School Bus Seat Belts and Carryover Effects in Elementary School Children

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 811 187		

4. Title and Subtitle	5. Report Date
School Bus Seat Belts and Carryover Effects in Elementary School Children	October 2009
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
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9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
National Highway Traffic Safety Administration 1200 New Jersey Avenue SE., NTI-130 Washington, DC 20590	11. Contract or Grant No. N/A

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Highway Traffic Safety Administration 1200 New Jersey Avenue SE., NTI-130 Washington, DC 20590	White Paper
	14. Sponsoring Agency Code NTI-131

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16. Abstract

The purpose of this paper is to explore the proposition that the lack of seat belts on school buses increases the likelihood that elementary school children will not use seat belts in personal vehicles. The paper reviews the limited evidence on this "carryover" effect and looks at current knowledge and understanding of human learning and cognitive development as it applies to the potential carryover effects of no seat belts on school buses to seat belt use in personal vehicles. This paper focuses specifically on children ages 5 to 10.

17. Key Words	18. Distribution Statement
Buses, Seat Belt Use, Children, Carryover Effects	Document is available to the public from the National Technical Information Service www.ntis.gov

19 Security Classif. (of this report)	20. Security Classif. (of this page)	21 No. of Pages	22. Price
Unclassified	Unclassified	20	

Form DOT F 1700.7 (8/72) Reproduction of completed page authorized

Executive Summary

In July 2007, the National Highway Traffic Safety Administration (NHTSA) held a public meeting to bring together a roundtable of State and local government policymakers, school bus manufacturers, seat manufacturers, pupil transportation associations, and public interest groups to discuss the issue of seat belts on large school buses. This review was conducted to update agency information about an issue relating to seat belts on the large school buses.

The purpose of this paper is to explore the proposition that the lack of seat belts on school buses increases the likelihood that elementary school children will not use seat belts in personal vehicles. The paper reviews the limited evidence on this "carryover" effect and looks at current knowledge and understanding of human learning and cognitive development as it applies to the potential carryover effects of no seat belts on school buses to seat belt use in personal vehicles. This paper focuses specifically on children 5 to 10 years old.[1]

In 1986, NHTSA funded a study by Gardner, Plitt, and Goldhammer that investigated the carryover effects of seat belts on school buses. The study found that whether seat belts were on school buses had little effect on student's use of seat belts in personal vehicles. Students reported that parents and mandatory seat belt laws played a significant role on their seat belt use in personal vehicles. While this study was conducted over 20 years ago, the lack of carryover effects is expected to still apply today.

In the intervening years since the study was published, much has changed in terms of policies and laws related to occupant safety, especially for passenger vehicles. Most States now require the use of seat belts for drivers and front-seat passengers; and *all* States require that children be secured in some form of child passenger protection device for very young children (i.e., child safety seats or booster seats) or by seat belts. Fewer changes have been made to implement occupant protection measures, such as seat belts, for other means of transportation such as school buses, city buses, and trains.

The mechanisms of human learning, however, are relatively constant. While much has changed with regard to policies and laws on occupant safety, theories on human learning and cognition suggest that vehicles with different restraint systems are not confusing to most children.[2] Human learning is often constrained to the situation in which it is learned, resulting in very little transfer across situations. Thus, information that is learned in one context, the school bus, has very little chance of transferring to another context, the personal vehicle. This occurs because learning is associated with the environment in which it is learned and will more likely be remembered in that specific context. In addition, specific feedback leads to situation-specific learning. If children receive specific explanations on why buses are different from cars, then they should be able to accept the inconsistent information on seat belt usage, and should be less likely to transfer their knowledge that they do not have to wear seat belts on buses to personal vehicles. Another

[1] While the effect of lack of seat belts on school buses is important to discuss with regard to pre-teen (11 to 13 years old) and teenage seat belt usage, this paper does not focus on these age groups because pre-teens and teens have a different set of developmental issues when it comes to seat belt usage.

[2] Throughout this paper *children* will refer to those in elementary school, which typically covers 5- to 10-year-olds.

factor that allows children to keep buses separate from cars is that scripts[3] can vary for similar situations. The behaviors and sequence of actions for riding in a car are different from the behaviors and sequence of actions for riding in a bus. Children's understanding of scripts helps them learn that what is done in one situation can be different in another situation.

This context-specific learning is often more pronounced in children for several developmental reasons. When children first learn a rule, they are often consistent and rigid in their application of the rule. For instance, once children know the rule is to wear seat belts in personal vehicles, they apply that rule with adamant consistency (sometimes to the chagrin of the other occupants). As children become teenagers, they begin to question inconsistent information and are able to integrate the inconsistent information into their understanding of the world. These changes in children's thinking are associated with the development of the brain from less organized to organized.

Socialization can play a key role in helping children to understand that while they do not need seat belts on buses, they do need them in personal vehicles. More specifically, parents play a significant role in shaping children's behavior and ultimately have control over children's seat belt use in personal vehicles. Parents model seat belt usage, they teach children what is right and wrong, and they can provide positive reinforcement to their children when their children correctly use seat belts.

Based on these issues, it is *unlikely* that children will assume that because they do not have to wear seat belts in school buses they do not have to wear seat belts in cars. This is because:

- Knowledge often does not transfer across situations. More specifically, children will be less likely to make the assumption that buses and cars are the same if they are given specific feedback that buses are not only different than personal vehicles but are designed to be safe without seat belts.
- Children and adults create scripts for separate events. The sequence of events and actions for a bus are different from the sequence of events and actions for a car, thereby allowing children to learn different and seemingly inconsistent rules.
- Once children learn a rule, they become consistent and rigid in their application of the rule within its context. Once they learn seat belts are necessary for riding in personal vehicles, they apply the rule to themselves and to all occupants in the vehicle.
- The immature development of the brain contributes to children's compartmentalized thinking and allows children to make a distinction between buses and cars.
- Ultimately, parents play a significant role in teaching children the importance of wearing a seat belt in personal vehicles by modeling the correct behavior, teaching children why seat belts are important in personal vehicles and reinforcing children's correct use of seat belts in personal vehicles.

[3] A script is a time-ordered sequence of behaviors that occur in a specific context.

School Bus Seat Belts and Carryover Effects

School buses are one of the safest forms of transportation in the United States. Every year approximately 474,000 public school buses, transporting 25.1 million children to and from school and school-related activities (School Transportation News, 2007), travel an estimated 4.8 billion route miles (School Bus Fleet, 2007). Over the 11 years ending in 2007, there was an annual average of 5 school-age children (younger than 19) killed on school buses involved in school-transportation-related fatalities. On average, there were 8 fatal crashes per year in which an occupant died in a school-bus-related crash (NHTSA, 2008). In 2007 there was only 1 school-age child killed on a school bus involved in a school-transportation-related crash (NHTSA, 2008). School buses are designed with a passive restraint system known as *compartmentalization* in which closely spaced, well-padded seats with high seat backs help to keep children safe without the use of seat belts. However, some proponents of seat belts on buses argue that compartmentalization is not consistent with current messages for children regarding the use of seat belts in all motor vehicles (American Academy of Pediatrics, 2007).

In 1986, NHTSA funded a study that investigated the possibility of carryover effects of seat belts on school buses (Gardner, Plitt, & Goldhammer, 1986). That study found that State mandatory seat belt use laws were the main predictor of children's seat belt usage; whether or not seat belts were on school buses had little effect on whether students used seat belts in personal vehicles. While this study was conducted over 20 years ago, and seat belt use among children has improved considerably, the lack of carryover effects is still expected to apply today.

In the intervening years since the study was published, much has changed in terms of policies and laws related to occupant safety, especially for passenger vehicles. Most States now require the use of seat belts for drivers and front-seat passengers; and *all* States require that children be secured in some form of child passenger protection device for very young children (i.e., child safety seats or booster seats) or by seat belts. Fewer changes have been made to implement occupant protection measures for other means of transportation (i.e., school buses, city buses, trains). The discrepancy between increased use of safety measures, such as seat belts, in personal vehicles but not in vehicles for mass transportation, has led some to conclude that an inconsistent message of seat belt use may lead some, especially children, to believe that there is no need to use seat belts in personal vehicles (American Academy of Pediatrics, 1996, 2007).

The NHTSA report (Gardner et al., 1986) serves as the sole study to directly address how children handle inconsistent messages regarding seat belts in cars but not in school buses. However, the nature of human learning and children's development suggest that children will be *unlikely* to think that they do not have to wear seat belts in personal vehicles if they ride in school buses without seat belts. Because of the scant literature in traffic safety regarding this issue, the purpose of this paper is to use psychological theories as a means of discussing limited carryover effects. In the sections that follow, we provide a description of theories covering the areas of cognitive (transfer, schemas, rule-based learning), physical (brain development), and psychosocial development (socialization, including the influence of caregivers) of elementary school children. These theories offer several rationales for *limited* carryover effects, especially in younger children (those 4 to 7 years old).

Transfer

Advocates for seat belts on school buses argue that children will transfer their knowledge that they do not have to wear seat belts on buses to all vehicles. There is a long research tradition in psychology and in educational research investigating carryover effects that are known in the literature as *transfer.*[4] In the psychological literature, transfer is "the process of using the knowledge acquired in one task to improve the learning of a related task" (Torrey, Walker, Shavlik, & Maclin, 2005, p. 1). However, the main issue in the literature on transfer is that knowledge does not automatically transfer across situations; and, for more than 30 years, researchers have attempted to understand the circumstances in which transfer will occur, especially in children and novices (Anderson, Reder, & Simon, 1996; Gick & Holyoak, 1980; Reed, Ernst & Banerji, 1974).

For instance, knowledge will transfer across situations when abstract instruction is combined with concrete practice. Scholckow and Judd (Judd, 1908, as cited in Anderson et al., 1996) had children practice throwing darts at an underwater target. One group of children received an explanation about the refraction of light while the other group did not. When the target was moved 8 inches up, children who received the abstract instruction and practice did much better than the children who only received practice. In other words, those who received abstract instruction and practice were able to transfer the knowledge they learned during the practice session to a new situation while the group that only practiced was unable to transfer what they learned in the practice situation to the new situation.

Complementary to this idea is the principle of *feedback specificity*, where frequent, immediate, and specific feedback leads to greater context-specific learning (Goodman & Wood, 2004). Children are less likely to transfer the information learned on a school bus to a personal vehicle if they are given developmentally appropriate explanations for any perceived inconsistency between the two situations. In addition, children are more likely to accept information from an adult they view as an expert (Danovitch & Keil, 2007). From a child's perspective, parents and school officials are the primary experts in keeping them safe.

In general, memory is often confined to a specific situation or context when it is taught only in that specific context (Bjork & Richardson-Klavehn, 1989) and this context-specific learning is enhanced with specific and immediate feedback (Goodman & Wood, 2004). For instance, a school bus is a context that is different from a car. School buses are large vehicles that transport many children to and from school. Personal vehicles, on the other hand, are significantly smaller than school buses, can only transport a small number of people, and are used for a variety of trips on both weekdays and weekends. In addition, the rules children learn in cars are different than the rules they learn in school buses. Before and during a child's experience with a school bus, children learn that they have to wear seat belts in personal vehicles. When they begin riding school buses, they learn that a school bus is a type of vehicle where they do not have to wear seat belts. Children can then be told that buses are designed to be safe without seat belts but personal vehicles like cars, trucks, vans, and SUVs need seat belts to keep people safe. Therefore, children can learn different kinds of information in two separate contexts and what they learn in each of these contexts will be confined to the particular situation in which it is learned.

[4] The terms *carryover* and *transfer* are used interchangeably throughout this paper.

Scripts

There are different sets of behaviors and sequences of events associated with riding in a personal vehicle as compared to those behaviors and events associated with riding on a school bus. Event-based schemas, or *scripts*, are another reason why children are able to discriminate between two situations. Scripts are sequenced, time-ordered arrangements of information. Scripts can be described as organizing mechanisms in long-term memory that help children and adults to retrieve information about a task or an event: what to do, who is involved, the timing and order of actions, and where it all takes place (Schank & Abelson, 1977). Even very young children (e.g., 2-year-olds, see Sell, 1992) are believed to use scripts to help organize information as it comes in and to rely on them to make predictions about familiar and recurring events (such as going to a restaurant or preparing for bed).

In the case of seat belts, children are likely to have a "riding in the car" script comprised of a set of tasks and behaviors that have an order, such as getting into and sitting down in the car (with or without a booster seat), putting on a seat belt, and closing the car door. This script would have carryover or transfer of knowledge to other cars with similar contextual elements (specifically to other's cars and vehicles with a similar interior set-up). There would be a different script for other vehicles with major differences in the context, order of events, and timing of actions (e.g., riding a bike, riding the subway, riding a school bus, riding a city bus).

Context-specific learning and scripts are not confined to children but can occur at all ages. Adults make use of similar scripts—they have one for riding on some form of public transportation (such as a subway or city bus) that usually has no seat belt, another script for riding in a personal vehicle, which does have seat belts, and possibly an old script for riding the school bus when they were children themselves.

There are additional developmental mechanisms that can also provide insight as to why transfer is less likely to occur between school buses and personal vehicles. The development of consistent thought processes and brain development also contribute to the lack of knowledge transfer.

Consistency of Rule Use

Before most children begin riding a school bus, they learn the rule from their parents that occupants in vehicles should always wear seat belts. In fact, children learn the rule so well that they often reprimand other occupants who do not wear seat belts. The development of children's systematic rule use is believed to begin as they start to follow and form grammatical rules as older infants and as toddlers. As children approach their third and fourth years they begin to show more consistent behaviors regarding the use of rules on routine tasks, but still require external feedback to apply them and to help them understand them. Siegler's studies describe how children acquire rules, specifically in academic tasks (Siegler & Chen, 2002). His theories of rule- and strategy learning can also be applied to real-world behaviors such as seat belt use.

Through analyzing his and others' previous works on rule use and strategy use, Siegler formulated four processes that can be applied to the development of the understanding and use of rules, strategies, and of new information. First, Siegler proposes that the child must initially *notice* the information that they had not paid attention to previously. Second, the child begins to make sense of the information by *formulating* a rule associated with the novel information (these

make sense of the information by *formulating* a rule associated with the novel information (these rules can be self-generated or externally generated). Once the rule has been acquired, children begin to *generalize* the rule by applying it consistently, in which case they tend to do so in a strict and rigid fashion, usually on one specific task. They use the rule in the way they learned it and still need feedback for how and when this information can be applied. Fourth, the culminating process occurs when the rule is *maintained*. Once children are able to maintain a rule, they are able to use the rule in a flexible fashion. With little help from others, they are able to use the rule as it was originally learned *and* to manipulate aspects of the rule for appropriate use on similar *or* different tasks. The sequence of Siegler's processes should occur each time one starts a novel task, learns new information, or is presented with unfamiliar rules.

The essential features of Siegler's four processes can be used to explain how information is acquired and how one learns the rules on any number of tasks. With regard to seat belt usage, toddlers begin to notice that they should always be secured in their car seats. When a mother accidentally forgets to tighten the straps of the car seat, the toddler will say, "Oh-oh, Mommy!" and taps the restraints on his seat. When the mother tightens him in, the child begins to develop a rule that he should always be secured in his car seat. As children get older and the rule is acquired, he begins to generalize the rule to all passenger vehicle occupants. Not only must the child abide by the rule, but all vehicle occupants must also be secured in their seats with seat belts. As children gain more experience in a variety of contexts such as riding in friends' cars, riding in relatives' cars, riding in buses, and riding in trains they develop a more flexible understanding of the rule, namely that seat belts are not as necessary for mass transit as they are in personal vehicles.

In essence, once young children acquire a rule they become rigid in the way a rule is applied. Many studies demonstrate young children's mental inflexibility in the cognitive literature. For instance, using the Dimensional Change Card Sort (e.g., Brooks, Hanauer, Padowska, & Rosman, 2003; Happaney & Zelazo, 2003), researchers first ask children to sort a stack of cards according to one rule (for example by the color of the pictures on the cards); later they ask the children to switch to another way of sorting the cards (e.g., by shape). One of the regular problems for younger children performing these tasks is that they find it hard to inhibit an old rule they have used regularly for a new rule (and to switch back and forth). As children get older, they become better at inhibiting the use of old rules for new rules and information.

There are several examples in the development of social cognition that also illustrate young children's rigid thinking. Nobes (1999) conducted a study on how children spontaneously develop rules for games. Nobes observed that when playing games with self-generated rules, children demonstrated flexibility while inventing rules. However, when playing the game later with a different group, the children enforced the rules as if they were "unalterable and non-negotiable" (p.1).

When an inconsistency in a message exists, young children are least likely to notice the inconsistency; and when children do notice, they are more likely to question an adult rather than another child (Elrod & Milner, 1986). Though Elrod and Milner's study demonstrated that children prefer adults over peers to help them with inconsistent information, a related study found that younger children do not discriminate who provides this instruction. Older children,

however, choose advisors based on domain of expertise (Danovitch & Keil, 2005). A last idea that supports Siegler's processes is a study from Sobel (2002) that investigated how young children deal with counterfactual information. He found that those with lower levels of expertise in a domain (i.e., novices and younger children) are less likely to explain causal connections and to generate counterfactual information about an event (see also Dixon & Tuccillo, 2001).

Brain Development

Children's ability to handle inconsistent information is related to the trajectory of brain development. Children are able to handle inconsistent information because their brains are less interconnected than those of adults (Happaney & Zelazo, 2003). The limitations of their developing brains are believed to be the physical basis for their less-developed cognitive and social skills, which are characterized by the rigidity of their thinking and compartmentalized knowledge.

Furthermore, an underdeveloped prefrontal lobe contributes to children's difficulty with inconsistent information and rules that interfere with practiced information (Nagahama et. al., 2001). According to Happaney and Zelazo (2003), the specific portions in the prefrontal cortex that are less well-developed contribute to a lower degree of connection between hemispheres, slower efficiency of processing of information, greater difficulty with inhibition, and problematic decision-making.

The children's game "Simon Says" is a real-world illustration of children's physical and cognitive limitations. Children receive directions that require them to perform a highly practiced behavior (i.e., to perform a directive such as "clap your hands") *only* when they hear a specific qualifier (e.g., "*Simon says* 'clap your hands'"). This presents difficulty for young children because of their underdeveloped prefrontal cortices; it is challenging for them to *inhibit*, or stop, an action, especially one that is highly practiced (Zelazo & Jacques, 1997). A highly practiced behavior, such as putting on a seat belt, is hard for children to inhibit. Children will continue putting on their seat belts in cars because this action is a highly practiced one that regularly occurs in a particular context (the personal vehicle). The highly practiced nature of seat belting would preclude any carryover effects from not wearing a seat belt on a bus.

As the physical development of the brain continues and the aforementioned problems subside, there is still the matter of the development of cognitive (e.g., memory, rule usage, attention) and social skills (e.g., moral matters, sociocultural rules) that continue even as brain development begins to stabilize. Because children have brains that are less mature, interconnected, and efficient, they would be expected to exhibit *less* carryover of information, and to have *more* difficulty recognizing commonalities among scripts, rules, and social information. The actions performed to wear a seat belt in a car are highly practiced in a specific context (usually in one's personal vehicle). As their brains are still developing, children are likely to represent the behavior *solely* with the context in which it occurs (though there may be other behaviors that are relatively similar). Since much of the information in their brains is held separately (i.e., compartmentalized), children have little difficulty when presented with information that is inconsistent with that presented previously. Caregivers play a considerable role in making these inconsistencies explicit, and also in making sure that children perform and practice the appropriate behaviors (especially those associated with safety).

Socialization

Ultimately, whether or not children wear seat belts in personal vehicles is dependent on what their parents' model and enforce. Studies have consistently found that driver restraint use is related to the restraint use of children (Agran, Anderson, & Winn, 1998; Decina & Knoebel, 1997; Miller, Spicer, & Lestina, 1997; Russell, Kresnow, & Brackbill, 1994). Restraint use among children under 10 was 75% when the driver was restrained and 27% when the driver was unrestrained (Agran et al., 1998). Regardless of what a child says, parents are ultimately responsible for whether or not their children are restrained in vehicles. Just because a child says he does not have to wear a seat belt in car because he does not wear one on the school bus does not mean that the parent has to concede. In a study conducted by Gardner, Plitt, and Goldhammer (1986) on the carryover effects of school seat belts, Gardner et al. found that parents were a factor on whether or not children wore seat belts in cars after riding in buses without seat belts. "Students said that parents, mandatory State belt use laws, and other car companions played more dominant roles in shaping their use of car belts than did school bus belt programs" (p. 14). Even when students rode buses with belts, they reported that parents were the strongest influence on their seat belt use.

Parents are a vital influence on children's understanding of right and wrong that can have a large impact on children's seat belt usage. Parents' domain-specific feedback about the nature of children's moral interactions provides a cognitive mechanism for facilitating moral development. Parents guide children's understanding of right and wrong by providing domain-appropriate and developmentally sensitive reasoning and explanations about the child's social world (Smetana, 1999). Therefore, children will better understand and be more likely to comply with seat belt usage in vehicles if parents model seat belt usage and provide developmentally appropriate explanations on why seat belts are needed in cars and not in buses.

Summary and Discussion

Each of the above sections provides some insight as to why children show little difficulty in dealing with seemingly inconsistent messages like the use of seat belts in cars but not in school buses. Research related to *transfer* demonstrates that children are constrained by their inability to perceive similarities and use them on similar tasks. Adults facilitate children's transfer by providing explicit information about the commonalities between tasks as the children learn the task and when they perform it. Children use *scripts* to help them understand and predict events that are highly familiar. Nonetheless, these scripts are highly context-based and there is little carryover from one script to another, mainly because the scripts are learned in the contexts in which the actions are performed. Studies investigating the *consistency of rule use* show that as children become increasingly reliable in their ability to use rules, they are very rigid in their use of the rules; as their mental ability develops, they become more flexible in the application of rules.

Brain development provides a physical explanation regarding children's acceptance of inconsistent messages. Unlike adults who have well-connected and highly efficient brains, children's brains start off with fewer neural connections. This is believed to be a contributing factor to why children are able to compartmentalize information. As their brains mature, children become more effective in perceiving relationships among similar events, rules, context, ideas, and behavior. The efficiency and interconnectivity of the adult brain makes it possible for them to notice and question information that is inconsistent, counterfactual, or irregular.

Last, through continual *socialization* children are trained to behave in certain ways in certain contexts. Parents and caregivers play a vital role in providing guidance for safety behaviors. Clearly, it is important that parents and caregivers understand that different restraint systems are needed on buses and personal vehicles in order to convey the right information to children. Future NHTSA research should determine gaps in parental and caregiver knowledge of passive and active restraints systems and assess what parents teach their children to better understand where parental and caregiver education can fill in the gaps.

As children enter the pre-teen and teenage years, they are able to cognitively handle inconsistent information but enter a new stage of social development that can be at odds with what they may know. Pre-teens and teenagers define who they are by testing limits, asserting independence, and conforming to their peer group. Essentially, pre-teens and teenagers are more of an issue when it comes to not wearing seat belts than younger children, independent of seat belt usage on school buses. However, the developmental issues that pre-teens and teens face can only be addressed in a separate paper and is an additional avenue of further research to better understand how to effectively reach teenagers about seat belt usage.

Certainly, it is important for consistency to exist in a child's life. For instance, children learn discipline when parents consistently administer positive consequences for good behavior (cookies after doing homework) and negative consequences for bad behavior (time outs or removal of a favorite toy). In addition, children are often secure and able to thrive in environments that are consistent. When routines are unpredictable, as in the case of a move or divorce, young children experience emotional anxiety and have difficulty in their day-to-day lives. Even less drastic changes in a child's routine like vacations can negatively affect a child's life. Inconsistent routines are often considered as contributors to sleep problems in children.

However, there will always be times in a child's life where it is important to recognize inconsistency and behave in inconsistent ways. Mastery of the intricacies of social interactions compels children to learn to respond differently depending on the situation. For instance, children are always told they should not lie; however, they learn that in some situations it is okay to tell a white lie for politeness purposes (Talwar & Lee, 2002). Children are also taught that they have to mask their disappointment if they receive an undesirable gift. Therefore, learning that a seat belt is necessary in one context but not in another is not only within a child's ability to learn but is one of many situations in a child's life where the child has to learn about inconsistent behaviors. Children's mastery of the complexities of a dynamic environment takes quite a long time to develop. However, the culture provides many knowledgeable experts (including parents, teachers, peers, etc.) to give support in the cognitive and social areas in which children are lacking.

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DOT HS 811 187
October 2009

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