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Decision-making heuristics and biases across the life span

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Abstract

We outline a contextual and motivational model of judgment and decision-making (JDM) biases across the life span. Our model focuses on abilities and skills that correspond to deliberative, experiential, and affective decision-making processes. We review research that addresses links between JDM biases and these processes as represented by individual differences in specific abilities and skills (e.g., fluid and crystallized intelligence, executive functioning, emotion regulation, personality traits). We focus on two JDM biases—the sunk-cost fallacy (SCF) and the framing effect. We trace the developmental trajectory of each bias from preschool through middle childhood, adolescence, early adulthood, and later adulthood. We conclude that life-span developmental trajectories differ depending on the bias investigated. Existing research suggests relative stability in the framing effect across the life span and decreases in the SCF with age, including in later life. We highlight directions for future research on JDM biases across the life span, emphasizing the need for process-oriented research and research that increases our understanding of JDM biases in people's everyday lives.

Keywords

sunk costs; framing effect; dual processes; heuristics; biases

Introduction

Behavioral economists acknowledge that decisions are often irrational and subject to systematic biases.^{1–3} However, they have not addressed whether judgment and decision-making (JDM) heuristics and biases universally characterize decisions across the life span. Most JDM research is based on college students. An understanding of JDM biases based solely on younger adults is incomplete. The frontal lobes of the brain remain immature until the mid-twenties,⁴ and there is substantial plasticity in the aging brain.⁵ Across the life span, people make decisions that affect themselves and other people, and the complexity and frequency of decisions about finances and health care increase in later life.^{6,7} The projected twofold increase in the number of people over age 80 by 2030⁸ creates an urgent need to increase our understanding of JDM biases across the life span.

Although the vast majority of research on JDM biases focuses on college students, JDM biases have been investigated in other age groups. The literature on heuristics and biases in childhood and adolescence is “wide but thin.”⁹ For instance, Klaczynski reviews research on the representativeness heuristic, hindsight bias, correspondence bias, conjunction fallacy,

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Conflicts of interest

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gambler's fallacy, counterfactual thinking, outcome bias, ratio bias, framing effect, and sunk-cost fallacy (SCF).¹⁰ Children's knowledge of stereotypes and use of base rate information have also been investigated.¹¹ Yet, there are less than a handful of studies on each topic. The adult development and aging literature on JDM biases also is thin. Peters and colleagues discuss JDM biases among adults, including the availability heuristic, fundamental attribution error, endowment effect, attraction effect, and framing effect.¹² In addition, the correspondence bias,^{13,14} overconfidence bias,^{15,16} and causal attribution bias¹⁷ have been investigated. Excepting recent research on the hindsight bias,^{18,19} most developmental research focuses either on childhood, adolescence, or later adulthood. Because the full spectrum of life-span development is rarely considered, our understanding of JDM biases across the life span is incomplete. To address this limitation, we review research on JDM biases in childhood, adolescence, and early and later adulthood. We focus on two JDM biases: the SCF and the framing effect. We focus on these two biases because sufficient research exists to consider life-span developmental trajectories.

JDM biases are systematic departures from rationality, not "momentary lapses of reason." The SCF is an irrational economic decision to invest more future resources after a prior investment has been made (costs are sunk) compared to a similar situation without a prior investment.²⁰ For example, if a person watches a boring movie longer after paying \$10.95 to watch that movie (compared to time spent watching that same movie for free), the person demonstrates the SCF. The rational decision is to base decisions on the likelihood of future returns such as the likelihood that the movie will improve, not irretrievable prior investments. All other things being equal, future returns are the same if the movie was paid for or free. The SCF fallacy has implications not only for individuals' decisions about how to invest time and money, but also for businesses' decisions about product development, and government agencies' investments in economic stimulus plans and foreign wars. One high profile example of the SCF is when President Bush justified the decision to "stay the course" in the Iraq War on the basis of the 2,527 troops who had already died.²¹ From a rational viewpoint, the decision to continue or desist should be based on future prospects such as whether the war is winnable and how many more soldiers may die. Lives already lost and prior investments of time, effort, and money are irrelevant because these "sunk costs" cannot be recovered.²²

The framing effect is a bias that refers to the tendency for people to make different decisions depending on how options that are objectively the same are presented or "framed." In their seminal research, Tversky and Kahneman presented a scenario depicting the outbreak of an "Asian disease" in the United States and demonstrated that describing potential treatments as gains (200 of 600 people will be saved) or losses (400 of 600 people will die) changed the decisions people made.²³ Variations in how information is described or framed should not change a rational person's choice. Objectively, the utility is the same. Framing effects have been extensively documented using the classic disease scenario, and in clinicians' and patients' medical decisions, consumers' decisions, and bargaining situations, among others.^{24,25}

Overview

We begin our review with the dual-process models that guide much JDM research and describe how these models have been extended to investigate developmental differences. Drawing from a life-span theoretical perspective, we outline a motivational model of JDM across the life span that focuses on abilities and skills. Next, we summarize existing research on the SCF and the framing effect. The research we review suggests the SCF decreases across childhood, adolescence, and adulthood with further decreases in late life. In contrast, the framing effect is apparent in decisions about gains and losses beginning in middle

childhood and remains relatively stable across the life span. We conclude our review by offering suggestions for future research.

Dual-process models

Dual-process theorists posit two different modes of thinking underlie decisions.^{26,27} One mode is referred to as affective or experiential. Decisions based on this mode are effortless, based on intuition and specific experiences; the process is fast and automatic. Use of rules of thumb or heuristics (e.g., “avoid waste” when making decisions about sunk costs) and biased attention to information (e.g., greater weighting of losses relative to gains) are often assumed to correspond to the affective/experiential mode. The other mode is deliberative. These decisions are effortful, based on reasoning and analysis of information; the process is thoughtful, conscious, and time consuming.

One function of the deliberative mode is to monitor the affective/experiential mode.²⁸ When dual-process models are extended to childhood and adolescence, gains in metacognitive abilities are posited to facilitate the evaluation of heuristics and use of a more deliberative mode such that JDM biases are expected to decrease with age.^{10,29} When considering adulthood and aging, the focus shifts to age-related declines in the deliberative mode. JDM biases are hypothesized to increase in late life except when the experiential/affective mode can compensate for deliberative declines.¹² Peters and colleagues¹² hypothesize that because affect regulation is maintained in later life, decisions that rely upon “integral affect” (learned positive or negative feelings relevant to choices) may be maintained, but because older adults lack cognitive resources to overcome intense moods, their decisions may be more influenced by “incidental affect” (decision-irrelevant moods).

Fuzzy-trace theory³⁰ offers an alternative to traditional dual-process models by emphasizing intuition instead of reason as the pinnacle of development. According to fuzzy-trace theory, as people develop, they increasingly make decisions based on the meaning or “gist” of information, rather than exact wording or verbatim details.^{30,31} Gist-based reasoning enables unbiased (consistent) decisions when situations have different verbatim details, but identical meaning. Message frames can change the meaning or gist of the information. Thus, fuzzy trace theory predicts “developmental reversals”—gist-based JDM biases are expected to increase rather than decrease with age. Yates and Patalano³² also posit a developmental progression—from the “analytic” mode, which places significant demands on working memory, to the “rule-based” mode (where the general rule is abstracted from experience or instruction), and finally to the “automatic mode” (where rule application becomes habitual). The automatic mode places minimal demands on working memory, allowing older adults to compensate for age-related declines in deliberative capacity. In both of these developmental models, experience-based learning and increased automaticity are keys for understanding the development of JDM. The theories differ in their emphasis on the compensatory nature of gist-based reasoning and the automatic mode, respectively.

Contextual framework of decision making as a three-dimensional process

Dual-process models provide fertile ground for developmental research and yield important insights. Yet, similar to critiques offered by others,³³ we caution that dual-process models overemphasize and reify distinctions between facets of decision-making. In Figure 1, we introduce a conceptual framework that portrays decisions as emerging from a three-dimensional network of processes. Each process has unique characteristics, but is connected to other processes. Experiential and deliberative processes are connected because people reason about experiences.³³ Affective and deliberative processes are connected when people reason about their feelings or interpret core affect.³⁴ Affective and experiential processes are connected because experiences have “somatic markers.”^{35,36} In some instances, the degree

of connection of affective and deliberative processes may be minimal, such as when a stimulus triggers affect that is not cognitively mediated but influences a decision.³⁷ In our framework, we view the extent to which the three processes are connected and involved in a decision as one of degree rather than a categorical difference.

By drawing attention to a network of three connected processes, we aim to stimulate research that uses a more process-oriented approach to JDM biases. Researchers often measure decisions and infer processes. A long-standing assumption within the JDM literature is that the deliberative mode results in “good” (unbiased, rational) decisions.³⁸ However, heuristics such as “avoid waste” often yield effective solutions and require minimal time and cognitive effort—they are “fast and frugal.”³⁹ Moreover decision-making processes cannot be equated with biased or unbiased decisions. For instance, a manager might deliberate over continuing to invest in a failing project by carefully considering alternatives, and decide that it is more important to avoid being perceived as wasteful by (irrational) employees than to base the decision only upon marginal returns on the investment and, thereby, demonstrate the SCF.³

Developmental change

Focusing on three processes highlights the multidimensional and multidirectional nature of developmental change. Classic Piagetian theories are unidimensional (focusing on logic) and unidirectional (focusing on gains and growth). Dual-process models of aging are unidirectional to the extent that they focus on declines in deliberative capacity and loss-based compensation.^{12,40} Life-span theorists posit that although the allocation of resources shifts from promoting growth to regulating losses in later life, there is “*no gain in development without loss and no loss without gain*” (p.583,⁴⁰ italics in original). From a life-span theoretical perspective, growth may occur across the life span, even in old age. Thus, reliance on affective and experiential processes may reflect not only loss-based compensation, but also selective use of decision-making abilities and skills that have been honed or optimized with development.⁴⁰ Basing decisions on knowledge derived from both affect and deliberation has been posited to signify wisdom.⁴¹ To the extent that people gain experience and improve their affect regulation skills as they grow older and decisions do not overtax deliberative capacity, normal aging (as compared to pathological aging) could be associated with improvements in decision making.

To understand deliberative, experiential, and affective processes, we focus on specific abilities and skills. Considerable research indicates age-related decline in what Baltes, Lindenberger, and Staudinger⁴⁰ refer to as the “mechanics” of cognitive functioning—processing speed, explicit memory, working memory, and executive functioning.^{42–46} We view these cognitive mechanics as foundational for deliberative processes.

In contrast to age-related declines in cognitive mechanics, cognitive functions corresponding to the “pragmatics” of everyday life (e.g., crystallized intelligence, knowledge derived from experience) are characterized by maintenance or gains across the life span.⁴⁰ For example, verbal ability remains relatively stable through the early seventies.^{45,47} In its highest form, expertise in “life pragmatics” is thought to define wisdom.⁴⁰ Experience-based knowledge corresponds to experiential decision-making processes.

Affective processes also change systematically with age. Age differences in responsiveness to affectively laden stimuli are evident at the neural⁴⁸ and psychophysiological⁴⁹ levels of analysis. Emotional well-being—the subjective experience of positive and negative emotion—improves across adulthood.⁵⁰ Positive emotional experience increases across the life span until about age 70 when it begins to level off and decline slightly among the “oldest old”—those 80 years or older.⁵¹ With age, emotions become more complex; positive and negative

emotions are more likely to co-occur.⁵¹ Emotion regulation—control over one’s emotional expression and experience—is maintained and may improve across adulthood,^{50,52} unless situational demands overwhelm the aging person’s resources.^{53,54} The experience and regulation of emotion corresponds to affective decision-making processes.

Contextual influences

As depicted in Figure 1, features of the immediate context and the more distal sociocultural and historical context, within which the immediate context is nested,⁵⁵ are important aspects of our conceptual framework. Features of the immediate context such as justifying one’s decisions to others, or making a decision about investing a small versus large amount of money are expected to have systematic consequences. Features of the larger sociocultural and historical context also are important—for instance, financial decisions about sunk costs may differ during economic recession versus expansion; decisions about treatments for fatal diseases may differ when affordable health care is scarce or plentiful.

Motivational model of JDM across the life span

Drawing from socioemotional selectivity theory (SST)^{56,57} and our work on everyday problem solving,⁵⁸ we have developed a model of JDM biases that accords a central role to motivation (see Fig. 2). Our work on everyday problem solving emphasizes that contextual influences combine with individual characteristics to give rise to goals in specific contexts. Goals in turn, influence strategies. Strategies correspond to deliberative, experiential, and affective processes. That is, the use of deliberative strategies depends not only on the person’s capacity (which may change systematically with age), but also on contextual cues that induce motivation to use such strategies. SST posits systematic age-related differences in motivational orientations that are posited to be chronically activated and most apparent in unconstrained contexts. According to SST, when people’s temporal horizons are restricted and time is perceived as “running out” (as in later life because mortality is associated with advanced age) people are motivated to maximize positive emotional experiences and to invest in meaningful experiences in the “here and now.” When temporal horizons are expansive and time is perceived as unlimited (as is typical in early adulthood) people are oriented toward acquiring knowledge that may prove useful in the future.

When contexts cue emotion, chronically activated motivational orientations may influence decisions. Older adults’ (65+ years) motivation to maximize positive emotion in the “here and now” is thought to explain why they demonstrate a relative preference for positive information over negative information—a phenomenon referred to as the “positivity effect.”^{57,59,60} This positivity effect contrasts with the “negativity bias” that characterizes information processing in early adulthood.^{61,62} Motivational orientations and information-processing biases may have implications for understanding age differences in JDM biases such as the framing effect, the SCF, and the endowment effect because loss aversion has been suggested to underlie these biases. Motivation to maximize positive emotion may dampen attention to loss.

Contexts also may cue individual differences in experience associated with different goals. Decisions about sunk costs are thought to reflect that people learn the “do not waste” heuristic.²⁰ For an older adult with greater experience, the same context could activate different learned heuristics—“don’t throw good money after bad,” or “quit while you are ahead.” Experience is thought to explain why older adults are less likely than younger adults to be influenced by the addition of an irrelevant alternative to a set of choices^{63,64} and has also been suggested to explain why the hindsight bias is more apparent in older adults.¹⁹ Experiential processes may be important for understanding age-related changes in JDM

biases that correspond to learned heuristics because older age is associated with greater lifetime experience with decision consequences.

In the sections that follow, we highlight research that addresses the role of affective, deliberative, and experiential processes by focusing on individual differences in abilities and skills corresponding to these processes. We also provide an overview of the methods, measures, and aspects of the decision-making context that have been investigated in research on the SCF and the framing effect.

The sunk-cost fallacy: overview

Methods

Researchers use a variety of methods and data sources to investigate the SCF. In a classic field study, Arkes and Blumer⁶⁵ observed that season ticket holders who received discounted tickets attended fewer theater performances than those who paid full price. Ticket price should not influence theater attendance because the already-incurred cost of the tickets cannot be recovered. Archival data from the NBA⁶⁶ and the banking industry⁶⁷ also demonstrate how prior investments influence decisions after the initial investment is irrelevant to future payoffs. Persistence in honoring sunk costs across repeated decisions—referred to as *escalation of commitment*⁶⁸—has been the subject of considerable attention. Some laboratory studies use behavioral measures of the SCF and operationalize the sunk cost as a required behavioral investment of time, money, or effort.^{69–72} More typically, behavioral measures of the SCF are obtained by using vignettes as stimuli to portray hypothetical investments. Hypothetical scenarios are used in both laboratory studies and survey research. To date, *all* research that has investigated age differences has used hypothetical vignettes as stimuli.

Decision context

Some hypothetical scenarios present choices middle-class Americans may face in their everyday lives: whether to go on a more expensive or a less expensive (but more attractive) ski vacation when both vacations are on the same date and have been paid for in advance,⁶⁵ or whether to remain committed to a suboptimal medical treatment or change to a more effective and less expensive treatment when one becomes available.⁷³ Scenarios often depict decisions about the consumption of goods and services that have or have not been paid for such as: eating a rich dessert when one is no longer hungry, watching a movie that is boring, or playing tennis after developing tennis elbow.^{15,74} Scenarios similar to those that college students may encounter (e.g., continuing versus dropping a paid-for course when a better, free course becomes available; going on a date arranged by a paid-for online dating service versus a free date arranged by a friend) have been investigated.^{75,76} Because the SCF has been extensively studied by economists, scenarios depicting business decisions (e.g., whether to invest a million dollars to develop an airplane after a rival company develops a better version of the same airplane) also have been used.^{65,77,78}

Aspects of the decision-making context that have been systematically compared include: gain/loss outcomes of prior decisions,⁷⁹ size of the prior investment, probability of future success,⁸⁰ reinvestment cost⁸¹ and whether the prior investment is money or time.⁸² The SCF is more evident for monetary sunk costs, after a large prior investment, and when the probability of success is unclear. The prior investment (sunk cost) portrayed in hypothetical scenarios is often money,⁶⁵ typically amounts many people do not deal with on a daily basis—such as thousands or millions of dollars.^{77,83–88} Researchers have begun to consider other investment dimensions such as time^{72,76,78,82,89} and effort.^{69,90}

Measurement

Some vignettes present a choice between two options embedded within a single scenario. Participants rate on a continuous scale how likely they would be to select one option relative to the other option¹⁵ or simply choose one of the two options.^{65,83} One option includes a prior investment (e.g., a \$100 layaway payment has been made on jewelry); the alternative option does not include a prior investment or has greater utility (e.g., the same jewelry could be purchased for less money elsewhere at an overall savings of \$10). When participants favor the option in which a prior investment has been made, they are subject to the SCF; when they do not exhibit this pattern, they are said to be resistant to sunk costs.¹⁵

In other vignettes that embed two options in a single scenario, a prior investment has been made in both options. For example, nonrefundable tickets have been purchased for two different ski vacations—a more expensive one in Michigan and a less expensive one in Wisconsin; the Wisconsin vacation is expected to be more enjoyable.⁶⁵ After purchasing the nonrefundable tickets, it is discovered that the vacations are on the same date. The person must choose one of the two vacations. Choosing to go skiing in Michigan when Wisconsin is expected to be more enjoyable is indicative of the SCF.

Instead of embedding two options in one vignette, other studies use vignette pairs that are analogous except for the presence or absence of an investment; SCF scores are computed by comparing choices on the analogous pairs.^{74,91,92} Decisions about future investments in the “investment” scenario (a boring movie that cost \$10.95) are compared to decisions in a “no investment” scenario (a free boring movie). Making exactly the same decision in both scenarios is rational and is referred to as the “normatively correct” response;⁹¹ spending more time or effort in the investment version is irrational and represents the SCF (spending less time or effort in the investment version is also irrational, but this error has received little attention). Scores that correspond to rational (normatively correct responses) and irrational (SCF) decisions often are used to investigate the development of analytic and heuristic processing, respectively. We use vignette pairs in our research⁹² because irrelevant features of the context that could influence decisions when two options are presented in one scenario (e.g., personal preferences about skiing in Wisconsin versus Michigan⁶⁵) are held constant.

Explanations

Researchers have offered a plethora of explanations for the SCF and escalation of commitment to sunk costs, including believing the attempt will succeed,⁸³ generating reasons for continuing versus pursuing alternatives,⁷² failure to consider alternatives,⁹³ maintaining a positive self-image,^{68,88} project commitment,^{94,95} being perceived by others as “wasting” a resource,⁹⁶ mental accounting,^{89,97,98} subjective interpretations of scenarios,⁷⁴ learning a lesson,⁹⁹ loss aversion^{65,100} and the “waste not” heuristic.^{65,101} In studies that investigate age-related differences, the “waste not” heuristic has received the most attention.

Individual differences in decisions about sunk costs

Individual difference characteristics that correspond to the mechanics and pragmatics of cognition have been examined in relation to the SCF. Stanovich and colleagues suggest that when within-subjects designs are used, greater cognitive ability (as indexed by college students’ self-reported SAT scores) and a dispositional tendency to enjoy and engage in critical thinking (high “need for cognition”) can facilitate rational decision making and recognition and inhibition of JDM biases.^{102–104} However, results from within-subjects designs are mixed for the SCF. One study indicated no relation between SAT scores and the SCF.¹⁰⁵ Another study indicated higher SAT scores were associated with a lesser tendency to display the SCF and that need for cognition was lower among college students who were

subject to the SCF.¹⁰⁶ Between-subjects designs indicate SAT scores are unrelated to the SCF.¹⁰² Thus, among college students, there is only modest evidence that personal resources, such as greater cognitive ability or a disposition to think critically, reduce the SCF.

Research examining cognitive mechanics and general knowledge in other age groups generally indicates small relations with the SCF. A study of children (ages 5–11) indicated higher scores on a composite measure of cognitive ability (WISC, working memory) were associated with a greater tendency to demonstrate the SCF.¹⁰⁷ However, research with adults indicates that correlations between fluid and crystallized intelligence and decisions about sunk costs are small.^{15,92,108} Executive functioning is unrelated to resistance to sunk costs in college students¹⁰⁹ and in male high-risk youth.¹¹⁰ Education is unrelated to resistance to sunk costs in adults aged 18–88.¹⁵

Although general knowledge does not appear to be central to the SCF, domain-specific knowledge or expertise (corresponding to cognitive pragmatics) may be important.¹¹¹ Petroleum geologists did not demonstrate the SCF when hypothetical decisions involved oil drilling.¹¹² Research with accounting¹¹³ and medical students¹¹⁴ suggests that the effect of expertise is domain-specific rather than domain-general. Accounting students were less likely than non-accounting students to exhibit the SCF when making a business decision, yet were equally likely to exhibit the SCF when deciding about vacationing at a resort.¹¹³ The amount of domain-specific knowledge is important. College students who had taken an economics course were not any less subject to the SCF compared to those who had not taken an economics course.⁶⁵ However, taking more courses in managerial accounting was related to better decisions about sunk costs and justification of decisions improved performance for those with more work experience.¹¹⁵ Thus, knowledge or experience may reduce the SCF, but only when it is directly relevant to the decision and contextual cues that motivate its use.

Recent research suggests the importance of individual differences in affective processes and temporal horizons. College students are more likely to escalate commitment to sunk costs when an optimistic frame of mind is induced,⁸⁰ when they are instructed to maximize future gains for a hypothetical company⁷⁹ or when their anticipatory emotions of the success of the project are positive.⁹³ College students who tend to dwell on the past are more subject to the SCF.¹¹⁶ When decision makers are responsible for the initial investment, negative affect is associated with a lesser escalation of commitment, perhaps in an attempt to escape negative affect aroused by the current situation.¹¹⁷ These studies suggest the importance of considering affect regulation within a temporal context. Life-span temporal horizons may be important for understanding age differences in the SCF because decisions about sunk costs involve a past investment, a decision about whether to continue to invest in the present, and uncertain future consequences. When older adults are motivated to maintain positive affect in the “here and now,” they may be less subject to the SCF.

Developmental trajectory

Childhood and adolescence

Based upon three studies of children (one of which investigated the SCF¹¹⁸ and two of which investigated “mental accounting”) and numerous studies indicating that nonhuman animals are not subject to the SCF (Concorde effect), Arkes and Ayton²⁰ concluded that young children are less subject to the SCF than adults because they lack the cognitive ability to overgeneralize a learned rule—“waste not.” In the study of the SCF included in their review, no age differences in the SCF were found in a group of children (ages 5–11), or in a second group (ages 7–15); 27% to 50% of children demonstrated the SCF (depending on the specific item used).¹¹⁸ Moreover, recent research suggests that pigeons are subject to the

SCF,⁹⁰ which is inconsistent with the nonhuman animal research available to Arkes and Ayton in 1999.

A more recent investigation of the SCF in children (ages 5–11) indicated no relation between age and the SCF or normatively correct (rational) decisions about sunk costs.¹⁰⁷ However, when the age range spanned childhood and early adolescence, the SCF was more apparent in 8-year-olds than in older children (11- and 14-year-olds); 8-year-olds demonstrated the SCF on 82% of their decisions.¹¹⁹ When early adolescents (7th and 8th grade), middle adolescents (10th through 12th grade) and college students were compared, there were no age differences in the SCF—at each age, 50% or more of the decisions honored sunk costs.⁹¹ However, early adolescents were *less* likely than middle adolescents and college students to make normatively correct (rational) decisions.

Together, the small number of studies of the SCF in childhood and adolescence suggests that the SCF that exists in early childhood, may decrease during early adolescence, and then remains relatively stable through mid-adolescence to early adulthood. Rational (normatively correct) decisions may show a slightly different relation with age—increasing during mid-adolescence and remaining stable through early adulthood. These findings are inconsistent with Arkes and Ayton's²⁰ conclusion that the SCF increases with age due to an increasing tendency to overgeneralize the “waste not” rule.

Klaczynski attributes age-related increases in rational (normatively correct) decisions to *metacognitive intercession*—the ability to cognitively monitor and control automatically activated heuristics.^{10,29} Jacobs and Klaczynski²⁹ posit that metacognitive intercession depends on executive functioning—a higher-order cognitive ability reflecting the capacity to monitor and control one's cognitive processes. Executive functioning increases from infancy through childhood, does not reach its peak until early adulthood, and declines in later adulthood.¹²⁰

Rather than assessing executive functioning, the development of metacognitive intercession is inferred from the decisions adolescents make after exposing them to logical arguments. Whereas the ability to understand logical arguments about the fallacy of honoring sunk costs emerges by mid-adolescence, applications of such arguments do not appear until later in adolescence.¹²¹ Metacognitive intercession depends on motivation such as whether deliberation protects or threatens personal values.^{121,122} Contextual cues to consider the situation from the perspective of a “perfectly logical person,” decrease the SCF.⁹¹ Thus, by late adolescence, deliberation can reduce the SCF and increase rational decisions when the context cues deliberation or when adolescents are motivated to deliberate.

Early and later adulthood

Four studies of adults indicate greater age is associated with making better decisions about sunk costs. Compared to younger adults, older adults are less subject to the SCF and are more likely to make normatively correct decisions.^{92,123} Greater age is associated with greater resistance to sunk costs¹⁵ (Hansson *et al.*, unpublished data). These age differences remain after controlling for fluid and/or crystallized intelligence.^{92,108} Thus, in contrast to the role cognitive mechanics may play in childhood and adolescence and the importance of these abilities for mediating age differences in other decisions,^{124,125} cognitive mechanics do not appear to explain why older adults are less subject to the SCF.

Based on relations among age, fluid intelligence, and resistance to sunk costs, Bruine de Bruin and colleagues¹⁰⁸ concluded that older adults' greater experience explains their resistance to sunk costs. Experience was not measured in Bruine de Bruin's study. However,

comparisons of experts and non-experts' sunk-cost decisions (reviewed earlier) are consistent with this explanation.

In recent research, to understand why older adults are less subject to the SCF, we investigated age-related differences in motivation.¹²³ Drawing from research on information-processing biases (negativity bias, positivity effect), we hypothesized older adults would be less likely than younger adults to spontaneously describe goals for preventing loss. As predicted, the lost investment was more salient to younger adults; age differences in the SCF and rational decisions were nonsignificant after taking into account the salience of the investment to individuals. These findings are consistent with our motivational model of JDM and with fuzzy-trace theory, which would predict that younger adults would be more likely to focus on verbatim details. The other goals people mentioned corresponded to researcher's explanations of the SCF (i.e., thinking the situation might improve,⁸³ considering alternatives,⁹³ and remaining committed).⁹⁵ However, these did not vary with age.

Summary

The SCF appears to decrease and rational decisions about sunk costs appear to increase from childhood through later adulthood. Researchers who focus on childhood and adolescence theorize that the development of abilities corresponding to cognitive mechanics (specifically, executive functioning) may explain age differences, but pertinent data have not been collected from these age groups. However, data from younger and older adults indicate resistance to sunk costs is not dependent on executive functioning. It is possible that cognitive mechanics are more influential in childhood and adolescence and become less central in adulthood due to increases in automaticity and cognitive pragmatics and greater reliance on gist. In later adulthood, temporal horizons that focus on the "here and now," coupled with motivation to maintain positive emotion may contribute to further decreases in the SCF. Motivation to maximize positive emotion in the "here and now" may decrease rumination about past losses and direct attention to rewarding alternatives in the present. In contrast, temporal horizons that focus on the future may be associated with increases in the SCF, but only when positive consequences of persistence are anticipated.

The framing effect: overview

Tversky and Kahneman's²³ seminal research indicated that a *preference reversal* occurs such that people are risk seeking (gamble for a potentially better outcome) when options are framed negatively as losses, but are risk averse (choose the "sure thing") when options are framed positively as gains. An extensive body of research investigates this classic framing effect and related variants.^{24,25} The combination of "gain/loss" and "sure thing/probabilistic" frames that yields Tversky and Kahneman's preference reversal is referred to as "risky choice framing;" "attribute framing" refers to differences in the descriptive valence of information in scenarios (e.g., describing meat as 90% lean versus 10% fat).²⁵ We focus mostly on age differences in risky choice framing and the classic preference reversal in choices. We include studies that use Bruine de Bruin and colleagues' measure of *resistance to framing*, (comprising risky choice and attribute framing) because it has been used in studies investigating age-related differences. In the literature, the preference reversal that defines the classic framing effect is referred to as "preference shift,"¹²⁶ "standard framing,"^{127,128} or simply as the "framing effect."¹⁰² We use these terms in our review. We use the term resistance to framing when describing results based on Bruine de Bruin and colleagues' measure.

Methods

Much research on the framing effect uses written vignettes that portray hypothetical situations and present a choice between two options—a “sure thing” versus a “risky” (probabilistic) outcome; participants do not experience tangible consequences based on their decisions. In research with children, framing tasks are made “child friendly,” by involving puppets,¹²⁹ or by making the task into a game.¹²⁷ Computer-based tasks, such as Weller and colleagues’ “cups” task have been used with both children and adults.¹³⁰ The cups task requires a series of choices between a sure thing and a risky outcome—represented by different numbers of cups. Both gain and loss trials are presented. Choices result in consequences that are either immediate, such as winning or losing a prize, dime, or quarter^{126,130} or are deferred until all decisions are made.¹³¹ We include studies that use computer-based tasks in our review when they address developmental and other individual differences in the preference shift that corresponds to standard framing. These tasks also address age differences in risk preferences, which is the focus of the review by Mata and colleagues in this volume.¹³²

Decision context

Hypothetical scenarios portray a variety of contexts. Scenarios have been made more personally relevant by placing the scenario in the context of personal decisions about medical treatment, among other variations.^{133–135} The Asian disease scenario yields the largest effect sizes, perhaps because the gains and losses described in this scenario pertain to human lives. However, context matters. Business and gambling scenarios have larger effect sizes than social scenarios pitting individual interests against the common good.²⁴

Measurement

To measure the framing effect, participants’ selection of the sure thing and the risky choice are compared as a function of gain or loss framing. The classic pattern (standard framing) occurs when participants choose the risky option in the loss frame and the sure thing in the gain frame. The reverse of the classic pattern (choosing the risky option in the gain frame and the sure thing in the loss frame) has been labeled *reverse framing*.^{127,128} Some researchers use selection of the risky option as a dependent variable and frame as a between- or within-subjects design factor.¹³³ Others use data from numerous trials to compute preference shift scores (i.e., the number of times a person chooses the risky option in the loss frame and the sure thing in the gain frame when probability is held constant).¹³⁰

In contrast to other metrics of the framing effect, Bruine de Bruin and colleagues’ measure, resistance to framing, indicates consistency of ratings across message frames.¹⁵ Scores correspond to the absolute difference in ratings made on continuous scales for options framed as gains versus losses (risky choice frames), and between ratings for attributes described in positive versus negative terms (attribute frames). For risky choice items, the sure thing and risky options are on opposite ends of a single scale and the person indicates their preference for one option relative to the other. Each scenario is presented twice—once with a gain frame, and once with a loss frame. For “attribute” items, ratings indicate the person’s assessment of some dimension of the item, such as the quality of meat, not a choice between two options. Each scenario is presented twice, framed in negative or positive terms. Thus, unlike other measures, resistance to framing does not indicate relative preference for the risky option versus the sure thing as a function of frame (at least as the measure is typically scored).

Explanations

Explanations of the framing effect span a continuum of levels of analysis—from neural asymmetries associated with gain versus loss decisions,¹³⁶ individual differences in responses to gain and loss cues,¹³⁷ and subjective interpretations of framing problems^{74,105} to the ecological and evolutionary utility of contextual cues.¹³⁸ Tversky and Kahneman's²³ prospect theory explains the framing effect in terms of two functions—the *probability weighting function* (which describes people as underweighting large probabilities and overweighting small probabilities) and the *value function* (which describes people's perceptions of the value of outcomes, with losses being weighted more heavily than equivalent gains). Reyna's³⁰ fuzzy-trace theory explains the standard framing in terms of the gist of the options—in the gain frame “better to save some lives for sure than maybe saving some (or none)” compared to the loss frame “better if none die than maybe some (or none) dying for sure.” Prospect theory is widely accepted as the leading theoretical explanation of the framing effect. However, a recent empirical test of predictions derived from fuzzy-trace theory and prospect theory indicated more support for the fuzzy-trace theory.¹³⁹

Individual differences in the framing effect

A number of studies suggest the importance of cognitive mechanics and pragmatics for understanding resistance to framing. Greater resistance to framing is related to higher fluid and crystallized intelligence scores and greater education in adults ages 18 to 88¹⁵ and in male high-risk youth.¹¹⁰ Resistance to framing is also related to the monitoring/inhibition dimension of executive functioning.¹⁰⁹

In contrast to the results for resistance to framing, research investigating cognitive mechanics, pragmatics, and the classic framing effect yields mixed results. In a small sample of children, no relation was found between WISC-R scores and the framing effect.¹²⁶ Experts appear to be no less susceptible to framing effects than nonexperts.^{140,141} Using a between-subjects design and the “Asian disease” scenario, Stanovich and colleagues found SAT scores were unrelated the framing effect.¹⁰² However, when a within-subject design was used, students with higher SAT scores, greater open-minded thinking, and greater need for cognition were more likely to avoid the framing effect.^{103,105}

Stanovich and West suggest that within-subject designs facilitate detection of the need to override the heuristic response among those with the ability and disposition to do so.¹⁰² However, when Levin and colleagues used a within-subject design, no relation between need for cognition and the framing effect was found.¹⁴² In their study, positive and negative frames were presented on two different occasions a week apart, reducing the likelihood of students noticing and overriding discrepant decisions. Yet, using a between-subjects design where cancer treatments were framed in terms of “survival” or “mortality,” students with a low need for cognition made different decisions depending on message frame.¹⁴³ Relative to the Asian disease scenario, the cancer treatment outcome information is more complex (immediate, short-term, and long-term outcomes are provided), and both treatments involve risk (there is no sure thing). Perhaps personal resources such as cognitive ability and a disposition to think critically reduce the framing effect only when contextual cues such as those presented by a within-subjects design or a complex hypothetical scenario induce motivation to use these resources (see Fig. 2). When contextual cues regarding the need to apply deliberative strategies are unambiguous (such as when debiasing procedures require participants to explain or provide a rationale for their decision) the framing effect is eliminated.^{144–147} Unambiguous contexts may restrict decision-making goals and strategies.

Levin and colleagues have investigated the stability of the framing effect across time and the relation between personality, temperament, and the framing effect. College students' Big

Five personality traits (higher neuroticism and conscientiousness scores and lower agreeableness and openness scores) are related to their greater likelihood of demonstrating the framing effect.¹⁴² Children's (6–8 years old) greater shyness, impulsivity, and approach, and lesser sadness are associated with demonstrating standard framing (as indexed by preference shift scores) on a computer-based task.¹²⁶ Levin and colleagues note that results for shyness in children parallel those for openness in adults, whereas results for sadness in childhood are similar to those for neuroticism in adulthood. In a three-year follow-up, stable individual differences in the framing effect were found for both the children and their parents.¹³⁷ Moreover, children's temperament at Time 1 predicted the extent to which they demonstrated framing effect three years later at Time 2. Greater *surgency* (as indexed by impulsivity, approach activity, high intensity pleasure, and low shyness) was associated with reduced preference shift.¹³⁷ Surgency, as operationalized in this study, was assumed to be analogous to Gray's neurobiological behavioral activation system (BAS).¹⁴⁸ Levin and colleagues suggest their results point to the importance of biological and evolutionary mechanisms. Their findings also provide some indication that individual differences in affect regulation may be related to the framing effect.

Developmental trajectory

Childhood and adolescence

There is a substantial body of research that examines risky decisions in adolescents,^{149,150} but only a small number of studies focus specifically on the framing effect. Of these, the primary focus is often on how children and adolescents evaluate different degrees of risk.^{151,152} Studies that include data pertinent to standard framing suggest the framing effect becomes more evident with increasing age. Some studies indicate that the effect is present in children as young as age 6,^{126,129,137} or at least by 5th grade,¹²⁷ and is less pronounced in children ages 5–11 compared to young adults.¹³⁰ Adolescents demonstrate standard framing—choosing the risky option more often in the loss frame than in the gain frame.^{128,153} When monetary rewards are smaller (\$5 or \$20) adolescents and adults are equally likely to demonstrate standard framing, but when rewards are large (\$150), adolescents demonstrate reverse framing—choosing the risky option more often in the gain frame than the loss frame.¹²⁸ Interestingly, Reyna and Ellis¹²⁷ found that preschool children (4-year-olds) were more likely than second (8-year-olds) and fifth graders (11-year-olds) to treat the gain and loss frames the same. When differences in rewards associated with the sure thing and the risky choice were large, second graders showed reverse framing. Fifth graders showed standard framing—except when rewards were large—in which case they also displayed reverse framing. Reyna and Ellis¹²⁷ interpreted these findings from the perspective of fuzzy-trace theory as indicating a developmental progression from quantitative verbatim reasoning to qualitative gist-based reasoning.

Early and later adulthood

Most research that uses hypothetical scenarios to compare younger and older adults indicates age similarities in the framing effect. One study that used hypothetical “fatal disease” and “cancer treatment” scenarios indicated the classic framing effect was apparent among older adults (58 and older), but not younger adults.¹⁴⁴ Notably, the age-related differences reflected that younger adults did not demonstrate the framing effect—however, the effect was found among younger adults in other studies using the same stimuli.^{135,154} Four other studies that compared younger and older adults indicated age similarities.^{133,155–157} One of the four¹⁵⁷ was a replication that used the same vignettes as the study indicating age-related differences. Thus, when the framing effect is measured using “risky choice” frames and hypothetical scenarios, evidence of adult age differences is very weak. Studies that use computer-based tasks also indicate that a preference shift

corresponding to standard framing characterizes decisions in older and younger adults¹³¹ and across the adult life span (ages 18–85).¹³⁰

Woodhead and colleagues¹⁵⁷ used a “think aloud” protocol to investigate strategies associated with age similarities and differences in the framing effect using the cancer treatment scenario. When people used a “data-driven” strategy (vocalized verbatim details of choices), their decision differed systematically depending on the survival or mortality frame. However, when people used an “experience-driven” strategy (vocalized personal experiences) they were uninfluenced by the frame. Older adults were less likely to use a data-driven strategy and more likely to draw from personal experience, but there were no age differences in decisions. This research suggests individual differences in strategies (rather than age *per se*) are important for understanding the framing effect.

In contrast to the age similarities in the classic framing effect, when resistance to framing is assessed using Bruine de Bruin and colleagues’ measure, two studies indicate older adults’ ratings are less consistent¹⁵ (Hansson *et al.*, unpublished data). Although the framing effect and consistency are related, they are not identical. Moreover, the resistance to framing measure includes both risky choice and attribute framing items. Young adults who perceive they are less numerate (able to work with and understand numbers) are more subject to attribute framing,¹⁵⁸ and numeracy has been linked to age differences in decision making.¹⁵⁹ Thus, the conflicting pattern of age differences across studies may reflect not only the types of frames investigated (risky choice versus attribute), but also the numerical abilities involved.

Summary

There appears to be age-related stability in the framing effect beginning around middle childhood. This conclusion differs from that of Peters and colleagues³⁸ but is consistent with Mata and colleagues’ meta-analytic review of age and risk preferences in decisions by description.¹³² Our review suggests that resistance to framing (as indexed by consistency of decisions across frames) is linked to individual differences in cognitive mechanics and pragmatics. Evidence of links between cognitive mechanics, pragmatics, and the standard framing effect is less conclusive but may depend on the experimental design and measures used. Deliberation (justification) can reduce the framing effect. Surprisingly little research has directly addressed the role of affective processes in framing studies. Indirect evidence from studies of personality and temperament suggests individual differences in affect regulation may play an important role.

Future directions

Life-span developmental trajectories of JDM biases depend on the specific bias investigated. Existing research suggests relative stability in the framing effect across the life span beginning in middle childhood, and age-related improvements in decisions about sunk costs, including in later life. Further research is necessary to better understand these trajectories and the extent to which they represent the development of expertise in the cognitive pragmatics of everyday life, the preservation of learning based on integral affect, and/or compensation for deliberative declines. The links between individual difference characteristics that correspond to experiential, affective, and deliberative processes identified in this review can be used to develop hypotheses to test in future research. Longitudinal and cohort-sequential designs are necessary to disentangle developmental change and cohort effects. Yet, given the paucity of research, cross-sectional comparisons remain useful and should be extended to include under-investigated age groups such as middle-aged adults.

Future research should be directed toward understanding decision-making as a process that unfolds over time. Research on links between decision-making strategies and the framing effect¹⁵⁷ and our research on goals and the SCF¹²³ illustrate the utility of a focus on process for understanding age differences and similarities. When investigating processes, it will be important to consider both the immediate and larger historical context. For example, a 2001 cohort of young adults was more willing to gamble for both gains *and* losses compared to Tversky and Kahneman's²³ benchmark sample.¹⁵⁶ Considering that recovery from the "Great Recession" characterizes the current historical context in the United States, researchers should be mindful of how this historical context (and the person's current financial situation) may relate to age differences in decisions about financial gains and losses. Similarly, worldwide flu pandemics (e.g., H1N1 in 2009) could influence decisions about disease treatment. When investigating processes related to sunk-cost decisions, researchers could focus on the role of personal responsibility in the decision-making process. Personal responsibility escalates commitment to sunk costs,^{68,88} making it important to capture this initial step.

Our current understanding of JDM in people's everyday lives is impoverished. Field studies would increase the ecological validity of research. Affective processes are likely to be more influential when real and enduring consequences are at stake; many of these consequences become more substantial with age. Consideration of the social context in which decisions are made may be important. Older adults perceive they are worse decision makers¹⁰⁸ and people prefer to involve others when they perceive deficits in their own functioning.¹⁶⁰

Research that links JDM biases to real-world outcomes^{15,110} and measures of decision-making competence¹⁵⁹ is needed. Subjective indicators of decision quality also should be examined. Some people may experience greater satisfaction when they "get their money's worth" (out of a boring movie), even though it is irrational and precludes pursuit of a more rewarding alternative. To the extent that age-related differences in JDM biases reflect differences in motivation, the quality of some decisions may be best defined in light of peoples' goals.

Finally, it will be important to keep in mind that not all children or older adults are the same. Individual differences play a role in decisions, both early and later in life. Birth cohort is another important consideration. Intraindividual variability in decisions also should be investigated, both across contexts and over time. The later period of the life span comprises at least three distinct periods—young old, old, and oldest-old;¹⁶¹ the trajectory of developmental change in experiential, deliberative, and affective decision-making processes may differ across these age periods.

Conclusions

When considering JDM heuristics and biases across the life span, it becomes apparent that decision making involves the integration of deliberative, experiential, and affective processes that correspond to individual differences in abilities and skills (see Fig. 1). We have outlined a life-span developmental model suggesting that the degree to which these processes are involved in a decision depends on motivation that is cued by features of a person's immediate or larger social and historical context (see Fig. 2). We applied our model to examine developmental trajectories of two JDM biases. Our review indicates each bias is characterized by different developmental trajectories. The SCF decreases across childhood, adolescence, and adulthood with further decreases in late life. In contrast, the framing effect is apparent in decisions about gains and losses beginning in childhood and remains relatively stable across the life span. A multitude of other such biases await systematic investigation of developmental differences.

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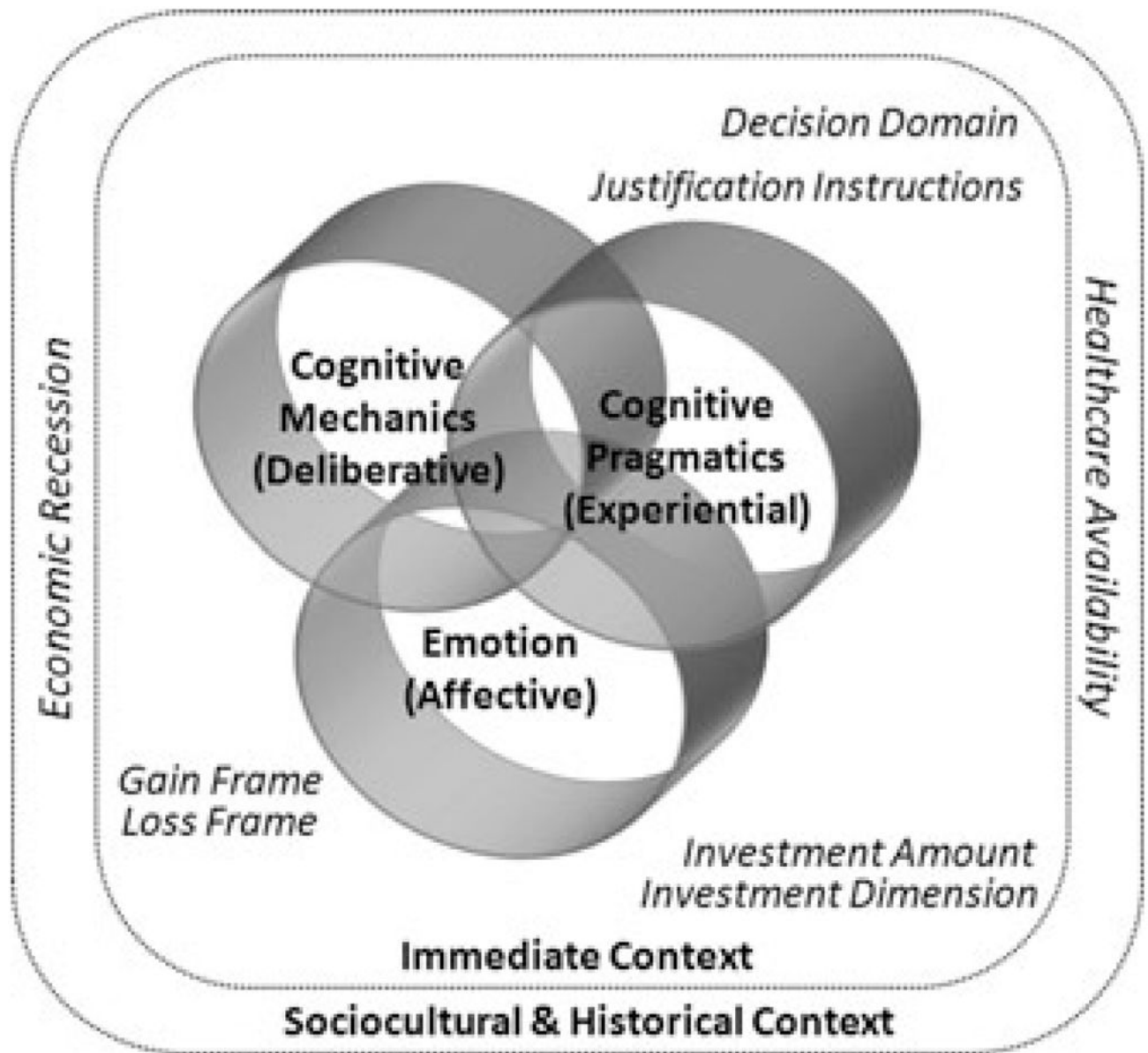


Figure 1. Schematic depiction of conceptual framework. Each of three circles corresponds to one process, which constitutes sets of abilities or skills. Overlapping circles represent connections between processes. Dotted lines represent the immediate and larger sociocultural and historical contexts within which the decision-making process occurs.

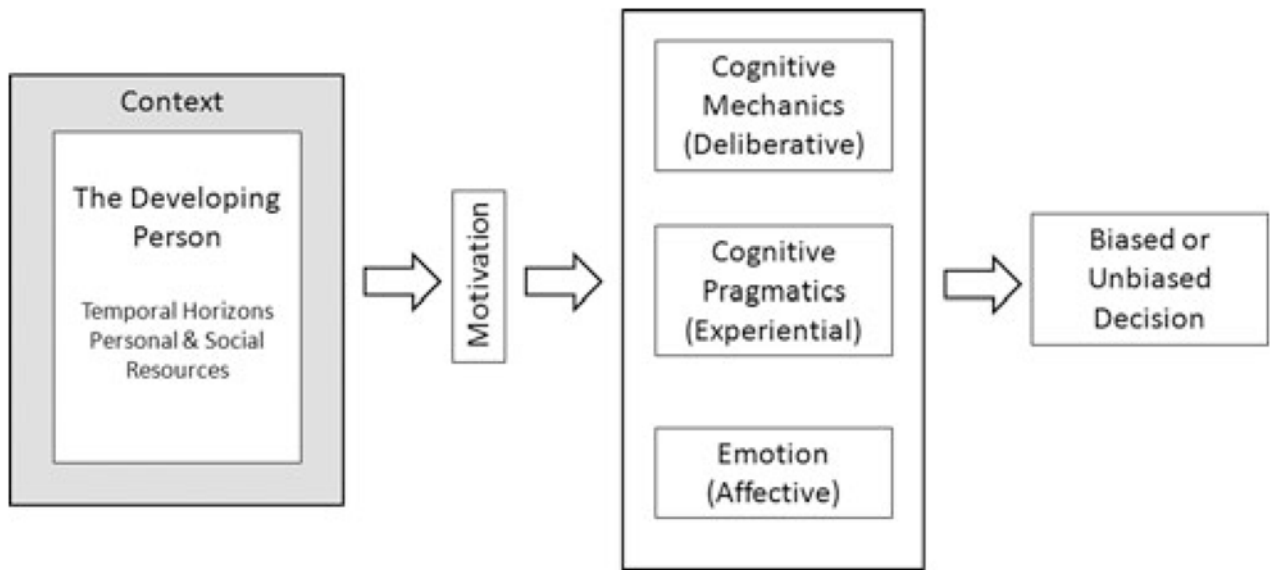


Figure 2. Schematic depiction of a motivational model of JDM across the life span.