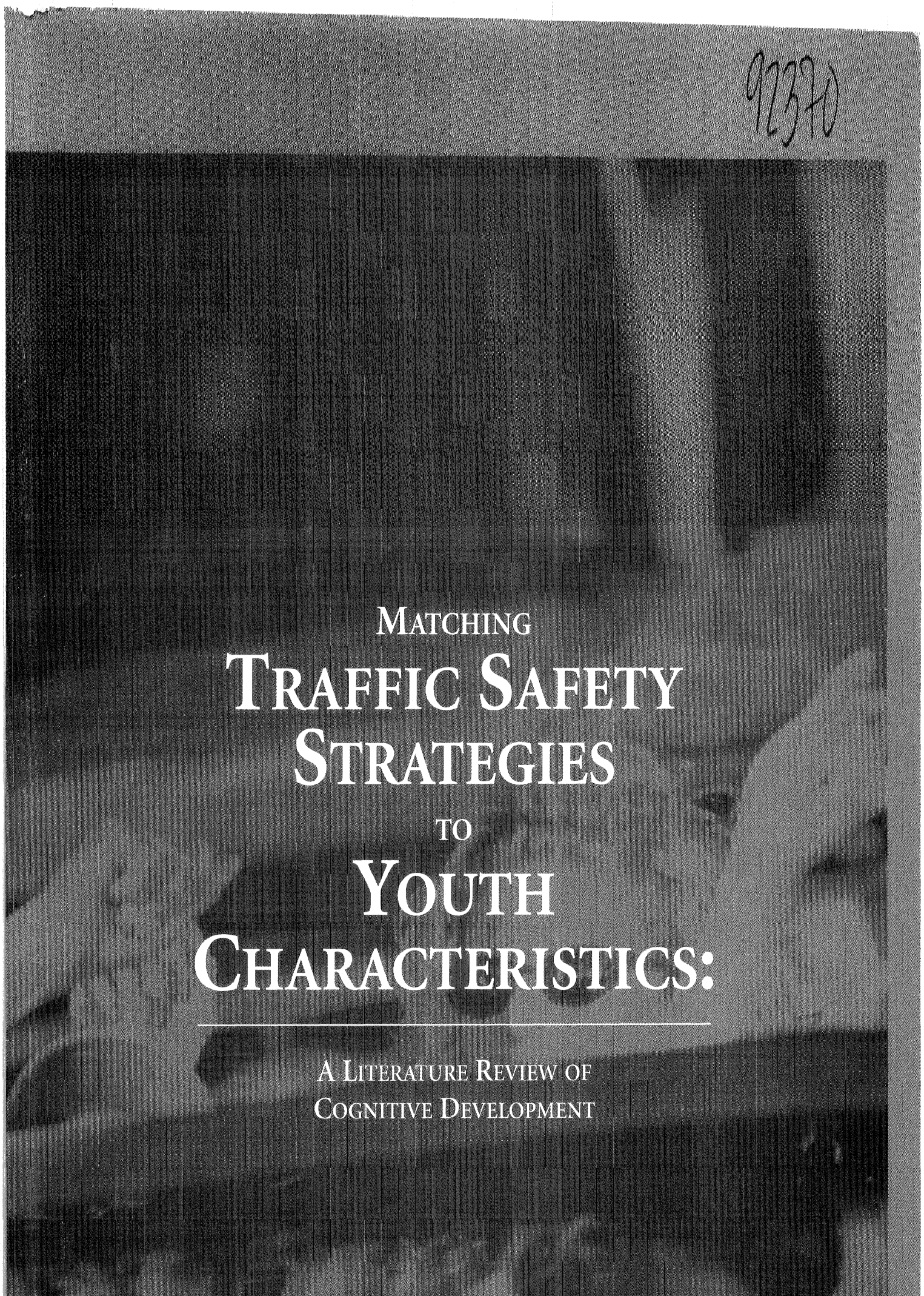

Matching Traffic Safety Strategies to Youth Characteristics:

A Literature Review of Cognitive Development

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16. Abstract

In an effort to reduce the high crash rate and resulting injuries of young drivers, the National Highway Traffic Safety Administration has sponsored research to assess the factors responsible for this heightened crash risk and to determine the implications for traffic safety programs. As part of this research, this review of research literature was conducted to determine what is known about cognitive development and information processing capabilities of youth. The goal of the project was to ascertain how traffic safety programs should be structured to match these cognitive characteristics. The review is divided into 12 sections. This literature review focuses primarily on cognitive development from about 10 to 24 years of age. The first section is about *memory*; that is, the processes that allow a person to retain knowledge over time. The second section, *attention*, discusses the factors related to the development of how people focus cognitive resources on perceptual or mental tasks, including selective, divided, and sustained attention. The third section, *learning*, discusses the processes by which people acquire information. The fourth section, *reasoning*, discusses types of reasoning and the problems young people have with this type of thinking. The fifth section, *motivation*, examines the factors that initiate and influence the intensity of behaviors. The sixth section, is a discussion of the development of *risk perception* and factors that contribute to the misperception of risk. The seventh section discusses the development of *problem solving and decision making* in a general way. While influenced by all other cognitive factors and their age-related limitations, general deficits of problem solving and decision making ability are discussed. The eight section, *social cognition*, covers those topics in the development of social cognition that are likely to have an effect on driving: attribution theory and social schemata/scripts. The ninth section, *attitude formation and change*, discusses several factors related to attitudes and persuasion. The tenth section examines briefly the development of *verbal ability*, that is, all use of language. Because many traffic safety messages and programs deal with moral issues in driving, the eleventh section is a review of *moral development*. Finally, because of the influence of his ideas on the field of cognitive development, the review concludes with a section on *Piaget's theory of cognitive development*.

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Executive Summary

Introduction

- Teenage drivers have by far the highest fatal crash involvement rate of any age group.

- One significant factor related to the elevated crash rate of young drivers is the frequency with which they engage in risky-driving behaviors.

- In an effort to reduce the crash propensity of young drivers, the National Highway Traffic Safety Administration (NHTSA) has begun a program of research designed to understand better the factors related to the high crash rate, in particular risk taking, for drivers under 25 years of age. A special focus of this program is to develop a conceptual framework for understanding young driver risk taking for use in the development of more effective traffic safety programs and messages.

- NHTSA has recognized that a conceptual framework for understanding risky-taking behaviors must include both internal (e.g., memory, attitudes, and risk perception) and external factors (e.g., family, peers, and environment). The focus of this review is the internal factors.

- As a way to define terms and to conceptualize risk taking driving behaviors from a cognitive perspective for this project, a cognitive model of risky-driving behaviors is presented that includes areas where traffic safety messages and programs (interventions) might be applied to increase the likelihood of safe driving. The model conceptualizes risky and safe driving behaviors as the outcome of a decision making process in which risky driving may be chosen over behaviors that are less risky because the risky driving affords the person greater perceived benefit.

- This project has two main goals. The first is to gain a better understanding of the internal factors in the risk taking conceptual framework. The second goal is to develop preliminary guidelines for constructing traffic safety messages that are based upon how young people process information. Both goals are achieved by reviewing the literature on several topics related to how young people think and process information, and through discussion with subject-matter experts. The guidelines are still under development.

Memory

- Traffic safety messages that cannot be remembered or recalled effectively when necessary will have little or no impact on a person's driving behaviors. It is, therefore, critical for readers interested in constructing traffic safety messages for

young people to understand how human memory develops and functions.

- Short-term memory (STM) has been described as working memory because it is the type of memory used for ongoing cognitive activities. It has also been characterized as the conscious part of memory where activities such as decision making, reasoning, symbol manipulation, and problem solving take place.

- Studies on STM capacity have shown that children can recall less information from STM than adults, suggesting that STM capacity may increase up to about 14 years of age. Thus, until this age, children cannot think about as many items at the same time as can adults. In addition, the speed at which information in STM can be processed increases up until about age 17. Therefore, any cognitive process requiring short-term memory, such as decision making, reasoning, or understanding a traffic safety message will proceed at a slower rate for younger people.

- Long-term memory (LTM) stores our experiences and knowledge. LTM capacity seems to be unlimited. The main difference between children and adults in LTM is that adults, through education and experience, have more knowledge about the world and specific strategies for dealing with potentially dangerous situations such as the situations that lead to risky driving. This specific knowledge allows adult drivers to more effectively problem solve and make decisions, assess the actual risk of certain behaviors, process the information in messages and programs, predict the outcomes of their behaviors, and think about the consequences of their behaviors in a more global way than younger drivers.

Attention

- Attention is a process of concentrating or focusing limited cognitive resources to facilitate perception or mental activity. Thus, attention is a process that is necessary for information processing--the information will not get into memory if it has not been attended to. In order to perceive, interpret, and understand a message, such as a traffic safety message, children or adults must be able to shift their attention to the appropriate message while filtering out other stimuli (called selective attention). Further, since they might be able to devote only part of their attention to the message (called divided attention), they must be able to devote enough attention to the appropriate message. They must also be able to focus their attention long enough to receive the entire message (called sustained attention). A lack of capacity in any of these attentional processes could lead to either a misunderstanding of traffic safety messages or a complete failure to receive them.

- The ability to filter out irrelevant and to focus on appropriate information increases up to about 17 to 20 years of age.

- The ability to divide one's attention between two information sources is quite poor for people of any age, but improves up to about 11 years of age.

- The ability to concentrate one's attention for a long period of time increases up to at least 16 years of age, with females having somewhat better ability for sustained attention.

Learning

- Learning has been defined as any relatively permanent change in behavior or thinking that results from past experiences. An understanding of learning processes is important for those interested in developing messages and programs that attempt to improve safe driving practices. Most traffic safety messages are designed to either change how people think about a traffic safety issue or to change people's safety behaviors. In other words, they are designed to educate people. Therefore, a comprehensive understanding of learning processes is central in the development of effective traffic safety messages and programs. Three learning processes are particularly relevant: classical conditioning, operant conditioning, and observational learning.

- The simplest kind of associative learning, classical conditioning, involves the association between reflexive responses (such as many emotional responses) and a stimulus (such as food or a person). Three main factors influence the chance of whether classical conditioning will take place: 1) The probability of classical conditioning occurring increases with the number of pairings of the unconditioned and the conditioned stimulus; 2) The probability of conditioning taking place decreases with increases in the time between presentation of the unconditioned and the conditioned stimulus; and 3) The probability of conditioning a response increases with the intensity of the unconditioned response.

- In operant conditioning, an action occurs that is followed by some outcome. If the outcome is positive, then the action is likely to be repeated. If the outcome is punishing, the action that led to it will become less likely to be repeated. Thus, through both reinforcement and punishment, new behaviors are learned and others are extinguished. Several factors affect whether and how a behavior is operantly conditioned: 1) The effectiveness of the reinforcement or punishment to change behavior decreases as the amount of time between the behavior and consequence increases; 2) The effectiveness of the reinforcement or punishment to change behavior increases with the intensity of the reinforcer or punisher; and 3) Behavior does not have to be reinforced or punished each time it occurs in order for that behavior to be conditioned.

- Humans can benefit from the experiences of others in order to learn behaviors and their consequences. Such learning is called observational learning. Four processes that influence observational learning have been identified: 1) *Attention.* Observational learning will not occur unless the person is paying reasonably close attention to the person or people performing the behavior; 2) *Memory.* Observational learning will not occur unless the person can remember the actions

and consequences at a later time; 3) *Ability to Reproduce the Action.* Observational learning will not occur if the person cannot reproduce the action; and 4) *Motivation.* Observational learning will not occur unless the person has some reason for performing the behavior.

Reasoning

- A prominent feature of human cognition is our ability to draw conclusions based upon the things that we have learned. The process by which people draw conclusions from their knowledge of the world is called reasoning. When people reason, they are generating a belief (i.e., conclusion) that has been inferred from what they know. Thus reasoning is intimately related to most other cognitive abilities including learning, moral development, verbal ability, memory, attitude formation, and problem solving. Many traffic safety messages and programs use logic to both teach and convince drivers to drive safely. Further, much of what people learn about the driving task and driving situations is based upon reasoning processes. Therefore, a thorough understanding of how reasoning develops and the problems people have with reasoning is necessary for the development of effective traffic safety messages.

- One common type of reasoning is called class-inclusion reasoning; that is, determining what "things" go with what category. Generally, the ability to draw logical conclusions from given premises in class-inclusion reasoning improves with age. However, people of all age groups have difficulty with class-inclusion reasoning, particularly when they are faced with conclusions that do not follow from the given information. Several causes for poor class-inclusion reasoning are reviewed.

- Another common type of reasoning involves people drawing conclusions based upon contingency relationships usually described in *if-then* premises, called conditional reasoning. Conditional reasoning ability improves with age. However, even at older ages, the ability is quite poor overall. As in class-inclusion reasoning, people especially have difficulty when conclusions do not follow logically from the given information. Several causes for poor conditional reasoning are reviewed.

- Another reasoning process in which people frequently engage is reasoning by analogy. In this type of reasoning, people draw a conclusion about something new by noting the similarities between the new item and something else for which they are already quite familiar. The ability to effectively reason by analogy improves up to at least 19 years of age with no differences between the sexes. Overall, people are relatively good at this type of reasoning. Several causes for poor analogical reasoning are reviewed.

- A final important reasoning process for people is hypothesis formation and testing. In this type of reasoning, a person forms a belief and then seeks information related

to the belief, similar to a scientist trying to understand a phenomenon. Ability for this type of reasoning is poor for people of all ages. Several causes for poor hypothesis formation and testing are reviewed.

Motivation

- Motivation is the set of influences that account for the initiation, direction, intensity, and persistence of behavior. Since traffic safety messages and programs are designed to change unsafe driving behaviors or enhance safe ones, understanding the reasons why these behaviors occur is necessary for constructing appropriate messages and programs. Moreover, an understanding of motivations is important because in order to change behaviors and ways of thinking, the young drivers must have a motivation for changing their behavior. If the driver has no motivation for learning the message or participating in the traffic safety program, then learning and behavior change will generally not occur. The review focuses upon two motives that are thought to have a great impact on the traffic safety behaviors of young drivers and the construction of traffic safety messages and programs for young drivers: sexual motivation and arousal/sensation seeking motivation.

- A powerful behavioral motivator is the need for sexual fulfillment or the sex drive. While the sex drive produces clear motivational effects on behavior, its influence on driving behaviors, particularly unsafe driving behaviors, is poorly documented. However, a few studies suggest that the sex drive, at least for males, may negatively influence traffic safety. At least one focus group study with college students (18 to 22 years of age) has shown that, by self report, one reason for drinking and driving is to show off in order to attract the attention of the opposite sex. In the population of young male drivers, drinking and driving activities may be motivated, in part, by the sex drive.

- A large body of work has documented the fact that the arousal motive can have negative traffic safety consequences for people who need to increase their levels of arousal, those commonly called sensation seekers. Accurate identification of sensation seekers is important both for the study of this motivation and for appropriately targeting traffic safety messages and programs.

- Zuckerman and his colleagues have developed a test (the Sensation Seeking Scale, SSS) in which behaviors related to sensation seeking are self reported. This test has been used extensively to define the demographics of sensation seeking and its relationship to unsafe driving behaviors. Numerous studies utilizing the SSS have shown that males score higher on the total SSS than females. Studies have also documented that scores on the SSS tend to increase with age, up until the late teens. Several studies have shown that high sensation seeking is related to drinking and driving, speeding, lack of safety belt use, and traffic violations.

Risk Perception

- An unavoidable component of a person's life is risk and uncertainty. Our thoughts about these risks and how we assess them have been termed risk perception. The perception of risk and uncertainty is integral to many cognitive tasks. People appraise risk when making decisions about uncertain events and situations. When reasoning about probabilistic information and the likelihood of negative outcomes, both children and adults must think about risk. Thus, an understanding of risk perception, and how people assess risk, is essential for understanding both risky-taking behavior and developing traffic safety messages to reduce risky driving.

- A number of studies have investigated perceptions of traffic crash and injury risk by age. The majority of these studies have found that young drivers tend to perceive less risk in specific crash scenarios and general driving than do older drivers, and are poorer at identifying hazards when driving. Young drivers also tend to see themselves as less likely to be in a crash than others in their own age group.

- Because of the elevated crash rate of males over females, many studies of risk perception have restricted their subjects to males. However, the few studies that have investigated crash risk perception for females have shown mixed results. Some studies found that males rated crash scenarios as less risky than did females. Other studies, however, have found no sex differences in crash involvement risk perception. It is clear, however, that females, like males, tend to consider themselves less likely to be in a crash and to be better drivers than others in their peer group, although to a lesser degree than males.

- The chances of a crash are judged to be greater when the subject is a passenger than when he or she is driving the vehicle, showing that perceived control of a vehicle is an important factor in the assessment of risk for younger drivers. In addition, younger drivers using safety belts tend to rate the risk of crash involvement as *higher* than those not using belts. This effect may be due to safety belt use sensitizing drivers to the possibility of a crash.

- Several factors may be involved in the misperception of risk. One is the optimism bias. Several studies have shown that young drivers tend to think of themselves as less likely to be involved in a crash than the average driver, primarily because of the belief that their driving skills are above average. Another is the availability heuristic. Instead of relying upon well-established facts and recognizing that their experiences, short-term memory capacity, and retrieval abilities are limited, people attempt to discern how frequently something occurs by trying to recall examples. People using the availability heuristic to assess traffic crash risk search memory and retrieve many trips that were crash free, leading even poor drivers to underestimate their risks. Another potential source of error in risk perception is the failure of young drivers to understand the effects of cumulative risk. A final factor that has been shown to bias judgment of outcome likelihood is the desirability of the outcome.

People have a tendency to judge outcomes that they want as being more likely than outcomes that they do not want.

Problem Solving and Decision Making

- Undoubtedly the most complex cognitive activity that humans engage in is attempting to find solutions to problems; this includes the activity of decision making. Problem solving is an ubiquitous activity in youthful driving and traffic safety. Much of high-risk driving can be conceptualized as a problem faced by a driver. Several traffic safety programs have attempted to teach young drivers new strategies for dealing with the problems that lead to high risk driving. Understanding the way young drivers go about finding solutions to problems (and making decisions) and the deficiencies they have in this process is important in the development of traffic safety messages.

- Efficient problem solving involves developed memory and attention processes, good verbal ability, proficient reasoning, and knowledge and experience of the world. As such, the ability to problem solve effectively develops along with these other cognitive processes. As children grow older, they adopt increasingly sophisticated strategies for solving problems. Included in the developmental changes that occur in the first 18 years or so is a tremendous increase in domain-general and domain-specific knowledge, the ability to generate several potential solutions to a problem, the ability to ignore irrelevant problem information, the ability to think about more than one dimension of the problem simultaneously, and the ability to think about relationships among events in a bidirectional way.

Social Cognition

- Social cognition has to do with how people make sense of other people and themselves. The study of social cognition is the study of how people think about others and how others influence a person's thoughts. Because driving typically occurs in a social setting or involves social thinking, such as attitudes, an understanding of social cognition is important in developing messages or programs to reinforce or change people's traffic safety related behavior. This section provides a brief overview of several key elements of social cognition that have implications for the development of traffic safety messages and programs including attributions, social schemata, and scripts.

- Attribution theory is concerned with how people go about assigning causes to the events they observe. It focuses on how people use information in the social environment to arrive at causal explanations for events. Thus, it is often described as the study of perceived causality, with attribution referring to the perception of inference of cause. An important theme of attribution theory is that in making attributions, people act as naive scientists; that is, people intuitively, or in a common

sense way, infer or deduct causes of events around them. A second theme is that there are several tendencies in attribution making. In general, people tend to be more likely to view two events as causally related if the events are similar to one another or if they occur near to one another in time or space, to attribute behavior to a single cause rather than multiple causes, and to attribute causes of other peoples' behaviors to internal factors while they attribute causes of their own behavior to external factors. A third theme of attribution theory has to do with how people make inferences about others' intentions and dispositions.

- Social schemata are cognitive structures representing organized knowledge about objects, people, and past situations, and are helpful in organizing, making sense of, and remembering details. Researchers divide social schemata into several types including person schemata, self-schemata, role schemata, and scripts. Because the last type of social schemata, scripts, represents a person's knowledge structure for a sequence of events, it is particularly important for driving. Many of the events in the "driving" script include traffic safety related behavior. Thus, an understanding of scripts is especially useful for the design of traffic safety messages and programs for young drivers.

- Scripts are structures that describe appropriate sequences of events in well-known situations. They are comprised of several sequential steps and serve to organize information about the sequence of predictable actions, locations, roles, and props that constitute events. Scripts are learned throughout a person's lifetime, both by participation in and observation of events and are activated automatically whenever a similar event is encountered in the real world or referred to verbally. In general, the more often a script is activated, the more abstract and complex it becomes. The more recently and the more frequently the script has been activated in the past, the greater the likelihood of activation in the future.

- There is evidence that scripts are not subject to much change and may in fact resist change (known as the perseverance effect), even when there is information that is inconsistent with or contradicts the script. Thus, it may be difficult for traffic safety messages and programs to effect change in a young driver's script. The perseverance effect appears to be reduced, *not* when people are simply told about the contradictions and requested to be unbiased, but rather, when people are asked to think carefully about *how* they evaluate the evidence and when people are cautioned to be aware of their biases as they interpret information. The perseverance effect may also be lessened when people are forced to counter argue their scripts; that is, to explain why their scripts might be wrong.

Attitude Formation and Change

- Attitudes can be thought of as relatively stable mental positions held toward ideas, objects, or people. While there is no universally agreed upon definition of attitudes, there is widespread consensus that: 1) evaluation constitutes a central and possibly

predominant aspect of attitudes, 2) attitudes are represented in memory, and 3) both behavioral antecedents and consequences of attitudes have affective, cognitive, and behavioral domains. Because appropriate traffic safety behaviors may be influenced by attitudes towards driving and traffic safety, knowledge about how attitudes develop, endure, and change is necessary for constructing effective messages and programs.

- Attitudes are learned. Thus, the processes discussed in the section on learning apply generally in attitude formation. Attitudes may be formed directly through questioning, personal experience, and operant conditioning, or indirectly through classical conditioning, social learning, and observation.

- Attitudes are believed to predict behavior in a complex way. A popular theory states that attitudes and cultural norms combine to determine behavioral intentions, which in turn produce a voluntary behavior. A number of studies have found that differences in the extent to which attitudes guide behavior result from differences in how easily or quickly a person can retrieve the attitude from memory. Highly accessible attitudes have been found to be more predictive of behavior than less accessible attitudes. It has been found that people holding highly accessible attitudes toward an object are more likely than those holding less accessible attitudes to evaluate information relating to the attitude object in a biased manner, and thus to shape their behavior in a direction consistent with their attitudes. Several studies have found a relationship between self-monitoring and attitude-behavior consistency. High self-monitors are individuals who monitor their behavioral choices on the basis of situational information, while low self-monitors guide their choices on the basis of salient information from relevant inner states such as attitudes, feelings, and dispositions. Other factors that have been found to mediate the relationship between attitudes and behavior include habit or past behavior, stability of attitudes over time, volitional control of behavior, and degree of direct experience with the attitude object.

- Attitudes not only affect behavior; they are also influenced by behavior. Two major explanations of the influence of behavior on attitudes have been advanced. The first is dissonance reduction. That is, because we have a strong need for cognitive consistency, we change our attitudes to make them more consistent with our behavior. The second explanation of the influence of behavior on attitudes is self-perception theory, which posits that when internal states (e.g., attitudes) are weak or ambiguous, people must infer them from knowledge about their overt behavior and the circumstances in which the behavior occurred. That is, we look to our behavior when our attitudes are not completely clear in order to figure out our attitudes.

- Because attitudes are learned rather than innate, they are susceptible to change through persuasion. Persuasion refers to the intentional attempt to influence or change the attitudes of other people. Thus, persuasion is a process that involves three components: communicator or source, message, and audience or target

population. Factors related to each of these components affect the chances and degree of attitude change resulting from the persuasion process. 1) *Communicator or Source*: Source credibility, to a large extent, is characterized by expertise and trustworthiness. In general, communications will be more persuasive if they are perceived to come from a highly credible and respected source, the person or source states an opinion that is contrary to what would be expected, the person or source is attractive, and the person or source is seen as similar to the recipient. 2) *Message:* Studies show that one-sided messages are more persuasive when audiences already favor the source's position; two-sided messages (both sides of issue) are more persuasive when they oppose it. Messages that include appeals to fear are generally effective only when the presented threat is severe, the likelihood of it occurring is high, and the audience is able to do something to prevent or eliminate it. 3) *Audience or Target Population:* There is evidence that audience involvement with an issue (often measured by personal importance) moderates the effects of communicator and message factors, as well as the persistence of attitude change. The motivation level and ability of recipients influences the cues they will be most likely to attend to during the persuasion process.

Verbal Ability

- The term verbal ability refers to all use of language, including oral communication, oral comprehension, reading, and writing. Traffic safety messages, of course, use verbal means for conveying information. If the verbal ability of the recipient is not accounted for in the messages, then the message will not be processed and will have no chance of improving traffic safety behaviors. Thus, an understanding of verbal ability is necessary for effective traffic safety messages and programs.

- Oral communication and comprehension increase with age. Phonology, which is the way in which the sounds of language are produced, begins to develop in infancy and continues through age five or six. The understanding of word meaning also begins in infancy and continues at least through 11 years of age, when children begin to master abstract word phrasings such as metaphors. Along the same lines, size of vocabulary increases dramatically during the first five years, approximately doubling in size each year and continues at a much slower rate throughout the lifetime. Grammar tends to appear around 1.5-to-2 years of age when children begin making two-word sentences and continues to improve up to at least 15 years of age.

- Reading and writing abilities increase with age. Reading skills begin to develop before 1 year. Fluent reading and simple comprehension appears around 9 years of age. Reading for complex comprehension of written material is achieved between 16 and 19 years of age.

- Females tend to be superior to males in oral language, reading, and writing.

Moral Development

- Moral development refers to the changes that occur with age and experience in how individuals deal with moral issues. A major influence on all driving behaviors, in particular high risk driving, is the moral principles or rules by which a person lives. Moral principles determine the motivation for many social behaviors, such as driving. Traffic safety programs such as victim impact panels attempt to appeal to peoples' morality in an attempt to get them to change their high risk driving behaviors. As such, it is important to understand the acquisition of moral thinking so that appropriate programs and messages that rely on moral thinking can be produced.

- The predominant approach to understanding moral development for the past 30 years builds on the social cognition work of Piaget, and is characterized by his ideas that individuals play an active role in their own development and that cognition is of central importance in social development. Piaget's early work included a preliminary examination of children's development of moral judgments, although he did not pursue these investigations. Research on moral development was expanded upon and refined by Kohlberg.

- Kohlberg viewed moral development as a process in which children form their own values and moral concepts out of active efforts to organize and understand social experiences. Kohlberg proposed six stages of moral development. Stages 1 and 2 make up the *preconventional* level, in which rules and social expectations are conceived as being external to the self. It is primarily children who are found at this level of moral development. Stages 3 and 4 make up the *conventional* level, in which individuals identify with or have internalized the rules and social conventions of others, including authorities. It is primarily adolescents and adults who are found at this level. Stages 5 and 6 make up the *postconventional* or *principled* level and are characterized by the ability of individuals to separate themselves from the rules and expectations of others and think in terms of self-chosen principles. Relatively few people attain this level of moral thinking.

- Kohlberg's moral stages point to, by definition, age differences in moral development. However, the relationship between age and moral development is not a simple one. Movement from stage to stage does not occur merely as individuals age, and movement through every developmental stage is not inevitable. Still, rough age patterns can be discerned.

- One of the more thorough reviews of the literature found that sex differences in moral reasoning are exceedingly rare. Of 108 studies reviewed, only eight clearly indicated significant differences favoring males and many of these were confounded by occupational level or educational status. It is concluded that the moral reasoning of males and females is more similar than different.

- Moral development is stimulated by the provision of role-taking opportunities and these opportunities arise from participation in school and peer life, and interaction with the political and social institutions of the larger society, as well as from family participation. All of these types of participation converge to stimulate moral development. The more social stimulation (through these role-taking opportunities), the faster the rate of moral development.

Piaget's Theory of Cognitive Development

- Jean Piaget devoted much of his life to studying children's cognitive development--the way in which mental processes such as thinking, reasoning, and perceiving the world evolve. Piaget's interest was in the qualitative rather than quantitative characteristics of development. That is, he was concerned, not with how much children know, but how they come to know it.

- Piaget's theory has several core assumptions. Foremost among these is the idea of constructivism--that children are active thinkers, constantly trying to construct more advanced understandings of the world. According to Piaget, children learn by doing--they not only observe and imitate the world around them, they interpret it as well. At the same time, Piaget recognized the role of experience in cognitive development, noting that the physical and social contexts in which children act help to give shape to their constructions of the world. In Piaget's view, adaptation, and thus, intellectual or cognitive growth, comes about through the dual processes of assimilation and accommodation. Assimilation involves modifying or changing new information to fit into what is already known and accommodation involves restructuring or modifying what is already known so that new information will fit in better. It is the constant balancing of these two processes that leads to adaptation to the environment and underlies the process of cognitive development.

- Piaget proposed four stages of cognitive development, each qualitatively different from one another. These stages include the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage. During each stage, distinctive styles of thinking emerge. Piaget's introduction of qualitatively different stages of thinking was in marked contrast to the prevailing view of the time that children's cognitive activity was identical to adults' cognitive activity, only less efficient. 1)*Sensorimotor Stage*: The sensorimotor stage is generally characterized by actions, movements, and perceptions that occur in the absence of language. These actions are coordinated through schemata, viewed by Piaget as simple mental images or patterns of action that individuals use to organize information and interpret the things they see, hear, smell, and touch. The main trend during this overall sensorimotor period is the development of object permanence. 2) *Preoperational Stage*: The preoperational stage is characterized by the development of symbolic or representational thinking; that is, thinking dependent on symbols rather than on sensorimotor relationships. Important characteristics of preoperational thought are children's lack of understanding of the concept of

conservation and their growing ability to overcome egocentrism. 3) *Concrete Operational Stage*: At about age seven, children begin to understand the concept of conservation. In Piaget's view, this understanding is essential for the acquisition and subsequent development of logical thought. The main characteristics of the concrete operational stage include: the ability to use operations and mentally reverse actions; attainment of conservation skills; use of logical reasoning instead of intuitive reasoning, but only in concrete circumstances; the inability to engage in abstract thought; and the capability to classify or divide things into sets or subsets and to consider their interrelations. 4) *The Formal Operational Stage*: During this stage, logical operations are no longer tied to concrete problems; children can now understand abstractions, consider hypothetical questions, and design formal ways to test abstract ideas. There is evidence that some presumably normal people never attain formal operations.

- The empirical support for Piaget's cognitive stages implies, by definition, that there are age differences in cognitive development. At the same time, Piaget, himself, made it clear that the ages associated with different stages are always average and approximate. Roughly, the sensorimotor stage extends from birth to age 1.5-to-2; the preoperational stage from about age 1.5-to-2 to 6-to-7; the concrete operational stage from age 7-to-8 to 11-to-12; and the formal operational stage from age 11-to-12 to 14-to-15.

- The effects of sex on cognitive development have not been widely studied. Thus, there is little support for sex differences in Piaget's theory.

- There have been a number of studies exploring whether children can be trained to display advanced cognitive skills. Based on several reviews of the conservation literature, it was concluded that conservation can apparently be taught, although even highly individualized training is only successful about half the time. Studies focusing on children's attainment of formal operational thinking have also shown that certain cognitive skills can be taught through training.

Introduction

Despite the fact that motor vehicle death rates have declined significantly since 1975, motor vehicle crashes continue to be the major cause of death and serious disability for adolescents and young adults. On a per population basis, drivers under age 25 in the United States (U.S.) had the highest rate of involvement in fatal crashes of any age group in 1996 and their fatality rate based on vehicle miles traveled was four times greater than the comparable rate for drivers age 25 to 65 (National Highway Traffic Safety Administration, NHTSA, 1997a). Teenage drivers have by far the highest fatal crash involvement rate of any age group based on number of licensed drivers (61.26 per 100,000 licensed drivers in 1993), and most teenage passenger deaths (67 percent) occur when a teenage driver is at the wheel (Insurance Institute for Highway Safety, 1995). Motor vehicle injury rates also show that teenagers continue to have vastly higher rates than the population in general.

Risky-driving behaviors may contribute heavily to the high crash and injury rates for drivers under the age of 25 years. For example, drinking and driving is a major factor in young driver fatal crashes. In spite of the fact that the proportion of fatally injured young drivers (21-to-24 years of age) with blood alcohol concentrations greater than or equal to 0.10 percent has declined steadily from 1982 to 1996, from 40 to 27 percent (NHTSA, 1997a), this age group has consistently had the highest proportions of any age group. A study by the University of Michigan Transportation Research Institute (UMTRI) found that Michigan drivers under the age of 21 accounted for 14 percent of drunk driving convictions when this same age group makes up only 8 percent of the licensed driving population. The study also discovered that of all alcohol-involved crashes in Michigan leading to a felony drunk driving conviction, 23 percent were for drivers under the age of 21 (Eby, 1995a; Eby, Hopp, & Streff, 1996). There is also evidence that young people, more frequently than others, speed (e.g., Jonah, 1986; Konečni, Ebbesen, & Konečni, 1976; Soliday, 1974; Wasielewski, 1984), travel with shorter headways (e.g., Wasielewski, 1984), run yellow lights (e.g., Konečni, Ebbesen, & Konečni, 1976), and fail to use safety belts (e.g., Eby & Hopp, 1997; NHTSA, 1997b). These facts underscore the need for effective traffic safety programs and messages designed specifically for adolescents and young adults.

In an effort to reduce the crash propensity and resulting injuries of young drivers, NHTSA has begun a program of research designed to better understand the factors related to the high crash rate, in particular, risk taking, for drivers under 25 years of age (see, e.g., NHTSA, 1995a, 1995b). A special focus of this program is to develop a conceptual framework for adolescent risk-taking behaviors that can assist in the development of measures, such as public information and education programs, to increase safe driving behaviors. NHTSA recognizes that a comprehensive framework for understanding risk-taking behaviors must include not only external factors such as social interactions or family life, but also internal factors such as the information processing capabilities and strategies of youth. NHTSA's framework is illustrated in Figure 1. As shown in this figure, internal and external factors mutually influence each other and can collectively give rise to risky-taking behaviors. The focus of the project reported here is limited to gaining a better understanding of

the internal factors. An additional focus of the project is to use the synthesized information to generate a set of guidelines for the development of effective traffic safety messages and programs for young people. The guidelines are currently being developed.

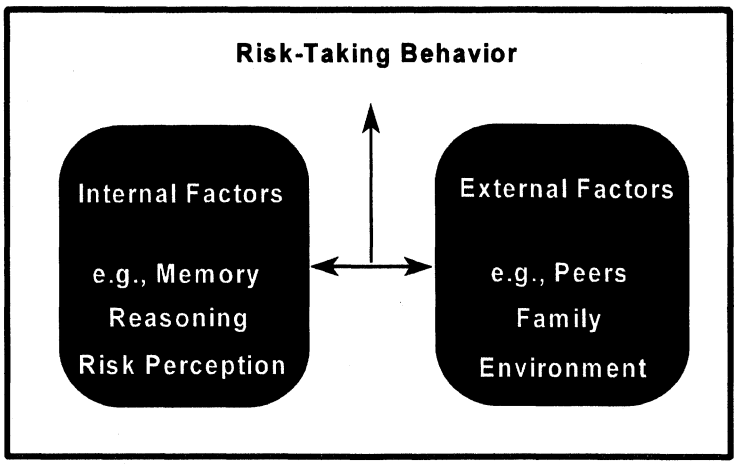

Figure 1: A conceptual framework for understanding risk-taking behavior. The internal factors are the focus of this literature review.

A Model of Risky-Driving Behaviors

An unavoidable component of a person's life is risk and uncertainty. As a matter of everyday living, we engage in activities and are exposed to situations that have some element of risk. Risk is particularly prevalent in motor vehicle travel and is influenced by a multitude of factors including the decisions that people make about how they drive, who they drive with, under what conditions they drive, and why they are driving. For example, in a survey of high school students, Summala (1987) found that about 60 percent of male students and 33 percent of female students reported that they at least occasionally engaged in high risk driving for fun. As NHTSA (1995a, 1995b) and others (e.g., Hodgdon, Bragg, & Finn, 1981; Jonah, 1986) have pointed out, decisions made by young drivers that result in risky-driving behaviors may strongly contribute to the elevated crash risk of young drivers.

Despite the prevalence of risk, and the abundance of research on risk and risk taking, there is disagreement about what constitutes risk and risky-taking behaviors (e.g., Fischhoff, 1985; Yates & Stone, 1992a). The large literature on young driver risk taking has been extensively reviewed and will not be reviewed here (see, e.g., COMSIS Corp. & the Johns Hopkins University, 1995; Hodgdon, Bragg, & Finn, 1981; Jonah, 1986, 1997). However, as a way to define terms and to conceptualize risk taking driving behaviors from a cognitive perspective for this project, we present a cognitive model of risky-driving behaviors (Figure 2) that includes areas where traffic safety messages and programs (interventions) might be applied to increase the likelihood of safe driving. While the form of this model is unique to this project, it draws heavily upon concepts presented by others (Fishburn, 1968; Furby & Bayth-Marom, 1992; Hodgdon, Bragg, & Finn, 1981; Jonah, 1986; Olk & Waller, 1998; Wilde, 1976; Yates, 1990; Yates & Stone, 1992a, 1992b).

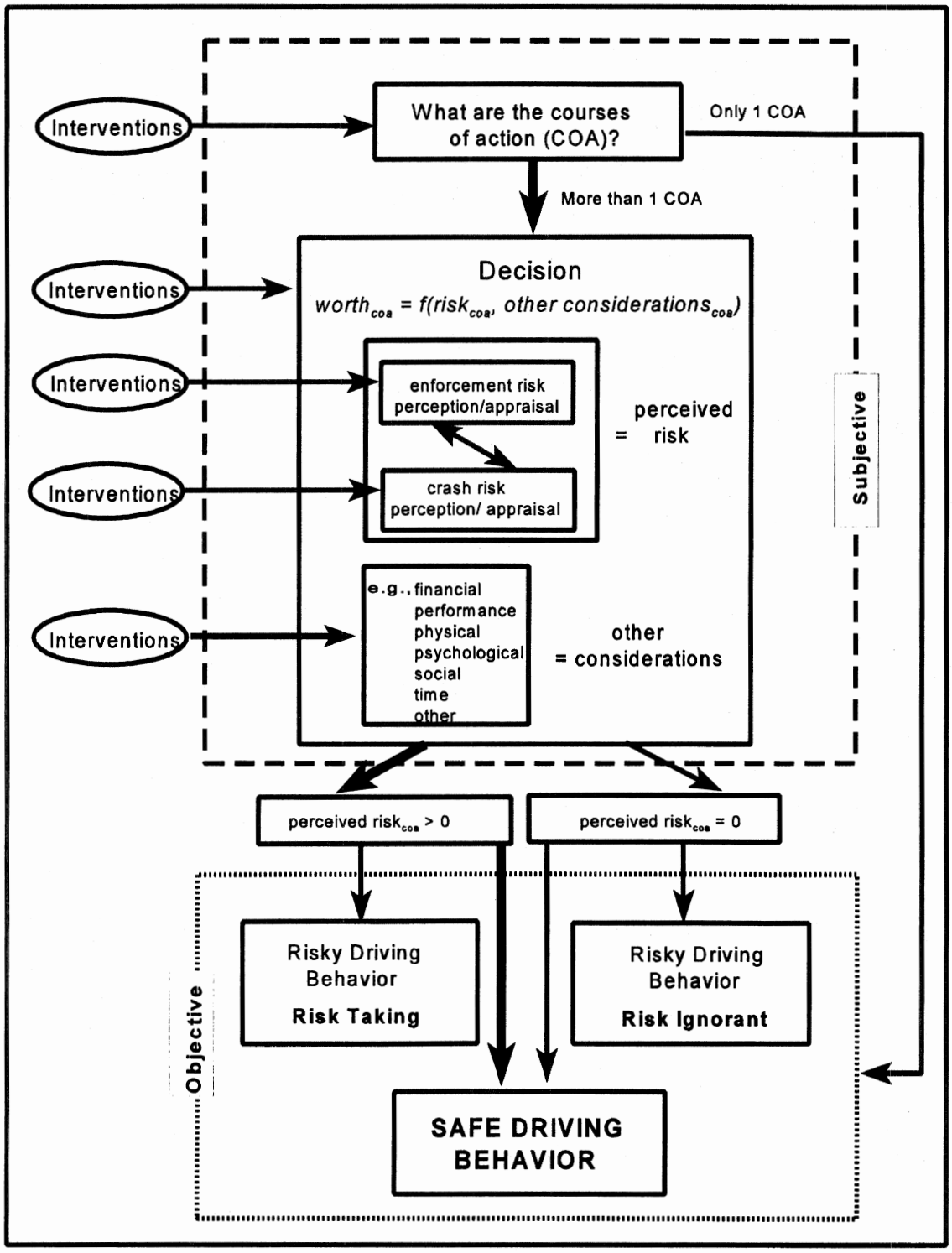

Figure 2. A decision making model of risky-driving behavior, showing where traffic safety messages and programs (interventions) might be applied to increase the likelihood of safe driving.

According to Yates (1990; Yates & Stone, 1992a), risky-taking behavior is the result of a decision process in which risk is just one component of a set of factors that are considered in the decision. Thus, the model presented here conceptualizes risky and safe driving behaviors as the outcome of a decision making process in which risky driving may be chosen over behaviors that are less risky because the risky driving affords the person greater perceived benefit. It is important to note that the decision process is not characterized by an intensive review of information and courses of action. The process may happen quite rapidly and the person may consider only partial information when making a decision. Further, the driver may not be aware of the decision process, either because it occurs rapidly or because the process is nonconscious. If at least two courses of action are considered, then the person chooses which action to take. The model applies only to a single decision made at a certain time. During the course of an automobile trip, the driver may make hundreds of decisions, some of which lead to risky-driving behaviors and some of which do not.

The model is divided into two parts: subjective and objective. The subjective component of the model, shown enclosed by a dashed line, represents the cognitive factors involved in the decision making process, including the driver's memories, attentional capacities, perceptions of risk, attitudes, motivations, moral influences, and learning, reasoning, and problem solving abilities. The objective component, shown enclosed by a dotted line, constitutes the driving behaviors; that is, those actions that we observe on the road. For this model, we define all driving behaviors as either safe or risky. Risky-driving behaviors are those actions that increase the objective likelihood of a crash or the severity of injury should a crash occur (e.g., Olk & Waller, 1998; Simpson, 1996; Williams, 1997). As such, a driver may not consider his or her action to be a risky one even though it increases his or her chances of being in a crash or becoming severely injured in a crash. This definition of risky-driving behavior also assumes a baseline from which to assess the increase in risk or crash severity. This baseline is set by societal standards. In the case of speeding, for example, the baseline may be the speed limit, "the speed of traffic flow," or the speed that is safe for the current conditions.

When a driver approaches a situation in which an action may be required, for example a young driver approaching a signalized intersection where the light has changed from green to yellow, the model proposes that an analysis of possible courses of action (COAs) is conducted. If the driver only knows about, or is only able to produce, a single possible action, then that action is performed. This outcome is represented by the arrow that exits the courses-of-action box (only 1 COA) and terminates at the objective driving behavior part of the model (dotted line). If only one action is possible, then no decision is made, the behavior could be either risky or safe, and the driver might or might not perceive the risks in taking the action. In the example of the young driver, he or she may either always brake when the light changes to yellow, or he or she may always continue through the intersection, regardless of all other considerations. Some researchers have suggested that many driving behaviors, in particular those related to risky driving, frequently are based on only one course of action (e.g., Jørgensen, 1988; Wagenaar, 1992).

In driving, however, there is nearly always more than one objective possible course of action, regardless of how unpleasant some of the other actions might be (e.g., the driver could always stop driving). If there is more than one perceived course of action, then the model supposes that the driver uses a decision process to choose a single course of action from the set of possible actions. This set of actions may be exhaustive or may only contain two alternatives. For example, when approaching an intersection where the light has changed from green to yellow, some possible courses of action are to continue at the same speed through the intersection, accelerate through the intersection, or brake and stop before the intersection. The driver may consider all three or may only consider a subset of the courses of action. As proposed by Yates and Stone (1992a), the driver evaluates each course of action by determining a subjective worth for each action. An increase in the subjective worth for a course of action means an increase in the likelihood that that course of action is chosen (Yates & Stone, 1992a). The choice of course of action is based on some decision rule that takes into account the subjective worth for each possible course of action.

The subjective worth is a complex combination of perceived risk and other considerations[1]. In the case of driving, the perceived risk of a certain course of action is a combination of the perceived probability of getting in a crash and its perceived severity, and the perceived probability of getting a citation and its perceived severity. The driver may perceive no risk of being in a crash or getting a citation, in which case the perceived risk for that course of action would not be a feature in the determination of that course of action's worth. The other considerations are features of the course of action that either result in perceived costs or in perceived benefits. A list of example considerations, derived from the risk taxonomy of Jacoby and Kaplan (1972), is included in Figure 2. For example, within a certain course of action there may be a time savings benefit, a financial cost, a social benefit, and a small physical cost, in addition to the perceived risk assigned to the action. The considerations that are included in the decision making process, their likelihood of occurring, and their magnitudes are all subjectively determined for that course of action at that time. Thus, for example, a young driver may heavily weight the perceived social benefits of running a red light (e.g., the driver may think it makes him look brave to his peers, thus, gaining perceived social status), and only minimally weight the injury costs, should a crash occur. The fact that nonrisk considerations might be perceived as highly beneficial for a risky-driving behavior means that high risk courses of action could be assigned a high subjective worth.

Once a course of action has been decided upon, it is performed. For the explanatory purposes of the model, the selected course of action has a perceived risk associated with it that is either zero or above zero. If the perceived risk is above zero, that is, the driver thinks that there is at least some chance of a crash or a citation from law enforcement, then the resulting behavior itself can still be either risky or safe, depending upon the socially-defined baseline for that driving situation. Those who engage in a risky-

[1]See Yates and Stone (1992a) for a description of the complexities involved in weighting, assessing probabilities, and combining the various subjective features of an alternative to determine subjective worth.

driving behavior, perceive a risk for that behavior, and have more than one perceived course of action, are defined as *risk taking*. Thus, the young driver who is approaching an intersection in which the light is yellow and decides to accelerate through the intersection, even though he knows he has other options, is engaging in risk taking if he knows he could get in a crash or receive a traffic citation from law enforcement. By the same argument, the driver who accelerates through the intersection because he is heavily weighting a time savings benefit (i.e., not having to wait through another cycle of the lights), is also risk taking if he perceives some chance of getting in a crash or being cited by law enforcement. On the other hand, if the perceived risk for that course of action is zero (i.e., the driver perceives no risk), then the behavior can also be risky or safe. If the action is considered by society to be a risky-driving behavior, the behavior is perceived by the driver as risk free, and there is more than one perceived course of action, then we define that person's behavior in this situation as *risk ignorant*. For example, the young driver approaching the intersection may wrongly think that other drivers at the intersection will watch out for him (i.e., no crash risk) and that since he sees no patrol cars, he will not get a traffic citation (i.e., no law enforcement risk). Given this lack of perceived risk, the young driver may continue into the intersection simply because he does not want to wait. A driver who has selected a course of action in which there is no perceived risk can also engage in safe driving behaviors (the two arrows terminating in the safe driving behavior box of the model shown in Figure 2); the person may still drive safely simply because he believes that people should follow traffic laws.

The goal of traffic safety researchers should be to get drivers, in particular young drivers, to follow the decision making pathway to safe driving behaviors represented by the thick arrows in Figure 2. Those drivers who engage in safe driving by this pathway in the model are the ones who recognize the risks associated with possible driving behaviors and choose the behavior that is safe. Those drivers arriving at safe driving by the other pathway do not adequately perceive the risks of driving and may end up driving in a risky manner in other situations.

Also shown in the model are points where traffic safety messages and programs (interventions) can be applied. One potential intervention point is when drivers first determine the courses of action available to them. Drivers can be made more aware of the many courses of action available to them when they are driving, or be helped to improve their ability to actually perform other actions (as may be the case in learning to drive). Another potentially fruitful focus for interventions is the basic decision making process. As has been recently tried by NHTSA, it may be possible to train young drivers to make better driving decisions (e.g., NHTSA, 1996). Another point of intervention is at the risk perception level. Messages and programs to change perceptions of traffic violation enforcement risk or of crash risk, might lead to less risky courses of action being chosen by young drivers. Focusing on other considerations evaluated in determining the worth of an action is another avenue for interventions. Programs and messages could attempt to get young drivers to consider information that they do not already use or to more appropriately weight the significance of the information that they do use.

While the model is specific to a single decision at a certain time, it can help us to understand why certain people may be prone to engage frequently in risky-driving behaviors and in other risky or problem behaviors (e.g., Barnes & Welte, 1988; Donovan, 1993; Elliott, 1987; Evan, Wasielewski, & von Buseck, 1982; Jessor, 1987a, 1987b; Jessor & Jessor, 1975, 1977). The model proposes that a risky behavior is the outcome of a decision process, and that persons engage in that behavior because of the benefits (or absence of losses) that they get from the action. It is reasonable to assume that the subjective aspects of the process are similar in other driving situations (i.e., how risk is perceived, weightings for considerations, etc.). If so, then we would predict that in driving situations involving risk, similar outcomes would occur because similar information processing is occurring. As many researchers have shown (e.g., Barnes & Welte, 1988; Donovan, 1993; Elliott, 1987; Evan, Wasielewski, & von Buseck, 1982; Jessor, 1987a, 1987b; Jessor & Jessor, 1975, 1977), risky driving is only one type of risky behavior that a person tends to engage in. Therefore, it is reasonable to think that an individual would apply the same decision making processes (and would have similar influences on this process) to most situations in which high risk behavior is undertaken.

More to the point of the current project, the model can also help us to understand why risky-driving behaviors seem to decline with age. As discussed in this literature review on cognitive development, several cognitive skills and abilities develop with age. Cognitive changes in the speed of information processing, memory capacity, attention, decision making ability, and general knowledge of the world, could all positively influence the decision making process leading to safe driving. It is important to remember that this literature review only covers the internal factors (see Figure 1). A thorough understanding of risky-driving behaviors among young drivers also requires a review of external factors, such as peer influences, family, and school. These factors are related to the decision making process (e.g., as considerations) and must be considered in the creation of effective traffic safety messages and programs (interventions).

The literature review is divided into 12 sections. The review focuses primarily on cognitive development from about 10 to 24 years of age. In addition, if literature reporting research on sex differences[2] was found, then it was included where applicable. While the topics are presented as chapters in this review, there is significant overlap among topics. The first section is about *memory*; that is, the processes that allow a person to retain knowledge over time. This section discusses the various types of memory and their development. Traffic safety messages, or the effects of programs that are not remembered or not recalled when necessary, will have little positive influence on safe driving behaviors. The second section, *attention*, discusses the factors related to the development of how people focus cognitive resources on perceptual or mental tasks, including selective,

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[2]Following Halpern's (1992) reasoning, the word "sex," rather than "gender," is used in this review. According to Halpern, gender is an inappropriate label for distinguishing differences between males and females because 1) it is used as a euphemism for the emotion-laden word "sex," 2) it was borrowed from the field of linguistics where "gender" is used to distinguish between masculine and feminine forms of nouns, and 3) the common use of gender for psychological differences and sex for physical differences between males and females is too artificial since the psychology and biology are so closely coupled.

divided, and sustained attention. A traffic safety message or program that is not attended to may be misperceived or missed completely, reducing or eliminating any chance for message or program effectiveness. The third section, *learning*, discusses three processes by which people acquire information: classical conditioning, operant conditioning, and observational learning. Because many traffic safety messages and programs have a learning component, an understanding of how people learn is paramount for development of effective messages and programs. The fourth section, *reasoning*, discusses several ways in which people draw conclusions from their knowledge of the world and how these processes develop with age. Because many traffic safety messages and programs use logical arguments to influence safe driving behaviors, it is important to understand how reasoning processes operate and develop in humans.

The fifth section of the literature review, *motivation*, examines the factors that initiate and influence the intensity of behaviors. Because these factors are numerous, the review discusses only two motivations that seem to influence risky-driving behaviors in young drivers: sex and the need for stimulation (sensation seeking). It is important to understand and consider young driver motivation when developing traffic safety messages and programs because risky driving, like other behaviors, is motivated by something and one needs to provide a motivation for following the recommendations in a traffic safety message or program. Also included in the review, in the sixth section, is a discussion of the development of *risk perception* and factors that contribute to the misperception of risk. As we have already mentioned, risk perception is an integral part of the decision making process that leads to risky-driving behaviors and has the potential to be influenced by traffic safety messages and programs. The seventh section discusses the development of *problem solving and decision making* in a general way. While influenced by all other cognitive factors and their age-related limitations, general deficits of problem solving and decision making ability are discussed. Again, an understanding of these processes is integral to understanding risky-driving behaviors. Also covered in this review are some of the social factors that influence how people think, known as *social cognition*. This eighth section covers those topics in the development of social cognition that are likely to have an effect on driving: attribution and social schemata/scripts. The ninth section focuses on *attitude formation and change*. Because appropriate traffic safety behaviors may be influenced by attitudes towards driving and traffic safety, knowledge about how attitudes develop, endure, and change is necessary for constructing effective massages and programs. The tenth section examines briefly the development of *verbal ability*, that is, all use of language. Traffic safety messages and programs use verbal means to convey information. If the verbal ability of the recipient is not accounted for, then message or program effectiveness may be diminished. Because many traffic safety messages and programs deal with moral issues in driving, the eleventh section is a review of *moral development*. This section examines a theory of moral development and many factors that influence moral thinking. Finally, because of the influence of his ideas on the field of cognitive development, we conclude our review with a section on *Piaget's theory of cognitive development*.

Memory

Introduction

In a very real sense, our memories determine who we are, what we do, and what we think. Whenever we maintain information over time, we are using our memories. Memory is therefore a critical feature of all cognitive processes. Traffic safety messages that cannot be remembered or recalled effectively when necessary will have little or no impact on a person's driving behaviors. It is, therefore, critical for readers interested in constructing traffic safety messages to understand how human memory develops and functions.

While there are many models of human memory, it is useful to conceptualize memory as composed of three stages (e.g., Atkinson & Shiffrin, 1968; Kintsch & Buschke, 1969; Klatzky, 1980): sensory memory[3], short-term memory, and long-term memory. This model of memory, known as the Atkinson-Shiffrin model, has been challenged by some researchers who cite experiments that suggest that the distinctions between these memory stages are somewhat unclear (e.g., Baddeley, 1984; Craik & Levy, 1976; Wicklegren, 1973). Despite this lack of agreement, we use the Atkinson-Shiffrin model as an efficient organizational framework for describing the empirical data about memory development and function.

Short-Term Memory

Short-term memory (STM) has been described as working memory (Klatzky, 1980) because it is the type of memory used for ongoing cognitive activities. It has also been characterized as the conscious part of memory where activities such as decision making, reasoning, symbol manipulation, and problem solving take place (Siegler, 1991). Klatzky (1980) provides a useful analogy for STM:

> "It may be helpful to think of STM as a workbench in a workroom where a carpenter is building a cabinet. All her materials are neatly organized on shelves around the walls of the room. Those materials that she is immediately working with--tools, boards... and so on--she brings from a shelf and places on the bench, leaving a space on the bench where she can work. When the bench gets too messy, she may stack material in orderly piles, so that more can be fit onto the bench." (Klatzky, 1980, pp. 88.)

In this analogy, the materials are bits of information and the materials stacked neatly on shelves are analogous to information in long-term memory to be discussed next. The analogy is useful because it describes many empirical properties of STM, such as a limited capacity and the ability to use organizational strategies to increase the capacity.

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[3]Sensory memory does not show any developmental trends (see e.g., Kail & Siegel, 1977; Morrison, Holmes, & Haith, 1974) and will, therefore, not be reviewed here.

The first study to investigate the capacity of STM was conducted by the German psychologist Hermann Ebbinghaus (1885/1960). Ebbinghaus developed a procedure whereby he learned various length lists of "nonsense syllables," such as LAR or SIF. He learned each list by reading aloud to himself the list and then attempting to recall it in the order it was read. If he made a mistake, he would reread the list and again he would attempt to recall the list. This procedure continued until he could recall the entire list in the correct order. He tallied the number of times he had to reread the list. Ebbinghaus discovered that if the list contained seven nonsense syllables or less, he could recall the list perfectly after only one reading. This finding suggested that the capacity of STM was seven items.

Subsequent research on STM capacity with adults confirmed Ebbinghaus' finding and showed that the capacity was the same for many other nonrelated items, such as digits or letters (e.g., Howard, 1983; Pollack, 1953). However, if the digits formed familiar numbers or the letters formed familiar words, then many more digits or letters than seven could be recalled perfectly after a single reading. For example, suppose that the following list of 12 digits were read to you: 1, 8, 1, 2, 1, 7, 7, 6, 1, 9, 4, 2. Since there are 12 items in the list, you would not be able to recall them in order after a single reading--the number of digits exceeds STM capacity. However, if you were to notice that the digits formed three important years in American history, 1812, 1776, and 1942, you would easily be able to recall the list after one reading. As in the workbench analogy, if you can stack up information in organized piles, then more can fit on the workbench. In a seminal paper, Miller (1956) called this type of information organization "chunking" and showed that the STM capacity was 7 ± 2 chunks; that is, it ranges from five to nine meaningful chunks of information. Thus, provided information can be chunked, STM can hold a large amount of information.

The durability of information in STM has also been measured. Consider what strategy you might employ to remember a telephone number said aloud. Most people would repeat this number continuously until they dial the telephone. This strategy, called rehearsal, allows information to remain in STM for as long as rehearsal continues (Klatzky, 1980). (Rehearsal is also one process that helps to move information into the long-term memory store.) However if rehearsal is prevented, by asking the person to perform an intervening cognitive task like counting backwards, studies with adults show that information is lost completely within about 15-to-20 seconds (e.g., Brown, 1958; Peterson & Peterson, 1959).

Are there age-related differences in STM? Studies on STM capacity have shown that children can recall fewer symbols than adults (e.g., Chi, 1976; Dempster, 1981; Keating & Bobbitt, 1978). This result could indicate that up to about age 13 or 14, STM capacity increases (e.g., Pascual-Leone, 1989a). However, other researchers (e.g., Brainerd, 1983; Siegler, 1991) have suggested two alternative explanations for the results: 1) Adults know more about the world and may be able to use this information to chunk information more efficiently; and 2) Adults are more likely to have learned and know when to use strategies, such as rehearsal, to help maintain information in STM. In any case, the

fact that adults can store more material in STM means that they are better equipped than children to understand and think about information.

There are also consistent age-related differences in the speed at which information is processed in STM, with processing speed increasing with age (e.g., Hale, 1990; Kail, 1986; 1988; Keating & Bobbitt, 1978). STM processing speed is typically studied using a paradigm developed by Sternberg (1966; 1969) called *memory scanning*. In this paradigm, the person is given a set of stimuli, such as the letters R, W, L, B, and S. The set usually contains fewer items than the capacity of STM. The person is then asked if a test stimulus, such as Y, is contained in the set of stimuli. The reaction time (RT) for a correct yes or no answer is measured. RT is taken as the amount of time for information to be processed in STM. Typically, as the number of items in the given set of stimuli increases, RT also increases by an equal ratio (Sternberg, 1966), suggesting that more processing time is required when more information is involved.

Keating and Bobbitt (1978) used the memory scanning procedure to investigate STM processing speed in 9, 13, and 17-year-olds. For stimulus set sizes of one, three, and five, they found average RTs to be the longest for the 9-year-olds, shorter for the 13-year-olds, and the shortest for the 17-year-olds. RT decreased by roughly one-third between each age-group. Thus, 17-year-olds processed information more than twice as fast as the 9-year-olds in this experiment. Similar results using different tasks have been obtained (e.g., Hale, 1990; Kail, 1986; 1988).

In summary, the research on short-term memory shows, among other things, that the speed at which information is processed and the amount of information that can be processed increases significantly with age among young people. Therefore, any cognitive process requiring short-term memory, such as decision making, reasoning, or understanding a traffic safety message will proceed at a slower rate for children and adolescents than for young adults. The amount of information that can be considered at the same time will also be less for children and adolescents. Consider the situation in which a driver is approaching a signalized intersection and the light changes to yellow. The driver is faced with a complex decision that requires rapid processing. The driver will have to consider the speed he or she is going, the distance to the intersection, the amount of time for the yellow cycle, the conditions of the roadway, the presence of other vehicles, and several other dimensions before deciding whether to brake or proceed into the intersection. If the driver is speeding, as young drivers often do, then the decision time can be quite short. The research we have discussed suggests that younger drivers, because of slower processing speed and lack of ability to consider several dimensions of a problem at the same time, are likely to inappropriately enter intersections on a yellow light. Further, the occurrence of this high risk driving behavior should be most frequent in young drivers who are speeding. A direct observation study of driver behavior at yellow lights supports this prediction. The study discovered that younger drivers violated a red light more often than older drivers, especially if they were traveling over the speed limit (Konečni, Ebbesen, & Konečni, 1976).

Long-Term Memory

Long-term memory (LTM) stores our experiences and knowledge. All that we know and have thought about is stored in LTM. It is believed that the capacity of LTM is unlimited for both adults and children--at least no study to date has been able to measure the capacity (e.g., Tulving, 1974). Adults, of course, differ from younger people in how much they have been able to store in LTM; that is, adults tend to be more experienced, especially in driving-related knowledge, than young adults or adolescents. A study by Chi and Koeske (1983), however, showed that expertise is not necessarily age-related. They showed that young children can develop expertise about something (i.e., in this case dinosaurs), that far surpasses the knowledge base for this topic in most adults.

As the name implies, the durability of information in LTM is quite long and can be impressively accurate (Shepard, 1967; Allen & Reber, 1980; Bahrick, Bahrick, & Wittlinger, 1975). In one study, Bahrick, *et al.* (1975) tested adult recognition of faces from high school year books 35 years later and found that people could accurately identify whether a face was in their year book 90 percent of the time! Since older people can remember events that took place when they were young, it is reasonable to conclude that the LTM durability does not change with age.

Despite such impressive capacity and durability of LTM, we are more likely to be aware of cases in which we cannot remember something. The fact that both adults and children sometimes forget things seems at odds with the large capacity of LTM. It is believed by some researchers that the cause of forgetting in LTM is not from loss of information but rather from an inability to retrieve the information (Tulving & Psotka, 1971; Ratcliff & McKoon, 1989). Good illustrations of this inability are instances in which a person feels like he or she knows a certain fact but cannot quite remember it (e.g., Nelson & Narens, 1980). This experience has been called the *tip-of-the-tongue (TOT) phenomenon*. Consider a study in which adults were read dictionary definitions of infrequently used words, such as "An instrument used by navigators for measuring the angular distance of a star from the horizon." (Brown & McNeill, 1966). If the persons could not recall the defined word, they were asked to report how many syllables were in the word, what letter it began with, or to name words that it rhymed with. People were quite accurate in reporting the features of the word, even though they could not recall it. In our example, the defined word is "sextant." The TOT phenomenon illustrates the effortful nature of retrieval from LTM and shows that LTM contains information of which we must not be consciously aware.

Experiences such as the TOT phenomenon also help to illustrate the different ways of retrieving information from LTM. If the adult in the example above was given a list of words that contained the word sextant, it is likely that he or she would have been able to easily pick it out of the list. That is, it is easier to recognize something than it is to recall it. Because of this distinction, psychologists typically distinguish between recognition and recall when investigating LTM retrieval (e.g., Anderson & Bower, 1972; Klatzky, 1980). This distinction is important when considering age-related differences in LTM retrieval.

As with adults, several studies have shown that children's recognition memory is quite impressive (Brown & Campione, 1972; Brown & Scott, 1971; Daehler & Bukatko, 1977) . For example, Brown and Scott (1971) showed 4 and 5-year-old girls and boys 32 pictures cut out of a children's book. Some of the pictures were shown to them once and some were shown twice. Recognition of the pictures as long as 28 days later was tested by individually showing the children the 32 pictures mixed in with an additional 12 filler pictures. For each picture, the children reported whether or not they had seen it before. The results showed that the children tested after 7 days were about 94 percent accurate in their recognition of pictures seen twice, and children tested after 28 days were about 75 percent accurate for the same pictures. Pictures seen only once were recognized correctly at a lower rate. No sex differences were reported. This impressive recognition accuracy is comparable to similar studies conducted with adults (e.g., Shepard, 1967). Further, studies that have compared adults with children on recognition memory of realistic pictures, abstract pictures, and abstract forms have shown no reliable recognition differences between adults and children (Nelson, 1971; Nelson & Kosslyn, 1976).

It is clear that even children have impressive recognition memory. However, as discussed by Kail (1986), the typical stimuli used in developmental studies of recognition memory are pictures of single objects. Kail further pointed out that children's recognition often involves much more complexity; that is, scenes that contain multiple objects. Using a paradigm similar to the one utilized by Brown and Scott (1971), several studies have shown that recognition accuracy for scenes containing multiple objects increases with age (e.g., Hock, Romanski, Galie, & Williams, 1978; Mandler & Robinson, 1978; Newcombe, Rogoff, & Kagen, 1977). For example, Newcombe, *et al.* (1977) tested recognition accuracy of 6-year-olds, 9-year-olds, and adults for several pictures of scenes, each of which contained multiple objects arranged in a natural setting. When tested after 5 days, recognition accuracy for the scenes was about 50 percent for the 6-year-olds, 80 percent for the 9-year-olds, and 90 percent for the adults. Collectively, this literature shows that retrieval of information from LTM is identical for adults and children when the to-be-remembered item is shown to the person (recognition) and is not too complex, such as a single object or simple scene. However, if the item is complex, such as in a real-world scene, recognition accuracy continues to improve up through adulthood.

Several authors have cited inexperience as a contributing factor to the elevated crash rates of young drivers (e.g., Catchpole, Cairney, & Macdonald, 1994; Eby, 1995b; Hodgdon, Bragg, & Finn, 1981; McPherson, McKnight, & Weidman, 1983; Pelz & Schulman, 1971). In terms of LTM processes, inexperience is related to a lack of knowledge about factors such as driving situations, vehicle handling, problem solving, and decision making strategies. Clearly, a major goal of driver education and graduated licensing programs is to allow young drivers to develop their expertise with driving while minimizing their crash risk.

Attention

Introduction

The word attention is used frequently in everyday language and, depending upon its usage, has several meanings. Cognitive psychologists, however, define attention as a process of concentrating or focusing of limited cognitive resources to facilitate perception or mental activity (e.g., Anderson, 1985; Bernstein, Roy, Srull, & Wickens, 1991; Broadbent, 1958; Kahneman, 1973; Matlin, 1989). Attention is a conscious process; that is, it is usually under voluntary control. For example, you have focused your attention on these words in order to be able to read them and, if your radio was on, you could shift your attention there in order to understand the radio announcer. Thus, attention is a process that is necessary for information processing--the information will get into memory only if it has been attended to.

For a traffic safety message or program to be effective, it must attract the attention of the target persons. The most important factor determining what people focus on is their level of interest in the information (e.g., Miller, 1982; Miller & Shannon, 1984). Thus, it is important to know what will attract the attention of the target audience and adjust the message format and content to utilize these interests.

In order to perceive, interpret, and understand a message, such as a traffic safety message, children or adults must be able to shift their attention to the appropriate message while filtering out other stimuli (called selective attention). Further, they might devote only part of their attention to the message (called divided attention). They must also be able to focus their attention long enough to receive the entire message (called sustained attention). A lack of capacity in any of these three attentional processes could lead to either a misunderstanding of traffic safety messages or a complete failure to receive them.

Selective Attention

Whenever we are awake, we are bombarded constantly with sensations. In order to make sense of this chaos, we have to determine what is most important to us and focus our attention on it. Parasuraman (1986) defined selective attention as, "a process in which the observer attempts to attend selectively to some stimuli, or some aspect of stimuli, or to some task, in preference to other stimuli or tasks." (pp. 43-2). Thus, selective attention is the process that determines which information sources we will consider.

Numerous studies have shown that adults are better able to ignore irrelevant information than children (see Dempster, 1993; Lane & Pearson, 1982; and Miller, 1990 for reviews). One of the most frequently studied phenomena in experimental psychology, the Stroop test, is a test of selective attention (Stroop, 1935). In this test, a literate person is required to name the color of ink used to print an incongruent color-word. For example, the person might be shown the word GREEN printed in red ink. In this example, the task would be to say "red" as quickly as possible, ignoring the meaning of the printed word. The time required to respond is typically compared to the time required to name a nontext color chip, with the difference in response time taken as the amount of attentional interference produced by the text. Response times on the Stroop test show clear age differences.

In one of the most thorough investigations of response times in the Stroop test by age, Comali, *et al.* (1962) found that performance on the Stroop test was strongly related to age. As shown in Figure 3, Comali, *et al.* found that the difference between response times in the Stroop task and naming color patches was greatest for 7-year-olds (the youngest age tested) and decreased fairly consistently up to about age 18. The differences remained fairly constant from 18 years of age to the middle age group (35 to 44 years of age) and increased significantly for the people in the 65-to-80-year-old age group. The effect of sex was not studied. Because greater response time differences are interpreted as a person having greater difficulty attending selectively to a relevant stimulus, these results show that the ability to selectively attend to important information develops up to about age 18, where it remains constant for the majority of the life span. Sometime after 44 years of age, selective attention ability declines appreciably.

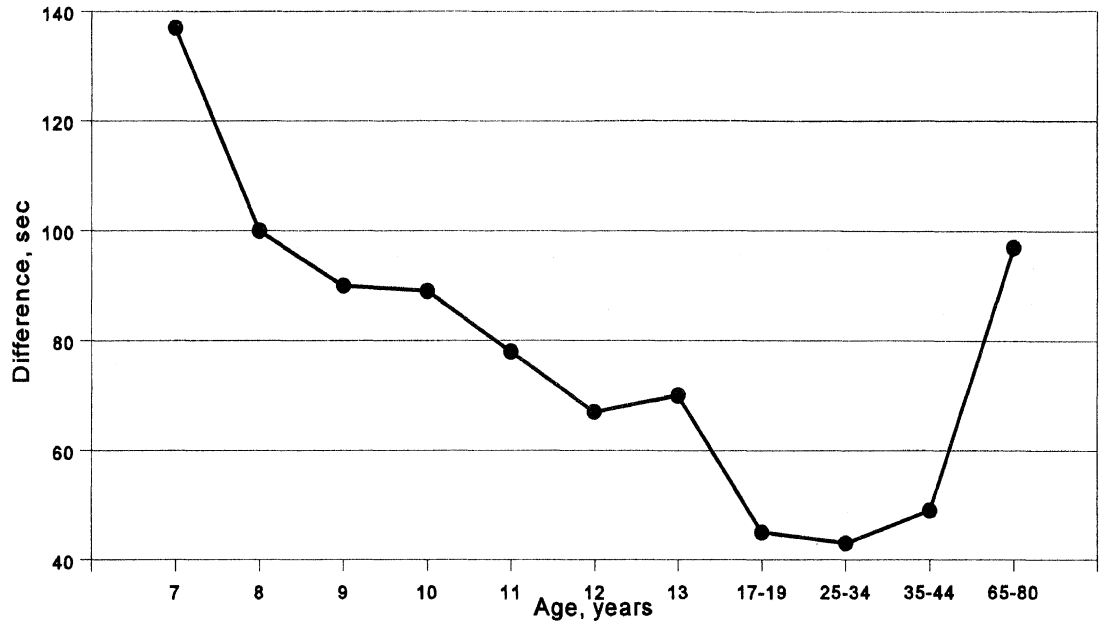

Figure 3: Response time on the Stroop test by age (Comali, *et al.*, 1962).

Converging evidence for the increasing selective attention ability with age is also found in *selective-listening* tasks (Cherry, 1953). In this approach, selective attention is investigated by having a person wear stereo earphones in which different messages are played in the left and right ears. The person is typically asked to listen to only one of the messages while ignoring the other. Selective attention ability is measured by determining the accuracy with which the person can report information about the to-be-attended-to message; in other words, how well the person can ignore the irrelevant message.

Many studies have shown that selective-listening ability increases with age (see, e.g., Doyle, 1973; Geffen & Wale, 1979; Geffen & Sexton, 1978; Hiscock & Kinsbourne, 1977, 1978; Maccoby & Konrad, 1966, 1967; Pearson & Lane, 1991; Sexton & Geffen, 1979). For example, Sexton and Geffen (1979, experiment 2) studied 7, 11 and 20-year-olds in a selective-listening task. In this study, the subject wore earphones that played

different recorded lists of words to each ear. The subject was told to ignore the list in one ear and to listen for a target-word in the other ear. When the subject heard the target-word in the proper ear, he or she pressed a button. Subjects were scored on the accuracy of identifying the target word, with higher accuracy being attributed to better selective attention ability. The researchers found that accuracy increased monotonically with age with no difference between sexes. Thus, the ability to ignore irrelevant auditory messages and to focus on a relevant message, such as a traffic safety message, improves at least up to about 20 years of age.

In addition to the Stroop test and selective-listening tasks, selective attention ability has been shown to improve with age in the processing of pictures (e.g., Day & Stone, 1980), the classification of three-dimensional objects (e.g., Pick, Christy, & Frankel, 1972) and stick figures (e.g., Smith, Kemler, & Aronfreed, 1975), the ability to sort cards based upon the characteristics of the cards (e.g., Strutt, Anderson, & Well, 1975), and exploratory searching tasks (Miller & Seier, 1994). Collectively, these studies show that the ability to focus attention on relevant and important information, and thereby to be most prepared to receive and process that information, is poor at 7 years of age but develops markedly during the next 10 to 15 years.

Divided Attention

A topic closely related to selective attention is divided attention. In tasks requiring selective attention, the person attempts to ignore irrelevant stimuli while focusing on a relevant stimulus. In a divided attention task, a person attempts to focus attention on more than one stimulus. Bernstein, *et al.* (1991) have defined divided attention as, "...devoting psychological resources to more than one task or stimulus at a time." (pp. 202). In nearly all driving situations, drivers must divide their attention among several tasks.

Divided attention is studied by having a person attempt to perform two tasks at once or to attend to two stimuli at once. One of the most frequently cited studies on this topic found that people generally are not very good at dividing attention (Neisser & Becklin, 1975). The method typically used to present two stimuli to a person is a variation of the selective-listening task described earlier. In this variation, the person is instructed to listen to the messages in both ears (called a dichotic-listening task) and produce a response when he or she hears a target word or event in *either* ear. In order for the researcher to determine which ear the subject is responding to, the subject is typically asked to press a button with the right hand if the target word is heard in the right ear, press a button with the left hand if it is heard in the left ear, and press buttons with both hands if the target word is heard simultaneously in both ears.

Using a dichotic-listening task, Sexton and Geffen (1979, experiment 3) investigated divided attention abilities of 7, 11, and 20-year-olds. They found several interesting results. First, divided attention ability was poor, with all people identifying accurately only about 55 percent of the target words. Second, accuracy increased significantly between 7 and 11 years of age. There was no consistent difference in accuracy between 11 and 20 years of age. Finally, there were no consistent effects of sex on dichotic-listening accuracy. Thus divided attention ability seems to peak quickly (by 11 years of age), is generally poor, and

does not seem to be affected by the sex of the person. Additional support for these conclusions comes from a variety of studies using several divided attention tasks (e.g., Hiscock & Kinsbourne, 1978; Pearson & Lane, 1991; Schiff & Knopf, 1985).

Sustained Attention

Once the most important stimulus has been selectively attended to, we must also be able to maintain our focus of attention on the stimulus in order to effectively process it. Parasuraman (1986) defined sustained attention as, "a process of maintaining attention to a critical stimulus or aspect of a stimulus for a sustained period of time." (pp. 43-3). The duration of sustained attention is sometimes called the *attention span* (e.g., Bjorklund, 1995). However, this phrase is misleading because it suggests that a time value (e.g., 5 minutes) can be assigned to the duration of sustained attention. This is not the case. The typical result in the literature is that performance on a task requiring sustained attention declines gradually over time (e.g., Parasuraman, 1986); that is, the person makes more errors, takes longer to respond, or, by self-report, has more difficulty with the task as duration increases. The rate of decline in performance is closely related to the characteristics of the task, with interesting tasks showing smaller performance decrement rates over time (see Parasuraman, 1986, for an extensive review).

The fact that both selective and divided attention abilities develop with age, suggests that sustained attention would follow a similar developmental trend. Several studies have shown that the ability for sustained attention does indeed increase with age Crow & Crow, 1963; Gutteridge, 1935; Murphy-Berman, Rosell, & Wright, 1986; Mussen, Conger, & Kagan, 1974; Tyler, Foy, & Hutt, 1979; van Alstyne, 1932). In particular, Murphy-Berman, *et al.* (1986) investigated sustained attention in children 7-to-16 years of age. Using a microcomputer to display simple drawings, participants were required to watch for a target picture that appeared in a certain part of the display screen. When the target picture appeared, they pressed a button as quickly as they could. Because the presentation rate of the pictures was adjusted for each child, a testing session lasted from 20-to-30 minutes. The results showed that sustained attention abilities generally improved between 7 and about 12 years of age, leveled off until 14 or 15 years of age, and then improved significantly for the 16-year-old subjects. There was a general sex trend, with females showing slightly better sustained attention ability across all ages, but it was not statistically significant. Thus, it appears that sustained attention ability does follow developmental trends that are similar to selective and divided attention trends.

Learning

Introduction

Learning has been defined as any relatively permanent change in behavior or thinking that results from past experiences (e.g., Bernstein, Roy, Srull, & Wickens, 1991). This rather broad definition accounts for the simplest learning such as habituating to a stimulus, as well as complex learning such as mastering a musical instrument or driving a car. The ability to learn, of course, is present at birth. Studies have shown that neonates can imitate the tongue protrusion of an adult and possibly other adult gestures (e.g., Anisfeld, 1991; Meltzoff & Moore, 1989). Other studies show that neonates habituate to visual and auditory stimuli (e.g., Bridger, 1961; Cole & Cole, 1989; Kellman & Spelke, 1983) and can recognize their mother's voice (e.g., DeCasper & Fifer, 1980).

Despite the innate presence of learning processes, learning is an integral component of cognitive development. Further, an understanding of learning processes is important for those interested in developing messages and programs that attempt to improve safe driving practices. Most traffic safety messages are designed to either change how people think about a traffic safety issue or to change people's safety behaviors. In other words, they are designed to educate people. Therefore, a comprehensive understanding of learning processes is central in the development of effective traffic safety messages and programs. Three learning processes are particularly relevant: classical conditioning, operant conditioning, and observational learning (Leahey & Harris, 1997).

Classical Conditioning

One basic learning process is the ability to identify relationships or make associations between events; for example, blue skies result in dry weather, or driving immediately before 8:00 am leads to sitting in rush hour traffic. The simplest kind of associative learning, classical conditioning, involves the association between reflexive responses (such as many emotional responses) and a stimulus (such as food or a person).

The scientific investigation of classical conditioning began with the now famous studies of the Russian physiologist Ivan Pavlov (1927). In his Nobel Prize winning studies of canine digestive physiology, Pavlov noticed that the dogs he was studying would salivate initially only when food was presented. However, over time, the dogs would also salivate at the sight of the previously neutral experimenter who fed them. Pavlov recognized that a reflexive response (salivating in the presence of food) could be associated with nonfood stimuli, such as the sight of an experimenter or the sound of a bell.

Around the same time as Pavlov's work, a pair of American psychologists demonstrated classical conditioning in humans (Watson & Rayner, 1920). Watson and Rayner were interested in the conditioning of emotional responses. They chose to study how fear toward a previously neutral object might develop. They selected as their subject a 9-month-old male called "Albert B." or as he later became known, Little Albert. Watson and Rayner first determined a set of objects toward which Little Albert showed no fear, including a rat and several other small furry objects. They then discovered a stimulus that

caused a fear reaction in their young subject--striking a metal bar with a hammer. This stimulus startled Little Albert and then produced crying. During conditioning, Albert was given a tame rat toward which he had previously shown no fear. When he first touched the rat, Watson and Rayner struck the metal bar with the hammer. This process was repeated for 7 days. Afterward, Albert was presented with the rat and no metal bar was struck. Albert showed a fear response towards the rat. The previously neutral object now produced fear for Little Albert. Further, Watson and Rayner showed that this fear also generalized to other furry objects such as a rabbit, a fur coat, a dog, a Santa Claus mask, and cotton balls. Thus, after only 7 days of fear conditioning, Little Albert now showed fear toward a wide range of objects. When Albert was tested 1 month later, his fear responses had been lessened but were still present.

Since the work of Pavlov (1927) and Watson and Rayner (1920), the properties of classical conditioning have been firmly established. Before discussing these properties, four classical conditioning terms need to be defined (Leahey & Harris, 1997). The stimulus that produces a response without any learning required (e.g., the sound of a hammer striking a metal bar) is called the unconditioned stimulus (US), while the reflexive response (e.g., fear) is called the unconditioned response (UR). The stimulus that, through learning (conditioning), leads to a response that is like the UR is called the conditioned stimulus (CS; e.g., the rat) and the response is called a conditioned response (CR). Three factors can affect the probability of a conditioned association being acquired:

1) The probability of a CS producing a CR increases with the number of pairings of the CS and US (Pavlov, 1927; Watson & Rayner, 1920). In other words, the more times the loud noise was paired with the rat, the more likely it was that Little Albert would associate a fear response with the rat.

2) The probability of a CS producing a CR increases with decreases in the temporal interval between presentation of CS and the US (e.g., Pavlov, 1927; Ross & Ross, 1971). In other words, the conditioned fear response toward the rat (the CS) was more likely to occur if the interval between presentation of the rat to Little Albert and hitting of the metal bar with the hammer was short. Studies have shown that the optimal interval between the CS and US is .5-to-1 second (Ross & Ross, 1971).

3) The probability of a CS producing a CR increases with the intensity of the UR. That is, a highly intense unconditioned response, such as the pain from an injection, can lead to a CS-CR association even after a single pairing.

Fortunately for Little Albert, once the CS-CR association has been established, it will not remain forever. With repeated exposure to the CS without the US, the CS-CR association will eventually disappear or become extinct. In other words, if Little Albert were to be continually presented with the rat but no loud noise, he would eventually lose his fear of the rat. The likelihood of this extinction increases with the number of exposures to the rat without the loud noise. Little Albert's fear response, however, was not experimentally extinguished (Harris, 1979).

Operant (Instrumental) Conditioning

Classical conditioning suggests a way in which two stimuli that occur together can become associated. But, clearly, people can also learn by doing something and seeing what happens. For example, children learn to say "please" in order to get something that they want. Because in this situation the individuals are operating on their environment and are instrumental in producing some outcome, this type of learning has been called both instrumental (Thorndike, 1898) and operant (Skinner, 1938) conditioning. It differs from classical conditioning in that people have control over events.

In operant conditioning, an action occurs that is followed by some outcome. If the outcome is positive, then the action is likely to be repeated. Psychologists call this type of outcome a reinforcer. An outcome can be reinforcing if it is pleasant (positive reinforcer) or if it removes something that is unpleasant (negative reinforcer). Outcomes can also be punishing. If the outcome is punishing, the action that led to it will become less likely to be repeated. Thus, through both reinforcement and punishment, new behaviors are learned and others are extinguished. Several factors affect whether and how a behavior is operantly conditioned.

1) The effectiveness of the reinforcer or punishment to change behavior is decreased as the amount of time between the behavior and outcome increases (e.g., Kalish, 1981). For example, many behaviors that people typically engage in have punishing consequences, such as drinking too much alcohol or not wearing a safety belt. One reason these behaviors continue is that the negative consequences are often delayed too much to be effective in changing the behavior. There is some evidence that the incidence of drunk driving may be reduced by decreasing the time between a drunk driving arrest and adjudication of the case (Streff & Eby, 1994).

2) The effectiveness of the reinforcer or punisher to change behavior increases with the magnitude of the reinforcer or punisher (e.g., Holmes & Robbins, 1987). For example, a crash in which a person was seriously injured because of a lack of safety belt use will be more effective in producing later belt use than a crash in which the person merely receives a cut or bruise.

3) A behavior does not have to be reinforced every time it occurs in order for that behavior to be conditioned (e.g., Skinner, 1961). The reinforcer may be presented on a fixed schedule, say, for example, after every third time a child raises his or her hand before speaking in class. The reinforcer may also be presented on a variable schedule, say after the fourth, tenth, and nineteenth time the child raises his or her hand before speaking in class. Both schedules of reinforcement have been shown to produce operant behaviors. At least one study has shown the effectiveness of a variable reinforcement schedule in increasing safety belt use. In this study, police randomly pulled over drivers and rewarded them with prizes for wearing safety belts (Mortimer, Goldsteen, Armstrong, & Macrina, 1988).

As in classical conditioning, learned behaviors are not necessarily permanent. In operant conditioning, a conditioned behavior will stop if it continues without reinforcement. The time required for this extinction is dependent upon the reinforcement schedule used to produce the behavior. If the behavior was reinforced every time it occurred (the quickest way to condition the behavior), then it will stop quickly. If the behavior was conditioned on a fixed schedule, then it will stop less rapidly. If, however, the behavior was conditioned on a variable schedule, it will stop the least rapidly.

Numerous traffic safety programs have utilized operant conditioning paradigms to increase positive traffic safety behaviors or decrease negative ones with varying levels of success (e.g., Marchetti, Hall, Hunter, & Stewart, 1992; Mortimer, Goldsteen, Armstrong, & Macrina, 1988; Roberts & Fanurik, 1986; Wilde, 1985; Wodarski, 1987). For example, Roberts and Fanurik (1986) showed impressive increases in elementary school children's belt use following a program in which belted children received tokens they could redeem for toys. In this evaluation, belt use increased over 50 percentage points immediately after the program and then gradually declined over the following 2 months. The use rate, however, stabilized at a level that was higher than the preprogram level. These findings are in agreement with the principles of operant conditioning. Had the token been given out on a variable schedule (e.g., 2 randomly selected days each week) rather than the fixed schedule that was used, then the increased belt use would have, most likely, lasted for a much longer period of time.

Traffic law enforcement programs work on the principle of using punishment, or the threat of punishment, to reduce the likelihood of unsafe driving practices. The effectiveness of such programs has been shown in studies of drinking and driving (e.g., Kinkade & Leone, 1992; Streff & Eby, 1994), safety belt use (e.g., Eby & Christoff, 1996; Jonah, Dawson, & Smith, 1982; Ulmer, Preusser, & Preusser, 1994); bicycle helmet use (e.g., Cameron, Vulcan, Finch, & Newstead, 1994; Coté, *et al.*, 1992; Healy & Maisey, 1992; Macknin & Medendorp, 1994), and motorcycle helmet use (e.g., Chinier & Evans, 1987; Lund, Williams, & Womack, 1991; Streff, Eby, Molnar, Joksch, & Wallace, 1993).

Observational Learning

Much of human learning conforms to the principles of both classical and operant conditioning, which require direct experience of either a stimulus pairing or an action and its consequences. However, it is clear that some learning does not follow conditioning principles or require direct experience. All of us do not need to receive head injuries or be thrown in jail to know that we should wear a helmet when cycling, and should not drive while drunk. Humans can benefit from the experiences of others in order to learn behaviors and their consequences. Such learning is called observational learning or vicarious conditioning (Bandura, 1965).

In a series of experiments, Bandura (1965) convincingly demonstrated observational learning in nursery school children. Using an equal number of boys and girls, Bandura showed children a film of an adult interacting aggressively with an inflatable, adult-sized punching bag doll called a "Bobo" doll. All children saw the adult punch, kick, and throw objects at the doll and then strike it with a hammer. One-third of the children then saw the

adult get punished for his or her behavior, one-third saw the adult get rewarded, and the remaining one-third saw no consequences. Individually, children were then placed alone in the room with the Bobo doll and their behavior was observed. Bandura found that those children who watched the adult get rewarded for aggressiveness initiated more imitative acts on the Bobo doll than those who saw the adult receive a punishment or no consequences at all. Overall, boys imitated more aggressive acts than girls. Bandura then rewarded all children for imitating the adult and found no differences between groups, except that boys generally imitated more aggressive acts than girls.

These results show two important findings. First, observing the consequences of someone else's behaviors can affect the behaviors a child chooses at a later date. Behaviors that were observed being punished were less likely to be imitated by children. Second, even though the behaviors were not imitated, when prompted and rewarded, all children showed that they had learned the behavior, even if they saw it being punished.

In several studies, Bandura (1977, 1986, 1989) has identified four factors that influence observational learning:

1) *Attention.* Observational learning will not occur unless the person is paying reasonably close attention to the person or people performing the behavior.

2) *Memory.* Observational learning will not occur unless the person can remember the actions and consequences at a later time.

3) *Ability to Reproduce the Action.* Observational learning will not occur if the person cannot reproduce the action (the reason why we all cannot play violin after watching Itzhak Perlman perform).

4) *Motivation.* Observational learning will not occur unless the person has some reason for performing the behavior. (See the chapter on motivation for further information on this topic.)

Undoubtedly, many driving behaviors, both good ones and bad ones, are learned through observation. DiBlasio (1986), for example, has reported that driving while drunk and riding with a drunk driver are partly acquired through a person's association with his or her peer group. He also mentions that observation of family models (children's parents, stepparents, and guardians) engaging in drunk driving behaviors is positively correlated with similar behaviors in children. Carlson and Klein (1970) compared the traffic conviction histories of men and their sons and found a positive correlation. The authors concluded that a greater proportion of driving behavior is learned through familial contact than through institutional contact (e.g., driver training). The principles of observational learning should be considered when developing traffic safety programs and messages.

Reasoning

Introduction

A prominent feature of human cognition is our ability to draw conclusions based upon the things that we have learned. This ability is so commonplace in everyday cognition that people frequently do not even notice when they are engaging in it. For example, if a friend were to introduce you to a young woman and an old man as his sister and father, respectively, you might conclude that the old man is also the woman's father. You would not have been told this, but you might reason that siblings have the same father, so the woman's father must be the old man. In most cases you would be correct, unless your friend and the woman are step-siblings. The process by which people draw conclusions from their knowledge of the world is called reasoning (e.g., Evans, Newstead, & Byrne, 1993; Garnham & Oakhill, 1994; Halpern, 1989; Johnson-Laird & Byrne, 1991). When people reason, they are generating a belief (i.e., conclusion) that has been inferred from what they know. Thus, reasoning is intimately related to most other cognitive abilities including learning, moral development, verbal ability, memory, attitude formation, and problem solving.

Many traffic safety messages and programs use logic to both teach and convince drivers to drive safely. Further, much of what people learn about the driving task and driving situations is based upon reasoning processes. Therefore, a thorough understanding of how reasoning develops and the problems people have with reasoning is necessary for the development of effective traffic safety messages.

The study of childhood and adult reasoning usually makes a distinction between two types of reasoning processes: *deductive* and *inductive* reasoning. In deductive reasoning, a person begins with information that is known to be true (called premises) and draws a conclusion based upon this information. If the information is true and the person follows the rules of logic, then the conclusion is both truthful and valid (e.g., Evans, Newstead, & Byrne, 1993; Halpern, 1989; Johnson-Laird & Byrne, 1991). Thus, in deductive reasoning, the conclusion must necessarily follow from the premises. In inductive reasoning, on the other hand, a person starts with information that may or may not be correct and then draws a conclusion (such as an hypothesis). The person then collects information to support or refute that conclusion (e.g., Halpern, 1989; Holland, Holyoak, Nisbett, & Thagard, 1986). For example, a young driver might conclude that safety belt use causes injuries rather than prevents them. This young driver might then talk with friends, read the newspaper, or watch the television to learn about safety belt use and injury outcomes in crashes. If the rules of logic are followed by the young driver, a single instance in which a safety belt prevents injury during a crash should cause him or her to modify or abandon the falsified belief.

Deductive Reasoning

Research has shown that children, even those as young as preschool age, can draw deductively valid conclusions (e.g., Dias & Harris, 1988, 1990; Hawkins, Pea, Glick, & Scribner, 1984). However, other studies have found that both adults (e.g., Evans, Newstead, & Byrne, 1993; Johnson-Laird & Byrne, 1991; Newstead & Evans, 1995; Wason

& Johnson-Laird, 1972; Woodworth & Sells, 1935) and children (e.g., Galotti & Komatsu, 1989; Kuhn, 1989; Markovits, 1993; Markovits, Schleifer, & Fortier, 1989; Ward & Overton, 1990) make frequent logical errors when reasoning deductively. The majority of research on deductive reasoning has focused on the subtypes: Class-inclusion reasoning and conditional reasoning.

Class-Inclusion Reasoning: One of the most popular paradigms used in the study of deductive reasoning is to have subjects judge the validity of class-inclusion reasoning problems called syllogisms (see Woodworth & Sells, 1935, and Wilkins, 1928, for some of the earliest work with this type of syllogism). A syllogism usually has three parts: two statements of given information (premises) and a conclusion. Both the premises and the conclusion contain "class inclusion" words, such as *all*, *no*, and *some*, that must be analyzed by subjects in order to decide whether the conclusion follows logically from the given premises. An example class-inclusion syllogism is:

Premise #1: All young people are poor drivers.
Premise #2: Some poor drivers are traffic hazards.
Conclusion: Therefore, some young people are traffic hazards.

In this case, the conclusion does *not* follow logically from the premises (i.e., it is invalid), even though some readers may believe that the conclusion is true. Maybe some young drivers are hazards on the roadways and maybe not-- we cannot decide based upon the given information alone.

Generally, the ability to draw logical conclusions from given premises in class-inclusion reasoning improves with age (e.g., Dias & Harris, 1988; Galotti, Baron, & Sabini, 1986; Galotti, Komatsu, & Voelz, 1997; Markovits, Schleifer, & Fortier, 1989; O'Brien & Shapiro, 1968; Roberge, 1970). A study by Roberge (1970) illustrates the typical results. Roberge investigated the ability of 228 children, whose ages averaged 10, 12, 14, or 16 years of age, to judge the validity of class-inclusion syllogisms such as:

All of the green coats in the closet belong to Sarah.
The coat in the closet is green.
Therefore, the coat in the closet belongs to Sarah. (Valid)

Or:

All of Hank's paintings are paintings of horses.
This is a painting of a horse.
Therefore, this is Hank's painting. (Invalid)

Among other things, Roberge used both valid and invalid syllogisms and analyzed his results based on the percentage of students in each age category who "mastered" that type of syllogism; that is, children could judge validity better than what would be expected if they were guessing. Figure 4 shows Roberge's results. As can be seen, childhood deductive reasoning ability improved with age. There was also a large difference in the

percentage of children within an age category who "mastered" the different types of syllogisms. Few children, regardless of age, could consistently identify syllogisms in which invalid conclusions were drawn. When the conclusion was valid, the majority of children, even at age 10, could identify it as valid. Thus, in deductive reasoning about class inclusion, children, regardless of age, have difficulty understanding and identifying invalid logic. These results show that the types of errors made in class-inclusion deductive reasoning are similar among all age groups studied, but occur more frequently in younger children.

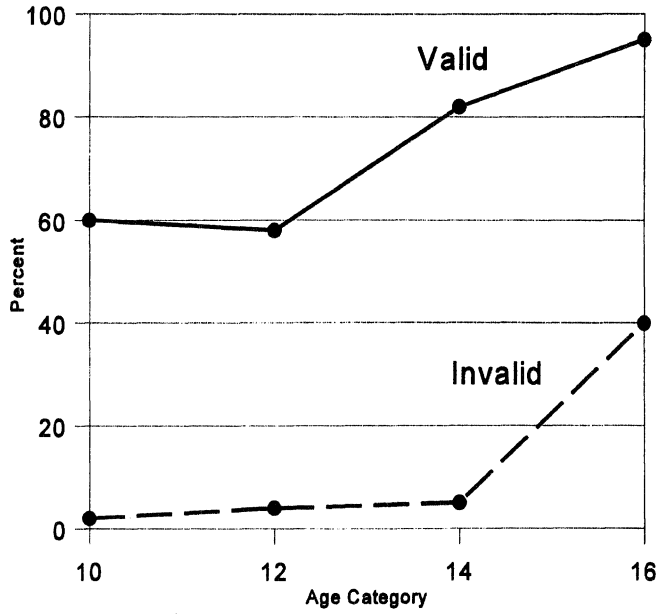

Figure 4: Percent of children mastering class-inclusion syllogisms (Roberge, 1970).

Diane Halpern (1989) has presented a thorough review of the problems both adults and children have with class-inclusion reasoning. One problem is that people, especially children (Ward & Overton, 1990), have a tendency to confuse truth with validity and reason based upon what they want to believe rather than using rules of logic (e.g., Evans, Barston, & Pollard, 1983; Henle & Michael, 1956; Wilkins, 1928). A second problem is that the context of the syllogism topic influences how people judge its validity (e.g., Braine, 1978; Evans, 1989; Ward & Overton, 1990); for example, a syllogism of the same form may be judged differently depending on whether the topic is safety belts or high school parties. A third problem people have with class-inclusion reasoning is that they unknowingly tend to transform a premise into a form that is not the same as the original statement; this is known as an illicit conversion (e.g., Chapman & Chapman, 1959; Dickstein, 1978). For example, a person reading the statement "All drunk drivers are dangerous drivers," may incorrectly also assume that "All dangerous drivers are drunk drivers." Such an illicit conversion could lead to reasoning errors.

A final problem with class-inclusion reasoning is that people have a tendency to use nonlogic-based heuristics to determine validity rather than the rules of logic (e.g., Begg &

Denny, 1969; Johnson-Laird & Steedman, 1978; Woodworth & Sells, 1935). The most common of these heuristics has been termed the atmosphere effect (Woodworth & Sells, 1935) which occurs because the quantifers in the premises ("all," "no," and "some") create a sense of what the quantifier in the conclusion should be. Begg and Denny (1969) have identified three common atmosphere effect rules that people inappropriately utilize. The first is that if one or both premises contain the word "some," then people incorrectly assume that the conclusion will contain the word "some." Because of the atmosphere effect, many people would judge the following syllogism as valid when it is not.

Some drunk drivers are dangerous drivers.
Some dangerous drivers do not use safety belts.
Therefore, some drunk drivers do not use safety belts. (Invalid)

The second inappropriate heuristic used by people is that if one or both premises contain the word "no," then people incorrectly assume that the conclusion will contain the word "no," as illustrated in the following example.

No drunk drivers use safety belts.
Some safety belt users drive the speed limit.
Therefore, no drunk drivers drive the speed limit. (Invalid)

A third inappropriate heuristic used by people is that if both premises begin with "all" then people incorrectly assume that the conclusion should also begin with "all." An example is shown in the following invalid syllogism.

All drunk drivers are dangerous drivers.
All speeders are dangerous drivers.
Therefore, all drunk drivers are speeders. (Invalid)

Conditional Reasoning: A more common type of deductive reasoning that is closely related to class-inclusion syllogisms, is conditional reasoning. In this type of reasoning, a person draws a conclusion based upon a contingency relationship usually described in an *if-then* premise. For example,

Premise #1: If she uses a safety belt, then she will be safer in a crash.
Premise #2: She uses a safety belt.
Conclusion: Therefore, she will be safer in a crash. (Valid)

Or,

Premise #1: If she uses a safety belt, then she will be safer in a crash.
Premise #2: She does not use a safety belt.
Conclusion: Therefore, she will not be safer in a crash. (Invalid)

As in class-inclusion syllogisms, the validity of the conclusion in conditional reasoning is based upon the information in the premises and the rules of logic.

Many studies have documented the fact that conditional reasoning ability improves with age (e.g., Girotto, Gilly, Blaye, & Light, 1989; O'Brien & Overton, 1980; Overton, Ward, Noveck, Black, & O'Brien, 1987; Paris, 1973; Roberge, 1970; Rumain, Connell, & Braine, 1983; Sternberg, 1979; Wildman & Fletcher, 1977). Using a procedure similar to Roberge's (1970), Wildman and Fletcher (1977) asked 281 students, whose average ages were either 14, 16, 18 or 21 years of age, to judge the validity of several *if-then* syllogisms. The percent correct reasoning for all types of problems by age category is shown in Figure 5. Wildman and Fletcher (1977) found that the ability to identify valid conditional reasoning increased gradually with age. However, even college students (21 years of age) performed quite poorly overall. Wildman and Fletcher analyzed the results by type of problem and found results that were similar to those of Roberge (1970). Subjects had the most difficulty correctly identifying syllogisms when the conclusion was invalid. Overall, these findings imply that the ability to draw valid conclusions from *if-then* statements is generally poor for people of any age, and the same types of errors are made. The percentage of people within an age group making that error, however, tends to decrease with increases in age.

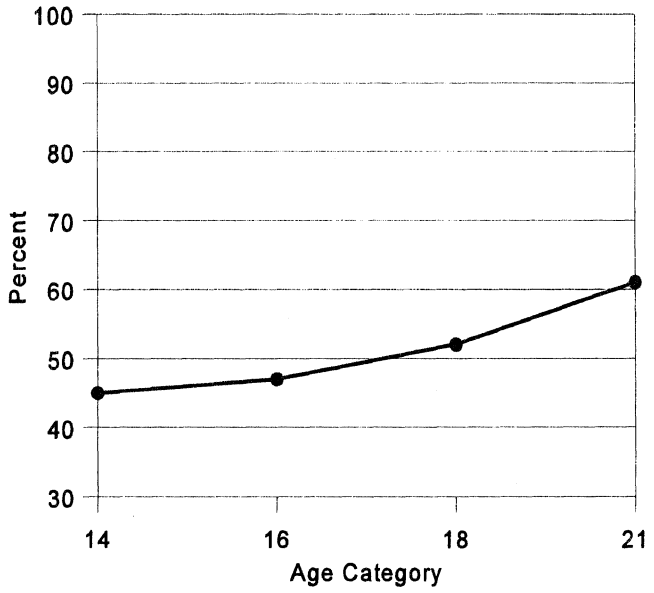

Figure 5: Percent correct reasoning by age (Wildman & Fletcher, 1977).

Several causes for poor conditional reasoning in both children and adults have been identified and summarized by Halpern (1989). The first source of error is that people have a difficult time ignoring the content of the premises and draw conclusions based upon what they would like to believe rather than on the basis of logic (see Braine, 1978). A second problem is that people have a tendency to make an incorrect conversion of the *if-then* premise. For example, the statement "If you use a safety belt, you will not be injured in a crash," might sometimes be interpreted as, "if you do not use a safety belt, you will be injured in a crash." While this conversion might make sense intuitively, it does not follow the rules of logic. A third factor that contributes to poor performance in conditional reasoning tasks is that people have difficulty processing negative information in conditional

syllogisms (e.g., Rumain, Connell, & Braine, 1983; Wason, 1969). Avery (1974) provides a good example by suggesting that children would have difficulty understanding the statement, "Cross the road when there are *no cars near*." He suggests that it would be easier for children to understand the statement if it were couched in positive rather than negative terms, such as, "Cross the road when *cars are a long way off*." Finally, people have a tendency to draw conclusions that support or confirm the premise rather than logically deducing the conclusion (e.g., Evans, 1989; Wason, 1966, 1969; Wason & Johnson-Laird, 1970, 1972).

Inductive Reasoning

Holland, Holyoak, Nisbett, and Thagard (1986) define inductive reasoning as "the inferential processes that expand knowledge in the face of uncertainty." (pp. 1). You are reasoning inductively when you create a new belief or conclusion based upon your experiences (Halpern, 1989). Thus, inductive reasoning is an integral component of thinking. It is involved in learning, decision making, and problem solving. Two types of inductive reasoning have been throughly investigated: reasoning by analogy and hypothesis testing.

Reasoning by Analogy: Reasoning by analogy is a process in which people draw a conclusion about something new by noting the similarities between the new item and something else they are already quite familiar with (e.g. Goswami, 1992). Goswami (1992) notes that many classic scientific discoveries have been made using this type of reasoning process, such as Archimedes' (3rd century B.C.) principles of displacement and Kepler's (1571-1630) theory of celestial mechanics. Analogies are frequently used as a teaching tool to help explain a concept. The utility of this tool in teaching is based entirely on the pupil's ability to reason by analogy.

As defined by Aristotle, reasoning by analogy follows the format "A is to B like C is to D." For example, "Bird is to Feather as Dog is to Hair" (Goswami, 1992). Typically, analogical reasoning is investigated by giving subjects the first three terms (e.g., "Food is to body as rain is to what?") and having them either pick the proper word from a list (water, storm, coat, *ground*) or generate the word by themselves (Gallagher & Wright, 1977). There is a broad literature investigating the development of reasoning by analogy. This work shows that performance on reasoning by analogy tasks improves with age (e.g., Bisanz, Bisanz, & Lefevre, 1984; Gallagher & Wright, 1977; Holyoak, Junn, & Billman, 1984; Piaget, Montangero, & Billeter, 1977; Sternberg & Rifkin, 1979).

In one of the most comprehensive studies on the development of reasoning by analogy, Sternberg and Rifkin (1979) tested groups of subjects whose ages averaged 8, 10, 12, and 19 years. In order to prevent performance decrements that could be related to verbal ability, the researchers used a pictorial version of Aristotle's reasoning by analogy task. This version, called the schematic-pictures analogy task, used drawings of cartoon people that varied in four binary attributes: hat color (white, black), suit pattern (striped, polka-dotted), hand gear (briefcase, umbrella), and footwear (shoes, boots). Subjects were shown two drawings of people (A and B) who had the same suit pattern (striped), hand gear (umbrella), and footwear (boots), but were each wearing a different color hat. They

were also shown a third person (person C), wearing a polka-dotted suit, shoes, a white hat, and carrying a briefcase. The subjects were instructed to select one of two pictures that correctly completed the analogy; in this case, a person in a polka-dotted suit, wearing a black hat and shoes, and carrying a briefcase. The researchers spent a significant amount of time making sure that all subjects understood the task prior to starting the experiment. They found that the time to correctly solve the schematic picture analogies decreased between 8 and 12 years of age and then did not change significantly into adulthood. The percentage of correctly completed analogies was high for all ages, but increased monotonically from 8 to 19 years of age, as shown in Figure 6. No sex differences were reported. While the high percentages of correctly completed analogies are not found in all studies, similar trends are typically found (see e.g., Bisanz, Bisanz, & LeFevre, 1984; Goldman, Pellegrino, Parseghian, & Sallis, 1982; Levinson & Carpenter, 1974; Lunzer, 1965). As a comparison to Sternberg and Rifkin's (1979) results, also shown in Figure 6 are the results of a comparable experiment using a different type of analogy and similar age groups (Bisanz, Bisanz, & LeFevre, 1984).

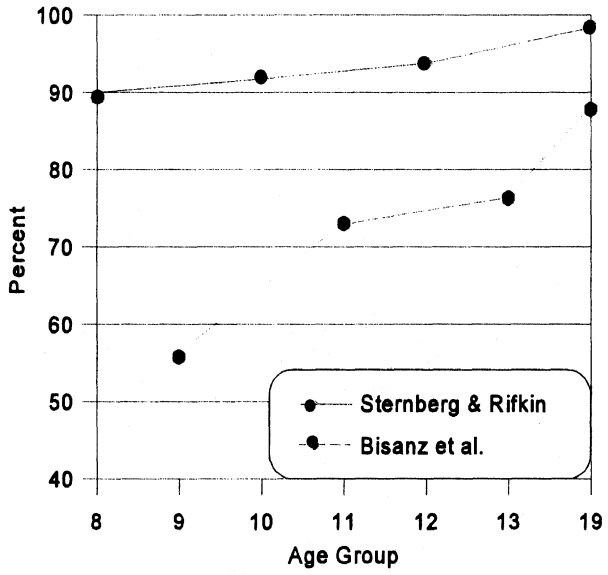

Figure 6: The percent correct analogical reasoning by age group.

The developmental mechanism responsible for increased proficiency in analogical reasoning is still being vigorously debated, but there is increasing evidence that proficiency is related to a person's knowledge of the world and knowledge of efficient problem solving strategies (see Goswami, 1992 for a review of childhood analogical reasoning theory). As such, some researchers have shown that proficiency can be significantly improved through training (e.g., Alexander, White, Haensly, & Crimmins-Jeanes, 1987; Alexander, *et al.*, 1987; Sternberg, Ketron, & Powell, 1982; White & Alexander, 1986). In one classroom-based study of fourth, eighth, and tenth graders, Alexander, White, Haensly, and Crimmins-Jeanes (1987) trained students through a detailed discussion of the mechanics of analogy and several sessions of practice analogies with feedback. They found that there were significant improvements on analogical reasoning for all groups studied, that

the improvements lasted for at least 6 weeks, and that the increased proficiency transferred to analogical reasoning tasks that were not trained.

Hypothesis Formation and Testing: While both an inductive and deductive process, hypothesis formation and testing is an important way in which both children and adults learn about how the world works (e.g., Garnham & Oakhill, 1994; Halpern, 1989). In this type of thinking, a person forms a belief through inductive processes, and then seeks information related to the belief through both inductive and deductive processes, similar to a scientist trying to understand a phenomenon. For example, a young man may form the hypothesis that, through his superb driving abilities, he will be able to avoid any situation that could lead to an automobile crash. He therefore does not use a safety belt. How this young driver might go about supporting or disproving this hypothesis has been the focus of a large volume of work during the past 30 years (e.g. see, Garnham & Oakhill, 1994; Kuhn, Amsel, & O'Loughlin, 1988; Newstead & Evans, 1995; Nisbett & Ross, 1980).

The paradigm that is frequently used to investigate hypothesis formation and testing is called the "2-4-6 task," developed by Wason (1960). In this task, the subject is told that the number sequence "2-4-6" is an instance of a rule the experimenter has in his or her head. In order to discover the rule, the subject is asked to think of additional sequences of numbers and the experimenter will say whether the numbers confirm or violate the rule. When subjects think they know the rule, they can articulate it. In typical results of the experiment, Wason found that most subjects would generate sequences of numbers that increased by two, such as "6-8-10" or "1-3-5." Subjects were told that these sequences satisfied the rule. Wason found that after a few sequences which confirmed the rule, most subjects were willing to state that the rule was "numbers increasing by two." In reality, this rule is wrong. The correct rule is "any ascending sequence of numbers." These findings highlight some of the typical difficulties both children and adults have in hypothesis formation and testing.

By far the most consistent error in hypothesis testing found in both adults and children is known as the *confirmation bias* (Evans, 1989; Wason, 1960, 1966, 1969; Wason & Johnson-Laird, 1970, 1972). This bias is the tendency for people to seek and select evidence that confirms their beliefs rather than finding information that disconfirms it. In the 2-4-6 task, subjects should attempt to find a number sequence that does not confirm the rule, such as "6-4-2." Instead, after minimal confirming evidence, people are willing to accept an incorrect hypothesis. In the real-world example discussed previously of the young man who believes he can steer away from potential crashes, the man is likely to remember or to seek out only information that confirms this belief, such as talking with a friend who nearly got in a crash or even experiencing a near crash.

Another factor that leads to poor hypothesis formation and testing, and is particularly relevant to driving safety, has been called the *optimism bias* (e.g., DeJoy, 1989a). Several studies have shown that most drivers tend to consider themselves less likely to be involved in a crash than the average driver (DeJoy, 1989a; Svenson, 1981; Svenson, Fischhoff, & MacGregor, 1985). This, of course, is a statistical impossibility; the crash likelihood of the

majority of drivers determines the "average" driver. Consider an experiment by DeJoy (1989a) who surveyed 106 college students with an average of about 5 years of driving experience. Among other responses, subjects judged the probability of themselves and others being involved in several crash scenarios and how much control they would have in avoiding the crash. Ten crash scenarios were investigated, ranging from scraping the side of a vehicle on a drive-up window at a bank, to being killed by a driver who was driving on a suspended license, to causing a serious crash while driving under the influence of alcohol. In 8 of the 10 scenarios, the subjects judged their risk of being in the crash to be significantly less than the risk they assigned to other drivers being in that crash. The largest disparity in assigned risks was found for "causing a serious accident [crash] while driving under the influence of alcohol." The high correlation of these results with the judgments of controllability showed that the optimism bias found in this study was closely related to subjects believing that they had control over whether the crash would occur.

In a series of studies, Deanna Kuhn and her colleagues have discovered several other difficulties children have with hypothesis testing and formation (e.g., Kuhn, 1989; Kuhn, Amsel, & O'Loughlin, 1988). In a study of sixth graders, adults, and adult expert hypothesis testers (scientists), Kuhn, Amsel, and O'Loughlin (1988) found a tendency among younger and novice reasoners to confuse the hypothesis and the evidence for it. The sixth graders, and, to a lesser extent, the adults in this study tended to support hypotheses by restating the hypothesis rather than by considering the evidence. Applying this to our young male driver, we could expect him to confirm his belief in his ability to avoid a crash by thinking he is a superb driver or driving fast or unsafely to show himself that he can handle the car. This is simply a restatement of his belief and not a test of it.

Kuhn, Amsel, and O'Loughlin (1988) also found that children, and to a lesser extent adults, had a tendency to adjust the evidence to fit with their beliefs. In other words, young subjects tended to ignore discrepant evidence, selectively attending to parts of the evidence that fit with their beliefs, or they distorted the evidence so that it fit with their beliefs. Along the same lines, DeJoy (1989b), in a review of several studies, has noted that people have a tendency to inappropriately assign crash causality based upon the crash outcome rather than the events of the crash. These findings suggest that the young male driver in our example may even get into a crash that he could not avoid (which should logically be enough evidence to disconfirm his belief), but either ignore that incident ("It was a freak occurrence"), remember and think about only part of the incident ("I avoided hitting that other car by braking appropriately"), or distort the incident ("Had the air bag not gotten in the way, I could have steered out of the crash"). In all cases, the disconfirming evidence was changed to confirming evidence.

Other problems that people have with hypothesis formulation and testing have been summarized by Halpern (1989). The first is the failure to recognize biases in the evidence. In a recent newspaper article, an emergency room nurse stated that a statewide safety belt use rate was in error because a far lower percentage of people entering her emergency room had been using a safety belt. This nurse failed to consider the fact that the sample of emergency room admissions was biased towards those who do not wear safety belts. Related to this problem is the fact that people have a tendency to ignore sample size.

Many people are willing to accept the testimonial of a single person rather than looking at well-established facts based on large numbers of cases. For example, a person who believes that a safety belt is less safe to use because he or she could be trapped in the car and burned in the event of a car fire, might base that belief entirely on one incident in which this occurred. If so, they would be ignoring the hundreds of thousands of cases in which injury was reduced through use of safety belts.

Motivation

Introduction

There is a reason why you got out of bed this morning, why you put on the clothes you are wearing, and why you are reading this document. For both children and adults, behaviors and thoughts generally occur for some reason; that is, there is usually a motivation for performing certain behaviors or thinking in certain ways. Traffic safety behaviors are also frequently guided by motives. Why do you either use or not use your safety belt? Why do you drive or not drive the speed limit? The study of *why* people engage in certain behaviors and ways of thinking is the study of motivation. The word motivation is derived from the Latin word *movere*, which means "to move." Thus, motivation is the set of influences that account for the initiation, direction, intensity, and persistence of behavior (e.g., Bernstein, Roy, Srull, & Wickens, 1991). These influences can be quite varied, ranging from hunger and thirst, to the need for achievement, to the need for stimulation.

When developing traffic safety messages for young drivers, it is important to consider motivation for at least two reasons. First, because traffic safety messages and programs are designed to change unsafe driving behaviors or to enhance safe ones, understanding the reasons why these behaviors occur is necessary for constructing appropriate messages and programs. For example, it is known that young drivers involved in fatal alcohol-related crashes often have young passengers in the vehicle with them (see e.g., Eby, Hopp, & Streff, 1996; Insurance Institute for Highway Safety, 1995). It is possible that the social influence of the passengers may cause the driver to engage in unsafe driving in order to gain status with his or her peers. An understanding of this motivation may help to generate appropriate messages and programs, such as creating other ways to satisfy this motive in a safe environment. As another example, a recent nationwide telephone survey showed that people of all ages are more highly motivated to drive safely in order to avoid negative consequences, such as a crash, citation, loss of license, or increased car insurance costs, than to obtain positive incentives such as good driver discounts (Williams, Paek, & Lund, 1995). This avoidance of negative consequence as a motive for moral behavior agrees with the findings in the section on moral development.

The second reason an understanding of motivations is important is that in order to change behaviors and ways of thinking, young drivers must have a motivation for changing their behavior. We cannot assume that a program designed to teach young drivers about the dangers of drinking and driving will have a positive effect. If the driver has no motivation for learning the message or for participating in the traffic safety program, then learning and behavior change will generally not occur. People will not change without a motive for doing so.

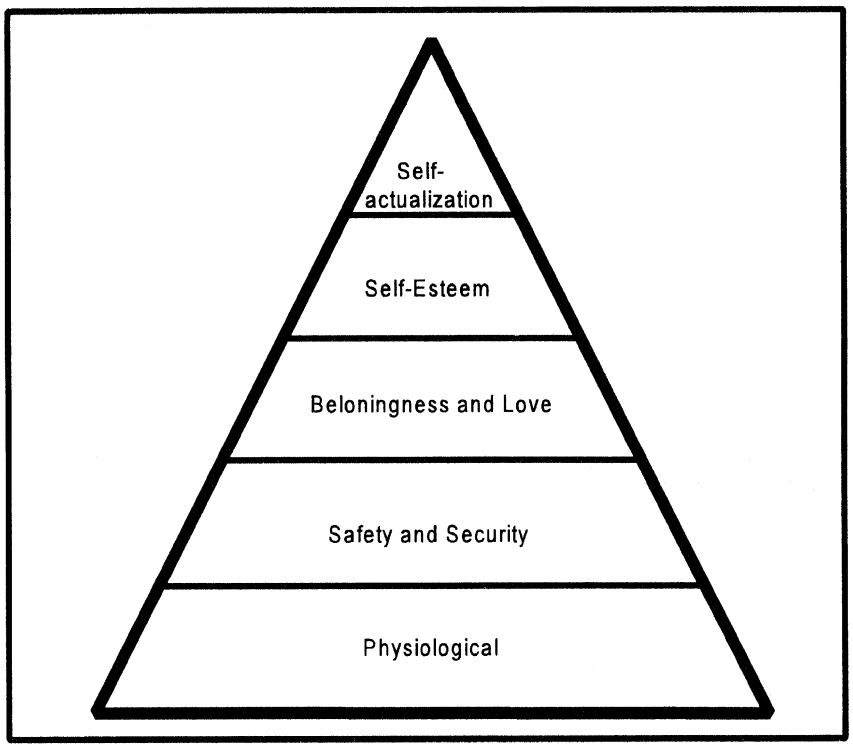

Figure 7. Maslow's hierarchy of needs pyramid, showing the relationship between types of needs.

The relationship between different motives has been aptly described by Abraham Maslow (1954, 1970, 1971) in his hierarchy of needs. As shown in Figure 7, motives can be thought of as arranged hierarchically, with motives at lower levels influencing behaviors, and thus needing to be satisfied, before higher levels can become motives. At the lowest level are the physiological motives (e.g., hunger, thirst, warmth, or sex), at the next level is the motivation to be safe and secure, and so on. According to Maslow, once all of the lower levels have been satisfied, behavior is able to be motivated by the need for self-actualization; that is, the need to fulfill all potential as a human being. Maslow (1971) also suggests that few people reach this highest level of motivational influence. While this organization of motivations has been criticized as being too simplistic (e.g., Gobel & Brown, 1981), it is useful for describing the various motivational influences on behavior. A discussion of each of the dozens of potential motivational influences is not possible in this review. Instead, we focus upon the two factors that are thought to have the greatest impact on the traffic safety behaviors of young drivers and the construction of traffic safety messages and programs for young drivers: sexual motivation and arousal/sensation seeking motivation.

Sexual Motivation

A powerful behavioral motivator is the need for sexual fulfillment. As noted in a leading textbook (Sdorow, 1990), the magazine sales for *Sports Illustrated* in February,

when the famous swimsuit issue is published, do not increase from the normal 100,000 issues to 2 million issues because people are interested in finding out about the latest swimsuit fashions. The dramatic 20-fold increase in sales is because people want to see attractive women dressed in sexually revealing swimsuits. Clearly, the sex is a strong motivator and, as noted by Sdorow (1990), has incentive value.

As a social motive, the sex motive produces behaviors that act toward reducing the need usually through direct or indirect contact with others; that is, sexual fulfillment. It is well documented in both human and nonhuman species that these behaviors are related to attracting a potential mate (e.g., displaying or "showing off"), competition among suitors (e.g., fighting), and, of course, sexual activity (Murray, 1964; Newcomer, Udry, & Cameron, 1983). The sex drive becomes active at the onset of puberty in early adolescence (e.g., Carlson, 1991; Murray, 1964; Udry & Billy, 1987) when production of androgens (male hormones) increases in both males and females (Udry, Billy, Morris, Groff, & Raj, 1985; Udry, Talbert, & Morris, 1986).

While the sex drive produces clear motivational effects on behavior, its influence on driving behaviors, particularly unsafe driving behaviors, is poorly documented. However, a few studies suggest that the sex drive, at least for males, may negatively influence traffic safety. At least one focus group study with college students (18-to-22 years of age) has shown that, by self report, one reason for drinking and driving is to show off in order to attract the attention of the opposite sex (Basch, DeCicco, & Malfetti, 1989). Study respondents also reported that drinking and driving afforded them higher social status. This finding could be interpreted as a competitive process among potential suitors for a mate. Thus, in the population of young drivers, drinking and driving activities may be motivated, in part, by the sex drive. However, other work suggests that drinking and driving is infrequent in dating situations (Vegega & Klitzner, 1989). This is an area where more research is needed.

Arousal/Sensation Seeking Motivation

It has long been known that performance on a task varies as a function of the arousal or alertness level of the individual performing the task (Hebb, 1955; Yerkes & Dodson, 1908). At both low and high levels of arousal, performance is poor and at medium levels of arousal, performance is high. This result suggests that there is an optimal level of arousal for performing a task. It has also been shown that the optimal level of arousal varies with the complexity of the task, with simple tasks requiring higher levels of arousal for optimal performance than complex tasks (Hebb, 1955). More recent studies have shown that within a task, such as driving a car, individuals vary somewhat in the level of arousal that is optimal (e.g., Ebbeck & Weiss, 1988; Plass & Hill, 1986). Thus, technically proficient drivers would require a higher level of arousal than would novice or less proficient drivers because the task of driving is less complex for the experienced driver.

A large body of work has documented the fact that the arousal motive can have negative traffic safety consequences for people who need to increase their levels of arousal, those commonly called sensation seekers (see, e.g., Jonah, 1997 and Zuckerman, 1979, 1990 for excellent reviews). As described by Zuckerman (1994), "the goal of a

sensation seeking behavior is the increase rather than the decrease of stimulation. Exploration of novel stimuli or situations occurs even in the absence of [other motivators]" (pg. 3). Zuckerman further defines *sensation seeking* behavior as "... the seeking of varied, novel, complex, and *intense* sensations and experiences, and the willingness to take physical, social, *legal*, and *financial* risks for the sake of such experiences." (italics his, pg. 27). Thus, a sensation seeker might drive recklessly, not to impress a potential mate, compete with other potential suitors, or to fit into a group, but rather to experience a situation in which physiological arousal will be elevated. There is good evidence that sensation seeking has a strong biological component (Zuckerman, 1994); that is, high sensation seekers have different brain chemistry than low sensation seekers.

Who are the sensation seekers? Accurate identification of sensation seekers is important both for the study of this motivation and for appropriately targeting traffic safety messages and programs. While efforts to identify sensation seekers through physiological tests have shown little promise (e.g., Zuckerman, 1990), behavioral measures have been more successful (see Zuckerman, 1994). Over the course of his career, Marvin Zuckerman and his colleagues (e.g., Zuckerman, Kolin, Price, & Zoob, 1964; Zuckerman & Link, 1968; Zuckerman, 1971; Zuckerman, Eysenck, & Eysenck, 1978) have developed a test in which behaviors related to sensation seeking are self reported[4]. This test, called the sensation seeking scale (SSS), has been used extensively to define the demographics of sensation seeking and its relationship to unsafe driving behaviors.

Sex and Age Differences: Numerous studies utilizing the SSS have shown that males score higher on the total SSS than females (e.g., Björk-Åkesson, 1990; Perez, Ortet, Pla, & Simo, 1986; Russo, *et al.* 1991; 1993; Teraski, Shiomi, Kishimoto, & Hiraoka, 1987; Zuckerman & Neeb, 1980). These studies also showed that males scored higher than females on several subscales of the SSS, including Thrill and Adventure Seeking, Disinhibition, and Boredom Susceptibility, while few differences between males and females were found for Experience Seeking. Several studies have also documented that scores on the SSS tend to increase with age up to about 16-to-19 years and then decline gradually through the life span (e.g., Ball, Farnill, & Wangeman, 1984; Farley & Cox, 1971; Giambra, Camp, & Grodsky, 1992; Magaro, Smith, Cionini, & Velicogna, 1979; Russo, *et al.*, 1993; Zuckerman, Eysenck, & Eysenck, 1978; Zuckerman & Neeb, 1980). Figure 8 is a composite of the results from two studies (Russo, *et al.*, 1993; Zuckerman, Eysenck, & Eysenck, 1978) and shows the typical relationship between total SSS scores, age, and sex. As can be seen in this figure, the difference between males and females on the total score on the SSS is consistent through the lifespan and total SSS scores vary consistently as a function of age, suggesting that sensation seeking behaviors follow similar trends.

[4]Those interested in the developmental history of the sensation seeking scale should see Zuckerman (1994) where an entire chapter on the history can be found.

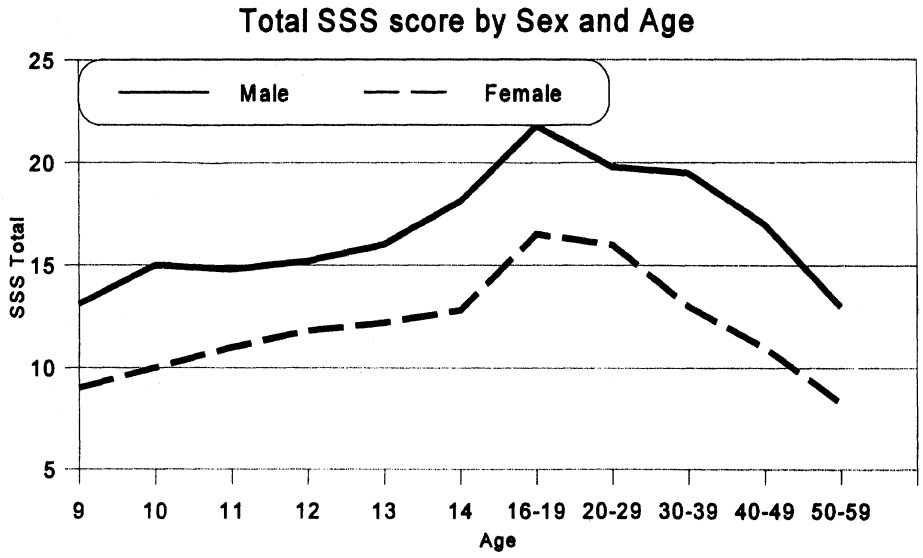

Figure 8. Total sensation seeking score by age and sex (adapted from Russo, *et al.*, 1993; Zuckerman, Eysenck, & Eysenck, 1978).

Sensation Seeking and Risky Driving: The large literature on the relationship between sensation seeking and unsafe driving behaviors and their outcomes (crashes and violations) has recently been summarized in an excellent article by Jonah (1997). Several studies reviewed by Jonah (1997) have shown that high sensation seeking is related to drinking and driving in the young driver population (e.g., Arnett, 1990; Arnett, Offer, & Fine, 1997; Johnson & Raskin White, 1989; Lastovicka, Murray, Jochimsthaler, Bhalla, & Scheurich, 1987; McMillen, Adams, Wells-Parker, Pang, & Anderson, 1992; McMillen, Pang, Wells-Parker, & Anderson, 1991; 1992). In the population of college age and younger drivers, these studies have shown that self-reported impaired drivers, drivers convicted of multiple DWI, and those arrested for DWI following a collision or violation score significantly higher on the SSS than those in comparison groups. In his summary of this work, Jonah (1997) concluded that this relationship is weaker for females than for males and that it may decline with age.

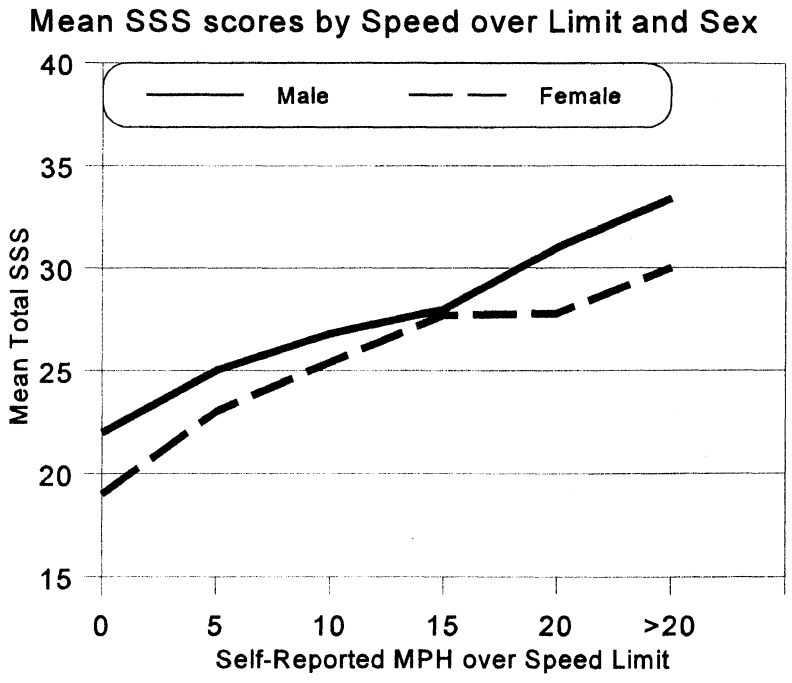

Figure 9. The relationship between mean total sensation seeking score and self-reported speeding by sex (adapted from Zuckerman & Neeb, 1980).

Studies that have investigated sensation seeking and speeding have generally found a positive relationship between scores on the SSS and driving speed (e.g., Arnett, Offer, & Fine, 1997; Clement & Jonah, 1984; Heino, van den Molen, & Wilde, 1992; Jonah, Thiessen, Au-Yeung, & Vincent, 1997; Lajunen & Summala, 1996; Zuckerman & Neeb, 1980). Collectively, these studies have found that scores on the SSS are positively correlated with self-reported driving speeds, simulator driving speeds, and actual driving speeds; that is, the faster people drive, the higher their score on the SSS. For example, one of the first studies on driving speed and SSS scores revealed a roughly linear relationship for both males and females (Zuckerman & Neeb, 1980). Figure 9 shows the results of Zuckerman and Neeb (1980), with subjects' reported usual driving speed on a 55 MPH road (shown here as MPH over the speed limit) compared to the total score on the SSS. The linear relationship is clear.

Little research has considered the relationship between sensation seeking and safety belt use. However, those studies that have investigated this issue have found consistent results. Clement and Jonah (1984; see also Jonah, Thiessen, Au-Yeing, & Vincent, 1997) found a negative correlation between safety belt use and sensation seeking; that is, as scores on the SSS increased, the frequency of safety belt use decreased. Wilson (1990) found that those drivers who reported using safety belts all of the time had lower SSS scores than those who reported less than consistent use. Other studies that have included safety belt nonuse as a part of overall risky driving (e.g., Bierness, 1995;

Wilson & Jonah, 1988) have found that risky driving is greatest among those people who have high scores on the SSS. Thus, it appears that sensation seekers tend not to use their safety belts.

Collectively, the results comparing scores on the SSS with traffic safety related behaviors show that at least a moderate link exists between the two. The fact that sensation seeking has a biological component makes it a particularly challenging problem for the design of interventions. Jonah (1997) suggested that the SSS might be given during the licensing process to identify high sensation seekers. Once identified, special educational programs could be developed that address high risk driving consequences and provide alternative ways of satisfying arousal needs other than on the roadways. Jonah rightly pointed out that such educational programs may not be effective for all high sensation seekers because they purposefully engage in the behaviors. In fact, it is probable that educational programs that discuss the consequences of risky driving may even promote greater risky driving. Another possibility is enforcement programs directed at high sensation seekers (Jonah, 1997). Unfortunately, as Jonah suggested, increased enforcement would likely increase the unwanted behaviors because high sensation seekers "...enjoy the thrill of breaking the law and avoiding detection." (pg. 663; Jonah, 1997). Jonah also suggested that engineering solutions (airbags, anti-lock brakes, ignition interlocks) might increase the safety of high sensation seekers. While this is undoubtedly true, Jonah pointed out the fact that these people may drive even less safely to keep the overall level of risk at the level it was at prior to the engineering solution (Streff & Geller, 1988; Wilde, 1982). In fact, a recent study has shown that by self-report, high sensation seekers said they would be more likely to drive fast on roadways and wet roads and drive after drinking (Jonah, Thiessen, Au-Yeung, & Vincent, 1997). The unfortunate conclusion from this work is that we still do not have an effective intervention for reducing the risky driving of high sensation seekers.

Risk Perception

Introduction

An unavoidable component of a person's life is risk and uncertainty. As a matter of everyday living, we engage in activities and are exposed to situations that have some chance of a negative outcome. Our thoughts about these risks and how we assess them have been termed risk perception (e.g., DeJoy, 1989a, 1990a; Fischhoff, Lichtenstein, Slovic, Derby, & Keeney, 1981; Leonard, Hill, & Otani, 1990), risk appraisal (e.g., Yates & Stone, 1992b), and hazard perception (e.g., Groeger & Chapman, 1996). Several authors have included risk perception as an important component in their models of risky-taking behaviors[5] (Hodgdon, Bragg, & Finn, 1981; Irwin, 1995; Millstein & Irwin, 1988). The perception of risk and uncertainty is integral to many cognitive tasks. People appraise risk when making decisions about uncertain events and situations. An understanding of risk perception, and how people assess risk, is essential for understanding both risky-taking behavior and developing traffic safety messages to reduce risky-driving behaviors.

Development of Risk Perception

Risk perception has its roots in probabilistic thinking; that is, understanding and applying the concept that an event may occur only some of the time (Fischbein, 1975). It is well established that skill in probabilistic thinking emerges early in a child's development and continues to develop until the early teens (e.g., Craig & Myer, 1963; Crandall, Solomon, & Kellaway, 1961; Messik & Solley, 1957). Risk perception, on the other hand, requires that the person not only have an understanding of probability but also have domain-specific knowledge about the activity and the factors that affect its probabilistic nature. For example, in driving, the person would have to know that crashes can occur while driving and that there are factors that influence this negative outcome. Thus, we would expect that risk perception ability would follow trends similar to those in the acquisition of knowledge and experience (e.g., see Chi & Koeske, 1983; DeJoy, 1990a).

Perceptions of Traffic Risk

Age: A number of studies have investigated perceptions of traffic crash and injury risk by age (see Jonah, 1986 and COMSIS Corporation & The John Hopkins University, 1995 for reviews). The majority of these studies have found that young drivers tend to perceive less risk in specific crash scenarios and general driving than do older drivers (e.g., Finn & Bragg, 1986; Groeger & Chapman, 1996; Sivak, Soler, Tränkle, & Spagnhol, 1989; Tränkle, Gelau, & Metker, 1990) and are poorer at identifying hazards when driving (e.g., Brown, 1982; Soliday, 1974; Soliday & Allen, 1972). Young drivers also tend to see themselves as less likely to be in a crash than others in their own age group (e.g., DeJoy, 1989a, 1990a; Finn & Bragg, 1986; Matthews & Moran, 1986; Svenson, 1981; Svenson, Fischhoff, & MacGregor, 1985). For example, Finn and Bragg (1986) studied male drivers who were either younger (18-to-24 years old) or older (38-to-50 years old). Subjects indicated the subjective risk of crash involvement in three ways: answering general

[5]Not all traffic safety researchers, however, believe that risk perception plays a prominent role in risky driving of youth (e.g., Evans, 1987; Näätänen & Summala, 1976; Wagenaar, 1992).

questions about crash involvement, rating the riskiness of several specific driving scenarios shown in photographs, and rating the riskiness of driving scenarios shown on videotapes. Finn and Bragg found that all drivers were poor at estimating the actual crash involvement rates for the U.S., their resident state, their age group, and other age groups. Younger drivers, however, reported that their own chances of a crash were significantly less than the chances for others in their age group. Older drivers, on the other hand, judged their crash involvement likelihood as the same as others in their age group. The results for judging the risk magnitude of crash involvement scenarios for still photographs showed that younger drivers, for all depicted scenes, reported significantly lower estimates of risk than older drivers. In the videotaped scenarios, however, no differences between younger and older drivers were found except for two scenarios. In a scenario depicting tailgating, younger drivers reported less risk than older drivers and in a scenario depicting a pedestrian suddenly entering the roadway, an opposite effect was found, with younger drivers perceiving more risk.

This latter effect highlights the fact that different traffic situations can yield different perceptions of risk by age. Table 1 lists the driving situations that younger drivers, as compared to older drivers, rated as less risky and the studies in which these findings were discovered. Older drivers rated the risk of driving on snow-covered roads and the unexpected presence of pedestrians as less risky than the ratings given by younger drivers (Finn & Bragg, 1986).

Table 1: Driving Situations that are Judged as Less Risky by Younger Drivers than by Older Drivers

Driving Situation	References
Tailgating	Finn & Bragg, 1986; Matthews & Moran, 1986
Driving in Darkness	Finn & Bragg, 1986; Tränkle, Gelau, & Metker, 1990
Driving on Curves	Tränkle, Gelau, & Metker, 1990
Driving on Inclines/Declines	Tränkle, Gelau, & Metker, 1990
Urban Driving	Finn & Bragg, 1986
Driving with Bald Tires	Finn & Bragg, 1986
Slow Driver on Road	Finn & Bragg, 1986
Wet Road Roadway	Finn & Bragg, 1986
Speeding	Finn & Bragg, 1986
Drinking and Driving	Finn & Bragg, 1986

Sex: Because of the elevated crash rate of males over females, many studies of risk perception have restricted their subjects to males. However, the few studies that have investigated crash risk perception of females have shown mixed results. Tränkle, Gelau, and Metker (1990) found that, unlike males, assessments of crash risk by females did not differ as a function of age. They also found that males rated crash scenarios, depicted in still photographs, as less risky than did females. This was confirmed by DeJoy (1990a) using verbal descriptions of crash scenarios. Other studies, however, have found no sex differences in crash involvement risk perception (e.g., DeJoy, 1989a; Groeger & Brown, 1989; McCormick, Walkey, & Green, 1986; Sivak, Soler, Trankle, & Spagnhol, 1989). While the differences between these studies may be reconciled by controlling for driving experience (Groeger & Brown, 1989), further research is needed on this topic. It is clear, however, that females, like males, tend to consider themselves less likely to be in a crash and more likely to be better drivers than others in their peer group (DeJoy, 1989a, 1990a; Groeger & Brown, 1989), although to a lesser degree than males.

Other Factors Affecting Risk Perception: Two factors believed to affect perception of crash involvement risk were investigated by Bragg and Finn (1985; see also Bragg & Finn, 1982). Their study addressed the effect that safety belt use and control of the vehicle had on perceptions of crash risk for younger (18-to-24 years of age) and older (38-to-50 years of age) male drivers. Subjects estimated risk of crash involvement while driving or riding in a vehicle, and while either using or not using a safety belt. The results showed no main effect of age; that is, over all conditions in the study, younger drivers did not differ in their judgments of risk when compared to older drivers. There were, however, significant main effects of both vehicle control and safety belt use. The chances of a crash were judged to be greater when the subject was a passenger than when he was driving the vehicle. This finding has been confirmed in other studies (e.g., Greening & Chandler, 1997; McKenna, 1993). The difference was larger for the younger drivers. Bragg and Finn concluded that this result showed that perceived control of a vehicle is an important factor in the assessment of risk for younger drivers. The effect of safety belt use is more difficult to interpret because of covarying factors, but the results generally showed that drivers (the effect was not investigated for passengers) who wore safety belts tended to rate the risk of crash involvement as *higher* than those who were not wearing belts but for the younger drivers only. Bragg and Finn suggested that this effect may have been due to safety belt use sensitizing the drivers to the possibility of a crash.

Factors that Contribute to Misperceptions of Risk.

Optimism Bias: As discussed previously, several studies have shown that young drivers tend to think of themselves as less likely to be involved in a crash than the average driver primarily because of their belief that their driving skills are above average (e.g., DeJoy, 1989a; Finn & Bragg, 1986; Matthews & Moran, 1986; Svenson, 1981; Svenson, Fischhoff, & MacGregor, 1985). DeJoy (1990a) has shown that this optimism bias was substantial for both sexes but that greater bias was found in males. DeJoy's study also revealed an interesting effect of past driving history and optimism bias. Those drivers who had experienced the negative outcomes of risky driving, as shown by their driving history (e.g., past crashes or citations), showed less optimism bias than drivers with less

experience with these outcomes. Thus, the more personal experience drivers have with the consequences of risky driving, the more likely they are to perceive their risk and driving skill as the same as the average driver.

Availability Heuristic: In thinking about probabilistic events, people frequently use heuristics, or rules of thumb, to arrive at a decision, solve a problem, deduce a conclusion, or to appraise risk. Heuristics are cognitive processes that require minimal cognitive effort and work some, but not all, of the time. Kahneman and Tversky (1973; Tversky & Kahneman, 1974) have identified a heuristic, called the availability heuristic, that people use frequently when thinking probabilistically, such as when appraising the risk of a certain activity. Instead of relying upon well-established facts and recognizing that their experiences, short-term memory capacity, and retrieval abilities are limited, people attempt to discern how frequently something happens by trying to recall examples of it. Halpern (1989) presented a good example. Consider the question: "Are there more deaths due to homicide or due to diabetes-related diseases in the United States?" Many people would answer this question incorrectly and state that there are more deaths due to homicides than to diabetes, because they frequently hear about homicides in the media and thus can easily recall several homicide cases, whereas few people have personal experience with diabetes-related fatalities and this type of death is rarely covered by the news. There are, in fact, about twice as many diabetes-related deaths than homicides in the U.S. People using the availability heuristic to assess traffic crash risk would search their memory and retrieve many trips that were crash free, leading even poor drivers to underestimate their risks of a crash.

Cumulative Risk: Another potential source of error in risk perception is the failure of young drivers to understand the effects of cumulative risk (e.g., Doyle, 1997). Most risky activities, such as driving, are engaged in repeatedly. Even without any change in actual crash risk, the more trips a person takes, the greater the chance is that he or she will be in a crash during one of these trips. That is, the overall chance of being in a crash in at least one of four trips is greater, than the chance of being in a crash on any single trip. Assume for example, that for a single trip the probability of a crash is one-in-two (.5) and that you take two trips. The possible crash-outcomes for those trips are shown in Table 2. As can be seen in this table, outcomes 1, 2, and 3 have a crash occurring during at least one of the trips. Since there are only four outcomes, the probability of a crash on one of the two trips is three-out-of-four or 75 percent--a much higher percentage than the crash risk for a single trip (50 percent). Thus, the more frequently a person engages in a risky behavior the more likely it becomes that there will be a negative outcome.

Research has shown that the majority of people do not understand cumulative risk (e.g., Shaklee, 1987, cited in Halpern, 1989). Slovic (1984) has suggested that safety belt use is low because people judge risk on a trip-by-trip basis (in which the crash risk is very low), rather than over a lifetime of trips (in which crash risk is high). Support for this idea is found in studies of safety belt use, where use differs depending upon the type of roadway (e.g., Eby & Christoff, 1996; Eby, Streff, & Christoff, 1995). These researchers have consistently found that safety belt use is lower on local roads than on limited access roads. Fockler and Cooper (1990) also have found that drivers report more frequent nonuse of

belts when they are taking short trips on local roads. These findings suggest that people may incorrectly consider freeway driving as more risky than driving on local roads, and that they may assess this risk on a trip-by-trip basis.

Table 2: Possible crash outcomes for two trips taken, each with a crash probability of 50 percent.

Outcomes	Trip 1	Trip 2
1	Crash	No Crash
2	No Crash	Crash
3	Crash	Crash
4	No Crash	No Crash

Positive Outcome Bias: Another factor that has been shown to bias judgment of outcome likelihood is the desirability of the outcome. People have a tendency to judge outcomes that they like as being more likely than outcomes that they do not like (e.g., Halpern & Irwin, 1973; Morlock, 1967; Nisbett & Ross, 1980). Even when presented with evidence showing that they are incorrect in their assessment of likelihood, people tend to persevere in their beliefs. In terms of traffic risk perceptions, the positive outcome bias could lead drivers to assign a higher than justified likelihood to crash free driving (a positive outcome). Evidence for the positive outcome bias in deciding whether to drink and drive comes from a focus group study of 18-to-22 year old drivers (Basch, DeCicco, & Malfetti, 1989).

Problem Solving and Decision Making

Introduction

Undoubtedly the most complex cognitive activity that humans engage in is attempting to find solutions to problems; this includes decision making[6]. Problem solving is an ubiquitous activity in youthful driving and traffic safety. Consider a scenario that young people say occurs frequently (Farrow, 1987; Farrow & Brissing, 1990). A young female may not want to have her intoxicated boyfriend drive her home. She also does not want him angry at her. What does she do? This scenario has all the components of a problem. There is an initial state (i.e., a need to get home safely and a drunk boyfriend who wants to drive) and a goal state (i.e., safely home without boyfriend driving or angry). There are also several potential ways to move from the initial state to the goal state; that is, solutions to the problem. Some are good solutions (e.g., convince the boyfriend to let his nonintoxicated friend drive them home) and some are not so good (e.g., get in the car with the intoxicated driver and hope that everything is okay). How this young woman goes about solving this problem and the difficulties she might have with it are the main focuses of scientists who study problem solving.

Much of high risk driving can be conceptualized as a problem faced by a driver (e.g., how can I show my peers that I am brave and worthy of their respect?). Several traffic safety programs have attempted to teach young drivers new strategies for dealing with the problems that lead to high risk driving (e.g., Behrens, Berger, & Berger, 1982; Klitzner, Rossiter, Grunewald, & Blasinsky, 1987; Mason, Patten, Micsky, Tarris, & Brydia, 1992). Understanding the way young drivers go about finding solutions to problems (and making decisions) and the deficiencies they have in this process, is important in the development of traffic safety messages.

Development of Problem Solving Ability

Problem solving requires the use of most of the cognitive processes discussed in this review. Efficient problem solving involves developed memory and attention processes, good verbal ability, proficient reasoning, as well as knowledge and experience of the world. As such, the ability to problem solve effectively develops along with these other cognitive processes (e.g., see Kuhn & Phelps, 1982; Miller & Seier, 1994; Piaget, 1954; Siegler, 1991; Siegler & Jenkins, 1989). Rudimentary problem solving ability, however, is present at birth (e.g., Baillargeon & DeVos, 1991; Cooper, 1984; Wagner, Winner, Cicchetti & Gardner, 1981), and continues to develop with age.

As children grow older, they adopt increasingly sophisticated strategies for solving problems (e.g., Ferretti, Butterfield, Cahn, & Kerkman, 1985; Siegler, 1976, 1978, 1991; Siegler & Jenkins, 1989; Surber & Gzesh, 1984). Included in the developmental changes that occur in the first 18 years or so is a tremendous increase in domain-general and domain-specific knowledge (e.g., Chi, 1978; Chi & Koeske, 1983), the ability to generate

[6]For the purposes of this review, decision making is included in problem solving because making a decision is, in effect, solving a problem and the cognitive aspects of both activities are similar.

several potential solutions to a problem (e.g., Kuhn & Phelps, 1982), the ability to ignore irrelevant problem information (e.g., Halpern, 1989), the ability to think about more than one dimension of the problem simultaneously (e.g., Ferretti, *et al.*, 1985; Inhelder & Piaget, 1958; Siegler, 1976, 1981), and the ability to think about relationships among events in a bidirectional way (e.g., Inhelder & Piaget, 1958; Surber & Gzesh, 1984).

Surber and Gzesh (1984) investigated the ability of both children and adults to solve scale-balance problems, using subjects whose ages averaged about 5, 8, 11, or 14 years, or college aged (no average age was given for the college students). A schematic scale-balance is shown in Figure 10.

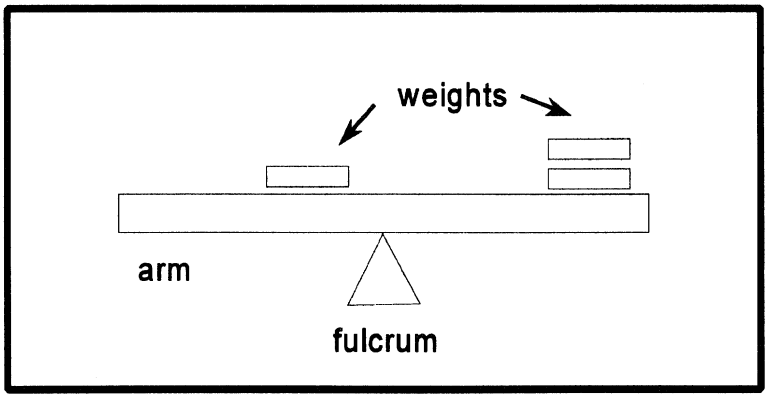

Figure 10: Schematic scale-balance used in the study of problem solving ability.

The balance consisted of an arm, fulcrum, and weights placed some distance from the fulcrum along the arm. The task was to know which end of the scale would drop or whether the scale would balance. To solve the task, both the amount of weight and its distance from the fulcrum had to be considered. Surber and Gzesh used a plastic model of the scale-balance and had subjects imagine that it was a "seesaw." The subjects were also asked to pretend that the weights were "kids" and "grown-ups," where a kid was a single weight and a grown-up was three weights connected together. The subjects' tasks were to predict where a grown-up would have to sit given an arrangement of kids sitting on one arm of the seesaw so that the scale would balance, and to predict where kids should sit given an adult sitting at some location on an arm (i.e., the opposite situation). Surber and Gzesh found that in all age categories studied, subjects had difficulty with both tasks, but there was a significant developmental trend toward using strategies that combined both distance and weight to solve the problem. When judgments between tasks were compared, the authors found that the strategies employed were not fully reversible even for college students; that is, one strategy was used for the first task and a different, less effective, strategy was used for the second. If the subjects' problem solving ability exhibited reversibility, they would have recognized that the two forms of the problem were in fact identical, except that they were in the opposite direction. While reversibility improved

with age, the authors concluded that reversible thinking was not even typical for college students.

Applying these results to our example of the young woman and her intoxicated boyfriend, we could expect that she may not consider or understand all the dimensions of the problem, such as the relationship between level of intoxication and her boyfriend's disposition. Further, she might attempt to solve the problem by using a direct, unsophisticated strategy such as telling him he is too drunk to drive and to give her his keys. With increased experience and knowledge of the problem, however, we would expect her to apply more sophisticated strategies such as, for example, slipping away from the party and letting the air out of his tires so that they have to find another way home.

Social Cognition

Introduction

Social cognition has to do with how people make sense of other people and themselves (Fiske & Taylor, 1984). More specifically, it involves people's attempts to make sense of what other people do in terms of factors such as how people think, perceive, infer, feel, and react (Hala, 1997). The study of social cognition is the study of how people think about others and how others influence a person's thoughts. The development of social cognition in children allows them to function effectively in their social worlds; similarly, social cognition helps adults explain, predict, and affect their own and others' behavior. Because driving typically occurs in a social setting or involves social thinking such as attitudes, an understanding of social cognition is important in developing messages or programs to reinforce or change people's traffic safety related behavior.

Many researchers believe that several of the principles that describe how people think in general also describe how people think about people (e.g., see Augoustinos & Walker, 1995; O'Mahony, 1988). At the same time, there are important differences between how people think about people and how people think about things. Fiske and Taylor (1984) have described these differences. First, people are more likely to be causal agents. Second, they are more likely to perceive as well as be perceived. Third, because they adjust themselves upon being perceived, many of their important traits must be inferred and the accuracy of these inferences is difficult to determine. Fourth, people frequently change and are unavoidably complex as targets of cognition. This section provides a brief overview of several key elements of social cognition that have implications for the development of traffic safety messages and programs including attributions and social schemata and scripts.

Attribution Theory

Attribution theory is concerned with how people go about assigning causes to the events they observe; it focuses on people's common sense explanations for why events occur (Bennett, 1993; Hewstone, 1983). Thus, it is often described as the study of perceived causality, with attribution referring to the perception or inference of cause (Fincham, 1983; Kelly & Michela, 1980). Attribution theory can help us understand behavior related to traffic safety. For example, suppose we were to come upon the aftermath of a motor vehicle crash. We see a car crumpled against a tree on the side of the road and a young male laying in the ditch. What thoughts go through our heads? Is the young man the driver? Did he cause the crash by running off the road and into the tree? Was he drinking or speeding or engaging in some other unsafe driving action, or were there factors beyond his immediate control such as mechanical failure, adverse weather or road conditions, or the actions of another driver? We infer answers to these and other causal questions in order to allow us to make sense of the crash scene we have encountered.

Research on attribution generally seeks to identify the rules people use and the thought processes they engage in when they are trying to determine why an action or outcome occurred (Zimbardo, 1985). Thus, attribution theories focus on how people use

information in the social environment to arrive at causal explanations for events; these theories are grounded in the belief that attributions are important and that causal analyses serve as the bases of behavior, other cognitions, and feelings (Fiske & Taylor, 1984). In attribution theory, causes of behavior can be either internal (i.e., factors inside the person such as effort, ability, and intention) or external (i.e., factors outside the person such as the difficulty of the task and luck; Hewstone, 1983).

The works of Heider (e.g., 1958), Jones and Davis (e.g., 1965), and Kelly (e.g., 1967) are considered central to the study of attribution and provide the basis for understanding the general themes that underlie attribution theory. Among these is the concern with everyday beliefs about the causes of behavior (Bennett, 1993). An important theme of attribution theory is that in making attributions people act as naive scientists; that is, people intuitively, or in a common sense way, infer or deduct the causes of events around them, accomplishing many of the same tasks as more formal scientists, using similar methods (Augoustinos & Walker, 1995; Jaspars, Hewstone, & Fincham, 1983). Thus, attribution making is influenced by a person's problem solving and decision making, reasoning, and memory abilities (see these sections of the review for more information).

A second theme of attribution theory is that there are several tendencies in attribution making. In general, people are more likely to view two events as causally related if the events are similar to one another or if they occur near to one another, especially in time (Hewstone, 1983). For example, a young man, after getting in a fight, squeals his tires leaving a parking lot. A person viewing these events would most likely attribute the tire-squealing to the driver being angry from the fight, rather than the driver trying to impress his friends. In addition, people tend to attribute behavior to a single cause rather than multiple causes. For example, a young woman notices that she is being tailgated by a young man, and she attributes the cause of that behavior to the young man's aggressiveness rather than to the facts that the traffic stream was slowing down and the young man was not paying attention and ended up too close to the young woman's vehicle. Furthermore, people have a tendency to attribute causes of other peoples' behaviors to internal factors while making attributions about the causes of their own behavior based on external factors (e.g., Heider, 1958). For example, a young woman who has witnessed a car running off the road is most likely to think that the event happened because the driver of the car is a poor driver. On the other hand, if she were to run off the road, she is most likely to attribute the cause of that event to an external factor (e.g., the weather or road conditions). Whether the behavior is believed to be caused by internal versus external factors (locus of causality) is considered to be central to understanding people's behavior.

A third theme of attribution theory has to do with how people make inferences about others' intentions and dispositions (see Jones & Davis, 1965). It is assumed that people search for explanations of others' behavior that are both stable and informative; the purpose of making attributions is to make judgments about others' intentions and behavior in terms of how such intentions and behavior *correspond* to some underlying stable quality or disposition, hence these judgments are called correspondent inferences (Fiske & Taylor, 1984). These stable qualities or dispositions can then be used to explain others' behavior across many different situations.

People respond to several "cues" in making correspondent inferences about others' behavior. People look at how distinctive an action and its effects are; it is the "noncommon effects" of different actions, rather than their shared characteristics, that guide people in identifying the dispositions or intentions of others (Hewstone, 1983). For example, suppose that there are two routes available to a destination that are identical in length, travel time, and other features, except that one is considerably more scenic than the other. If you were to choose the scenic route, one might infer that you are a person to whom scenic views are important.

When there is ambiguity about an action's meaning, however, people can be further guided in making correspondent inferences by trying to determine whether the action is socially desirable, freely chosen, or consistent with social roles or prior expectations (Fiske and Taylor, 1984). For example, if you are observed running a red right, it might be inferred that you are someone who is a risk taker. One's confidence in making this inference would be strengthened by the fact that running a red light is a socially undesirable action; if you are willing to violate societal rules and risk adverse consequences, it is more likely that your action reflects your true disposition. However, if you are on your way to the hospital with a passenger who requires immediate medical treatment to save his life, then your action of running the red light is situationally constrained and does not represent a choice made freely. Knowing this, it would be ill-advised to infer that you are a risk taker, based solely on this one incident. Similarly, if you are a law enforcement officer, running the light might be part of doing your job, and would not necessarily reflect your true disposition. Finally, if your action represented a departure from past behavior and the expectations others have for you (i.e., you have never run a red light before and therefore others do not expect you to), one would probably be less confident in inferring that you are a risk taker. On the other hand, if you have frequently run red lights in the past, then inferring that you are a risk taker might be warranted.

To account for how people assign causes to events and decide whether observed actions are due to internal or external causes, Kelly (e.g., 1967) identified three types of information that combine or "covary" in certain ways to influence whether causes are attributed to characteristics of the person, the stimulus, or the circumstances. These types of information include consensus information, consistency information, and distinctiveness information. Consensus information has to do with the degree to which other people behave similarly in the same situation; consistency information concerns the degree to which an individual has behaved similarly in similar situations in the past; and distinctiveness information concerns the degree to which an individual responds similarly to other kinds of situations (King, 1983).

Several studies of attribution provide empirical support for all, or at least some of Kelly's ideas (e.g., Ferguson & Wells, 1980; Hayes & Hesketh, 1989; Hewstone, 1983; McArthur, 1972; Orvis, Cunningham & Kelly, 1975; Zuckerman, 1978). In one of the most widely cited of these studies, McArthur (1972) gave subjects information about the occurrence of some event (e.g., John laughs at the comedian), followed by three statements reflecting either high consensus (almost everyone who hears the comedian laughs at him) or low consensus (hardly anyone who hears the comedian laughs at him),

high consistency (in the past, John has almost always laughed at the same comedian) or low consistency (in the past, John has almost never laughed at the same comedian), and high distinctiveness (John does not laugh at almost any other comedian) or low distinctiveness (John also laughs at almost every other comedian). Subjects were then asked to choose the probable cause for the event from among four possible causes which included something about the person, something about the stimulus, something about the particular circumstances, or some combination of the three.

McArthur (1972) found that person attributions were more likely to result with low than high consensus information, with low than high distinctiveness information, and with high than low consistency information. Stimulus attributions were more likely to result with high than low consensus information, with high than low distinctiveness information, and with high than low consistency information. Circumstance attributions were more likely to result with high than low distinctiveness information and with low than high consistency information. Findings also indicated that overall, both subjects and controls were more likely to make person attributions than stimulus attributions; according to the author, this suggests that there exists a bias in favor of attributing behavior to characteristics of people rather than to the stimulus characteristics of their environment.

Attribution Theory and Motor Vehicle Crashes: Attribution theory has been applied in a variety of settings to better understand people's perceptions, attitudes, and behavior. Several studies have examined attributions of responsibility for motor vehicle crashes. When attribution theory is applied in situations involving injury without alcohol, researchers have generally found that assignment of responsibility is affected by severity of injury (Kelly & Campbell, 1997). For example, Walster (1966) found that crash victims were assigned increasing responsibility for their crash as the severity of the crash increased.

Many of the studies of attribution of responsibility for crashes have focused on crashes involving alcohol. In general, such studies have found that attributions are related to the severity of the outcome and whether drinking and driving is accompanied by obvious unsafe driving behavior (e.g., DeJoy, 1985, 1990b; DeJoy & Klippel, 1984; Taylor & Kleinke, 1993). In addition, studies suggest that attributions of responsibility are more sensitive than assignments of penalties to nuances of the situation such as road conditions or the contributing negligence of the other driver (DeJoy, 1989b). Baldwin and Kleinke (1994) also found that drivers were considered by others to be more reckless and emotional when crashes were severe.

DeJoy and Klippel (1984) examined attribution of responsibility for hypothetical alcohol-related near-miss crashes. They found that less responsibility was assigned to perpetrators of near misses than to perpetrators of more severe crashes, regardless of the presence or absence of unsafe behaviors including drinking, and drinking and speeding. No sex differences were found in the study. The authors concluded that people apparently do not consider near misses to be particularly serious events, and therefore expend relatively little effort thinking about what factors may have caused them or how they can avoid similar situations in the future. The authors recommended that safety programs should make participants aware of the significance and seriousness of near misses, while

driver training and improvement programs should stress the predictive value of near misses and encourage students to analyze both their own near misses and those that they witness.

Age and Sex Differences: Few studies of general attribution theory have focused on age or sex differences. Harris (1977) examined developmental differences in attribution making among male and female students from grades 1, 3, 6, 8, and college. Subjects viewed videotapes of scenes involving a female actress breaking a chair. Each subject saw one scene from a set of five scenes representing increasing levels of internal causation (ranging from the actress and the event associated only by physical proximity to the event intentionally caused by the actress). Findings indicated that older subjects (grades 6, 8, and college) assigned greater responsibility to the actress as her behavior became more internally directed. In contrast, attributions of younger subjects (grades 1 and 3) did not generally differ as the actress's intentions changed. No sex differences were found. The author concluded that causal attributions are affected by interactions between the age of the person making the attribution and the degree of internal causation associated with the event.

Some studies have examined sex differences within the context of attribution of responsibility for alcohol-related crashes. In general, it appears that males and females do not differ significantly in their judgments of alcohol impaired drivers involved in crashes (e.g., DeJoy, 1985, 1989b; DeJoy & Klippel, 1984; Taylor & Kleinke, 1993). However, Baldwin and Kleinke (1994) found that females were more likely than males, when making attributional judgements, to consider impaired drivers involved in crashes as being reckless.

Social Schemata and Scripts

Social schemata are cognitive structures representing organized knowledge about objects, people, and past situations (Fiske & Taylor, 1984). The importance of schemata in helping people organize, make sense of, and remember details has been shown in many studies (Zimbardo, 1985). New information, which is often incomplete or ambiguous, is more understandable when people can relate it to knowledge in their stored schemata. Thus, schemata allow people to simplify reality, in part, by interpreting specific instances in light of a more general case.

Researchers divide social schemata into several types including person schemata, self-schemata, and scripts (see Table 3 for descriptions of these schemata types). Because the latter type of social schemata, scripts, is a person's knowledge structure for a sequence of events, it is particularly important for driving. A person's script for driving, for example, includes a number of event sequences common to the behavior of driving a car (e.g., putting on the safety belt, starting the engine, checking the rearview mirror, and so on). Because many of the events in the "driving" script include traffic safety related behavior, an understanding of scripts is especially useful for the design of traffic safety messages and programs for young drivers.

Scripts are structures that describe appropriate sequences of events in well known situations (Abelson, 1981; Schank & Abelson, 1977). They are comprised of several

sequential steps and serve to organize information about the sequence of predictable actions, locations, roles, and props that constitute events (Hudson, 1993). Scripts are learned throughout a person's lifetime, both by participation in and observation of events (Abelson, 1976). They are activated automatically whenever an event is encountered in the real world or referred to in text or in conversation (Hudson, 1993).

Table 3. Types of Social Schemata

Type of schemata	Description
Person schemata	Knowledge about the traits and goals that shape other people's behavior.
Self-schemata	Information about one's own personality, appearance, and behavior that guides information processing about the self.
Role schemata	Knowledge about appropriate norms and behavior for broad social categories, based on age, race, sex, and occupation.
Scripts	Prior knowledge of the typical sequence of events on standard social occasions that helps people understand ambiguous information, remember relevant information, and infer consistent information where it is missing.

Adapted from Fiske and Taylor (1984).

As described by Schank and Abelson (1977), people's common sense understanding of behavior in particular situations is characterized by a large repertoire of unconscious knowledge and assumptions. This repertoire is stored in memory and activated unconsciously whenever it is needed. However, according to the authors, scripts are more than just stereotyped sequences of events. They provide the basis for anticipating the future, setting goals, and making plans, enabling people to set strategies to achieve such goals by specifying the appropriate behavioral sequences through which they must proceed (Augoustinos & Walker, 1995). Although we cannot know what goals and motivations drive each individual, Schank and Abelson (1977) have suggested that there are universal goals or motives that we use to understand most people's intentions and future actions, irrespective of their cultural and social location. These include the satisfaction of basic needs such as hunger, sex, and sleep, and avoiding negative physical and psychological experiences.

Develcpment and Change of Scripts: Scripts, and more generally, social schemata, appear to be learned or acquired over time from direct and indirect experience with the social environment, although there is little in the literature about the specific mechanism of acquisition (Fiske & Taylor, 1984). Some have suggested (e.g., Fiske & Dyer, 1985) that schemata development proceeds from an initial learning of many independent and unintegrated components to a single and integrated schematic unit with strong links between the components. These links become strengthened through experience and use,

so that, in time, the entire structure is activated by the activation of any one of its components.

In general, the more often a script is activated, the more abstract and complex it becomes. This increasing abstraction is illustrated by an example of how people learn a driving script from experience with concrete instances, reported by Abelson (1976). According to the author, the first car a person learns to drive has certain distinctive features (e.g., the feel of the clutch, the shift pattern, the location of the headlight switch). Thus a person's driving script is likely to be concretely limited to that car until he or she has driven several cars. The more cars he or she drives, the more abstract and general will be his or her conception of such automobile features.

The activation of a script appears to be determined primarily by how recently and how frequently it has been activated in the past. The more recently and the more frequently the activation in the past, the greater likelihood of activation in the future (Fiske & Taylor, 1984). Abelson (1981) has pointed out that not all scripts are linked directly to action. He identified two kinds of scripts, scripts for understanding and scripts for behavior, and argued that to act out a script, people must not only understand that such a possibility exists but must commit themselves to the performance of it. According to the author, three conditions appear to be necessary for scripted behavior to occur. First, people must have a stable cognitive representation of the script; second, an evoking context for the script must be presented; and third, people must enter the script.

There is evidence that scripts are not subject to much change and may in fact resist change, even when there is information that is inconsistent with or contradicts the script (Schank & Abelson, 1977). Thus, it may be difficult for traffic safety messages and programs to effect change in a young driver's script. The finding that scripts, and more generally social schemata, persist, even in the face of evidence to the contrary, is referred to as the *perseverance effect* and has been demonstrated in a variety of settings (Anderson, 1983). An example of the perseverance effect in the area of traffic safety might be the case of a driver who steadfastly refuses to use his safety belt solely because he thinks it increases his risk of injury in the event of a crash, despite evidence to the contrary.

The perseverance effect appears to be reduced, *not* when people are simply told about the contradictions and requested to be unbiased, but rather, when people are asked to think carefully about *how* they evaluate the evidence and when people are cautioned to be aware of their biases as they interpret information (Lord, Lepper, & Thompson, 1980). The perseverance effect may also be lessened when people are forced to counter argue their scripts; that is, to explain why their scripts might be wrong. Anderson (1982), for example, found that inducing people to create causal explanations of opposite social theories produces more flexible responses to challenges to those theories. He also concluded that the success of this strategy supports the idea that perseverance effects are based on the relative availability of plausible causal explanations or scenarios, and do not appear to depend on when the competing explanations are generated.

In another study, Anderson (1983) examined whether beliefs based on concrete data were more resistant to challenges than beliefs based on abstract data. He found the perseverance effect to be more pervasive when based on the type of data that is most likely to be challenged and discredited--weak but vivid, concrete case history data. Subjects exposed to only two case histories (concrete data) of questionable representativeness clung to their initial theories to a significantly greater extent than did subjects exposed to raw data and statistical summaries of twenty cases (abstract data). In the case of the driver who refuses to use his safety belt because he considers it to be unsafe, Anderson's findings would suggest that this driver may be relying on concrete rather than abstract data (e.g., he has information about a case in which a driver ostensibly survived a crash because she was not using a safety belt and was thrown clear of the car).

Age and Sex Effects on Scripts: It has been shown that children as young as age three are able to reproduce the order of scrambled sequences, demonstrating their ability to use temporal order as an organizing principle (O'Connell & Gerard, 1985), and to report coherent verbal scripts for what happens in familiar events (e.g., Fivush, 1984; Fivush, Kuebli, & Clubb, 1992; Hudson, 1990; Hudson, 1993; Hudson & Shapiro, 1991; Levy & Fivush, 1993). Once children form scripts for familiar events, they have a well organized knowledge base that is available to them for understanding stories, communicating with others, planning for future events, and organizing their knowledge of the world. Because their knowledge is accessed automatically, they do not need to develop sophisticated strategies for drawing inferences from event knowledge (Hudson, 1993).

Although children are able to provide script reports after a single experience, their event knowledge does become more elaborate and more complex with increasing age and experience (Fivush & Slackman, 1986; Hudson, Fivush, & Kuebli, 1992). However, most studies of developmental differences relative to scripts have followed children only through early childhood (i.e., until 5 or 10 years of age), suggesting that such differences do not persist once individuals have moved out of childhood or at least are no longer meaningful enough to study. While there are a few studies of differences between younger and older adults, the focus is on changes that occur as a result of aging in later years of life.

While there is little in the literature on sex differences in the development and use of scripts, Levy and Fivush (1993) examined the role of gender scripts, which, like more general scripts, are temporally organized event sequences. In generic scripts, sex of the performer is either unimportant or interchangeable. In gender scripts, sex of the performer is a defining characteristic. The authors noted that gender scripts possess a gender-role stereotype component that defines which sex stereotypically performs a given sequence of events. Young children appear to have better organized knowledge of events that are stereotypically associated with their own rather than the other sex.

The issue of sex roles also emerged in a study of the relationship between adolescents' social problem solving scripts and the scripts of their parents (see Keltikangas-Jarvinen & Asplund-Peltola, 1995). Adolescents were categorized as either aggressive or sociable. While there was little congruence between the social decision making scripts of adolescents and their parents, there were sex role expectations

associated with scripts. Boys were not expected to ask for help from parents, although the boys themselves offered such a solution. At the same time, parents expected sociable girls to ask for help from them, even though this idea was not confirmed by the girls' own scripts.

Scripts and Thinking About the Future: While concerns for the future are a motivating force in everyday behavior across the lifespan, thinking about and planning one's future is especially typical for adolescents (Nurmi, 1987). This "future orientation," which has to do with how people see their personal future in terms of goals, hopes, expectations, and concerns (e.g., see Nurmi, 1991), is important for adolescents because of the crucial decisions concerning education and occupation that must be made during this stage of life.

Future orientation has generally been studied by either focusing on content (i.e., what kind of interests, goals, and expectations people have concerning their future life) or temporal extension (i.e., how far into the future people's goals and expectations extend) (Nurmi, Poole, & Seginer, 1995). Much of the recent work on future orientation has been done by Nurmi and his colleagues (e.g., see Nurmi, 1987, 1989, 1991; Nurmi, Poole, & Kalakoski, 1994; Nurmi, Poole, & Seginer, 1995). Several of these studies have found that adolescents' future-oriented goals and concerns tend to reflect the major developmental tasks of their own age and those of early adulthood such as future occupation, education, family and marriage, and property-related topics (e.g., see Nurmi, 1991; Nurmi, Poole, & Kalakoski, 1994). Study authors attributed these findings to the fact that age-graded developmental tasks and role transitions supply the knowledge of what is possible, acceptable, and desirable at different ages.

Nurmi (1987), for example, examined the future orientation of 73 female and 75 male adolescents and young people, age 10-to-11, 14-to-15, and 17-to-19, in Finland. Of all fears mentioned by subjects, nearly one-half had to do with war, while 14.2 percent had to do with the subjects' own health or death and 12.8 percent had to do with the health or death of others. As subject age increased, the frequency of fears related to subjects' own health increased, with health comprising 5.9 percent of fears among 10-to-11-year olds, 12.5 percent among 14-to-15-year olds, and 24.5 percent among 17-to-19-year olds.

A significant age effect was also found for temporal extension of future orientation, as well as for knowledge about and planning for the future. That is, as subject age increased, the extension of subject's future orientation decreased, whereas their knowledge about and planning for the future increased. However, the levels of knowledge about and planning for the future were relatively low among all subjects, regardless of age. Similar age effects were found in a longitudinal study of future orientation conducted by Nurmi (1989).

Thus, it appears that while adolescents and young adults do think about the future, health issues, including those related to traffic safety, do not constitute a large part of their future orientation because this age group is more concerned with immediate developmental issues such as occupation, education, family and marriage, and property-related topics. Further, knowledge about and planning for the future in general is low among young people

of all ages, suggesting that health and safety are not as strong motivators for everyday behavior as other future considerations.

Script Theory and Improving Health Behaviors: Script theory and broader conceptualizations of social schemata have been applied in various settings in order to better understand and, in some cases, change behavior. A study reported by Hirschman and Leventhal (1989) illustrates how schemata may contribute to adverse health behavior and may, in turn, be used to prevent such behavior. The authors reported findings from a successful smoking prevention program based on a cognitive developmental stage model postulating four stages through which individuals progress toward becoming a smoker. The authors described these stages as: a preparatory stage during which attitudes toward smoking and schemata of self-as-smoker are formed and modified; an experimental stage during which pleasant, neutral, or aversive initial experiences with cigarettes confirm or disconfirm expectations, and influence subsequent use; a regular smoking stage during which smoking at certain times and situations becomes established as a behavioral pattern; and an addictive smoking stage characterized by heavy daily smoking, withdrawal symptoms, and craving upon quitting. An important focus of the program intervention was to correct or alter subjects' interpretations of their smoking experience; that is, to change their self-schemata regarding smoking. Thus, the program was designed not to prevent cigarette "tries", but rather to alter the experience of initial tries so that fewer students would progress toward regular smoking.

Attitude Formation and Change

Introduction

Attitudes can be thought of as relatively stable mental positions held toward ideas, objects, or people (Gleitman, 1991). While there is no universally agreed upon definition of attitudes, there is widespread consensus that 1) evaluation constitutes a central and possibly predominant aspect of attitudes, 2) attitudes are represented in memory, and 3) both behavioral antecedents and consequences of attitudes have affective, cognitive, and behavioral domains, although these domains will not necessarily all apply to a given attitude (Olson & Zanna, 1993). Cognitive evaluations refer to thoughts people have about the attitude object, affective evaluations refer to feelings or emotions people have in relation to the attitude object, and behavioral evaluations refer to people's actions with respect to the attitude object (Eagly & Chaiken, 1993)[7]. Because appropriate traffic safety behaviors may be influenced by attitudes towards driving and traffic safety, knowledge about how attitudes develop, endure, and change is necessary for constructing effective messages and programs (see e.g., McPherson, McKnight, & Weideman, 1983).

Attitudes, like many of our cognitive structures, provide a framework that allows us to interpret our often ambiguous social environment--they serve as prisms through which we can view the world (Houston & Fazio, 1989). Thus, although attitude formation and change can be characterized as internal individual processes, attitudes link us to a social world of other people, activities, and issues, including people who are actively engaged in helping form or change our attitudes (Zimbardo, 1985).

Attitude Formation

Although attitudes represent relatively stable attributes, they appear to be learned rather than innate (Zimbardo & Ebbesen, 1969). Thus, the processes discussed in the section on learning apply generally to attitude formation. Attitudes may be formed directly through questioning, personal experience, or operant conditioning (i.e., positive reinforcement or punishment; Fossey, 1993; Sdorow, 1990). They may also be formed indirectly though classical conditioning (i.e., learning through association, such as pairing something desirable or undesirable with the attitude object) or through social learning and observation (Fossey, 1993; Sdorow, 1990). This last type of attitude formation is captured by social learning theory (see Bandura, 1977) which highlights the process of acquisition of knowledge and attitudes from important others, such as parents, teachers, peers, and media figures.

While the issue of when attitudes form has not been widely studied, recent efforts have focused on determining the conditions that foster evaluation of attitude objects. Olson

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[7] Despite alternatives to this cognitive-affective-behavioral conceptualization of attitudes, it remains the most useful way of thinking about attitude formation and change and is therefore highlighted in this brief review of the literature For more detailed reviews of the literature, see Ajzen and Fishbein (1980), Himmelfarb and Eagly (1974), Kiesler, Collins, and Miller (1969), Petty and Cacioppo (1996) and Rajecki (1990).

and Zanna (1993) identified several of these conditions, including an individual's expectation to interact with the attitude object, being asked about one's attitude, and having a lot of knowledge about an issue. The authors noted that such research findings underscore the important function attitudes fulfill in orienting people to their social environment.

In contrast to specific circumstances of attitude formation, Tybout and Scott (1983) pointed to a more general perspective of attitude formation in the literature that considers individuals' personal knowledge to be the key determinant of attitudinal judgments. That is, attitudes are formed by aggregating internal information about an object that is available to an individual at the time of judgment. This perspective characterizes several information processing approaches to attitude formation and change (e.g., Anderson, 1968, Fishbein & Ajzen, 1975, Wyler, 1974). In their own research, Tybout and Scott (1983) found that the availability of well defined internal knowledge is determined by the availability of immediate sensory data. In the absence of such sensory data, a self-perception process is used to make inferences about attitudes.

Attitudes as Predictors of Behavior

As late as the 1970s, it was argued that the relationship between attitudes and behavior was so weak that the concept of attitude should be abandoned (Santrock, 1991). While current thinking appears to favor a relationship between attitudes and behavior, it is also recognized that the relationship is more complex than previously studied. Thus researchers no longer question *if* attitudes predict behaviors; instead, they are interested in the circumstances under which attitudes predict behaviors (Bentler & Speckart, 1981; Cialdini, Petty, & Cacioppo, 1981).

The most popular single approach for predicting behavior from attitudes is the theory of reasoned action (Tesser & Shaffer, 1990). Proposed by Fishbein and Ajzen (1975), the theory states that attitudes and cultural norms combine to determine behavioral intentions, which in turn produce a voluntary behavior (Olson & Zanna, 1993). The theory has been used to predict intentions or behaviors in various domains including smoking (Norman & Tedeschi, 1989), applying for a nursing program (Strader & Katz, 1990), performing testicular self-exams (Steffen, 1990), and safety belt use (Stasson & Fishbein, 1990).

In order to incorporate behaviors not fully under voluntary control, Ajzen (1985) added perceived behavioral control to the reasoned action model as a third predictor of intentions, independent of attitudes and cultural norms. Most comparisons of the two models have found that the revised model (the theory of planned behavior) has a predictive advantage (Olson & Zanna, 1993). Ajzen (1991) reviewed relevant studies and concluded that the evidence supports the theory of planned behavior and that adding further variables to the model would not significantly enhance its predictive power.

A number of studies have found that differences in the extent to which attitudes guide behavior result from differences in how easily or quickly a person can retrieve the attitude from memory (Olson & Zanna, 1993; Sherman, Judd, & Park, 1989). Highly

accessible attitudes (i.e., those that come readily to mind) have been found to be more predictive of behavior than less accessible attitudes (Fazio, 1990; Fazio & Williams, 1986; Fazio & Zanna, 1981). In trying to explain the effect of accessibility on attitude-behavior consistency, Santrock (1991) noted that, because attitudes we think about at length come quickly and easily to mind, they influence our perceptions of events and are therefore more closely tied to our behavior. Similarly, Dilliard (1993) pointed to evidence that accessibility plays a causal role in attitude change by making salient whatever attitude currently exists.

Houston and Fazio (1989) and Fazio (1990) found that people holding highly accessible attitudes toward an object are more likely than those holding less accessible attitudes to evaluate information relating to the attitude object in a biased manner, and thus to shape their behavior in a direction consistent with their attitudes. However, such bias can possibly be removed by directing people to focus on the nature of the judgmental process. In addition, if motivation is sufficiently high, people may shift, on their own, to a less biased strategy when evaluating attitudinally relevant information (Houston & Fazio, 1989). Accessibility may also be related to other attitude qualities such as attitude centrality, certainty, affective-cognitive consistency (e.g., see Fazio & Williams, 1986), attitude extremity (Fazio & Williams, 1986; Houston & Fazio, 1989; Powell & Fazio, 1984), and how often the attitude has been expressed in the past (Powell & Fazio, 1984).

Several studies have found a relationship between self-monitoring and attitude-behavior consistency. High self-monitors are individuals who monitor their behavioral choices on the basis of situational information, while low self-monitors guide their choices on the basis of salient information from relevant inner states such as attitudes, feelings, and dispositions (Snyder & Tanke, 1976). There is evidence that the process of self-monitoring moderates the relationship between attitudes and behavior such that, low self-monitors show greater consistency between attitudes and behavior than high self-monitors (DeBono & Snyder, 1995; Schwartz, 1973; Sherman, Judd, & Park, 1989; Snyder, 1974, 1987; Snyder & Swann, 1976). There is also evidence that this relationship may be mediated by accessibility--with low self-monitors having attitudes that are more accessible than high self-monitors (e.g., see Kardes, Sanbonmatsu, Voss, & Fazio, 1986).

Other factors that have been found to mediate the relationship between attitudes and behavior include habit or past behavior (e.g., Triandis, 1977), stability of attitudes over time (Schwartz, 1978), volitional control of behavior (Davidson & Jaccard, 1979), and degree of direct experience with the attitude object (e.g., Regan & Fazio, 1977; Zimbardo, 1985). The role of direct experience appears to be especially important. For example, it is more likely that knowing someone personally who drove drunk and died in a car crash will affect our behavior than reading about crash statistics in the newspaper. Findings from Fazio, Zanna, and Cooper (1978) support the idea that attitudes formed through direct experience with an attitude object are better predictors of later behavior than attitudes formed through indirect experience. Their study also showed that the superior predictive power of the attitudes formed by direct experience is not necessarily a function of the amount of information about the attitude object available to the individual. Rather, it may be that direct experience affects the attitude formation process by altering the way in which available information is processed. Other studies have found that direct experience

increases the likelihood that attitudes will be accessible (e.g., Fazio & Zanna, 1981).

Influence of Behavior on Attitudes

Attitudes not only affect behavior; they are also influenced by behavior. Two major explanations of the influence of behavior on attitudes have been advanced. The first is dissonance reduction, proposed by Festinger (1957). Dissonance refers to an unpleasant arousal that arises from differences between one's attitudes and how one acts that drives a person to resolve the inconsistency (e.g., Festinger, 1957; Tesser & Shaffer, 1990). That is, because we have a strong need for cognitive consistency, we change our attitudes to make them more consistent with our behavior (Santrock, 1991). Recent evidence suggests that dissonance reduction is not always a cognitive matter. For example, several studies have found that we often try to reduce dissonance for more emotional reasons, especially to maintain a favorable picture of ourselves (e.g., see Aronson, 1969; Cooper & Fazio, 1984; Steele & Liu, 1983). Thus, dissonance reduction can be compared to what Sigmund Freud called rationalization.

The second explanation of the influence of behavior on attitudes is self-perception theory, proposed by Bem (1972). It posits that when internal states (e.g., attitudes) are weak or ambiguous, people must infer them from knowledge about their overt behavior and the circumstances in which the behavior occurred (Olson & Zanna, 1993). That is, we look to our behavior when our attitudes are not completely clear, in order to figure out what our attitudes are (Santrock, 1991). Several studies on the inference of attitudes from behavior suggest that behavior affects an attitude when the behavior is relevant to the attitude. Salancik and Conway (1975), for example, found that subjects use behavioral information to derive their attitude judgments when the information is both salient and relevant to their judgments. They concluded that the critical variable was not the behavior *per se* but the information that a person has available about that behavior.

It appears that these two explanations are not mutually exclusive; each may hold true under different circumstances. For example, Tesser and Shaffer (1990) reported findings from several studies that are consistent with both Bem's assertion (1972) that self-perception processes will predominate when initial opinions are weak or otherwise inaccessible, and with Festinger's assertion (1957) that behavioral violations of unimportant attitudes create little if any dissonance.

Attitude Change or Persuasion

Because attitudes are learned rather than innate, they are susceptible to change through persuasion. Persuasion refers to the intentional attempt to influence or change the attitudes of other people (Sdorow, 1990). Thus, persuasion is a process that involves three components: communicator or source, message, and audience or target-population (Zimbardo & Ebbesen, 1969). Factors related to each of these components affect the chances and degree of attitude change resulting from the persuasion process.

Communicator or Source: Source credibility, to a large extent, is characterized by expertise and trustworthiness. In general, communications will be more persuasive if they are perceived to come from a highly credible and respected source (Hovland & Weiss,

1951). There is, however, an effect such that over time, credible communicators will lose some of their persuasive impact (Zimbardo, 1985). Messages that seem contrary to what we would expect from particular sources are perceived to be especially trustworthy (e.g., Wood & Eagly, 1981). For example, a musician who was known for living a risky lifestyle, but supported the use of safety belts, might be a particularly effective communicator to the appropriate target population. Other factors that make communicators more persuasive include source attractiveness and similarities between the source and the audience that have nothing to do with the message the source is trying to convey. For example, a message about the dangers of drinking and driving delivered to an audience of high school athletes will likely be more persuasive if delivered by a relatively young professional athlete than an older librarian, even though the message has nothing to do with which career path to choose in life.

Message: Messages can be characterized as one-sided (only the source's position is communicated) or two-sided (both the source's position and the opposing position are communicated). Studies show that one-sided messages are more persuasive when audiences already favor the source's position; two-sided messages are more persuasive when they oppose it (Sdorow, 1990; Zimbardo & Ebbesen, 1969). Thus, it is important to know the audience's attitude towards traffic safety before constructing a message to influence traffic safety attitudes and behaviors.

Messages that include appeals to fear are generally effective only when the presented threat is severe, the likelihood of it occurring is high, and the audience is able to do something to prevent or eliminate it (Rogers & Mewborn, 1976). This implies that appealing to a person's fear of a horrible traffic crash because of high risk driving would not be particularly effective, since young people do not perceive a high likelihood of a crash, as discussed in the section on risk perception. A final message factor that may influence attitude change is the presence of distractions that, *under certain conditions*, may serve to make a message more persuasive by reducing the audience's ability to think of counterarguments (Zimbardo & Ebbesen, 1969). For example, an audience watching a slide show while also listening to a speaker's message may become so distracted by attending to the slide show that they are unable to think of counterarguments against what the speaker is saying; as a result, the audience may accept the speaker's message more easily than an audience not exposed to an accompanying slide show.

Audience or Target Population: There is evidence that audience involvement with an issue (often measured by personal importance) moderates the effects of communicator and message factors, as well as the persistence of attitude change. For example, Fiske and Taylor (1984) reported that the effects of communicator credibility and attractiveness were strongest for uninvolved recipients. Supporting these conclusions are study findings that highly involved subjects express more thoughts directly related to the message (Chaiken, 1980). Recipient intelligence has also been found to affect message persuasiveness, with recipients of relatively high intelligence being more likely to be influenced by rational arguments, and recipients of relatively low intelligence being more likely to be influenced by factors other than the merits of the argument (e.g., characteristics of the source or the situational context; Sdorow, 1990).

The extent to which message recipients are motivated and able to think about the issue at hand appears to affect what cues they will be most likely to attend to during the persuasion process. Motivation to think about the issue at hand relates to how relevant a particular issue is to the message recipient. Message recipients who are highly motivated and able to think about the issue at hand tend to pay more attention to the merits of the argument itself, while message recipients with low motivation and ability tend to pay more attention to factors unrelated to the merits of the argument, such as source credibility or attractiveness (Cialdini, Petty, & Cacioppo, 1981; Tesser & Shaffer, 1990). Thus, it is important to know the motivation and ability level of your audience in order to know which cues to emphasize in a traffic safety message or program. Recipients who change their attitudes based on thoughtful consideration of the merits of the argument generally experience more enduring attitude change than recipients who change their attitudes based on other factors, unless the latter type of attitude change is later strengthened by supporting cognitive argument (Cialdini, Petty, & Cacioppo, 1981).

Tesser and Shaffer (1990) identified several variables found to either motivate or enable recipients to attend to the merits of the argument. Enabling variables include repeated exposures to persuasive arguments, absence of situational distractions, an affectively neutral state of mind, extensive prior knowledge about the message topic, and direct experience with the attitude object. Variables that motivate issue-relevant thinking include dispositional factors (e.g., high self-acceptance, either high or low certainty orientation, and high need for cognition). Motivating situational factors include high personal relevance of the message topic, high match between the persuasive context and recipient's functional predispositions, use of interrogative formats to assess recipients' opinions, and delivery of independent arguments by multiple spokespersons.

Verbal Ability

Introduction

Traffic safety messages, of course, use verbal means for conveying information. If the verbal ability of the recipient is not accounted for in the message, then the message will not be processed and will have no chance of improving traffic safety behaviors. The term *verbal ability* refers to all use of language, including oral communication, oral comprehension, reading, and writing. There is good support that language use and thinking mutually influence each other (Kuczaj, Borys, & Jones, 1989; Vygotsky, 1962); thought influences word meanings, and language influences the development of concepts and categories. Thus, verbal ability is an integral component of thinking.

Development of Verbal Ability

It is clear that oral communication and comprehension increase with age. Phonology, the way in which the sounds of language are produced, begins to develop in infancy and continues through age five or six (e.g., Siegler, 1991). The development of understanding of word meaning also begins in infancy and continues at least through 11 years of age (e.g., Winner, Rosensteil, & Gardner, 1976), when children begin to master abstract word phrasings such as metaphors. Size of vocabulary also increases dramatically during the first 5 years, approximately doubling in size each year (Smith, 1926), and probably continues to increase at a much slower rate throughout the lifetime. Grammar, the system of rules governing how sentences are formed, tends to appear around 1.5-to-2 years of age when children begin making two-word sentences (e.g., Bowerman, 1973; Slobin, 1973). Advances are made in understanding grammar up through 7-to-15 years of age (Snow & Hoefnagel-Hohle, 1978; Johnson & Newport, 1989).

Reading and writing abilities also increase with age. As with oral communication, reading skills begin to develop before 1 year of age when children begin to learn to recognize letters (Chall, 1979). Fluent reading and reading for simple comprehension (e.g., literal meanings or single viewpoint comprehension) appears aound 9 years of age. Finally, complex comprehension of written material is achieved between 16 and 19 years of age (Chall, 1979). Thus, the actual skill of reading is acquired early, but skilled comprehension of the information is acquired at a much later age.

Several factors probably account for the superior reading comprehension of young adults over younger age groups (Siegler, 1991). The first is that because of automatization, older readers spend less attentional capacity translating printed words into their meanings, allowing them more capacity to comprehend the printed message (Lesgold, Resnick, & Hammand, 1985). A second factor is that short term memory (STM) capacity is larger in adults than childen, as already discussed. As discussed by Siegler (1991), a larger STM capacity would be useful for understanding words with multiple meanings because several meanings could be held in STM at the same time. A third factor is that adults simply know more about the world than children and this knowledge aids comprehension. A fourth factor in superior comprehension is that adults may be better able to monitor their own comprehension of text than children. This ability allows the reader to make adjustments while reading, such as changing reading pace or rereading paragraphs, to improve

comprehension. A final factor is that adults may be better at selecting reading strategies than children. For example, adults are more likely to use different strategies depending on whether a newspaper or textbook is being read.

Numerous studies have documented the fact that verbal ability varies by sex, with females usually showing greater proficiency. Girls tend to develop language ability at an earlier age, have greater reading comprehension, produce longer sentences, have higher test scores on spelling and punctuation, and have larger vocabularies than boys (Horgan, 1975; Martin & Hoover, 1987; McGuiness, 1976; Moore, 1976; Shucard, Shucard, & Thomas, 1987). Longitudinal and meta-analytic studies have shown that females maintain this advantage over males in many areas of verbal ability at least until age 25 (Butler, 1984; Hyde & Linn, 1988; Martin & Hoover, 1987).

Moral Development

Introduction

Moral development refers to the changes that occur with age and experience in how individuals deal with moral issues (Liebert, 1984). An important influence on all driving behaviors, in particular high risk driving, is the set of moral principles or rules by which individuals live (e.g., Parker, Manstead, & Stradling, 1993). Moral principles determine the motivation for many social behaviors, including driving. Traffic safety programs such as victim impact panels attempt to appeal to people's morality in an attempt to get them to change their risky-driving behaviors. As such, it is important to understand the acquisition of moral thinking so that appropriate programs and messages that rely on moral thinking can be produced.

The predominant approach to understanding moral development for the past 30 years builds on the social cognition work of Piaget (1932, 1960), and is characterized by his ideas that individuals play an active role in their own development and that cognition is of central importance in social development (Hoffman, Paris, & Hall, 1994). Piaget's early work included a preliminary examination of children's development of moral judgments, although he did not pursue these investigations. Research on moral development was expanded upon and refined by Kohlberg (e.g., Kohlberg, 1969).

Kohlberg's Theory of Moral Development

Kohlberg viewed moral development as a process whereby children form their own values and moral concepts out of their active efforts to organize and understand social experiences (Turiel, 1973). While emotions and motives may be involved in moral development, they are largely mediated by changes in cognition (Kohlberg, 1969). Thus, an understanding of moral thinking is critical to an understanding of moral development and moral action.

Kohlberg proposed six stages of moral development. Stages 1 and 2 (see Table 4) make up the *preconventional* level, in which rules and social expectations are thought of as being external to the self. It is primarily children who are at this level of moral development. Stages 3 and 4 make up the *conventional* level, in which individuals identify with or have internalized the rules and social conventions of others, including authorities. It is primarily adolescents and adults who are at this level. Stages 5 and 6 make up the *postconventional* or *principled* level and are characterized by the ability of individuals to separate themselves from the rules and expectations of others and think in terms of self chosen principles. Relatively few people achieve this level of moral development (Kohlberg, 1969).

The moral reasoning or modes of thinking that characterize each stage of moral development were originally derived from examination of a core group of American boys, age 10, 13, and 16 (see Colby, Kohlberg, Gibbs, & Lieberman, 1983). Subjects were studied longitudinally over several years, with their moral development assessed at 3-year intervals from early adolescence through young adulthood. Stages of moral development

were measured by how subjects assessed the morality of others. During interviews, subjects were presented with hypothetical moral dilemmas, in which human needs or welfare conflicted with the commands of authority or obedience to the law. For example, one dilemma involved whether a man should steal a drug to save his dying wife if the only druggist with the drug demanded an excessive price that the husband could not afford. After the subjects were presented with each dilemma, probing questions were used to elicit justifications, elaborations, and clarifications of their moral judgments.

Table 4: Kohlberg's Stages of Moral Development

Stage	What Is Right	Reason for Doing Right
Stage 1: Pleasure/pain orientation	Avoiding breaking rules backed by punishment; obedience for its own sake; and avoiding physical damage to persons and property.	Avoidance of punishment and the superior power of authorities.
Stage 2: Cost/benefit orientation	Following rules only when it is in someone's immediate interest; acting to meet own interests and needs and letting others do same. Right is what's fair, an equal exchange, a deal, an agreement.	To serve one's own needs or interests in a world where you have to recognize that other people have their interests too.
Stage 3: Good child orientation	Living up to what's expected by people close to you or what is generally expected of people in your role. Being good is important and means having good motives, showing concern, keeping mutual relationships such as trust, loyalty, respect.	The need to be a good person in your own eyes and those of others. Belief in the Golden Rule. Desire to maintain rules and authority that support stereotypical good behavior.
Stage 4: Law and order orientation	Fulfilling the actual duties to which you have agreed. Laws are to be upheld except in extreme cases of conflict with other fixed social duties. Right is contributing to society, the group, or institution.	To keep the institution going as a whole, to avoid the breakdown in the system "if everyone did it," or the imperative of conscience to meet one's defined obligations.
Stage 5: Social contract orientation	Being aware that people hold a variety of values and opinions; most values and rules are relative to one's group, but these relative rules should usually be upheld in the interest of impartiality and because they are the social contract. Some nonrelative values and rights (life and liberty) must be upheld in any society regardless of majority opinion.	A sense of obligation to law because of one's social contract to make and abide by laws for the welfare of all and for the protection of all people's rights. A feeling of contractual commitment, and concern that laws and duties be based on rational calculation for overall utility.
Stage 6: Ethical principle orientation	Following self chosen ethical principles. Laws or social agreements are usually valid because they rest on such principles. When laws violate these principles, one acts in accordance with the principle. Principles are universal principles of justice--the equality of human rights and respect for dignity of human beings.	The belief as a rational person in the validity of universal moral principles, and a sense of personal commitment to those principles.

Adapted from Colby, Kohlberg, Gibbs, and Lieberman (1983) and Zimbardo (1985).

The procedures used to score subjects' responses have undergone several revisions by Kohlberg and his colleagues to improve the reliability and validity of the assessment instrument, and stages 5 and 6 have been merged (Colby, *et al.*,1983). An alternative

instrument for assessing moral stages, developed by Rest (1979), is also used in moral development research. The Defining Issues Test (DIT) requires subjects to rate and rank the importance of different issues in resolving a range of moral dilemmas. The issues are designed to characterize stage-distinctive ways of defining moral dilemmas, with the stages generally, but not exactly, following Kohlberg's stages (Rest, Davison, & Robbins, 1978). While there have been other extensions to or departures from Kohlberg's work (e.g., Damon, 1984a; Eisenberg-Berg, 1979; Eisenberg, Carlo, Murphy, & Van Court, 1995; Gilligan, 1982; Hoffman, 1981), Kohlberg's theory of moral stages remains the best organizing framework for examining the empirical literature on moral development.

Several key premises underlie Kohlberg's stage theory of moral development (Colby, *et al.*, 1983). First, stages of moral development represent qualitatively different modes of thinking or of solving the same problem at different ages. Second, these stages form an unvarying sequence, order, or succession in individual development. Third, each stage forms a structured whole. That is, within a stage, the underlying thought organization that determines how an individual responds is the same although the situations being responded to may be very different. Finally, stages represent hierarchical integrations, with each stage building on the previous stage, as individuals reorganize their earlier understanding into a more balanced and complex view of morality. Each successive stage is characterized by increasing differentiation and integration, thus, extending an individual's ability to resolve conflicts (Tapp & Kohlberg, 1971).

According to Kohlberg (1969), the rate at which individuals progress through the stages of moral development is determined primarily by their attainment of appropriate levels of cognitive development and exposure to appropriate sociomoral experiences that allow them to increase their skills at perspective taking. Perspective taking refers to the ability to take another person's point of view, and to understand the other person's thoughts, emotions, intentions, and viewpoints (Holmes & Morrison, 1979). Sociomoral experiences arise through interpersonal relationships with family and friends and through real participation in the economic, political, and legal institutions of society, providing opportunities for role taking in conflict situations (Walker, 1984).

Empirical support for cognitive foundation of moral development

Some have argued that moral behavior does not involve cognition but rather comes about because one possesses a character disposition or trait toward virtue. However, efforts to measure traits such as honesty, responsibility, obedience, and courage with any precision or reliability have been unsuccessful and these traits have not been useful in predicting behavior from one situation to another later in life (Turiel, 1973). In contrast, there is considerable evidence that cognitive development is a necessary but not sufficient condition for the development of moral reasoning (e.g., Rest, Cooper, Coder, Masanz, & Anderson, 1974; Tomlinson-Keasey & Keasey, 1974; Walker, 1980).

Walker (1980), for example, studied 146 fourth through seventh grade children to assess cognitive development and perspective-taking functioning. He found that subjects needed to be functioning at the beginning of Piaget's formal substage of cognitive

development (coordination of inversion and reciprocity) and the third stage of perspective taking (mutual perspective taking) before they could make the transition to Kohlberg's third stage of moral development. As another example, Tomlinson-Keasey and Keasey (1974) focused on the relationship between formal operations and principled moral reasoning (Kohlberg's fifth and sixth stages). Based on a sample of 30 sixth-grade and 24 college students, they found that sophisticated cognitive operations were a prerequisite for advanced moral judgments, but that there was a lag between the acquisition of such operations and their applicability to the area of morality. They suggested that this lag may be due to their subjects' lack of social experience. Such experience is important because opportunities for social interplay not only directly affect the course of moral development, but they also help stabilize structures that have been successfully applied in the physical realm so they can be extended to the social realm.

Findings from studies that use the DIT to assess moral development provide additional evidence of the cognitive foundation of moral development. A review of over 100 U.S. studies using the DIT found clear support for the assertion that moral judgment is primarily governed by cognitive processes (Rest, 1979). Measures found to correlate with DIT scores included intelligence quotient (IQ), aptitude, and achievement. Rest, *et al.* (1974) found that subjects' DIT scores were related to other measures usually assumed to correlate with development (Kohlberg's measure of moral judgment development, comprehension of socio-moral concepts test, and the Differential Abilities Test). They concluded that as subjects develop cognitively they come to define moral dilemmas in a more complex way and to place greater importance on principled moral thinking than do less cognitively advanced subjects. Findings of correlations between the DIT and other cognitive measures provide evidence of a large cognitive component in moral judgment. While such findings suggest that development in the capacity to understand high-stage moral concepts is related to individuals' tendencies to use and prefer those concepts in making moral judgments, moral judgment remains a distinct area of cognitive development and not reducible to verbal IQ, Piagetian formal operations, or logical development in general (Rest, Davison, & Robbins, 1978).

Empirical support for hierarchical and sequential nature of stages

Findings from a variety of studies support the hierarchical and sequential nature of Kohlberg's stages (e.g., see Colby & Kohlberg, 1984; Colby *et al.*, 1983; Edwards, 1985; Rest, 1979; Snarey, Reimer, & Kohlberg, 1985a; Turiel, 1973; Walker, deVries, & Bichard, 1984; Walker & Taylor, 1991). For example, results of a 20-year longitudinal study of Kohlberg's moral stage development reported by Colby *et al.* (1983) indicated that subjects appeared to use a consistent logic or form of reasoning across a variety of moral dilemmas. Subjects' thinking developed in a regular sequence of stages, without skipping a stage or reverting back to use of a previous stage. Additionally, moral judgment was found to be positively associated with age, socioeconomic status, IQ, and education, and stage scores in childhood were significantly related to scores in adulthood.

Walker, de Vries, and Bichard (1984) provided additional empirical support for the hierarchical and sequential nature of moral stages, controlling for the level of language of each moral stage. They concluded that stages represent more than just differences in

language. Each successive stage provides a more adequate framework for decision making; that is, each stage integrates the considerations of the previous stage into a more complex and comprehensive structure.

Cross cultural studies of moral development have also suggested that the sequence of moral development stages is unvarying. In several studies in Turkey, Mexico, and Malaysia reviewed by Turiel (1973), children progressed through the same stages in the same sequence. Progress through the stages occurred in step-by-step fashion without stage skipping. Similarly, a review of over 20 studies conducted outside the U.S. concluded that moral development change appears to be gradual and positive throughout the childhood and adolescent years in a wide variety of cultures (Edwards, 1985). Little evidence was found of stage skipping or stage regression over time. Taken together, cross cultural studies suggest that culture may play a role in accelerating or delaying stage development, but it does not affect the quality or order of these different modes of thinking (Tapp & Kohlberg, 1971).

Several studies of moral development have focused on how movement occurs from stage to stage and what is required for such movement. Walker and Taylor (1991) examined how stage transitions occur and how they can be predicted, using a sample of 240 individuals from 80 family triads (father, mother, and child), with children drawn in equal numbers from grades 1, 4, 7, and 10. They found that most individuals reasoned primarily at a single stage, with smaller amounts of reasoning at adjacent stages. A number of studies reviewed by Turiel (1973) suggest that periods of transition from stage to stage are characterized by 1) growing criticism by individuals of their existing way of thinking (due to the awareness of contradictions and inadequacies in this way of thinking), 2) an attempt to construct new ways of thinking which results in some tension because these new ways are still intuitive, and 3) an attempt to subordinate the earlier way of thinking into the new one, ultimately leading to integration.

Age Differences in Moral Development

The empirical evidence of developmental trends in Kohlberg's moral stages point to, by definition, age differences in moral development. That is, evidence of the unvarying order of the stages, with each stage building on the previous stage, accounts for age-related development (Tapp & Kohlberg, 1971). However, the relationship between age and moral development is not a simple one. Movement from stage to stage does not occur merely as individuals age, and movement through every developmental stage is not inevitable. Still, age patterns can be discerned.

Kohlberg's original 20-year longitudinal study of U.S. boys indicated a clear relationship between age and moral judgment stage, with several age norms being identified (Colby & Kohlberg, 1984). The authors also found that scores at ages 13-14 were the best predictors of later stages. Figure 11 (adapted from Colby & Kohlberg, 1984) shows the percentage of moral reasoning at each stage for each age group in the study. Age-related developmental trends are clearly evident, with moral reasoning shifting to higher stages of development with each successive age group. As can be seen, stage 5

moral reasoning was not used before age 20 and was used by only a small percentage of people in either the 20-to-22 or 24-to-26-year-old age groups.

As a follow-up to this work, Snarey, Reimer, and Kohlberg (1985a, 1985b) studied 92 adolescent males and females from an Israeli kibbutz, 64 of whom were interviewed longitudinally over a 9-year period. Mean moral maturity scores gradually and consistently increased with age. A regression analysis indicated that age accounted for 40 percent of the variance in subjects' moral maturity scores. According to the authors, age norms in their study compared favorably to findings from the U.S. longitudinal study (Colby & Kohlberg, 1984), as well as one conducted in Turkey (Nisan & Kohlberg, 1982), although the kibbutz sample's mean stage scores at all ages were consistently higher than mean scores in the U.S. and Turkish samples.

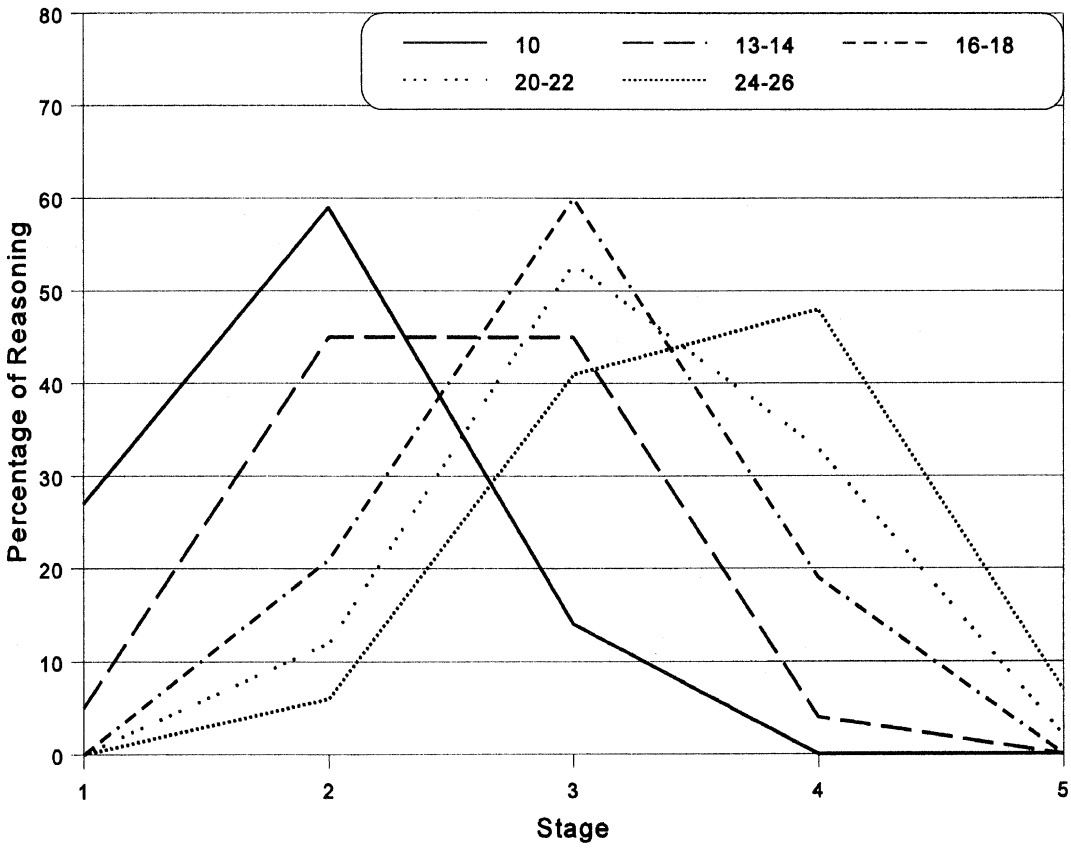

Figure 11: Percentage of people by age group at each stage of reasoning (from Colby & Kohlberg, 1984).

Studies of moral development based on the DIT also provide evidence of age-related directional change. Rest, Davison, and Robbins (1978) reviewed several such studies and concluded that the number of years since birth and the number of years in school affect the way in which subjects judge moral issues. Students moving through high school and into college appeared to experience the most dramatic changes in development, while development of adults was characterized by a slow-down in their 20s and a leveling off once they left school. However, adults who continued their education in

areas emphasizing moral thinking (e.g., doctoral students in moral philosophy or political science) scored higher on the DIT than other adults, suggesting that, for adults, moral judgment is more strongly related to education than to chronological age.

In a more recent review of the DIT research focusing on college students, Rest (1993) also found formal education to be an important influence on moral development. He concluded that the basic assumptions and perspectives by which individuals define what is morally right or wrong change during the college years; that the change is just as dramatic and fundamental as change in the years before puberty; and that formal education (years in college or professional school) is a powerful and consistent correlate of this change.

Carroll and Rest (1981) examined age-related changes in moral development by focusing on the rejection of lower stage statements rather than the acquisition of higher stages. They found definite age trends in the rejection of lower stage reasoning such that the older the subject, the greater the rejection of lower stage statements. The authors noted the consistency of their findings with several intervention studies in which gains from pretest to posttest were more likely to result from declines in lower stage use than acquisition of higher stage use (e.g., Erickson, 1974; Turiel, 1966).

Sex Differences in Moral Development

One criticism of Kohlberg's theory is that it fails to adequately represent the moral thinking of females (Walker, 1989). In particular, Gilligan (1977,1982) has argued that Kohlberg's moral stages have a built-in bias against females because they emphasize the acceptance of justice over the more traditional female values of caring and responsibility. However, Kohlberg's scoring system has been revised in recent years to avoid this problem (Hoffman, Paris, & Hall, 1994) and there is little evidence of sex differences in moral development (e.g., Colby, *et al.*, 1983; Lapsley, 1996; Rest, 1979, 1993; Silberman & Snarey, 1993; Snarey, Reimer, & Kohlberg, 1985a; Vasudev, 1988; Walker, 1984, 1989; Walker, deVries, & Trevethan, 1987).

Walker (1984), conducted one of the more thorough reviews of the literature and found that sex differences in moral reasoning are exceedingly rare. Of 108 studies reviewed, only eight clearly indicated significant differences favoring males and many of these were confounded by occupational level or educational status. Also, most of the studies reporting sex differences relied on Kohlberg's early stage definitions and scoring procedures, which have since been extensively revised. Walker concluded that the moral reasoning of males and females is more similar than different.

Silberman and Snarey (1993) pointed out that most investigations of sex differences in moral development do not take into account the earlier maturation of adolescent girls than boys. In their view, girls would be expected to score higher than boys during early adolescence because of their earlier growth spurt in social-cognitive development. The authors assessed the moral development of 190 young adolescent boys and girls and found girls' scores to be higher than boys in stage of moral development. They concluded

that their findings are consistent with a growing body of studies that refute the assertion of sex bias in moral development theory.

Moral Behavior

Moral reasoning appears to play an important role in real life decision making. At the same time, interactions with other factors complicate this relationship and rule out simple linear correlations between moral judgments and moral action (Rest, 1979). Based on findings from several hundred studies of the relationship between internal psychological processes and actual behavior, Rest (1993) concluded that the link between moral judgment and behavior seems reasonably well established, but that the strength of the relationship is not high, suggesting interaction with other, as yet unmeasured, factors. He found consistent and significant, but not high, correlations between DIT scores and a number of behaviors related to delinquency, school problems, ratings of medical interns on clinical performance, promise keeping, compliance and conformity, distribution of rewards, cheating on school tests, voting in the 1976 presidential election, and public policy issues. Other reviews have found similar patterns (e.g., see Blasi, 1980).

Facilitation of Moral Development

The issue of how to facilitate moral development has traditionally been viewed within the framework of childrearing in the family (Lickona, 1976). However, Kohlberg (1969) contended that family participation is not unique or essential to moral development. He argued that moral development is stimulated by the provision of role-taking opportunities and that these opportunities arise from participation in school and peer life and interaction with the political and social institutions of the larger society, as well as from family participation (Reimer, 1993). In Kohlberg's view, all of these types of participation converge in stimulating moral development, and the more social stimulation (through these role-taking opportunities), the faster the rate of moral development (Kohlberg, 1969). Kohlberg saw the challenge of moral development as being how to present individuals with stimuli that are contradictory enough to produce conflict in their existing stage schemata, yet harmonious enough to be assimilated. To this end, he cited work of Turiel (1966), and Rest, Turiel, and Kohlberg (1969) that suggests there will be maximum assimilation of moral judgments one stage above the individual's own stage of moral development.

School: Kohlberg (1980) viewed school as an intermediary between the family and society. In particular, he argued that it should be the responsibility of the high school to provide opportunities for role taking through experiential learning rather than curriculum development. Several early efforts to facilitate moral development among high school students through classroom discussion of moral dilemmas generally resulted in about one quarter to one-half of students moving significantly toward their next stage of moral development (e.g., Blatt & Kohlberg, 1975; Kohlberg, 1980). Other studies of group discussion of moral dilemmas or group participation in democratic governance conducted in schools, prisons and halfway houses yielded similar results of individual moral stage advancement (e.g., Higgins, Power, & Kohlberg, 1984).

Higgins, Power, and Kohlberg (1984) emphasized that real life moral decisions generally take place within the context of group norms or "moral atmosphere" as Kohlberg called it. Therefore, they suggested that, in many cases, the best approach to moral education may be to reform the moral atmosphere in which individual decisions are made through the creation of "alternative" high schools characterized by student-involved democratic governance. Lickona (1976) extended this idea by proposing that frequent and varied models of fair and cooperative behavior, whether on television, in the home, or at school, may support moral development by contributing to the moral atmosphere of a group or institution.

Snarey, Reimer, and Kohlberg (1985b), expressed caution, however, about the extent to which alternative schools can become a dominant force in moral development. Writing over a decade ago, when alternative schools were more common than they are today, the authors noted that alternative high schools (like the Israeli kibbutz that inspired their creation but accounts for less than 4 percent of Israel's population), will likely remain a minority influence in American education. Similarly, attempts to integrate the principles underlying alternative schools without actually creating alternative schools also face significant obstacles, including lack of teacher commitment to noncurriculum-based goals, need for structural reorganization of the school day, and difficulties in training teachers (Leming, 1986).

It may also be possible to facilitate moral thinking abilities by teaching broad thinking skills. Newmann (e.g., 1988, 1991, 1992) was concerned with how to promote "higher-order thinking" in the classroom, particularly among high school social studies students. He defined higher-order thinking as the interpretation, analysis, or manipulation of information to answer a question that cannot be resolved through the routine application of previously learned knowledge (Newmann, 1988). He argued that such a broad conceptualization of thinking, as opposed to specific types of thinking like critical thinking, informal reasoning, and moral reasoning, is more adaptable to a variety of content and skill objectives and is more likely to attract wide support from high school teachers. Further, a broad conceptualization addresses what Newmann considered to be the real problem in the classroom--not the failure to teach some specific aspect of thinking but the profound absence of thoughtfulness in general.

Based on research on the nature of thinking (summarized by Walsh and Paul, 1987), Newmann concluded that higher-order thinking, both within and beyond social studies, requires a combination of in-depth knowledge of subject matter, skills in processing information, and attitudes or dispositions of reflectiveness. In Newmann's (1991) view, teachers can facilitate higher-order thinking by providing opportunities for students to gain in-depth knowledge; activities to help students practice skills in the analysis, interpretation, and manipulation of knowledge; and support for students to develop dispositions of thoughtfulness. However, not only did he find little research in social studies on effective instructional techniques for promoting higher-order thinking, his own research identified a number of barriers to increasing student practice with higher-order challenges. These barriers included: a lack of informed commitment to the goal of higher-order thinking by teachers and society at large; difficulty in balancing depth and breadth in classroom

curriculum, the problem of how to teach so that students both acquire knowledge and use it; organizational constraints on the conduct of instruction; lack of opportunities for staff development; curriculum guidelines and testing programs that require coverage of vast amounts of material; students' apparent preferences for highly structured work with clear, correct answers; and teachers' conceptions of knowledge that emphasize the acquisition of information more than interpretation, analysis, and evaluation (Newmann, 1991, 1992).

To assess the success of classroom teachers and departments in promoting higher order thinking, Newmann (1992) developed a set of observable dimensions of classroom thoughtfulness that could be used to rate classroom lessons. Beginning with a set of 15 dimensions, he chose six dimensions as being most fundamental, although he noted that all 15 dimensions could, presumably, contribute to thoughtful discourse. These six dimensions include: 1) there is sustained examination of a few topics rather than superficial coverage of many; 2) the lesson displays substantive coherence and continuity; 3) students are given an appropriate amount of time to think, that is, to prepare responses to questions; 4) the teacher asks challenging questions and/or structures challenging tasks (given the ability level and preparation of the students); 5) the teacher is a model of thoughtfulness; and 6) students offer explanations and reasons for their conclusions. The six dimensions were combined into a single scale that could serve as the indicator of classroom thoughtfulness for an observed lesson.

Between the fall of 1986 and spring of 1990, 287 classroom lessons in 16 demographically diverse high schools were observed and in-depth interviews were conducted with 56 teachers, social studies department chairs and principals (Newman, 1992). The author found considerable variation among lessons, teachers, and departments in regard to classroom thoughtfulness. Classroom thoughtfulness was higher among teachers who appeared to conceptualize the nature of thinking more carefully, who gave attention to skills and dispositions as well as knowledge, and who preferred depth over coverage in their approach to knowledge. Classroom thoughtfulness was also higher among schools and departments in which there was strong leadership and a focused departmental vision in support of higher-order thinking.

Peer Learning/Interaction: Efforts to facilitate moral development through peer interaction have not been limited to high-school-age youth. The benefit of peer learning for younger children (i.e., children learning from one another) has been advanced by Damon (e.g., 1984b), among others. Like Kohlberg, Damon (1988) emphasized the role of social experience and social interaction in the moral development of children. In particular, he argued that peer group interaction promotes perspective or role-taking skills, which in turn, enhances the growing moral awareness of children. As an example of this, Damon and Killen (1982) found that children age five to nine who participated in peer discussions about issues related to justice were more likely than controls to advance in their moral reasoning. Age and sex were not associated with subjects' changes in moral reasoning.

Overall, peer learning has been linked to several potential benefits including increased self-esteem, interest in challenging tasks, scholarly achievement, and prosocial

behavior (Damon, 1984b). However, peer learning may take different forms; the two general forms of peer learning that figure most prominently in the literature are peer tutoring and peer collaboration. Peer tutoring refers to situations in which one child, in the role of expert, teaches a second child, in the role of novice. In peer collaboration, children work together to solve tasks; no one child is considered to have expert or tutor status (Phelps & Damon, 1991).

Peer collaboration has been associated with the development of empathy, kindness, and a sense of justice (e.g., Piaget, 1932; Sullivan, 1953; Youniss, 1980). The literature also suggests that peer collaboration may facilitate cognitive development as well as moral reasoning by fostering the kind of autonomous thinking that is necessary for both moral and cognitive development (e.g., see Phelps & Damon, 1991). An example of this is the study finding that peer collaboration is an effective method for helping children acquire conservation skills and the basic reasoning skills that underlie them (Damon, 1984b).

Peer tutoring has been associated with benefits for both the children being tutored and the tutors themselves. Among the benefits identified by studies conducted in the 1970s were improved self-esteem, attitudes toward schooling, social adjustment, and prosocial behavior (e.g., see Allen, 1976; Staub, 1975). More recently, Sprinthall (1994) conducted a study of peer tutoring involving high school females serving as math tutors for elementary school girls. He found that tutored students experienced significant gains in math skills and were more likely to attribute their success to their own efforts and less likely to blame themselves when faced with learning difficulties. As importantly, the tutors became more principled in their moral judgment. The author noted that an important part of the tutoring program was the opportunity by tutors for guided reflection through weekly journal entries; he stressed that such guided reflection is necessary for the development of role-taking skills and subsequent psychological growth.

To identify the unique contributions of peer collaboration and peer tutoring to cognitive development, Damon (1984b) reviewed a number of studies and concluded that each form of peer learning is best suited to a different type of cognitive advancement. He found peer tutoring to be useful for transmitting information and drilling special skills, while peer collaboration was useful for facilitating intellectual discovery and acquiring basic knowledge. Similarly, Phelps and Damon (1991), in studying pairs of fourth graders trying to solve a series of cognitive tasks, concluded that peer collaboration is an effective learning method for tasks that require logical reasoning, but not for rote learning or copying situations. The authors argued that because effective peer collaboration requires subjects to publicly verbalize their own understanding of the task in order to explain their solution, subjects are forced to make conscious the ideas they are just beginning to grasp intuitively, thus, facilitating intellectual growth.

In actual practice, it appears that the distinctions between peer tutoring and peer collaboration may be somewhat blurred. In many studies of peer collaboration, children's levels of expertise or competence do in fact differ even though individual subjects are not afforded expert or tutor status. Duran and Gauvain (1993) examined the effects of age and expertise on peer collaboration during shared planning among children age five and seven.

They found that cognitive gains were achieved by children who collaborated with peers more expert in the problem solving activity than themselves, especially when the less expert children were highly involved in the task and were the same age as their partner. However, there is also some evidence that the more expert partner may not derive the same benefits from peer collaboration as the novice partner. For example, Trudge (1992) found that within pairs of children who differed in their level of expertise or competence, the more competent partner actually regressed in his or her thinking in many cases as a result of peer collaboration.

Within the area of traffic safety, there are many examples of programs that rely on principles of peer learning, while not strictly adhering to models of peer collaboration or peer tutoring. For example, efforts to promote alternatives to drinking or drinking and driving among student populations (e.g., see Morritz, Seehafer, & Maatz-Majestic, 1993) often involve direct student development and implementation of program activities. By serving as program planners and leaders, students, in effect, become peer educators for their fellow students. However, evaluation of such programs has been limited and it is unclear how effective these programs are in changing attitudes and behavior (Fennell, 1993).

Moral Education and Traffic Safety: One series of studies provides some evidence that training in moral reasoning may be effective in increasing traffic safety, in this case, reducing repeat drunk driving (Little & Robinson, 1989a, 1989b, 1989c; Little, Robinson, & Burnette, 1990). The authors, who developed the moral reasoning program, treated a sample of prison inmates convicted of drunk driving during their incarceration. After a 2-year period, the arrest records of subjects in the treatment group were compared to those of control subjects. The authors found that about 10 percent of treatment group subjects had been rearrested for drunk driving while 15 percent of the control group had been rearrested for this offense. While no statistical tests for differences were conducted, these studies suggest that moral reasoning education may have a beneficial effect on traffic safety. More research is needed on this topic.

Piaget's Theory of Cognitive Development

Background and Overview

Jean Piaget devoted much of his life to studying children's cognitive development--the way in which mental processes such as thinking, reasoning, and perceiving the world evolve (Zimbardo, 1985). Piaget's interest was in the qualitative rather than quantitative characteristics of development. That is, he was concerned, not with how much children know, but how they come to know it (Singer & Revenson, 1978).

Although Piaget's theory of cognitive development has its detractors, Piaget is variously credited with being the most important figure the field of cognitive development has ever known (Flavell, 1996), the single most influential developmental theorist and researcher of this century (Fischer & Hencke, 1996), the author of a theory that has no rival in developmental psychology in scope and depth (Beilin, 1992), and the man whose ideas and findings must be understood if one is to understand the field of developmental psychology (Siegler & Ellis, 1996). Piaget's most important contribution was to establish the field of cognitive development as it is known today, providing the field with a new vision of the nature of children and their cognitive growth (Flavell, 1996).

Piaget's theory of cognitive development underwent many changes during his lifetime, ultimately evolving into a research program on a vast scale (Beilin, 1985). Beilin (1992) described four phases of Piaget's research program. The first phase focused on children's conception of reality mediated through language and social interaction, with research based primarily on verbal exchanges between investigators and children, or between children themselves (e.g., see Piaget, 1926, 1928, 1929, 1930, 1932). The second phase focused on sensorimotor development of young children and was based mainly on Piaget's observations of his own three children (e.g., see Piaget, 1951, 1952a, 1952b, 1954). The third phase focused on the structures underlying cognitive growth and was characterized by the introduction of models adapted from logic and mathematics (e.g., see Beth & Piaget, 1966; Piaget, 1970; Piaget & Garcia, 1974; Piaget & Inhelder, 1956a, 1956b). The fourth phase was characterized by a renewed focus on cognitive functions (e.g., see Inhelder & Piaget, 1980; Piaget, 1976, 1978, 1985, 1987a, 1987b). The review presented here is intended as a brief overview of Piaget's stage theory of cognitive development--it is not a comprehensive review of Piaget's work.

Concepts Underlying Piaget's theory

Despite changes in emphasis, interpretation, and content since its initial conceptualization, Piaget's theory has remained consistent in most of its core assumptions (Beilin, 1992). Foremost among these is the idea of constructivism--that children are active thinkers, constantly trying to construct more advanced understandings of the world (Siegler & Ellis, 1996). According to Piaget, children learn by doing--they not only observe and imitate the world around them, they interpret it as well (Singer & Revenson, 1978).

Piaget clearly viewed children's cognitive behavior as being intrinsically rather than extrinsically motivated; that is, children think and learn essentially because they are built

that way (Flavell, 1996). At the same time, Piaget recognized the role of experience in cognitive development, noting that the physical and social contexts in which children act help to give shape to their constructions of the world (Fischer & Hencke, 1996). Thus, Brainerd (1996) described Piaget's constructivism as a process in which "knowledge is literally created by infants and children from whole cloth as experience interacts with their biological dispositions" (pg. 194).

Piaget conceptualized intelligence within the context of human adaptation to a complex environment (Sigel, 1968). He described intelligence as the ability to cope with the changing world through continuous organization and reorganization of experience (Singer & Revenson 1978). In Piaget's view, adaptation, and thus, intellectual or cognitive growth, comes about through the dual processes of assimilation and accommodation. As described by Zimbardo (1985), *assimilation* involves modifying or changing new information to fit into what is already known (i.e., trying to understand new experiences by applying old solutions). *Accommodation* involves restructuring or modifying what is already known so that new information will fit in better (i.e., changing our conceptions of the world in order to interpret new experiences). It is the constant balancing of these two processes that leads to adaptation to the environment and underlies the process of cognitive development.

Another assumption underlying Piaget's theory is that of *structuralism*, the idea that there are cognitive structures (or modes of thinking) that form the essence of human intelligence (Brainerd, 1996). These structures generate stable states of equilibrium that correspond to Piaget's major periods of cognitive growth. To Piaget, cognitive development represented a gradual, step-by-step process of structural acquisition and change, with each new mental structure growing out of its predecessor, through the continuous operation of assimilation and accommodation (Flavell, 1996). Thus, he viewed cognitive development not within the context of specific intellectual skills that children acquire at different ages, but rather, within the context of the knowledge structures responsible for the expression of those skills.

Piaget likened the role of cognitive structures to that of structures in the physiological world. That is, "just as the physiological structure of organisms coordinates their physiological activities, cognitive structures coordinate cognitive activities so that they relate to one another, forming a whole. As a whole, cognitive structure functions to make the world coherent and comprehensible, just as physiological structure makes it possible for the organism to adapt to its environment" (Richards, Armon, & Commons, 1984, pg. xxiii). Despite criticism of the specific structures proposed by Piaget, there is considerable agreement that some type of structural framework is needed to adequately characterize cognitive development (Flavell, 1996).

Stages of Development

Piaget proposed four stages of cognitive development, each qualitatively different from one another. These stages include the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage. During each stage, distinctive styles of thinking emerge. Piaget's introduction of qualitatively different stages

of thinking was in marked contrast to the prevailing view of the time that children's cognitive activity was identical to adults' cognitive activity, only less efficient (Sutherland, 1992).

Kohlberg and Armon (1984) described four criteria commonly used to identify Piaget's cognitive stages. First, stages imply a qualitative difference in the mental structures present at various points in development. Second, these structures form an unvarying sequence, order, or succession in individual development. While cultural factors may play a role in accelerating or delaying stage development, they do not affect its order. Third, each of these different and sequential modes of thinking forms a "structured whole". That is, within each stage, there is an underlying thought organization that determines stage responses, apart from the particular tasks being responded to. Fourth, stages represent hierarchical integrations, with each stage building on the previous stage and representing increasing differentiation and integration. Piaget emphasized that development through the stages is gradual and continuous, involving sequences rather than punctuated achievements. The stages are described below and summarized in Table 5.

Table 5: Piaget's Stages of Cognitive Development

Stage Name	Approximate Age, Years	Stage Description	Defining Characteristics or Accomplishments
Sensorimotor	0 to 2	Infants progress from simple reflexive actions at birth to the beginning of symbolic or representational thinking. They construct an understanding of the world by coordinating sensory experiences with physical actions.	Development of object permanence (understanding that objects and events can continue to exist when they cannot be directly seen, heard, or touched).
Preoperational	2 to 7	Children begin to develop symbolic or representational thinking.	Inability to engage in operations (mental representations that are reversible); inability to understand conservation; egocentric.
Concrete operational	7 to 11	Children can now reason logically about concrete events and classify objects into different sets.	Ability to use operations; ability to understand conservation; logical reasoning replaces intuitive reasoning in concrete circumstances; classification skills.
Formal operational	11 to adult	Adolescents reason in more abstract and logical ways. Thought is more idealistic.	Ability to use abstract, idealistic, and logical (hypothetical-deductive) reasoning; adolescent egocentrism.

Adapted from Santrock, 1986.

Sensorimotor Stage: The sensorimotor stage is generally characterized by actions, movements, and perceptions that occur in the absence of language (Modgil & Modgil, 1976). That is, the infant's mental world is geared towards doing, rather than symbolic

activity such as language (Sutherland, 1992). These actions are coordinated through *schemata*, viewed by Piaget as simple mental images or patterns of action that individuals use to organize information and interpret the things they see, hear, smell, and touch (Singer & Revenson, 1978).

During the sensorimotor period, infants develop through six substages, from simple reflexive actions toward symbolic or representational thinking (Fischer & Hencke, 1996). Characteristics of these substages are detailed elsewhere (e.g., see Flavell, 1963; Piaget, 1951, 1952b, 1954). The main trend during this overall sensorimotor period is the development of *object permanence,* which refers to the understanding that objects have a reality of their own that extends beyond the immediate perception by the individual; that is, they exist independently from an individual's awareness of or action toward them (Ginsburg & Opper, 1969). In early infancy, object permanence is lacking--objects cease to exist when they pass out of an infant's immediate sight, hearing, or touch. After about 8 months of age, infants begin to search for objects that have been hidden from their view, indicating that they have developed object permanence--they are able to maintain mental images of physical objects even when the objects are no longer in sight (Sdorow, 1990).

Preoperational Stage: The preoperational stage is characterized by the development of *symbolic or representational thinking*; that is, thinking dependent on symbols rather than on sensorimotor relationships (Zimbardo, 1985). At the same time, children at this stage are not yet ready to perform *operations* (i.e., mental representations that are reversible; Santrock, 1986). Thinking still relies more on appearances than concepts or rules because children have not yet developed the mental structures for logical or abstract thought (Modgil & Modgil, 1976). Important characteristics of preoperational thought are children's lack of understanding of the concept of *conservation* and their growing ability to overcome *egocentrism* (Gleitman, 1991). Conservation refers to the idea that changing the form or arrangement of something does not change its amount, while egocentrism, refers, not to self-centeredness, but rather, to the inability to separate one's own perspective from another's (i.e., difficulty in picturing a scene from someone else's point of view; Sdorow, 1990).

Concrete Operational Stage: At about age seven, children begin to understand the concept of conservation. In Piaget's view, this understanding is essential for the acquisition and subsequent development of logical thought (Sigel, 1968). The main characteristics of the concrete operational stage, as described by Santrock (1986), include: the ability to use operations and mentally reverse actions; attainment of conservation skills; use of logical reasoning instead of intuitive reasoning, but only in concrete circumstances; the inability to engage in abstract thought; and the capability to classify or divide things into sets or subsets and to consider their interrelations.

The Formal Operational Stage: During the formal operational stage, logical operations are no longer tied to concrete problems; children can now understand abstractions, consider hypothetical questions, and design formal ways to test abstract ideas (Zimbardo, 1985). Formal operational thinking can be characterized as abstract, idealistic, and logical. Adolescents think more abstractly than children; they think about what is

possible and about ideal characteristics of themselves, others, and the world; and they begin to think more like scientists, devising plans to solve problems and systematically testing solutions (referred to by Piaget as *hypothetical-deductive reasoning*; Santrock, 1986). Piaget viewed formal operational thinking as a fundamental reorientation towards cognitive problems--for him it represented not a specific behavior or behaviors, but rather, a generalized orientation toward the organization of data, the isolation and control of variables, the hypothetical, and logical justification and proof (Flavell, 1963).

The formal operational stage is also characterized by egocentrism, particularly during early adolescence. This adolescent egocentrism is different from earlier egocentrism and has several dimensions. Adolescents believe that others are as preoccupied with them as they are with themselves; they believe that they are unique; and they believe that they are indestructible (Elkind, 1978). Essentially, adolescents go through a phase in which they attribute unlimited power to their own thoughts (Inhelder & Piaget, 1958). This egocentrism is often manifested in attention seeking behavior, reflecting the desire to be noticed and visible.

Postformal Thinking: Critics of Piaget argue that he ignored cognitive development after adolescence and failed to recognize the considerable developmental potential beyond formal operations. Numerous models have been developed to capture this "more sophisticated" thinking that are collectively labeled postformal models (Richards, Armon, & Commons, 1984). Proposed postformal stages include, but are not limited to, a dialectical stage (Basseches, 1984; Riegel, 1975), an epistemological stage (Broughton, 1978), a relativistic stage (Sinnott, 1984), a stage of unitary operations (Koplowitz, 1990), and a problem finding stage (Arlin, 1975, 1977). In addition to the development of single postformal stages, a model with three postformal stages has been proposed, including systematic, metasystematic, and cross-paradigmatic stages (Commons, Richards, & Kuhn, 1982).

Proponents of postformal stages argue that such stages (unlike Piaget's formal operational stage) take into account development after adolescence, and allow individuals to deal with the relativistic nature of knowledge, the acceptance of contradiction, and the integration of contradiction into an overriding whole (Kramer, 1983). However, Lourenco and Machado (1996) counter that Piaget never claimed cognitive development stops after adolescence. That is, "final in Piaget's formal stage refers to the structure, not the content, of the stage; it characterizes the operative way of solving physical, logical, and mathematical problems, and does not preclude, nor is incompatible with, a widening knowledge base in any domain of human experience..." (pg. 155).

Others point out that Piaget's formal operational stage, itself, is actually comprised of several levels, some of which share postformal characteristics. For example, Kohlberg (1990) noted that although Piaget was somewhat unclear about the specific levels of formal thinking, many of his colleagues suggest at least five levels of formal operations, with the most advanced of these levels (consolidated basic formal operations) being comparable to the postformal stage of systematic operations.

Empirical Support for Piaget's Cognitive Stages

Empirical evidence appears to support Piaget's basic descriptions of the stages of cognitive development (Elkind & Flavell, 1969; Halford, 1989a, 1989b; Neimark, 1975, 1979; Pascual-Leone, 1989b; Sigel & Hooper, 1968). For example, Elkind and Flavell (1969) and Sigel and Hooper (1968), reported on replication studies of Piaget's work that confirmed the occurrence of most of the phenomena he reported. Similarly, Halford (1989a), in reflecting on 25 years of Piaget's work, found that Piaget's empirical work has held up reasonably well and Neimark (1975) concluded that the earlier findings of Piaget appear to be clearly replicable and that his stages of development provide an accurate description of a vast amount of data.

Much of the criticism of Piaget's theory centers not on whether his stages occur, but the *explanation* for why they occur as they do. Halford (1989a), for example, noted that there is opposition to Piaget's structural explanation for stage differences. Others, investigating the ages at which certain cognitive behaviors appear, contend that Piaget underestimated children's understanding, particularly young children's operational competency. However, Piaget never claimed that children's understanding of various cognitive concepts appears at specific ages (Strauss, 1989). His focus was on sequence rather than age and he cautioned that the ages characteristic of each stage are never more than average (Modgil & Modgil, 1976). In addition, many studies challenging Piaget's results have been shown to contain basic methodological errors and conceptual confusion (Lourenco & Machado, 1996). Further, it has been argued that studies in which subjects mastered cognitive tasks at earlier ages than found by Piaget are more likely to be studies in which cognitive tasks were simplified from Piaget's, subjects were given opportunities to practice, or subjects were provided with instruction or structured choices (e.g., see Bidell & Fischer, 1980).

Age Differences

The empirical support for Piaget's cognitive stages implies, by definition, that there are age differences in cognitive development. At the same time, Piaget, himself, made it clear that the ages associated with different stages are always average and approximate (e.g., see Piaget & Inhelder, 1969). In Piaget's view, age is at best an indicator, not a criterion of developmental stage (Lourenco & Machado, 1996). He noted that "it is possible to characterize stages in a given population in terms of chronology, but this chronology is extremely variable. It depends on the previous experience of the individuals... and it depends above all on the social milieu which can speed up, slow down, or even prevent its manifestation" (Piaget, quoted by Lourenco & Machado, 1996, pg. 147).

Despite these caveats, Piaget did report age norms for each cognitive stage. In a later work, for example, he described the sensorimotor stage as extending from birth to age 1½-to-2; the preoperational stage from about age 1½-2 to 6-7; the concrete operational stage from age 7-8 to 11-12; and the formal operational stage from age 11-12 to 14-15 (Piaget, 1972). He cautioned that these age norms were based largely on a sample of children in Geneva and that subjects from other types of schools or different social environments sometimes exhibit somewhat different age norms, especially for the formal operational stage. He hypothesized that the attainment of formal operations may be

extended to age 15-20 depending on individual aptitude and one's degree of professional specialization (advanced studies or different types of apprenticeships).

There is evidence that some presumably normal people never attain formal operations (Kuhn, Langer, Kohlberg, & Haan, 1977; Neimark, 1975). Kuhn, *et al.* (1977), for example, found that considerable numbers of adults either never begin or never complete the transition to formal operational thought. Findings from their longitudinal study of 265 people age 10-to-50 years and a smaller group of 75 preadolescents (age 10-12) indicated that although formal operational thinking had started to appear in most subjects by early adolescence and underwent fairly rapid development during this period, only 30 percent of adults had completely achieved the transition to consolidated formal operations--most remained transitional between concrete and formal operations and about 15 percent showed no formal thought at all.

The authors found that the extent to which formal thought was evident among subjects varied considerably according to the type of problem with which they were presented. They considered this finding to be consistent with Piaget's assertion that, unlike earlier cognitive stages, formal operational thinking may emerge only in those content areas in which individuals have a certain level of interest, aptitude, and activity (Piaget, 1972). In Neimark's view (1975), which she likens to Piaget's, the stage of formal operations cannot be said to be attained until its component operations are integrated and fully generalizable. As long as skills remain situation-specific, task-specific, or score-specific, they are not generalizable and therefore represent only a transitional state between concrete and formal operations.

Sex Differences

The effects of sex on cognitive development have not been widely studied. Available findings relate primarily to formal operations and are generally secondary to analyses of other variables thought to affect cognitive development such as ability or cognitive style. Keating and Schaefer (1975), for example, compared "bright" and "average" boys and girls (including 52 boys from the fifth and seventh grades and 40 girls from the sixth and eighth grades) on a variety of Piagetian tasks. The authors found that bright subjects showed earlier acquisition of formal operational reasoning than average subjects; the only significant sex difference was for younger bright subjects, with boys scoring higher than the girls even though the girls were 10 months older. The authors noted the consistency of this finding with other findings that suggest that sex differences in high-level reasoning are greater at high levels of ability (e.g., see Stanley, Keating, & Fox, 1974).

Acceleration of Stage Development

There have been a number of studies exploring whether children can be trained to display advanced cognitive skills. Most of these studies focus on the transition from preoperational to concrete operational thinking. Murray (1979) noted, for example, that, between 1961 and 1978, about 150 studies were published that were designed specifically to train young children between the ages of four and seven to understand the concept of conservation. Based on several reviews of the conservation literature (e.g., Beilin, 1971,

1977; Brainerd & Allen, 1971; Glaser & Resnick, 1972; Goldschmidt, 1971; Peill, 1975; Strauss, 1972), he concluded that conservation can apparently be taught, although even highly individualized training is only successful about half the time.

Studies focusing on children's attainment of formal operational thinking have also shown that certain cognitive skills can be taught through training. For example, Siegler, Liebert, and Liebert (1973) attempted to train 10 and 11-year-olds to solve a "pendulum problem" (used by Piaget to test for formal operational thinking). They found that subjects were able to master the pendulum problem if given appropriate instruction (including a general conceptual framework for viewing the problem, guided solution of two problems unrelated in content to the pendulum problem but requiring similar solution strategies, and instruction in relevant data measurement and recording).

The limitation of most of these studies on the acceleration of cognitive development is that they either make no attempt to generalize skill training in one area to other areas or fail to demonstrate such generalizability. Thus, Neimark (1979) concluded that evidence that trained skills can be transferred to other contexts is still generally lacking. More recently, however, Adey and Shayer (1990), noted that some studies (e.g., Kuhn & Angelev, 1976; Rosenthal, 1979) suggest that general acceleration of formal operations may be possible. According to Adey and Shayer, an important feature of these studies is that rather than providing direct training of formal schemata, subjects are given the essential mental tools to enable them to construct the formal schemata for themselves.

Adey and Shayer reported findings from their own efforts to accelerate development of formal thinking in middle and high school students through a school-based intervention. Over a 2-year period, science teachers in eight schools taught up to 30 lessons designed around the schemata of formal operations. Study findings indicated that, overall, subjects exposed to the lessons made gains in level of cognitive development that were statistically greater than those made by the study's control group. Differences were still evident 3 years after the intervention ended (Shayer & Adey, 1993).

Apart from specific studies to accelerate cognitive development, there have been efforts to derive from Piaget's theory the general conditions that foster cognitive growth. For example, Sigel (1969) identified social interaction and stimulation as significant and necessary conditions for the transition from one cognitive stage to another. He proposed that such "confrontations with the social environment" can be facilitated by parents, teachers, and peers, enabling children to move beyond egocentrism. For this to occur, however, children must be able to absorb information being imparted to them. Thus, they must be at a stage of development that has the mental structures necessary for assimilating the information (Piaget, 1964).

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