PROBLEM SOLVING ACROSS THE LIFE SPAN

10

Cynthia A. Berg and JoNell Strough

Across the life span, we experience numerous problems to be solved. The following examples illustrate the range of problems considered under the broad label of "problem solving." An infant prior to self-locomotion cannot reach a toy that he or she wishes. A school-aged child must solve an arithmetic problem as well as a problem at recess with a child who prevents him from entering a game of kick ball. An older student must solve a complicated chemistry problem as well as a conflict with a romantic partner. Young adults must solve problems pertaining to achieving career objectives, in addition to interpersonal conflicts within long-term relationships. In midlife and later adulthood, problems may arise as interpersonal relationships with adult children change and individuals deal with changing finances and health.

This array of problems share a common, defining feature—an individual faced with an obstacle to goal-directed behavior applies a strategy to overcome the obstacle and achieve the goal (Siegler & Alibali, 2005). This conceptualization of problem solving has its roots in Piaget's notion of individuals' adaptation to their environment (Piaget, 1952) and has been a central component of intelligence more broadly (Binet & Simon, 1961). That is, successful problem solving involves individuals achieving a better fit between themselves and the demands present in the environment. Given the centrality of adaptation to one's environment in problem solving, diversity in the content of problems individuals face across the life span is not a surprise. As is emphasized in contextualist approaches to intelligence (e.g., Baltes, Dittmann-Kohli, & Dixon, 1984), the contexts or domains of problems change across the life span along with individuals' broader goals and developmental life tasks (Heckhausen, 1997; Roisman, Masten, Coatsworth, & Tellegen, 2004).

We take a broad approach to problem solving across the life span, seeking answers to the question, "What develops across the life span?" Because of diversity in problems and paradigms for examining problem solving, we begin by presenting an organizational framework to provide a guide for our literature review. We then take four domains of problem solving (well-structured, everyday problem solving, social problem solving, collaborative problem solving) and review the literature to address the question, "What Develops?" We highlight features of the problem-solving process that change across the life span. We end by discussing directions for future research to link problem solving to successful adaptation to developmental contexts.

A FRAMEWORK FOR UNDERSTANDING PROBLEM SOLVING ACROSS THE LIFE SPAN

Numerous models of problem solving partition the problem-solving process into a series of discrete stages (Dodge, 1986; Rubin & Krasnor, 1986; Spivack & Shure, 1982).

PROBLEM SOLVING ACROSS THE LIFE SPAN

10

Cynthia A. Berg and JoNell Strough

Across the life span, we experience numerous problems to be solved. The following examples illustrate the range of problems considered under the broad label of "problem solving." An infant prior to self-locomotion cannot reach a toy that he or she wishes. A school-aged child must solve an arithmetic problem as well as a problem at recess with a child who prevents him from entering a game of kick ball. An older student must solve a complicated chemistry problem as well as a conflict with a romantic partner. Young adults must solve problems pertaining to achieving career objectives, in addition to interpersonal conflicts within long-term relationships. In midlife and later adulthood, problems may arise as interpersonal relationships with adult children change and individuals deal with changing finances and health.

This array of problems share a common, defining feature—an individual faced with an obstacle to goal-directed behavior applies a strategy to overcome the obstacle and achieve the goal (Siegler & Alibali, 2005). This conceptualization of problem solving has its roots in Piaget's notion of individuals' adaptation to their environment (Piaget, 1952) and has been a central component of intelligence more broadly (Binet & Simon, 1961). That is, successful problem solving involves individuals achieving a better fit between themselves and the demands present in the environment. Given the centrality of adaptation to one's environment in problem solving, diversity in the content of problems individuals face across the life span is not a surprise. As is emphasized in contextualist approaches to intelligence (e.g., Baltes, Dittmann-Kohli, & Dixon, 1984), the contexts or domains of problems change across the life span along with individuals' broader goals and developmental life tasks (Heckhausen, 1997; Roisman, Masten, Coatsworth, & Tellegen, 2004).

We take a broad approach to problem solving across the life span, seeking answers to the question, "What develops across the life span?" Because of diversity in problems and paradigms for examining problem solving, we begin by presenting an organizational framework to provide a guide for our literature review. We then take four domains of problem solving (well-structured, everyday problem solving, social problem solving, collaborative problem solving) and review the literature to address the question, "What Develops?" We highlight features of the problem-solving process that change across the life span. We end by discussing directions for future research to link problem solving to successful adaptation to developmental contexts.

A FRAMEWORK FOR UNDERSTANDING PROBLEM SOLVING ACROSS THE LIFE SPAN

Numerous models of problem solving partition the problem-solving process into a series of discrete stages (Dodge, 1986; Rubin & Krasnor, 1986; Spivack & Shure, 1982).

Individuals first interpret and define the problem (What is the essential problem?). Next, individuals set goals regarding what they want to accomplish in the particular problem-solving situation. After goal setting, individuals generate and explore various strategies for solving the problem, anticipating the outcomes that might be associated with strategy implementation. Finally, individuals implement a strategy and then evaluate the effectiveness with which the strategy dealt with the blocked goal. Models consistent with this general framework have guided research investigating laboratory-based logical problem solving (Halford & Andrews, 2006) and social problem solving (Chang, D'Zurilla, & Sanna, 2004; Crick & Dodge, 1994).

Although this general framework has been influential in guiding research on problem solving, scholars argue that it misses important aspects of the problem-solving process. First, problem solvers may implement plans to prevent problems from occurring (Aspinwall & Taylor, 1997; Berg, Strough, Calderone, Meegan, & Sansone, 1997). Planning to prevent problems may become increasingly important for older adults, especially for social problem solving (Charles, Piazza, Luong, & Almeida, 2009; Sorkin & Rook, 2006). Second, the serial order of these processes has been called into question (Crick & Dodge, 1994; Sansone & Berg, 1993)—problem solvers may continually update their problem definitions and modify goals as they evaluate strategy effectiveness. Third, the process focuses on an "individual" problem solver, missing the inherently social nature of much problem solving (Berg, Meegan, & Deviney, 1998). Problems are frequently defined with other people (Beveridge, Berg, Wiebe, & Palmer, 2006) and solved in collaboration with others (Rogoff, 1998; Strough & Margrett, 2002). Fourth, this framework has been criticized as overly logical and rational, neglecting the fact that much problem solving takes place with cognitive short-cuts (Gigerenzer, 2008; Rivers, Reyna, & Mills, 2008), such as heuristics, that circumvent the critical evaluation of strategy effectiveness in relation to goal attainment. Relatedly, the focus on logical problem solving has obscured the powerful role of affect regulation and emotion in the problem-solving process (Blanchard-Fields, 2007). Most importantly for our treatment of problem solving across the life span, the framework is not a developmental one, as it was developed largely within the information-processing revolution within cognitive psychology (Klahr & Robinson, 1981; Siegler, 1978).

We propose a revision of this framework to facilitate a life-span developmental conceptualization of problem solving (Figure 10.1). We maintain that processes of anticipatory problem solving, problem definition, goal setting, strategy selection, and regulation of affect *may* occur in the problem-solving process depending on the cues that are encoded within the context and accessed in one's memory store and long-term knowledge base. However, these processes may occur in a more recursive fashion rather than a specific linear order. In addition, Figure 10.1 depicts that problem solving may involve more than one problem solver (represented by the two circles reflecting problem-solving processes); pairs, as well as larger groups, may encode cues, select strategies, and regulate affect together. Research on collaborative problem solving (reviewed later) points to the important role of partners' shared knowledge and memories for facilitating collaborative performance (depicted in the shaded area of Figure 10.1).

As outlined in Figure 10.1, our revision of the framework emphasizes that the problem-solving process occurs in proximal contexts (e.g., school, work, family) that change across the life span and that these proximal contexts are bounded by the

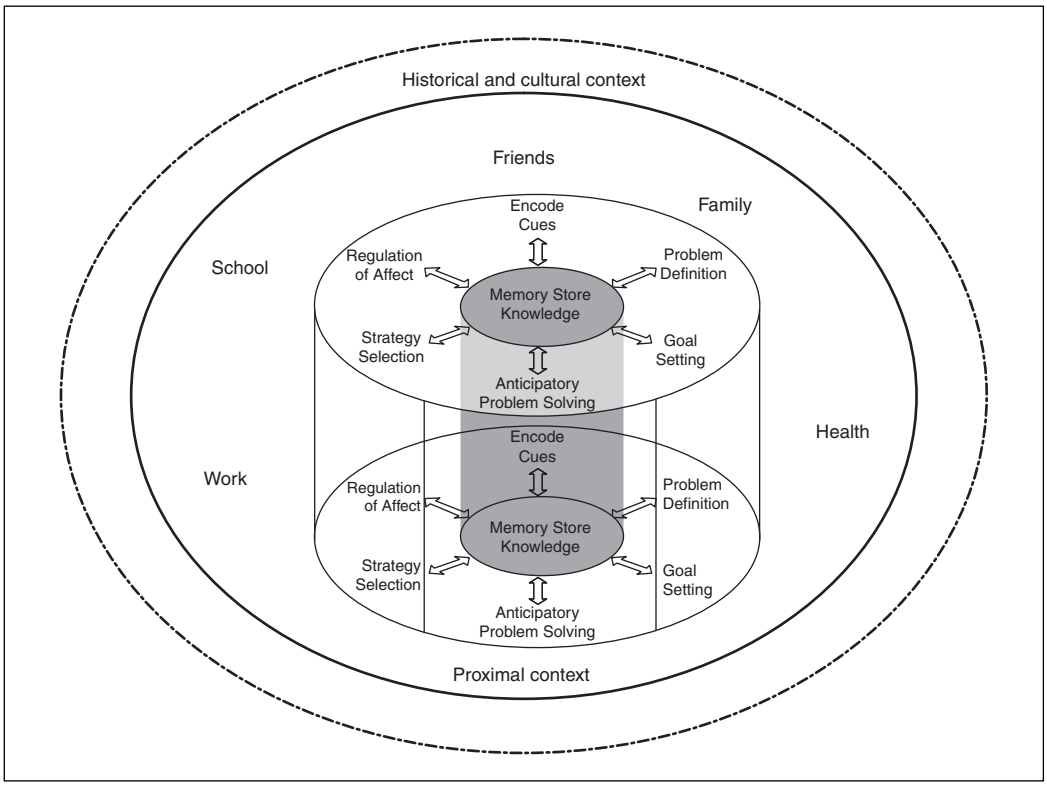

FIGURE 10.1 **Depiction of problem-solving process occurring between two people embedded within a proximal context as well as larger historical and cultural context.**

larger cultural and historical context (Dittmann-Kohli & Baltes, 1984). Consistent with the notion that adaptation at different periods of the life span is organized by different developmental tasks (McCormick, Kuo, & Masten, Chapter 5), we propose that the problem-solving contexts that are most relevant for adaptation vary across the life span. For instance, well-structured problems (e.g., arithmetic problems) occurring within contexts such as school may be more salient and indicative of adaptation for individuals for whom school is a proximal context of development (e.g., children living within a culture and time in history emphasizing compulsory education). Well-structured problem domains also may be salient and indicative of adaptation in adulthood for individuals within specific occupations (e.g., spatial problem solving for architects; Salthouse, Babcock, Skovronek, Mitchell, & Palmon, 1990). The school context may be linked with developmental goals such as autonomy (Hoppmann, Coats, & Blanchard-Fields, 2008) and achievement and learning goals (Grant & Dweck, 2003). Individuals' goals within a specific context may be associated with particular problem-solving cues and strategies. For instance, when a problem is embedded in a school context and achievement goals are salient, problem solvers may attend to cues (e.g., multiple-choice format; an instructor who emphasizes critical individual thought) that communicate that the problem is to be solved alone, via one correct answer using a logical problem-solving process. As individuals'

proximal developmental context shifts from school to work, the problem-solving context becomes less structured, more complex, and may be guided by heuristics, biases, and naturalistic decision making (Kahneman & Klein, 2009). Consistent with life-span developmental principles (Baltes, 1987), historical time and birth cohort also have implications for the relevance of problem contexts. The pervasive influence of modern technology (Charness, Fox, & Mitchum, Chapter 13) illustrates how problem contexts may emerge and present new challenges and resources for adaptation to the environment.

Interpersonal relationships present within individuals' proximal developmental contexts also shift in importance across the life span. For example, peer relationships grow in importance across childhood (Larson & Richards, 1991) and the prominence of relationships with same- and other-sex peers undergoes systematic changes from early childhood through later adulthood (Mehta & Strough, 2009). Relationships with friends and romantic partners become especially important in adolescence and emerging adulthood (Roisman et al., 2004). In midlife, familial relationships and relationships with coworkers are important within the proximal contexts of daily life, whereas in later adulthood, relationships with coworkers may recede and family relationships may remain prominent. Characteristics of interpersonal relationships such as whether they are voluntary (e.g., friends) or obligatory (e.g., family) may be associated with emotional cues and social constraints that elicit goals to maintain the relationship or change the behavior of another. In turn, goals may be associated with specific problem-solving strategies such as regulating emotion, collaboration with others, and heuristics that short-cut the logical problem-solving process (Sorkin & Rook, 2006).

Although contexts may provide cues for problem-solving goals and strategies that explain some of the between-person variability across the life span, extensive intraindividual variability in problem solving also exists (Berg & Klaczynski, 2002; Lindenberger & Oertzen, 2006; Siegler, 2006a, 2006b). That is, a single individual will vary in their approach to problems within a domain depending on the specific conditions of the problem (Klaczynski, 2000; Siegler, 2006b). In our review, we highlight both interindividual and intraindividual variability in problem solving across the life span.

REVIEW OF PROBLEM SOLVING ACROSS THE LIFE SPAN

We review research on problem solving from two traditions: well-structured versus ill-structured problems (Wood, 1983). Problems that are "well-structured" are those where problem definitions and goals are well characterized (often constrained by the experimenter through instructions), there are a limited number of strategies available to address the problem, and emotion arousal is muted. Problems that are ill-structured are those where there is great diversity in the ways that people can define the problem, diversity in the goals and strategies to approach the problem, such that there is not a single correct way to solve the problem, and part of the problem approach may be how to avoid the problem and regulate one's emotional reaction. In our review, we focus on well- and ill-structured problems where sufficient research exists across age periods to begin to address the question of "What Develops?" in problem solving.

proximal developmental context shifts from school to work, the problem-solving context becomes less structured, more complex, and may be guided by heuristics, biases, and naturalistic decision making (Kahneman & Klein, 2009). Consistent with life-span developmental principles (Baltes, 1987), historical time and birth cohort also have implications for the relevance of problem contexts. The pervasive influence of modern technology (Charness, Fox, & Mitchum, Chapter 13) illustrates how problem contexts may emerge and present new challenges and resources for adaptation to the environment.

Interpersonal relationships present within individuals' proximal developmental contexts also shift in importance across the life span. For example, peer relationships grow in importance across childhood (Larson & Richards, 1991) and the prominence of relationships with same- and other-sex peers undergoes systematic changes from early childhood through later adulthood (Mehta & Strough, 2009). Relationships with friends and romantic partners become especially important in adolescence and emerging adulthood (Roisman et al., 2004). In midlife, familial relationships and relationships with coworkers are important within the proximal contexts of daily life, whereas in later adulthood, relationships with coworkers may recede and family relationships may remain prominent. Characteristics of interpersonal relationships such as whether they are voluntary (e.g., friends) or obligatory (e.g., family) may be associated with emotional cues and social constraints that elicit goals to maintain the relationship or change the behavior of another. In turn, goals may be associated with specific problem-solving strategies such as regulating emotion, collaboration with others, and heuristics that short-cut the logical problem-solving process (Sorkin & Rook, 2006).

Although contexts may provide cues for problem-solving goals and strategies that explain some of the between-person variability across the life span, extensive intraindividual variability in problem solving also exists (Berg & Klaczynski, 2002; Lindenberger & Oertzen, 2006; Siegler, 2006a, 2006b). That is, a single individual will vary in their approach to problems within a domain depending on the specific conditions of the problem (Klaczynski, 2000; Siegler, 2006b). In our review, we highlight both interindividual and intraindividual variability in problem solving across the life span.

REVIEW OF PROBLEM SOLVING ACROSS THE LIFE SPAN

We review research on problem solving from two traditions: well-structured versus ill-structured problems (Wood, 1983). Problems that are "well-structured" are those where problem definitions and goals are well characterized (often constrained by the experimenter through instructions), there are a limited number of strategies available to address the problem, and emotion arousal is muted. Problems that are ill-structured are those where there is great diversity in the ways that people can define the problem, diversity in the goals and strategies to approach the problem, such that there is not a single correct way to solve the problem, and part of the problem approach may be how to avoid the problem and regulate one's emotional reaction. In our review, we focus on well- and ill-structured problems where sufficient research exists across age periods to begin to address the question of "What Develops?" in problem solving.

Well-Structured Problem Solving

Tasks and Methods

A diverse set of well-structured tasks (Tower of Hanoi or London, logical syllogisms, analogical reasoning, scientific reasoning, etc.) have been used to investigate problem solving. In these investigations, the problem solver's goal is constrained by the experimenter; the focus is on individual problem solving and on understanding the development of logical problem solving. Tasks are often age specific and are designed to measure qualitative shifts in the developing person's cognitive structure of logical problem solving, in accord with the influence of Piaget's (1952) theory. During infancy and toddlerhood, studies focus on sensorimotor problem solving (Cohen & Cashon, 2006) such as means–ends problem solving (Chen & Siegler, 2000), deferred imitation (Bauer, 2006), and an understanding of physical objects such as object permanence (Baillargeon, Li, Ng, & Yuan, 2009). During the preschool years, analogical reasoning (Halford & Andrews, 2006), planning problems such as the Tower of Hanoi (Klahr & Robinson, 1981) and planning an efficient route to get items at a grocery store (Gauvain & Rogoff, 1989) are examined. For school-aged children, problem solving on school-based tasks (e.g., arithmetic, Siegler, 1996, 2006a, 2006b), scientific reasoning tasks (e.g., balance scale task, Case, 1985, Siegler, 1981), scientific experimentation (Lehrer & Schauble, 2006), and reasoning more broadly (Halford & Andrews, 2006) are investigated. Across adolescence and adulthood, judgment and reasoning tasks (e.g., Reyna & Rivers, 2008; Weber & Johnson, 2009) as well as tasks more frequently found to reflect tasks of everyday living (e.g., completing tax forms, understanding medication instructions; Allaire & Marsiske, 2002) have been used to investigate logical problem solving.

The age-based segregation of tasks and methods in literature investigating well-structured problem solving makes it challenging to compare problem solving across the life span (see Case & Okamoto, 1996; Siegler, 2006a, for exceptions). For instance, during infancy methods such as habituation (Cohen & Cashon, 2006) and actions on objects (Chen & Siegler, 2000) are used, whereas during the school-aged and adult years verbal justifications (Siegler, 1996) and choosing among alternative answers are examined.

Arithmetic Problem Solving as an Example of Well-Structured Problems

For our review of well-structured problem solving, we examined arithmetic, as it is one of the few tasks that has been extensively studied across the life span. Basic quantitative knowledge may emerge in infancy. Such knowledge has been characterized by Horn and Hofer (1992) as a crystallized ability that is relatively well maintained across the life span. Development of arithmetic problem solving has implications for success in the school context as well as everyday life (e.g., doing price comparisons at the grocery store, Lave, 1989). Further, research on arithmetic problem solving focuses on key issues such as age differences in the ability to adapt strategies to problem features (Lemaire, Arnaud, & Lecacheur, 2004) and intra-individual variability in problem-solving strategies (Siegler, 2006b).

Consistent with research on other well-structured tasks, work on arithmetic problem solving addresses only parts of the problem-solving framework outlined

in Figure 10.1. The focus is on the development of strategies, how individuals select strategies in response to problem parameters and adaptively fit those strategies when parameters change. Experimenters typically constrain problem definitions and goals through instructions and the role of affect regulation is only rarely addressed.

Infancy. Research in infancy focuses on a basic understanding of numerosity, ordinality, and addition and subtraction (Geary, 2006). Research on numerosity uses the paradigm of habituation, where infants' abilities to discriminate among new and previously seen objects are assessed (e.g., Starkey & Cooper, 1980; Xu & Spelke, 2000). Results of studies using habituation have been used as evidence that infants discriminate among small sets of items (e.g., two versus three), but not larger sets (four from six) using a perceptual process called subitizing. Research on ordinality uses violation of expectation experiments and suggests that infants may understand rudiments of ordinality (that two is more than one) and simple arithmetic and subtraction (e.g., Wynn, 1990).

Results suggesting infants' abilities to understand aspects of number and simple arithmetic have been replicated across dozens of studies (Geary, 2006). There is disagreement, however, regarding the mechanisms underlying performance. Some view results as evidence for an underlying innate preverbal counting mechanism (Gallistel & Gelman, 1992) that has evolved specifically for quantity representation. Others interpret results as operating off a perceptual process (the displays look different) and not reflecting specific number information.

Preschool and School-Aged Children. An extensive literature exists on preschool and elementary school-aged children's ability to solve single-digit addition and subtraction as well as multiplication problems (Siegler, 1996, 2006a, 2006b). Typically, children are presented with simple arithmetic problems (e.g., 2 + 9) and asked to produce the answer or are presented candidate answers (10, 11, 12) and asked to verify whether the answer is correct or incorrect. For preschool-aged children, problems are presented in a story problem format. The strategies that children use to solve the problems are examined via videotape, from children's self-report, and inferred from reaction time and error analyses of task performance in response to particular aspects of problems presented across many trials. Numerous strategies have been identified such as counting (raising the number of fingers for each addend and counting), sum strategy (counting from 1), min strategy (counting from the larger addend the number of the smaller addend), decomposition (in solving the problem 2 + 9, rounding 9 up to 10 and thinking that the answer is 12–1), retrieval (accessing the answer directly from memory), and guessing. Retrieval strategies are used when the strength of the answer in long-term memory is highly associated with the problem (Shrager & Siegler, 1998).

At all stages of learning, there is extensive intraindividual variability in strategies (Siegler, 2006a, 2006b), a view that contrasts with older views of children's strategy development, where development involved a progression from less sophisticated (e.g., counting) to more sophisticated strategies (e.g., min strategy and then finally retrieval). Even young children (4–8 years) adapt their strategies depending on features of the problems (e.g., using retrieval on easier problems and back-up strategies

such as counting on more difficult problems, Siegler, 1996). Although use of optimal strategies such as retrieval increase with age and learning, multiple strategies are used across development, with the discovery of new strategies being an important process of development. The movement from early emerging, less sophisticated "back-up" strategies such as counting to more sophisticated retrieval strategies is dependent on schooling and instruction as well as maturational factors (Geary, Bow-Thomas, Liu, & Siegler, 1996).

Early and Later Adulthood. Consistent with research during childhood, intraindividual variability in strategy use persists into early adulthood. Although retrieval becomes the most frequently used strategy during young adulthood, some adults continue to use back-up strategies (e.g., min counting, decomposition). Hecht (2006) found that for adults who were labeled "not-so-good retrievers" back-up strategies were adaptive, whereas for other adults (labeled "perfectionists") back-up strategies were not needed. Perfectionists have been identified during childhood as well (Siegler, 1988). Hecht's research demonstrates how individual differences may exist in the extent to which intraindividual variability in strategies is adaptive.

Although individual and intraindividual differences in strategies have been investigated, individual differences in goals are not typically considered within the literature on arithmetic problem solving. However, in accord with our problem-solving framework (Figure 10.1), individual differences in goals for accuracy may be present. For example, accuracy goals may be more salient to perfectionists than to "good retrievers" or "not-so-good retrievers." Additional individual differences in strategy selection have been found among those with high math anxiety (Ashcraft & Ridley, 2005), who do not fit their strategies to problem characteristics in the same way and appear to place a greater emphasis on the goal of speed (perhaps as a way to end an experimental session they find aversive) than those without math anxiety. Research on math anxiety reveals how emotion regulation may be involved in problem solving, even for well-structured problems (see Figure 10.1). Moreover, the larger sociohistorical context may affect performance within this domain. For example, some individual differences in math anxiety and expectations about performance may reflect the salience of cultural stereotypes tied to gender or minority group status. When experimental manipulations reduce the salience of such stereotypes, performance may improve (Ben-Zeev, Duncan, & Forbes, 2005; Good & Aronson, 2008).

Individual differences are apparent when younger (typically college-aged, 18–25 years) and older (60 years of age and older) adults are compared. Such comparisons use two-digit multiplication problems to address age differences in the adaptivity of adults' problem-solving strategies to problem conditions (Lemaire et al., 2004; Lemaire & Lecacheur, 2004). For instance, Lemaire et al. (2004) asked adults to estimate answers to 2-by-2 digit multiplication problems (43 × 78). Estimation strategies varied in terms of their efficacy for different types of problems. For instance, for the problem 43 × 78 (answer = 3354) a rounding down strategy (e.g., 40 × 70 = 2800) would be more accurate than rounding up (50 × 80 = 4000), but both would be less accurate than a mixed rounding strategy (rounding down to 40, but up to 80). Older adults, in comparison to younger adults, took more time to complete such problems and were less accurate. Although older and younger adults did not differ in their

strategy preferences (all participants preferred rounding down strategies presumably because they were easier to implement), older adults' selected strategies were less optimal in terms of the fit between the strategy and the features of a particular problem (i.e., using rounding down strategies more frequently on problems where rounding down yielded the best estimate). These age-related differences in strategy selection suggest that older adults are less adaptive or less flexible in fitting their strategies to problem characteristics (Lemaire & Lecacheur, 2004).

Similar age-related individual differences are obtained when experimenters attempt to increase the salience of various goals (e.g., instructions to be highly accurate or to be as fast as possible), when individuals are allowed more latitude in strategy selection (e.g., allowed to use the mixed-rounding strategy), and are given additional time to make estimation decisions (Lemaire & Lecacheur, 2004). Older adults' relative lack of flexibility is attributable, in part, to differences in processing speed (Duverne & Lemaire, 2005). However, the reduced flexibility of older adults' strategies to conditions of the problem does not extend to subtraction, where overlearned facts may preserve the ability to flexibly adapt strategies (Arnaud, Lamaire, Allen, & Michel, 2008).

Summary. Across early childhood through late adulthood, individuals use a variety of strategies to solve arithmetic and multiplication problems and they adapt those strategies to fit the constraints of the problem. Age differences are seen in the frequency of retrieval strategies—use of these strategies increases across the life span. Some age differences exist in the ability of individuals to adapt their strategies to fit problem characteristics, with older adults being less flexible. Although researchers typically constrain the goal and definition of the task by asking participants to perform a specific operation often with a specific strategy (e.g., use a rounding-up strategy), individuals at all ages are able to change their strategies in response to goals (e.g., instructions to be more accurate elicit greater back-up strategies such as counting versus instructions to be faster in completing problems elicit more retrieval strategies).

Ill-Structured Problems

In contrast to well-structured problems, ill-structured problems are ones where there are multiple ways to interpret or define the problem and the problems have multiple correct or "good enough" solutions. Such problems are often examined in research on everyday problem solving and social problem solving. Everyday and social problems are problems people encounter on a regular daily basis and are characterized by multiple features (Berg, Skinner, & Ko, 2009; Blanchard-Fields, 2007): (1) they can occur over an extended time frame (e.g., weeks versus the minutes that often characterize well-structured problems), (2) occur in a rich interpersonal context where others may be not only part of the problem but also used for the solution, and (3) explicitly include emotion regulation as part of the problem-solving process. Everyday problems can include both well-structured problems (e.g., how to double a recipe, how much medication to take based on a prescription label) as well as ill-structured ones (e.g., how to get expensive repairs covered by your landlord, how to solve a computer problem at work). We review the work on everyday problem

solving and then the literature on social problem solving separately, noting points of overlap between these two literatures.

Everyday Problem Solving

The field of everyday problem solving largely arose within the field of aging as contextualist approaches to intelligence (Baltes et al., 1984) pointed to the changing contexts of intelligence across adulthood from one initially in late adolescence focused within the school context to one that includes adaptation to a variety of contexts (e.g., work, family, and health). Accordingly, there is little research in the field of everyday problem solving present for children younger than early adolescence. However, work within the field of stress and coping examines daily hassles that are similar in content to the types of problems examined in the everyday problem-solving field; the coping responses examined are similar to the problem-solving strategies examined (Seiffge-Krenke, Aunola, & Nurmi, 2009). Both literatures frequently assess problem solving by either presenting individuals with hypothetical everyday problems or stressors or by having individuals describe problems or stressors that they have recently experienced. Thus, we incorporate this work when examining work on everyday problem solving in childhood. In the following section, we review research highlighting some of the key issues addressed within the everyday problem-solving literature over the past decades.

Relation Between Performance on Well-Structured Everyday Problems, Ill-Structured Everyday Problems, and Real-World Adaptation. One important question within the everyday problem-solving literature is whether performance on "well-structured" problems predicts performance on "ill-structured" problems. Allaire and Marsiske (1999, 2002) devised ill-structured everyday analogues of well-structured inductive reasoning, knowledge, declarative memory, and working memory problems. Correlations between the everyday analogues and well-structured problems ranged depending on the specific measure (*rs* = .13 to .58); correlations between two metrics of performance on ill-structured problems were relatively low (*r* = .19). Performance on both the ill-structured and well-structured measures contributed to performance on a measure of Instrumental Activities of Daily Living (a measure of the ability to function and complete activities independently in one's environment). These results illustrate the distinctiveness of the measures and suggest that these two dimensions of everyday problem solving are both important for real-world adaptation.

Age-Related Differences in Problem Solving. One metric used to examine age-related differences in everyday problem solving is the number of strategies a person generates when presented with a hypothetical problem (Denney, 1989; Shure & Aberson, 2006). Preschool children who generate more strategies to a problem have higher ego resilience (Arend, Gove, & Sroufe, 1979). Meta-analytic reviews indicate that older adults generate fewer strategies than do younger adults (Thornton & Dumke, 2005), even when problems are designed to be most familiar to older adults (Denney & Pearce, 1989) and when adults are instructed to mention as many strategies as possible (Berg, Meegan, & Klaczynski, 1999; Denney, Tozier, &

Scholtthauer, 1992). These findings have been interpreted to mean that everyday problem solving peaks in midlife (Denney, 1989). However, Berg et al. (1999) found that the smaller number of strategies generated by older adults may reflect their greater experience with everyday problems. Age differences in strategy generation may also be due to the extent to which older adults view generated strategies as effective (Strough, McFall, Flinn, & Schuller, 2008) and their perceived efficacy to solve problems (Artistico, Cervone, & Pezzuti, 2003).

Research has also examined age-related trends in the ability to generate strategies that focus not only on solving the problem but also dealing with emotions and cognitively reappraising the problem to fit better with one's goals and problem-solving capabilities. One benefit to the availability of multiple types of strategies is that if one type fails, other strategies will be available. Spivack and Shure (1982) found that more socially adjusted children were able to generate a greater variety of strategies. Preschool children move from a near exclusive focus on problem-focused strategies to a greater combined use of emotion-focused and cognitive problem analysis (Band & Weisz, 1988). During adolescence, both cognitive and problem-focused strategies increase in frequency with most of the developmental change being situation specific (Seiffge-Krenke et al., 2009). Older adults, compared with younger adults, prefer a mixture of strategies that focus on both addressing the problem as well as regulating one's distressing emotions (Birditt, Fingerman, & Almeida, 2005; Blanchard-Fields, Chen, & Norris, 1997; Blanchard-Fields, Jahnke, & Camp, 1995; Blanchard-Fields, Mienaltowski & Seay, 2007; Watson & Blanchard-Fields, 1998).

Findings regarding age differences in the types of strategies individuals endorse have been interpreted as indicating age-related improvements in everyday problem-solving performance (Blanchard-Fields, 2007), especially for interpersonal problems (as we discuss in more detail in a later section). Because multiple strategies may be effective, measuring the quality of strategies is one challenge that everyday problem solving researchers must face. Strategy quality has been defined as the correlation between individuals' endorsement or generation of strategies and expert judges' ratings of strategy effectiveness (Berg, 1989; Blanchard-Fields et al., 2007; Cornelius & Caspi, 1987), as well as by experts' assessments of strategy effectiveness (Allaire & Marsiske, 2002), researchers' judgments of strategy safety and effectiveness (Denney, 1989), and individuals' perceptions of their strategy effectiveness (Berg et al., 1999). Although few studies compare different methods of assessing strategy quality (cf. Allaire & Marsiske, 2002), different conclusions regarding age trajectories in everyday problem-solving strategies emerge depending on the way in which strategy effectiveness is measured (see Berg et al., 2009 for a review). Older adults typically outperform young adults when their responses are compared to expert judges' responses (Blanchard-Fields et al., 2007; Cornelius & Caspi, 1987) whereas older adults perform worse when the number of strategies is used as the performance metric because they do not generate as many strategies as younger adults (Thornton & Dumke, 2005).

Contextual Specificity of Strategy Selection Across Age. Consistent with the literature investigating well-structured problem solving, the question of age-related differences in the ability of individuals to adapt their strategies to particular features of problems has been of interest. Across childhood and adolescence, individuals show

increases in the context specificity of problem-solving strategies (Berg, 1989). Across adulthood, older adults' strategies appear to be more sensitive than those of younger adults to the domain in which a problem is presented (e.g., home, friends, finances), especially when hypothetical problems are used and individuals rate lists of strategies (e.g., Blanchard-Fields et al., 1997). Thus, in contrast to research investigating performance on well-defined problems, older adults may be more likely to adapt their strategies to fit constraints and conditions of the problem.

Summary. The everyday problem-solving literature portrays a different view of problem-solving capabilities across the life span than that depicted by the literature on well-structured arithmetic problems. Age differences are found with respect to the number of strategies individuals generate in response to hypothetical everyday problems with individuals during middle-age able to generate the most strategies. However, the diversity of strategies generated and the ability to fit strategies to conditions of problems may increase throughout the life span. In the everyday problem-solving literature, instrumental problems (dealing with problems at work, school, technology, finances) often are contrasted with more social problems (conflicts with family or friends). We now review research on social problem solving.

Social Problem Solving

Our definition of social problem solving aligns with the conceptualization offered by D'Zurilla, Nezu, and Maydeu-Olivares (2004) as problem solving that occurs in the "real world." Social or interpersonal problems are frequently viewed as a subset of everyday problem solving in the adult development literature (Berg et al., 2009). In everyday life, interpersonal problems may occur in numerous relationships (family, friends, romantic partners, coworkers, acquaintances) and others may not only be the problem but are also often available to the individual as a means of solving the problem (e.g., Berg, Smith et al., 2007; Strough & Margrett, 2002).

To understand the development of social problem solving, we draw from four literatures, each of which investigates the problem-solving process within specific age groups. First, we examine infants' behavioral regulation strategies in response to mild stressors to provide insight as to the early origins of problem solving within a social context. Second, we consider research addressing associations among social information processing and social competence (e.g., Crick & Dodge, 1994). Third, we use research examining the development of conflict resolution skills across childhood and adolescence (see Laursen, Finkelstein, Townsend Betts, 2001; Newcomb & Bagwell, 1995 for reviews) as a demonstration of the intraindividual differences in strategies that occur across development and across relationship contexts. Fourth, we draw from research examining interpersonal everyday problem solving (see Blanchard-Fields, 2007; Thornton & Dumke, 2005 for reviews) to consider adult age differences in problem definitions, goals, and strategies.

Emotion Regulation Strategies in Infancy and Toddlerhood. Young infants are faced with problems and experience distress in response to frustrating events, many of which reflect their dependency and the control others have over their environment. Researchers have used mothers' reports of their infants' behavior in response to

frustration as well as a variety of laboratory-based observational tasks to mimic the problems infants face. Such tasks include preventing access to a desirable toy (Crockenberg & Leerkes, 2004), removing a toy (Stifter & Braungart, 1995), restraint of movement (Little & Carter, 2005), maternal separation or unavailability (Ross & Karraker, 1999), and Ainsworth and Bell's (1970) Strange Situation (Diener, Mangelsdorf, McHale, & Frosch, 2002). Together, such studies suggest a developmental progression in that younger infants are more likely than toddlers to use self-soothing behaviors and seek proximity to their mothers, whereas toddlers are relatively more likely to use self-distraction and to employ problem-focused strategies (Karraker, Lake, & Parry, 1994).

Both individual and intraindividual differences are apparent in infancy. Some individual difference characteristics linked to infants' emotion regulation strategies include attachment classification (Diener et al., 2002), temperament (Rothbart, Posner, & Kieras, 2006), and visual attention skills (Morales, Mundy, Crowson, Neal, & Delgado, 2005). Intraindividual differences in strategies are found across situations (Miller, McDonough, Rosenblum, & Sameroff, 2002) and across transient states such as degree of infant fatigue (Ross & Karraker, 1999). Early emotion regulation skills may be linked to later social competence in childhood (Eisenberg et al., 1995; Sallquist et al., 2009).

Social Information Processing. Dodge, Pettit, McClaskey, and Brown (1986) developed naturalistic observations and staged peer group entry and provocation situations to examine children's social information processing. Children's self-reports of their problem interpretations and strategy selection were gathered after children watched videos of peer group entry (joining a game) and ambiguous provocation (one child knocks over a tower of blocks built by another child). Written and auditory vignettes describing hypothetical situations have also been used to assess social information processing and strategy selection (see de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002 for a review), with the content tailored to reflect developmental tasks and contexts of the age group under investigation (e.g., Nas, de Castro, & Koops, 2005; Pettit, Lansford, Malone, Dodge, & Bates, 2010). Teacher report, mother report, peer report (sociometric techniques), and self-report have been used to assess externalizing behaviors (Dodge et al., 1986; Pettit et al., 2010).

Dodge and colleagues' (1986) early research provided a compelling demonstration of links between social information-processing deficits (encoding, interpretation, search and evaluation of potential strategies) and social behavior (enactment of aggressive strategies). A large number of studies now document a link between boys' hostile attributions of other's intent in ambiguous situations and their aggressive behavior (de Castro et al., 2002). Effect sizes are largest when staged provocations are used to assess aggressive strategies and larger when vignettes are presented via audio rather than by actors in videos presumably because watching an actor changes the child's perspective to that of an observer, making it more difficult for the child to imagine the situation happening to them (de Castro et al., 2002). When a greater number of steps of information processing are deficient, the risk of externalizing behavior increases (Lansford et al., 2006). Accordingly, information-processing deficits are considered a proximal process in understanding why more distal individual differences (e.g., gender, race, temperament) are associated with variation in social behavior.

In regards to developmental trajectories, Lansford et al. (2006) found within-person continuity in the number of social information-processing deficits (i.e., encoding cues, making attributions, generating responses, selecting responses) from early to later adolescence (8th to 11th grade), but little continuity from elementary school to adolescence. Moreover, the relation between concurrent information-processing deficits and externalizing behavior became stronger with age through late adolescence, perhaps reflecting that the link between social cognition and behavior becomes stronger with age.

Similar to the framework that guides this Chapter, a central tenet of the social-information processing model (Crick & Dodge, 1994; Dodge, 1986) is the situational or contextual specificity of the problem-solving process. Early work indicated that deficits in social information processing were specific to the situation (e.g., peer entry or provocation). That is, children displayed competence in some settings but not others (Dodge et al., 1986). Recent longitudinal research has examined whether social information-processing deficits within one relationship domain (i.e., peers) predict social deficits (externalizing behavior) across domains (Pettit et al., 2010). Violence in peer relationships shows some evidence of domain specificity, whereas violence in romantic relationships does not.

Research guided by Dodge and colleagues' social information-processing model (Crick & Dodge, 1994; Dodge, 1986) continues to advance our understanding of the cognitive processes underlying social competence. Deficits in social competence are associated with defining ambiguous situations in a more hostile manner and using more aggressive strategies. However, social information processing in one domain does not necessarily translate into other domains nor is there extensive continuity in processing from young childhood through adolescence. Social information-processing deficits of the type examined by Dodge have not been examined in the adult development and aging literature. However, work on hostile personality traits across development does suggest some continuity in hostility in children's temperament from early childhood through adolescence (Raiikkonen, Katainen, Keskivaara, & Keltikangas-Jarvinen 2000) and through young adulthood (Keltikangas-Jarvinen & Heinonen, 2003), which might be suggestive of some continuity in at least some social information processes. One step in Crick and Dodge's (1994) model that has received relatively less emphasis is the step corresponding to clarification of goals. However, the literature on conflict management strategies (reviewed next) suggests that goals are a key element of the problem-solving process.

Conflict Management Strategies Across Childhood, Adolescence, and Early Adulthood. Studies investigating the development of social problem solving in childhood and adolescence focus on strategies used for solving interpersonal conflicts with friends. Learning how to successfully manage interpersonal conflict with peers becomes increasingly important during adolescence, consistent with the high salience of friends during adolescence (Shantz & Hartup, 1992) as well as emerging adulthood (Arnett, 2000). Friends' relative equivalence of status and power are thought to create a context where children learn to use compromise and negotiation strategies to balance self-interest with the interests of others, strategies that are then applied to other relationships later in life such as romantic relationships (Buhrmester, 1996). The voluntary nature of friendships is presumed to promote goals for maintaining the relationship and strategies that serve this goal.

Age-related differences in strategies for resolving actual and hypothetical conflicts are evident when comparing self-reported and observer-reported strategy use across childhood, adolescence, and early adulthood. Based on narrative and meta-analytic reviews of the literature Laursen and colleagues (Laursen & Collins, 1994; Laursen et al., 2001) conclude that coercive strategies (i.e., verbal or physical aggression, commands) decrease across childhood, adolescence, and early adulthood. Among children, coercion is more likely to be employed in actual conflicts than would be expected based on children's endorsement of this strategy when presented with a hypothetical conflict. Thus, hypothetical conflicts may be a less powerful method of detecting age-related decreases in coercive conflict management strategies than actual conflicts. Age-related decreases in coercive strategies could reflect that individuals learn contingencies associated with the use of such strategies in childhood—hostile, coercive strategies result in fewer friends (Rose & Asher, 1999). Importantly, coercive strategies do not completely disappear from individuals' problem-solving repertoires with age. In conflicts with siblings, use of coercive strategies remains stable from childhood through early adulthood reflecting that sibling relationships are obligatory relationships (Laursen et al., 2001).

Negotiation strategies (i.e., talking things out, compromising) increase from childhood through adulthood (Laursen et al., 2001). During adolescence there appears to be a gap between competence (endorsing these strategies when presented with a hypothetical conflict) and performance (using compromise strategies in actual conflicts; Laursen & Collins, 1994). Accordingly, methods that rely upon hypothetical conflicts may provide an inflated estimate of the extent to which adolescents resolve conflicts via negotiation. The competence performance gap in negotiation strategies appears to narrow in early adulthood (Laursen et al., 2001).

Negotiation strategies vary not only according to age but also according to the nature of the interpersonal relationship (Laursen et al., 2001) and individual difference characteristics such as gender (Rose & Rudolph, 2006). Negotiation is more common in conflicts with romantic partners than with friends and is more common in conflicts with friends than acquaintances. On an average, girls are more likely than boys to endorse prosocial strategies such as negotiation.

The differential prevalence of negotiation strategies across relationships is assumed to reflect differences in goals for maintaining these relationships. Specifically, individuals are presumed to have goals for maintaining affiliative ties with friends and romantic partners; such ties are absent in acquaintances (Laursen et al., 2001). Individual differences in the use of negotiation strategies may reflect differences in goals (affiliative goals for relationships may be associated with more negotiation and compromise strategies; Rose & Asher, 1999).

In turn, individual differences in goals may arise from interpretations of features of the situation (e.g., the sex of the person with whom one interacts, the nature of the relationship). For example, intraindividual variability in young men's and women's goals corresponds to whether they interact with a confederate of the same- or other-sex (Pickard & Strough, 2003). Children's self-reported goals vary depending on relationships with specific same-sex classmates (Salmivalli & Peets, 2009) and whether vignettes portray a hypothetical conflict, victimization by peers, or a more benign social interaction (Ojanen, Aunola, & Salmivalli, 2007). Adolescent girls' relatively greater endorsement of negotiation strategies with romantic partners (Feldman &

Gowen, 1998) and their use of prosocial strategies more generally (Rose & Rudolph, 2006) may reflect their participation and socialization within contemporary American culture which views such behaviors as more typical of girls and women (Liben & Bigler, 2002). Thus, goals appear to be a proximal process useful in understanding the variation in social behavior that is often associated with more distal individual difference characteristics such as gender.

In addition to age-related increases in negotiation strategies from childhood through early adulthood, endorsement of passive/avoidant strategies such as withdrawing or disengaging from the conflict also increase as adolescents learn to walk away from conflict (Laursen et al., 2001). Children rarely use this strategy and are more likely to rely on coercion. Individual differences in endorsement of avoidant strategies also are found. Asian-American adolescents are relatively more likely than European-American adolescents to endorse avoidance as a strategy for managing conflict with romantic partners, perhaps as a reflection of exposure to eastern cultural values that emphasize interpersonal harmony (e.g., Feldman & Gowan, 1998).

In sum, research that compares children's, adolescents', and young adults' strategies for managing conflict indicates contextual and individual differences in strategy use. Researchers often suggest that differences in strategies for managing conflict reflect differences in goals. In turn, goals are theorized to correspond to distinguishing characteristics of relationships such as whether the relationship is voluntary or obligatory. Although explanations of strategy variability are often attributed to variability in goals, goals are rarely measured within the literature on conflict management. The utility of investigating links between goals and strategies is evident in research examining social problem solving in adulthood (reviewed next).

Goals and Strategies in Early and Later Adulthood. Within the adult development and aging literature, links between problem-solving strategies and goals are addressed. In line with a contextual approach, some of these studies compare age differences in problem-solving strategies as a function of the problem context such as whether the problem consists of a conflict with a family member or friend, or occurs at work or at school (e.g., Berg, Strough, Calderone, Sansone & Weir, 1998; Cornelius & Caspi, 1987). Researchers use hypothetical problems and either ratings of strategies (e.g., Blanchard-Fields et al., 2007) or strategy generation (e.g., Strough et al., 2008), or ask individuals to describe problems they experienced in their everyday lives and the strategies they used (e.g., Berg et al., 1998).

A handful of studies investigate problem-solving goals and include adolescents, young, middle-aged, and older adults within the same cross-sectional study (Berg et al., 1998; Blanchard-Fields, 1986; Hoppmann et al., 2008; Strough, Berg, & Sansone, 1996). These studies frequently contrast more instrumental domains (e.g., finances, health, and work) with interpersonal domains (e.g., family, friends). When people describe goals for solving their instrumental and interpersonal problems, they often report problem-solving goals that are consistent with developmental tasks (Hoppmann et al., 2008; Strough et al., 1996). For example, Strough et al. (1996) found that preadolescents' problem-solving goals were more likely than those of adults to reflect concerns about task improvement—in accord with developmental tasks pertaining to achieving mastery and competence during this developmental period (Veroff & Veroff, 1980). Hoppmann and colleagues found that adolescents and younger adults

had the highest proportion of autonomy goals, in accord with their independence tasks (Collins & Steinberg, 2006); whereas older adults had the highest probability of generativity goals, in line with developmental tasks of later life (Erikson, 1968; Lang & Carstensen, 2002). These findings demonstrate how individuals' larger developmental tasks may be reflected in their problem-solving goals.

In addition to the correspondence between goals and developmental tasks, the fit or match between goals and strategies has been more thoroughly investigated within the adult development and aging literature. For example, among older adults who recalled a negative social exchange they had experienced (e.g., receiving unwanted advice), strategies that entailed asserting one's point of view by arguing (conceptually akin to the "coercion" strategy examined in the conflict management literature) were relatively more frequent when the goal was to change the behavior of a partner than when attempting to maintain a harmonious relationship (Sorkin & Rook, 2006). Cognitive distancing (an avoidant strategy) was more frequent when the goal was to maintain the relationship than when the goal was to change the other person. Although the content of goals may differ by age, research indicates that the fit or match between strategies and goals is similar across age groups (Berg, et al., 1998; Hoppmann et al., 2008).

Not only is there some evidence within the adult development and aging literature that goals are systematically related to strategies, but there is also evidence to suggest that goals are useful in understanding the interplay of age and context in strategy selection. For example, in independent studies, Berg et al. (1998) and Hoppmann et al. (2008) each found that goals were a more precise predictor of the strategies individuals reported they used to solve their own everyday problems than the specific context (health, family, friends, finances, work) in which the problem occurred. Berg and colleagues' findings also suggested that the utility of goals over problem context for understanding strategies was more apparent when individuals were directed to describe a problem that had occurred within a specific domain (e.g., family or work) than when individuals were free to select a problem from any domain, perhaps reflecting that domains elicit specific cues regarding goals.

Related to the fit between goals and strategies, there is a growing interest in older adults' goals for avoiding social problems (Charles et al., 2009; Sorkin & Rook, 2006), because of their greater interest in preserving positive emotional affect and close relationship ties (Carstensen & Mikels, 2005; Charles & Carstensen, 2010). Older adults may be better able to solve emotionally salient interpersonal problems (Blanchard-Fields, 2007), in part, because they prioritize emotion regulation goals and may have a decreased tendency to express emotions such as anger (Blanchard-Fields & Coats, 2008; Coats & Blanchard-Fields, 2008). Further, older adults may experience less emotional arousal by engaging more in anticipatory efforts to avoid social problems, but may actually experience greater affective reactivity if their attempts to avoid social problems are unsuccessful (Charles et al., 2009).

Summary. The literature examining social problem solving as it pertains to social competence, conflict management, and negotiation strategies among friends and romantic partners reveals that strategies vary as a function of contexts, goals, and individual difference characteristics (e.g., gender). Age differences in strategies reveal a drop in coercive and aggressive strategies and an increase in negotiation and other

affiliative strategies. Older adults may be especially adept at resolving interpersonal conflicts, in part, because of their greater skill at regulating emotions and anticipating and avoiding problems before they occur. Although the interpersonal problem-solving literature examines abilities to resolve interpersonal conflict, the focus has been on how an "individual" solves these problems. We next turn to a review of the collaborative problem-solving literature that addresses how individuals may solve problems in conjunction with another individual.

Collaborative Problem Solving

Research on collaborative problem solving investigates how individuals work together to solve problems that are both well- and ill-structured (Gauvain, 2001; Martin & Wight, 2008; Meegan & Berg, 2002; Rogoff, 1998; Strough & Margrett, 2002). Research on children's collaboration was initiated within the Piagetian and sociocultural views of cognition to understand how adults (e.g., parents, teachers) and peers can scaffold children's performance to optimize their problem solving or spur shifts in children's thinking (see Gauvain & Reynolds, Chapter 11; Rogoff, 1998). Research on adults' collaboration was initiated to understand how adults working together might compensate for individual performance deficits seen in normal aging as well as optimize performance (Baltes & Staudinger, 1996; Dixon & Gould, 1996).

We illustrate the findings in this field by focusing on well- and ill-structured problem-solving tasks (e.g., scientific problem solving, planning tasks, and everyday problems). Three types of designs are frequently used to examine collaboration: (1) explicit comparisons of collaborative performance and individual performance (e.g., Gauvain & Rogoff, 1989; Margrett & Marsiske, 2002), (2) comparing individual differences in collaborative performance across age (e.g., Berg, Smith et al., 2007; Cheng & Strough, 2004; Dixon & Gould, 1998), relationship status of dyads (Margrett & Marsiske, 2002), or interactive communication within the collaborative session (Berg, Johnson, Meegan, & Strough, 2003; Berg, Smith et al., 2007), and (3) comparing the performance of interacting pairs to their dyadic potential as indexed by the combined performance of two individuals who do not interact (the "nominal" pair design, Johansson, Andersson, & Ronnberg, 2000; Strough et al., 2008). The general conclusion from this body of work is that collaborative units can, under certain circumstances, yield better performance than individuals on their own. Collaboration allows individuals to access knowledge and memories that they cannot do independently and thereby boosts performance. Working together, especially within close relationships, may provide individuals with access to a transactive memory or shared knowledge system (see shaded portion of Figure 10.1) that goes beyond the memory and knowledge of either individual (Wegner, Erber, & Raymond, 1991), allowing individuals to cue each other regarding effective strategies and stored memories.

Although much of the literature assumes that collaborators' primary goal is task performance, collaboration involves the coordination of task as well as social demands (Strough, Berg, & Meegan, 2001). However, because collaborative settings also contain social demands, goals may focus on mutual participation (e.g., ensuring consideration of both partners' ideas, making partners feel good about their ideas and getting along) versus controlling the interaction (e.g., getting the partner to pay attention to one's own ideas). Consistent with the framework outlined in Figure 10.1, goals

relate to strategies that are used to work with others (interactive strategies involving warm affiliation versus control; Berg, Smith et al., 2007; Kimbler & Margrett, 2009; Strough & Berg, 2000). For instance, when preadolescent classmates were focused on mutual participation goals they employed conversation strategies that were more affiliative in nature (Strough & Berg, 2000). Further, goals mediated the stereotypical gender difference in girls' greater use of affiliative strategies relative to boys (see Rose & Rudolph, 2006 for a comprehensive review of gender differences in strategies for peer interaction).

Children and adolescents use more sophisticated strategies when they interact with adults rather than peers, although peers can be effective under certain circumstances. The enhanced effect of working with adults is that children are able to access their own knowledge that they cannot access alone or use the knowledge and skills of the adult partner (akin to Vygotsky's, 1978, zone of proximal development). For children during the early school years (ages 5–9 years) working on an errand planning task, the greater benefit from collaboration with adults was more pronounced for older children (Radziszewska & Rogoff, 1991). With adults, children engaged in more sophisticated strategies such as moves that involved advance planning (rather than one-step moves) and also engaged in discussions about strategy effectiveness.

Working with a peer on well-structured tasks such as the balance scale task (Tudge, Winterhoff, & Hogan, 1996) or replicating a Lego model (Azmitia, 1992) can be effective if the peer is more competent (Tudge et al., 1996), perhaps due to observation and learning of expert peers' strategies (Azmitia, 1992). Further, collaborative performance is enhanced when preadolescents enter peer collaborative settings with greater expectations concerning enjoyment and affiliation (Strough, Swenson, & Cheng, 2001), which are more likely to occur in same-sex dyads and among classmates with greater friendship. Among young adolescents, peer collaboration can be beneficial when tasks are difficult (Azmitia & Montgomery, 1993), perhaps because greater friendship of collaborators reduces the salience of social problem definitions (Strough et al., 2001) and interpersonal conflict (Swenson & Strough, 2008).

During adulthood, collaboration can be beneficial especially where collaborative partners are familiar, which allows partners to engage in high-level interactive strategies that benefit task performance. Cheng and Strough (2004) found that pairs of same-sex friends outperformed individuals on a composite measure of collaborative performance and made fewer planning mistakes. Kimbler and Margrett (2009) found that the benefit of collaboration was more pronounced among married couples than unacquainted pairs. This enhanced effect for married couples may be due to greater use of shared knowledge or transactive memory in couples (Johansson et al., 2000) and less frequent socializing (Kimbler & Margrett, 2009). Socializing "getting to know you" interactions are more prevalent among unacquainted partners compared to married couples (see also Gould, Kurzman, & Dixon, 1994). The collaborative task performance of married couples is enhanced when dyads interact in ways that are warm and affiliative (Berg et al., 2003) as well as involve "teaching" or "tutoring" episodes (Kimbler & Margrett, 2009). Further, collaborative performance is enhanced when couples adjust the way that they control the task direction as a function of their own and their partner's cognitive abilities (e.g., the more cognitively capable member controls task direction, Berg, Smith et al., 2007).

When a nominal pairs design is used to compare collaborating pairs' performance with their dyadic potential, social interaction may appear to be detrimental,

to have no effect, or to be beneficial, depending on the performance metric and qualities of the dyadic relationship (Martin & Wight, 2008). Dyadic potential is indexed by the pooled performance of two people who do not interact, pairs "in name only" (nominal pairs). Strough et al. (2008) found that interacting pairs produced fewer strategies to everyday problems (a measure of fluency of everyday problem-solving performance) than nominal pairs, but there were no differences in the types of strategies generated. Similarly, on more well-structured memory tasks, interacting pairs do not achieve their dyadic potential—interacting pairs remember fewer items than nominal pairs (Johansson et al., 2000), except in the case where older married couples are able to access a transactive memory system. Older married dyads show their collaborative expertise on difficult problem-solving tasks that require the coordination of complex reasoning and memory (Peter-Wight & Martin, in press).

Although much of the research has focused on collaboration within the confines of the laboratory, where pairs were explicitly instructed to work together, there is extensive interest in how naturally occurring pairs and groups may work together in everyday life (Berg, Wiebe et al., 2007; Rogoff, 1998). During the school years, people may choose to work together to complete homework assignments or study for exams. In addition, group projects that require students to work with classmates to complete an assignment are frequently used in elementary, middle, and high school as well as in college. In adulthood, collaboration may be required in some contexts such as at work where teams or committees complete assignments together. Diversity in the contexts in which problems occur and individuals' assessments of their abilities to meet the challenges presented by a given context may be important for understanding the conditions under which collaboration voluntarily occurs in everyday life. In general, people report that they use and prefer self-directed action strategies that focus on solving the problem directly (Berg et al., 1998; Blanchard-Fields et al., 2007). However, when older adults perceive limitations in their own problem-solving abilities in gender-stereotyped contexts, they prefer solving problems collaboratively rather than alone (Strough, Cheng, & Swenson, 2002). For example, older women prefer to solve problems involving household repair collaboratively; whereas men prefer to solve problems with meal preparation collaboratively. Thus, older adults appear to prefer to collaborate when collaboration facilitates compensation. Other features of the problem context such as the greater severity of problems (Strough, McFall, & Schuller, 2010) and the availability of preferred partners such as spouses (among those who are married, Strough, Patrick, Swenson, Cheng, & Barnes, 2003) also may facilitate the occurrence of collaborative everyday problem solving.

In sum, the old adage that "two heads are better than one" appears to hold true in some situations—where children work with partners who are more expert than themselves and when adults work with a familiar partner compared to working alone or with a stranger. There is much left to understand about collaborative problem solving across the life span. Although recent work has emphasized the "social" goals that may be present in the collaborative context, more work is needed to understand how collaborative units coordinate both social and task demands of any given task. Further, although multiple types of relationship partners have been examined in the literature (most especially parent–child, friends, spouses), other existing natural collaborators (most especially siblings and adult child–parent relationships) should be examined to understand the contextual conditions of collaborative problem solving.

FUTURE ISSUES IN THE STUDY OF PROBLEM SOLVING ACROSS THE LIFE SPAN

In this chapter, we reviewed a large body of research that examines problem solving across the life span in both well- and ill-structured domains. Age-related differences appear in many aspects of the problem-solving framework guiding this work: in the ways that individuals define their problems, set goals, the strategies that are used, and the regulation of affect. From early in the life span through middle-adulthood, the picture of what develops across the life span is one of increasing adaptivity and fit of strategies to specific problem-solving conditions and the goals that individuals wish to accomplish. In later adulthood for well-structured problems there is some suggestion of an age-related decrease in the fit between older adults' strategies and the constraints of problems. However, in the ill-structured domain of solving interpersonal problems, compared to younger adults, older adults' strategies appear to fit better with the demands of such problems, which may reflect goals for maintaining personally meaningful relationships and their ability to regulate emotions and mute expression of some emotions. Although we considered a variety of ill- and well-structured problems, there are important domains of problem solving that we did not cover (e.g., problem solving in the domains of health, family interaction and conflict), as work in these areas has not explicitly measured aspects of problem-solving performance. However, the field will benefit by an integration of these related fields. In the following section, we consider two broad directions for future research on problem solving across the life span.

Link Between Problem-Solving Capabilities and Relevant Real-World Adaptation

The definition of problem solving we used emphasizes the process whereby individuals overcome obstacles to goal-directed behavior and adapt to the environment. Our definition makes it crucial to understand how successful problem solving relates to successful adaptation to changing contexts across the life span. Our framework posits that problem solving within certain contexts will be differentially important for predicting adaptation at different points during the life span. Yet, the literature is mostly silent on the link between problem solving and adaptation to relevant environments across age. For instance, given our framework one would predict that problem solving couched in the school context would be less predictive of adaptation for older adults than for school-aged children. This assertion is difficult to assess with the current literature as few studies use similar tasks across the life span and we are aware of no studies that examine problem solving across multiple age periods and at the same time include broad-based measures of adaptation. Even within the confines of a specific problem-solving task such as mental arithmetic, we do not know whether differences in the adaptivity of strategy selection of older adults in response to problem parameters translates into their poorer mathematics performance (a relevant measure of adaptation in the school context) or more broadly their ability to use mathematics in everyday life (e.g., at the grocery store in comparing unit prices, see Lave, 1989). Although some research does include more broad-based measures of adaptation to real-world contexts (e.g., Allaire & Marsiske's, 2002 use of the instrumental activities of daily living, a measure of independent functioning in late

FUTURE ISSUES IN THE STUDY OF PROBLEM SOLVING ACROSS THE LIFE SPAN

In this chapter, we reviewed a large body of research that examines problem solving across the life span in both well- and ill-structured domains. Age-related differences appear in many aspects of the problem-solving framework guiding this work: in the ways that individuals define their problems, set goals, the strategies that are used, and the regulation of affect. From early in the life span through middle-adulthood, the picture of what develops across the life span is one of increasing adaptivity and fit of strategies to specific problem-solving conditions and the goals that individuals wish to accomplish. In later adulthood for well-structured problems there is some suggestion of an age-related decrease in the fit between older adults' strategies and the constraints of problems. However, in the ill-structured domain of solving interpersonal problems, compared to younger adults, older adults' strategies appear to fit better with the demands of such problems, which may reflect goals for maintaining personally meaningful relationships and their ability to regulate emotions and mute expression of some emotions. Although we considered a variety of ill- and well-structured problems, there are important domains of problem solving that we did not cover (e.g., problem solving in the domains of health, family interaction and conflict), as work in these areas has not explicitly measured aspects of problem-solving performance. However, the field will benefit by an integration of these related fields. In the following section, we consider two broad directions for future research on problem solving across the life span.

Link Between Problem-Solving Capabilities and Relevant Real-World Adaptation

The definition of problem solving we used emphasizes the process whereby individuals overcome obstacles to goal-directed behavior and adapt to the environment. Our definition makes it crucial to understand how successful problem solving relates to successful adaptation to changing contexts across the life span. Our framework posits that problem solving within certain contexts will be differentially important for predicting adaptation at different points during the life span. Yet, the literature is mostly silent on the link between problem solving and adaptation to relevant environments across age. For instance, given our framework one would predict that problem solving couched in the school context would be less predictive of adaptation for older adults than for school-aged children. This assertion is difficult to assess with the current literature as few studies use similar tasks across the life span and we are aware of no studies that examine problem solving across multiple age periods and at the same time include broad-based measures of adaptation. Even within the confines of a specific problem-solving task such as mental arithmetic, we do not know whether differences in the adaptivity of strategy selection of older adults in response to problem parameters translates into their poorer mathematics performance (a relevant measure of adaptation in the school context) or more broadly their ability to use mathematics in everyday life (e.g., at the grocery store in comparing unit prices, see Lave, 1989). Although some research does include more broad-based measures of adaptation to real-world contexts (e.g., Allaire & Marsiske's, 2002 use of the instrumental activities of daily living, a measure of independent functioning in late

life; Dodge's work linking social information processing to social competence), such work typically focuses on only one age group. Addressing the question of whether measures of problem solving are equally relevant for measures of adaptation across the life span will require the development of valid measures of successful adaptation, a task that in itself is a significant undertaking.

One issue important for understanding the development of problem solving across the life span pertains to transitions to and from the contexts most prevalent during a particular age period. What are the consequences of success (or failure) in solving problems that emerge within one developmental context for the success or failure in dealing with the demands of the contexts one encounters later in life? That this question has received relatively little attention within the extant literature is surprising given that one of the earliest theories of life-span human development (Erikson, 1968) highlighted key developmental competencies associated with distinct age periods. Of the research we have reviewed, the research conducted by Dodge, Pettit, and their colleagues comes closest by examining how success or failure with one important task of childhood, acceptance or rejection within the peer group, relates to interpersonal relationships in adulthood. Such work is important in understanding the rigidity or plasticity of developmental trajectories of problem solving and is necessary to advance understanding of what develops in problem solving across the life span.

Mechanisms of Developmental Change

Researchers have begun to address the mechanisms that underlie developmental differences in aspects of the problem-solving process. Such mechanisms may be different for well-structured versus ill-structured problems, although rarely are similar mechanisms examined in these two literatures. For instance, for well-structured problems such as arithmetic problems, one mechanism that may underlie older adults' lower adaptivity of strategies in response to changing problem parameters may be slower processing speed (see Duverne & Lemaire, 2005 for a review). Slower processing speed is a central resource that has been implicated in numerous age differences in cognitive tasks across the life span (Salthouse & Ferrer-Caja, 2003). Across childhood, one mechanism contributing to changes in strategy selection for solving arithmetic problems is thought to be the experience that children have with specific types of problems, especially the experience derived from the school environment (Siegler, 1996).

For ill-structured problems, the mechanisms purported to underlie age differences in strategy selection include emotion regulation skills, greater experience with social situations and contingences, and changes in goals for social problems. The mediating mechanism that has perhaps the greatest evidence for older adults' greater effectiveness in dealing with interpersonal everyday problems is emotion regulation skills (Blanchard-Fields, 2007). Although greater experience has frequently been posited as a factor important for understanding age differences in strategies (Berg et al., 1999; Cornelius & Caspi, 1987), experience is rarely measured in a way that elucidates its role as a mechanism. Researchers have not determined whether the key aspect of experience is the number of times that a person has had a similar problem, global experience or training within the domain (e.g., expertise within a domain like mathematics), or life-long experience such as understanding that confronting one's

partner within a close interpersonal relationship may have greater long-term costs than avoiding conflict.

A better understanding of the role of experience may be gained from applying microgenetic designs to examine problem-solving models across time. These designs have been used extensively for well-structured problems (arithmetic, Siegler, 2006a, 2006b). For instance, examining social problem solving in the context of a new social setting where individuals' ability to manage conflict with others is tracked across time might allow for the examination of multiple mechanisms underlying changes in strategies, goal-strategy fit, context specificity of strategies, and individual differences versus intraindividual variability in problem solving. Comparisons across well- and ill-structured problems within the same domain would also be an important contribution to understanding whether the mechanisms of developmental change vary across these two different types of problems (Allaire & Marsiske, 2002).

CONCLUSIONS

To conclude, from infancy through later adulthood, individuals experience a myriad of both well- and ill-structured problems that they must solve in order to adapt to their daily environments. Individuals implement strategies, either on their own or in collaboration with others, that are in large part fit to their goals and reflect the demands of their larger developmental contexts. Building an understanding of "What Develops?" for problem solving across the life span will require researchers to face a number of challenges. Importantly, researchers will need to move beyond the boundaries of the age period under investigation in any given study to think more broadly about developmental precursors and consequences for later periods of development. Although developmental scientists tend to specialize in an age period (e.g., childhood) a greater appreciation and acknowledgment that development occurs across the entire life span will advance our understanding of "What Develops?" In this review, we brought together what we believe are related areas of inquiry (e.g., social problem solving, conflict management) to address one barrier to understanding the development of problem solving across the life span. By highlighting some of the similarities present in what have traditionally been treated as distinct areas of inquiry, our review provides an initial understanding upon which to build future research on the development of problem solving across the life span. The field is armed with an array of interesting tasks and paradigms and is thus well poised to address what develops in problem solving across the life span.

ACKNOWLEDGMENTS

Preparation of this chapter was supported in part by grant R01 DK063044 from the National Institute of Diabetes and Digestive Kidney Diseases. The authors thank Vito Rontino for his assistance in preparing the figure for this chapter and Joseph McFall and Emily Keener for their comments on a draft of this chapter.