more efficient to focus training on one sound pair and improvement would occur over a wide range. Theoretically, evidence of such generalization would support the psychological reality of the particular feature and also help decide among alternative feature taxonomies. These alternatives could then be evaluated back in the laboratory outside of the therapy context (see Broen, 1980, and Broen & Jons, 1978, for related research).

A second approach to intervention is what might be termed environmental engineering. If one understands the basic processes involved in accomplishing a perceptual/cognitive/action task, it would be possible to engineer the situation so that a child of a given age can perform it—or cannot perform it if it involves unacceptable dangers. This is one of the ideas behind the concept of affordance. The environment can be structured or altered so that the child can perform the task when that is what is wanted and so that the child cannot even begin the task when it is potentially dangerous for a child of that age or ability level. Simple engineering is exemplified by techniques such as making toys with handles appropriately sized for children of particular ages to grasp them. Somewhat more complex engineering involves structuring an environment so that, for instance, children of particular ages would be able to find their way and not get lost.

FINAL COMMENT

The field of cognitive development is poised for integrating basic and applied research. In fact, many researchers are beginning to consider the implications of their basic research findings for applied problems (e.g., Baker-Ward et al., 1993; Ceci & Bruck, 1993; Futterweit & Ruff, 1993; Lee et al., 1984; Ornstein et al., 1997; Plumert, 1995; Schwebel & Plumert, 1999; Uttal et al., 1998; see also, Kramer, 1998). The challenge for the twenty-first century is to carry out unified research programs that both add to our understanding of basic cognitive processes and address practical problems confronting children. In our estimation, such research has the potential to both enhance the welfare of children and also move us closer to a meaningful theory of cognitive development.

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