

# Do Children and Adults Learn Differently?

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This article addresses a question that was a topic of debate in the middle decades of the 20<sup>th</sup> century but was then abandoned as interest in children's learning declined. The question is, does learning develop? In other words, does the learning process itself undergo age-related change, or does it remain invariant ontogenetically and phylogenetically, as early learning theories claimed? We suggest that new conceptions of learning make the question worth revisiting. A study is presented of 11- to 12-year-old children and young adults engaged in an identical learning task. Results support the proposal that learning comes to operate under increasing executive control in the years between middle childhood and early adulthood.

Kendler and Kendler (1959, 1962, 1970) are remembered for their bold challenge to the behaviorist tenet, widely accepted in the middle of the 20<sup>th</sup> century, that the learning process functions in an identical manner both across species and across the life cycle within species. Within the human species, the Kendlers argued to the contrary, learning develops. Young children, they claimed, learn strictly via associationist mechanisms. By age 6 or 7 years, the learning process has been transformed into one involving internal mediating concepts that connect overt stimuli and responses.

Today it is apparent that the Kendlers overstated their case in claiming that preschool children do not form concepts. There is ample evidence to the contrary, and a different explanation for age differences on Kendlers' learning tasks is required. Following the Kendlers' work, the question of developmental changes in the learning process was largely put aside as interest in children's learning declined in general (Siegler, 2000). Yet the question remains an open one and is the topic of the work presented here. It is now, however, a somewhat different question than it was

in the Kendlers' day, as the cognitive revolution has brought with it a substantially different conception of learning. Rather than formation of S-R bonds or strengthening of behaviors, learning is now more likely to be defined as "change in understanding" (Schoenfeld, 1999). In this context, we claim, it is productive to resurrect the question largely abandoned following the Kendlers' work.

### DOES LEARNING DEVELOP?

The learning we address here is declarative learning about the world as opposed to procedural learning of skills or strategies, which raises similar but also some distinct issues. A long-standing assumption has been that children (as well as adults) come to know about the world through a process of induction (Holland, Holyoak, Nisbett, & Thagard, 1986). After encountering a sufficient number of similar cases, they make inferences that this is the way things are. Such understandings are not imposed on a blank slate, however. From an early age, children construct theories as a way of understanding the world around them, and they revise these theories as they encounter new information.

It is such changes in understanding that we can regard as learning, and the hypothesis we examine here is that this learning process itself develops—in other words, it does not function in an identical manner across the life span. The hypothesis is a challenging one to entertain because of the competing alternatives that arise. Older individuals, for example, may learn more effectively than younger ones because they learn more rapidly or because they have a greater base of knowledge to bring to bear on their learning, without there existing any difference between the two groups in the nature of the learning process itself. The research presented here was designed in a way that would allow such alternatives to be addressed.

### EXECUTIVE CONTROL OF LEARNING

The specific thesis we examine here is that the process of learning comes to operate under increasing executive control in the years between childhood and early adulthood. The thesis is consistent with growing evidence of late occurring developments in the prefrontal cortex that are implicated in executive function (Casey, Giedd, & Thomas, 2000). It is also consistent with growing recognition of the importance of metacognitive functions and executive control in cognitive performance beginning at an early age. Research by Zelazo and colleagues (Zelazo, Muller, Frye, & Marcovitch, 2003) has been pioneering in this respect in showing that young children's faulty performance in a simple sorting task lay not in mastery of either of two simple sorting rules (sort by color or sort by shape) but in weak metalevel knowledge of which rule to apply. Zelazo's task is a performance, not a

learning, task, but his work suggests that preschoolers' difficulty in Kendlers' learning tasks lay not in inability to form concepts but in metalevel understanding of which of two concepts was relevant.

To develop executive control, according to Zelazo et al. (2003), subjective experiences at one level must become objects of reflection at a higher level. Applying this idea to learning as change in understanding, two entities can be identified. One is existing understanding. The other is new information that is encountered. Each of these is experienced subjectively. Both have the potential, however, to become objects of reflection. At this higher level they become representational entities that are contemplated, managed, and acted on by an executive.

At either level, learning can occur. At the lower level, new information may alter existing understanding, yet the process occurs outside of the individual's awareness or control. At the higher level, the individual maintains two distinct representations—of the existing understanding on the one hand, and of the new information on the other—and monitors and manages the process whereby the two are coordinated. Our thesis, then, is that with development learning of the second type becomes more frequent.

## METHOD

### Design

In the typical case of a learner encountering complex new information, some of the information is consistent with the learner's existing understanding and some conflicts with it. We therefore replicated this situation in the design, in which younger and older participants were asked to learn identical material. Other design features were included with the aim of minimizing alternative explanations of any differences in the learning displayed by the two groups. Since we were not interested in speed of learning, material was introduced sequentially and remained displayed until the participant's final response was made. Materials were selected to be of comparable interest value to the two age groups, and it was not plausible that either group had greater knowledge that could be brought to bear on the topic. Finally, neither group was highly academically accomplished, making it unlikely that the two groups relied to a differential extent on learning strategies acquired in their school experience.

### Participants

The younger group consisted of 20 sixth graders (10 girls and 10 boys) in an urban alternative public middle school. They were all either 11 or 12 years old. Their ethnicity was predominantly Hispanic and African American.

The older group consisted of 20 young adults (14 females and 6 males), ranging in age from late teens to late twenties but primarily in their early twenties, enrolled in an introductory psychology course in an urban public community college. Their ethnicity was predominantly Hispanic and African American. Adults were each paid \$5 for their participation.

### Materials

Materials included a teddy bear, 41 cm tall, dressed in shirt and pants (Figure 1), and seven accessories that could be included with the bear—hat, sweatshirt, vest, shoes, backpack, keychain, and companion mouse. The bear with all its accessories is shown in Figure 2. The bear and all accessories were purchased from Toys'R'Us.<sup>TM</sup>



FIGURE 1 Bear as introduced without accessories.



FIGURE 2 Bear with all accessories.

## Procedure

Participants were interviewed individually in a room adjacent to their classroom. Their task was to identify the preferences displayed by donors for a gift they were to receive as a token of thanks for a charitable donation. The following introduction was presented by a young Hispanic female interviewer:

A charity is trying to raise money for health care for sick children in Africa. To get more people to donate, they are offering a free teddy bear to each family that donates money. They have a lot of the teddy bears on hand. Here's one of them. [The teddy bear is displayed; Figure 1.] But they are thinking that the bears look kind of plain wearing just a shirt and pants and they might get more donations if they dressed the bears up a bit more. So they went to a store and got samples of clothes and accessories they might include with the bear. Let me show them to you. [The participant observes while the interviewer dresses the bear in all seven accessories; Figure 2.] They can't include all of these extras, because it would cost too much. But they can afford to include a few.

The interviewer then assessed the participant's beliefs about the desirability of these accessories by means of the following four questions:

- a. Which one do you think would be best to include to make people want a bear?
- b. Which would be the next best one to include to make people want a bear?
- c. Now choose one you think wouldn't help make people want a bear.
- d. Last, choose one more you think wouldn't help make people want a bear.

The remaining three accessories, not chosen as one of the above four, were then removed from view and not referred to again. Information was then presented regarding the actual effects of the four chosen by the participant: "They did some test runs with different accessories to see how they would affect donations. And I have some results here. Let's look at some results for the accessories you chose."

The interviewer then presented photographs (10 cm sq.) of the various accessory combinations and an associated laminated strip (8 cm × 30 cm) containing the donation information (printed as shown and read by the interviewer). Each accessory combination and associated donation outcome was presented sequentially until all five were in view (one in the middle and one in each corner of the table):

1. abcd Donations increased by 20 percent!
2. ab-d Donations increased by 20 percent!
3. a--d Donations increased by 10 percent.

4. ab-- Donations increased by 10 percent.
5. -b-d Donations increased by 20 percent!

The letters a, b, c, and d refer to the accessories chosen by the participant as indicated previously. Thus, the participant believed that a and b accessories should have a positive effect on donations and c and d accessories should not.

Comparisons between pairs of cases permit inferences regarding the effects that each of the accessories in fact have on donations. A comparison of Case 1 and Case 2 confirms the participant's belief that c is not effective. Comparison of Case 2 and Case 3 confirms the belief that b is effective. Comparison of Case 4 with Case 2 shows d to be effective, disconfirming the participant's belief that d is not effective, whereas comparison of Case 5 with Case 2 shows a to be ineffective, disconfirming the participant's belief that a is effective. Thus, of the participant's four beliefs, two are contradicted by the data, one in showing an effect the participant did not expect and the other in failing to show an effect the participant did expect.

Following each of the five presentations, the participant was asked to note and account for the outcome by means of the questions, "Why did this bear get more donations?" or "Why didn't this one do as well?" The interviewer included probe questions when necessary to clarify which features the participant implicated in the outcome ("Which things are helping to get donations?"). After the five cases had been presented and interpretations of each elicited, a final question was then asked, which was taken as an assessment of the participant's learning: "So, seeing all of these results, which accessories do the results say they should offer, to get the most donations but spending as little as possible to do it?" If the participant's answer was incorrect, the interviewer asked this follow-up question: "If they want to offer as few accessories as possible, and not spend any more than they need to, but still get the most donations, is this the best choice?" The answer the participant gave to this question was taken as his or her final answer, and no further questioning occurred (although most offered spontaneous explanations of their answers, which were recorded). The correct answer—b and d— can be deduced from the case comparisons identified previously, but it can also be obtained directly from examination of Case 5, which shows that combination of the two accessories b and d produces the more favorable outcome with fewest accessories.

## RESULTS

Although Case 5 prominently displayed the correct answer, strikingly, a majority of children and a significant minority of adults failed to produce this answer. They had not accurately learned the information that the presentation conveyed. The percentages of each group responding correctly to the final question, either ini-

TABLE 1  
 Percentages of Participants Showing Correct  
 and Incorrect Final Responses, by Age Group

	<i>Children</i>	<i>Adults</i>
Correct initially	25	65
Correct after follow-up	10	10
Incorrect	65	25

tially or in response to the follow-up question, and responding incorrectly appear in Table 1.

Responses also can be analyzed by degree of correctness, assigning 1 point for each effective feature correctly included in the final response and 1 point for each ineffective feature correctly omitted from the final response (after the follow-up question). The score of an entirely correct respondent is thus 4, and the scores of incorrect respondents can assume values from 0 to 3. Based on this system, the mean score for children is 2.90 (with a range of 1–4) and the mean score for adults is 3.55 (range = 2–4), a significant difference,  $t(38) = 2.29, p = .028$ .

A score of 2 would be expected on the part of participants whose choices were entirely uninfluenced by the information presented, that is, who continued to base their responses exclusively on their prior expectations. Scores of 3 and 4 therefore indicate that at least some learning occurred. Scores of 3 or 4 were obtained by 60% of children and 80% of adults. No gender differences emerged in any analyses.

Table 2 shows the frequencies of the various kinds of errors made by each group. Errors were most frequent when the information to be acquired contradicted expectations (first and third rows in Table 2). Thus, existing understandings interfered to some degree with the representation of new information in both groups. Both adults and children, note, are particularly resistant to noting the lack of causal efficacy of a feature believed causal but are more willing to note the causal power of a feature previously believed noncausal, a difference consistent

TABLE 2  
 Percentages of Participants Exhibiting Various Types of Errors

	<i>Children</i>	<i>Adults</i>
Incorrectly identifies ineffective feature as effective		
Feature originally believed effective	55	25
Feature originally believed ineffective	20	00
Fails to identify effective feature as effective		
Feature originally believed ineffective	35	15
Feature originally believed effective	00	15

TABLE 3  
 Numbers of Participants Offering Various Types of Justifications  
 for Final Responses by Success of Learning and Age Group

	<i>No Justification</i>	<i>Theory Based</i>	<i>Mixed</i>	<i>Evidence Based</i>	<i>Evidence Based &amp; Metacognitive</i>
Unsuccessful child learners	2	8	1	2	—
Successful child learners	1	1	3	2	—
Unsuccessful adult learners	1	1	3	—	—
Successful adult learners	2	1	1	5	6

with findings in the developmental literature on causal inference and scientific reasoning (Klaczynski, 2000; Kuhn, Garcia-Mila, Zohar, & Andersen, 1995).

The spontaneous justifications of final responses that participants offered were assessed as *theory based* (i.e., based on expectations of what the outcomes should be or explanations of why these outcomes are to be expected), *evidence based* (i.e., based on the nature of the observed outcomes), *mixed* (containing both theory-based and evidence-based elements), or *metacognitive*. Justifications in the latter category were evidence-based with the addition of an unsolicited comment to the effect that the findings differed from their expectations (e.g., “I don’t like the keychain but it gave good results”). (See Table 3.) Justifications were independently coded by two coders, and an interrater agreement of 82.5% was obtained. Unsurprisingly, justifications of successful learners were more likely to be evidence based. Only adult participants, however, included explicit, metacognitive reference to the disparity between expectation and outcome in their final justifications. This does not, of course, rule out the possibility that younger successful learners were nonetheless aware of the disparity, and we in fact have anecdotal comments from a few younger participants that we present later indicating that they did have such awareness.

Our main concern is interpretation of the difference in performance between the younger and older groups. Is the inferior learning of the younger group attributable to differences in the learning process itself, or can other factors be invoked? One possibility is that despite the prominent display of the correct answer (in Case 5), learning depends on application of the particular inference strategies noted earlier (in which two cases are compared) and these inference strategies are more available to the older group than to the younger group. To evaluate this possibility, we identified use of these strategies during the earlier portions of the presentation (prior to presentation of Case 5). Two basic strategies can be identified, both involving comparison of two cases that differ with respect to only one feature, for example, abc versus ab. An inclusion strategy notes different outcomes for the two cases, leading to the inference that the c feature has an effect. An exclusion strategy



notes identical outcomes for the two cases, leading to the inference that the *c* feature has no effect. As noted earlier, the sequence presented allows for two valid inclusion inferences and two valid exclusion inferences.

Protocols of all participants who did not produce a correct final response were examined for inclusion and exclusion inferences, with or without accompanying verbal justifications. Strikingly, of the 13 incorrectly responding children, all 13 displayed correct use of at least one of the two inference types, and some showed both. In other words, the appropriate inference (inclusion or exclusion) was made at an appropriate point in the presentation, based on accurate interpretation of the evidence. Percentage of incorrect child respondents showing an inclusion inference was 62%, and percentage showing an exclusion inference was 77%. The majority of these (100% of inclusion inferences and 80% of exclusion inferences) were accompanied by explicit verbal justifications (e.g., “It came out just as good without it.”). These percentages were not inferior to those shown by incorrect adult respondents (100% of 4 adults making an incorrect inclusion inference and 50% of 4 adults making an incorrect exclusion inference). Moreover, percentages were comparable among child and adult respondents who gave *correct* final answers (100% for inclusion and exclusion for adults and exclusion for children and 83% for inclusion for children). The implication, then, is that inability to interpret the presented evidence cannot account for differential performance between the two age groups on the final assessment of learning and other explanations must be sought.

## DISCUSSION

In addressing the central question of how to interpret the difference in performance between the two age groups, it should first be highlighted that performance of the two groups overlaps substantially. Individual variation is high, with some 12-year-olds performing as well as the typical adult, and some adults performing no better than most 12-year-olds. Nonetheless, a developmental trend from late childhood to early adulthood clearly exists, in the direction of performance like that of the successful adults. How should it be explained? Why does the typical adult learn the presented set of relations more effectively than the typical 12-year-old?

Explanations in terms of developmental factors such as processing capacity or efficiency are not likely because time is not a factor and all information remains displayed. Nor is differential ability to interpret the evidence, as reported in the Results section. Another factor commonly invoked in accounting for developmental differences is knowledge. The content of the task presented here, however, makes a knowledge explanation unlikely. There is no reason to suppose that the older group had greater knowledge about people’s preferences in teddy bear accessories. A

major criterion in selection of the task content was equal familiarity to the two age groups.

Another frequent explanation of developmental differences is that one group understood the task differently than the other or kept the task goals in mind less well than the other. To minimize the latter likelihood, instructions were reiterated throughout, and, in particular, a follow-up question was included after the final question in which the task goals (maximize donations and minimize expense by minimizing accessories) were again repeated and participants permitted to modify their answer. Another possibility is a more subtle one having to do with demand characteristics, or rules of the game. Perhaps to a greater extent than younger participants, older ones interpreted the task as some sort of arbitrary logic game, in which the object was to interpret the presented relations between conditions and outcomes apart from any genuine meaning attributable to them. To explore participants' interpretations of the task, we examined their verbal explanations during the sequential presentation and in particular were alert for any differences in approach across age groups. We found no evidence that either group ceased the effort to make sense of the results as the presentation progressed. The proportion of responses following each presentation that included some attempt to make conceptual sense of the outcomes (i.e., included a theory-based component) remained very high (more than 90%) for both groups. Following, for example, are typical responses:

Oh, okay, and now just three, and it's the same. So, obviously the hat [c] didn't affect it very much. Nobody really wanted the hat. With or without the hat. Because the sweatshirt has a hood, so why would they need a hat? [A11,<sup>1</sup> following Presentation 2]

So this means people like the mouse [d] better, and the shoes [b] that make it look good. Because they have so much color, they are attractive. [A9, following Presentation 5]

The hat and the sweater (Why?) 'Cause the hat and the sweater puts on 20% of donations. When you have four it was 20%. But you really don't need the shoes or the backpack, because the bear's not going nowhere. All he's doing is staying in the corner. [C4, following final presentation]

In each of these cases, the participant appropriately interprets the data but then goes on to seek an explanation that makes sense of it.

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<sup>1</sup> A = adult; C = child.

### The Executive Thesis

It is not the case, however, that we found no differences in sense-making approaches across groups, which brings us to the explanation for the age group difference that we propose. Older participants, we propose, are more likely to employ a metalevel executive that allows them to simultaneously maintain dual representations, one a representation of their own understanding (of the relations they expect or see as most plausible) and the other a representation of the new information they are being asked to register. The executive allows these two representations to become objects of reflection and to be maintained simultaneously and attended to flexibly. It is this executive control that enables an individual to temporarily set aside or *bracket* existing beliefs and thereby effectively inhibit their influence on the interpretation of newly presented data. In the absence of this executive, there exists only a singular experience—of “the way things are”—that serves as a framework for understanding the world. New information may be assimilated to it, but no executive is available to monitor and manage the process.

These contrasting characterizations represent opposing ends of a continuum, with much cognitive functioning taking place somewhere on the continuum between the two. More specifically, in the middle range of this continuum there exists a weakly functioning executive not able to consistently maintain the dual representations required. Many of the responses we observed are suggestive of this weak executive. Common is a single depiction to which both theory and data contribute. For example:

The sweatshirt [a] and the shoes [b]. (Why?) I like them better. I think they have a better chance. (Do the results we've seen show that?) Yes. [C13,<sup>1</sup> final choice]

I would suggest the keychain [d] the mouse [b] and the sweatshirt [a]. (Why?) Because the sweatshirt matches with the mouse and without the sweatshirt you can't attach the keychain. [C15, final choice]

Others exhibited more difficulty in integrating theory and data into a single portrayal:

I'd never think the sweatshirt [b] and the keychain [d] [would do well]. I think the shoes [a, not present] probably are the bigger add to it, 'cause you rarely see a teddy bear with sneakers. [C20, following Presentation 5]

So, I don't get it. How is this one 20% and the first two also 20? (What do you think?) The shoes [a] and the sweatshirt [b] really matter. People think it's cute. But the keychain [d] is ... without the keychain it'll still be 20, so

why is the keychain still involved in it? (What do you think?) I really don't know. Maybe they're trying to get more money from people. (So what's this last case saying?) Right now they're being picky. I'd really prefer the sweatshirt [b] and the shoes [a]. (So what do these results say?) The sweatshirt and the shoes. The shoes are not in. There is something wrong. (The results did show it went up 20%.) It's confusing me! Probably because they like the keychain [d]; it has glasses and a little hat. But people are not gonna take it out 'cause it's gonna be annoying. [C18, following Presentation 5]

One child expressed awareness of his own developing capacity for the required dual representations:

Sometimes I just get off track and say things are not important when almost anything is important to other people. 'Cause that's my opinion. 'Cause a lot of things that's important to other people aren't things that are important to me. [C16, following Presentation 5]

### Executive Control of Learning

Successfully performing adults and children, in contrast, showed markedly different reactions. They had no difficulty maintaining distinct representations of their own expectations and the information presented. For example:

I guess the keychain did affect it. The keychain is cute. It's really cute, but I didn't think it would have affected it that much. But I guess it does. [A1, following Presentation 4]

For me I think the mouse is not necessary. But it may be that the mouse makes the bear look more attractive. [A9, following Presentation 3]

I don't know why that happens, because they both look good to me [C11, following Presentation 4]

It is important to keep in mind that the participant's task in this study is merely to register and characterize the presented information. Commonly, people confront the further challenge of coordinating new information with existing beliefs to reach their own new beliefs and understandings. Although we do not examine that process here, it clearly requires registering and representation of the evidence as an initial step. Hence, those who are not successful in the task examined here are unlikely to fare well when faced with this more demanding challenge.

## The Role of Familiarity

How does a concrete, familiar everyday context, like that we employed here, affect learning? Much research supports the facilitative effect of a familiar context. If the task entails only performance, rather than learning, or if the material to be learned is consistent with what is already known, the facilitation effect is likely to hold. An abstract problem full of *ps* and *qs* suddenly becomes transparent when it is translated into one of having the ticket that grants permission to enter the hall.

But what about the situation in which the material to be learned conflicts with existing understanding? In this realm of misconceptions, contextualization of the new material may make it more, rather than less, difficult to acquire. As seen here, for example, compared to a noncausal belief, belief that a feature causally affects an outcome is difficult to relinquish in the face of discrepant evidence. Or, more precisely in this context, the discrepant evidence is more difficult to register. Unsurprisingly, then, discrepant evidence in a social domain, where beliefs may be more strongly held, is more difficult to process than the same evidence in a physical domain (Kuhn et al., 1995).

The thesis proposed here offers an explicit way to conceptualize such findings. To the extent to which an individual holds detailed, elaborate, vivid, and affectively potent existing theories, which a familiar context facilitates, a weak executive operator makes it more difficult to maintain the needed dual representations (of theory and evidence). A less potent representation on the theory side may give the two representations a better chance to coexist while an executive seeks to coordinate them.

## The Development of Learning

What, then, are the implications of the data we have presented with respect to our original question? Does learning develop? Some years ago, Carey (1985) answered this question with a categorical no, claiming there was no reason to believe that the learning process operated any differently in children than in adults. The results presented here suggest that Carey's sweeping claim, although containing some truth, is not entirely correct.

Our answer to the question of whether learning develops is the inevitable qualified one that social scientists are well known for: It depends. Specifically, it depends on the individual and on the learning task. A great deal of the learning children and adults engage in, both in and out of school, is simple associative learning. It is not mindful learning, and there is no evidence to indicate that the nature of associative learning processes undergoes developmental change. It certainly does not disappear with development, to be replaced by another kind of learning, as the Kendlers' account implied. It is not, however, the only kind of learning that hu-

mans engage in, nor the kind that Schoenfeld (1999) had in mind in defining learning as “change in understanding.”

Indeed, a major criticism of the learning that goes on in schools today is that too much of it is associative and not enough is conceptual, that is, requiring cognitive engagement on the part of the learner (Kuhn, 2005). These kinds of learning invoke executive processes, as mental resources must be allocated, monitored, managed, and reflected on, as part of the learning process. For these reasons, there is considerable contemporary interest in the development of executive processes and their influence on academic performance (Williams et al., 2002).

The findings presented here underscore the fact that executive control of mental processes does not emerge at one discrete point in cognitive development. In Zelazo et al.'s (2003) studies, preschoolers were in the process of developing executive control of a very simple activity requiring dichotomous categorization on a single variable (e.g., blue or orange) in the absence of prior theoretical expectation. These control functions will undergo years more of exercise before they are developed sufficiently to manage our deceptively simple task, which entails mental management of one's own prior expectations in addition to new information that specifies relations between multiple variables. And some individuals, the findings presented here suggest, may never attain the needed level of executive function. Indeed, all indications are that interindividual, as well as intraindividual, variability in executive function is the norm in adulthood (Diamond & Kirkham, *in press*; Kuhn, 2001; Zelazo, Craik, & Booth, 2004).

The thesis we proposed at the outset of this article is that with development, executively controlled learning becomes more frequent. Yet, the interindividual variability just noted remains one of our major findings. It is also a finding that offers some insight with respect to the difficult question of how executive functions develop (or fail to develop). Many childhood cognitive attainments are quite closely age linked. Mastery of Zelazo et al.'s (2003) executive control task at age 4 or 5 years (but rarely before or after) is an example. In the case presented here, in contrast, we observed a number of 12-year-olds exhibit mastery on a task that a significant number of adults failed. This fact tends to rule out general experience as an explanatory factor in the development of the executive processes alleged necessary for success. Compared with 12-year-olds, young adults have had 10 or more additional years of experience learning things, making causal inferences, acquiring all sorts of knowledge that 12-year-olds lack. Yet this experience was not a sufficient condition for adults' success on the task. Nor were these years of experience a necessary condition for success on the part of many 12-year-olds. Some more specific kinds of experience are thus implicated.

Empirical studies focused on metacognitive or executive processes are relatively recent in the study of cognitive development, as are empirical studies of mechanisms of developmental change. Research addressed to the intersection of

the two thus remains largely a project for the future. Microgenetic research, however, has proven productive in the study of mechanisms of change, and this method offers a promising lead in pointing to consistent exercise of cognitive functions as a sufficient condition to promote their development (Kuhn, 1995; Kuhn et al., 1995). The findings presented here suggest that some 12-year-olds have become as capable as many adults in managing the interaction of theory and evidence in their own thinking, in a way that supports effective learning. Microgenetic studies of more and less skilled young people engaged over time in acquiring knowledge promise more insight into how these skills of mental management develop.

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