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Decision Making and Aging

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Each of us makes decisions continually. In our personal lives, we make both routine, everyday decisions—such as what to wear each day, what to eat for dinner, and what movie to see on a Friday night—as well as more difficult, novel ones—such as whether to go to college, when to have children, and what medical treatments to accept. We also make consequential decisions in our work lives. Indeed, in some of our jobs, decision making is the core of our responsibilities—what tests a patient should have, what candidate should be our company's next vice president, what plan is best for investing our client's money. Typically, our decisions have significance for more than our own well-being; they greatly affect the welfare of those around us, including our families, our employers, and our communities. The specific content of the decision situations we face undoubtedly changes over the life span. But, the need to make decisions—and to make good ones—is always present.

These observations thus motivate the primary focus of the present chapter: How and why does the character of decision making change in the later stages of normal, healthy adulthood? To anticipate, some of the changes can be construed as weaknesses and others as strengths. This therefore raises corresponding management questions as well: How might the weaknesses be offset and the strengths exploited, more than is customary today, particularly in medical contexts?

The plan of the chapter is as follows: First, we discuss the special nature of decision making. Particular attention is directed to characteristics that make it

especially difficult to even discuss notions like age-related "declines," a topic of traditional importance in gerontology. We then address a concept that appears to have considerable significance for discussions of age differences in decision making—decision modes. The remaining and most extensive sections of the chapter are identified with elements of what is arguably the most central mode, "analytic" decision making. In each of those sections, we first sketch the basic decision theoretic concepts. We then discuss plausible as well as documented age differences in how and how well people approach the given activities. As space permits, we also consider the practical challenges and opportunities those differences represent.

Before continuing, we should acknowledge a surprising reality. The literature on basic and applied research on decision processes is large and diverse. And the aging literature is sizable and growing rapidly, too. But we have been struck by how remarkably small is the intersection of those literatures. This chapter therefore differs in character from most of those in this volume, attempting to provide more high-level integration, than is necessary for other topics. Another consequence is that, in much of what follows, our ability to draw firm conclusions is severely limited by the dearth of hard research, empirical or otherwise. By necessity, we have been more speculative than we would like. Viewed more positively, the circumstances have permitted us to offer what we hope will prove to be a useful theoretical framework for organizing productive research on important but neglected issues.

THE SPECIAL NATURE OF DECISION MAKING

Our working definition is that a *decision* is the selection of an action with the aim of producing satisfying outcomes (cf. Yates, 1990, 1998). Thus, decision making can be seen as a special case of problem solving. The main thing that is special about decision making—its hallmark—is implicit in the expression *satisfying outcomes*: subjective value. What is satisfying to one decision maker (i.e., valued by him or her) easily can be unsatisfying to another, or even to the same decision maker at some later time. The correct solution to an algebra test problem is the correct solution for everybody—forever. But, a perfectly ideal car for one buyer could be completely repugnant to his or her best friend. (Hence, the seemingly endless variety of cars on the market.) And, even if one loves its styling today, one might be indifferent to it tomorrow. Another feature common to many decision problems, although not a defining characteristic, is uncertainty. For instance, many of the events that ultimately determine the extent to which a buyer is indeed satisfied with the car selected are uncertain at the time that choice occurs.

Suppose we wish, as we do, to address questions of decision quality, such as whether it has declined for a given individual. Value and uncertainty complicate that enterprise considerably. If what is satisfying can differ markedly from one person to the next (or from Time 1 to Time 2 for the same person), how can we, as

outside observers, say for sure that the consequences of Mr. Smith's decisions are worse than they used to be? And, if the consequences of a given decision are, to some extent, uncertain propositions, how can we attribute even patently adverse outcomes to the decision maker's possibly diminished skills? Why should we not attribute them to, say, chance?

Practical concerns like these are part of the reason decision specialists have been forced to think hard about the very concept of decision quality. Those deliberations have led to implicit consensus about quality notions embodied in Yates's (1998) synthesis. In that view, a good decision is one that exhibits few serious deficiencies. Decision deficiencies, in turn, come in five varieties:

Aim Deficiencies. An aim deficiency occurs when a decision fails to meet the decision maker's explicitly formulated aim(s). Suppose a job seeker chooses a particular job with the goal of making \$40,000 within 2 years. If, however, at the end of 2 years he is making only \$32,000, then the original decision was deficient in the aim sense.

Need Deficiencies. People do not make decisions for no reason. Rather, decision episodes are instigated when a person senses that some need either is unmet currently or will be unmet in the future unless a decision is made. The decision maker may or may not recognize what the true need actually is, hoping to capture it in broadly conceived aims. Regardless, if the decision fails to quiet that instigating need, then a need deficiency has occurred. If our job seeker had indeed achieved his \$40,000 goal, he might still have felt the emptiness he was expecting to escape by attaining that goal. His unsettling ennui made it clear that something was amiss, suggesting the need for a decision. But the decision he actually made was deficient in meeting whatever that need happened to be.

Aggregate Outcomes Deficiencies. It is not at all unusual to have decision makers report that, although a decision meets their aims (and perhaps their original needs as well), that decision is disastrous because other outcomes are negative and outweigh the aim achievement (e.g., a newly chosen job pays extremely well but is numbingly dull). Such a decision exhibits an aggregate outcomes deficiency: collectively, the entire array of outcomes from the decision leaves the decision maker worse off than some reference, for example, the status quo.

Competitor Deficiencies. Suppose that, at the time a decision is made, some other option is available (or could be created), which would leave the decision maker in a better position than the decision actually pursued. Then, even if the selected option is okay with respect to the previous criteria, it is still deficient in the competitor sense. Thus, a job that is identical to a perfectly fine job but pays \$1,000 more makes the selection of that "perfectly fine job" deficient in the competitor sense.

Process Cost Deficiencies. Suppose that Decision A is the same as Decision B except that it takes twice as long to arrive at Decision A. Then, Decision A is deficient in terms of its process costs. More generally, a decision exhibits a process cost deficiency to the extent that the decision maker incurs inordinately high costs

in making that decision, costs such as time, money, effort, and tolerance for aggravation of various kinds (e.g., the kind of anxiety that indecisive decision makers tend to report; Frost & Shows, 1993).

What do these observations have to do with research on decision making and aging, or actual health care practices involving older persons? Contrast the situation with that for memory and aging research. At the risk of overstatement, the appropriate criterion in the typical memory study is straightforward and uncontroversial. The research participant either does or does not freely recall a given item that was presented during the earlier learning stage of an experiment. And it is "simple" to determine whether the probability of such a recollection is higher or lower for older than for younger participants. Ideally, what would we do in order to make a similar determination about the probability of making a good decision in an ecologically representative situation? We would appraise decisions against each of the yardsticks implicit in the deficiency classes described earlier.

Although there is insufficient space here to describe all the details, it takes little to convince anyone that following the proper script for assessing decision quality is an arduous enterprise indeed. And that is why, in actual practice, decision researchers virtually never do follow it, in the context of aging or more generally. So, what does happen in practice? One strategy is to avoid the complications by ignoring them or by limiting attention to situations in which there is arguably only a single overriding consideration. The best example of this approach is provided by the vast number of studies that examine how much money (or how many reward points) participants accumulate via their decisions. Another tack is to establish by fiat some particular theoretical criterion as the yardstick against which research participants' decisions are measured. Frequently used standards include expected value, expected utility, and multiattribute utility or value (e.g., Bettman, Johnson, Luce, & Payne, 1993).

The most common and perhaps most generally defensible strategy that is used rests on assumptions or expectations about connections between ultimate decision quality (e.g., deficiencies) and specific elementary operations the decision maker might perform. Probably the best illustration of this "process approach" to decision quality assessment is implicit in the enormous literature on so-called judgmental heuristics and biases, most visibly identified with Tversky and Kahneman (e.g., Tversky & Kahneman, 1974). There, the focus has been on, for instance, how people arrive at their judgments of event chances and how good those judgments are. The latter is established by observing whether the focal events actually happen or by comparing the judgments to the prescriptions of probability or statistical theory (cf. Yates, 1982, 1990). The eminently reasonable underlying assumption is that such judgments contribute substantially to people's decisions. For instance, if a car buyer sees cars A and B as equivalent except that A is likely to have better resale value in five years, then the buyer can be expected to purchase A.

It is important to recognize that seemingly innocuous assumptions like these can be wrong. Poses, Cebul, and Wigton (1995) provided a good illustration. These

investigators trained physicians to make better probability judgments for streptococcal pharyngitis, with the expectation that this would reduce those physicians' overprescription of antibiotics. The training did indeed markedly improve the physicians' judgments, but this had no effect at all on the treatments they selected.

The particular instantiation of the process evaluation approach we advocate (cf. Yates, 1998) differs in subtle but important ways from others that are common in the decision literature (see, for instance, Baron & Brown, 1991; Janis & Mann, 1977). It is interesting that this strategy, which we describe in the section on cardinal decision issues, just happens to be captured partly by some contemporary techniques for evaluating the competency of older patients for making their own treatment decisions (cf. Marson, Ingram, Cody, & Harrell, 1995). A topic for consideration by competency specialists is whether and how those techniques might be refined to correspond even more closely to current decision theoretic conceptions of decision quality. It is curious that the legal standards guiding the techniques make no acknowledgment of what we have noted makes decision making unique among cognitive functions—subjective value. Before pursuing the cardinal issues at the core of our recommended evaluation approach, we must bring attention to a class of distinctions that might well have special significance for age variations—distinctions among various decision modes. As will be apparent, the recognition of such modes provides a plausible explanation for puzzles like those posed by the results of Poses et al. (1995).

DECISION MODES

Decision making can be seen as operating in three modes: analytic, rule-based, and automatic (Yates, 1998). These are qualitatively distinct patterns of procedures that people of all ages use in making decisions. A decision situation that arises routinely in driving a car—whether to try to pass a huge trailer truck ambling along in front—illustrates the distinctions:

- To a new driver who was licensed just this morning, a truck-passing decision is a terrifying one that is made by doing things like deliberately considering and comparing the alternatives (as well as the other activities entailed in addressing the cardinal issues discussed later). New drivers make the decision via the *analytic decision mode*, effortfully reasoning through to what action makes sense given their personal representation of the circumstances.

- A driver who has been taught professionally is likely to have been given a set of rules about when one should and should not attempt a passing maneuver. An experienced untutored driver could have developed similar rules simply through that experience. Either of these drivers, however, employs the *rule-based decision mode*. In such circumstances, decision makers compare their representation of the decision problem to the preconditions, C , of a decision rule of the form $C \rightarrow A$. If

the representation-precondition correspondence is sufficiently close, the decision maker follows the rule's prescription, selecting action A.

- Drivers who have been on the road many years seem to give no thought at all to the passing decision, perhaps even continuing a normal conversation while making it. The decision appears to simply pop out quickly and effortlessly. Indeed, if asked how they arrived at their decision, they might well not recall having made a decision at all ("What truck?") and thus certainly could not describe how they did so. The decision was made in the *automatic mode*, a behavior displaying all the commonly acknowledged markers of automaticity (see the now-classic papers by Schneider & Shiffrin, 1977, and Shiffrin & Schneider, 1977). Both the rule-based and automatic decision modes rely on $C \rightarrow A$ sequences and matches between precondition C and the decision maker's representation R of the situation. In rule-based decision making, the match between C and R is a deliberative judgment. In contrast, in automatic decision making, after the representation R is constructed, if there exists a sufficiently close match between R and the precondition for some particular action sequence $C \rightarrow A$ readily available in long-term memory, then action A is evoked, essentially involuntarily.

As implicit in our illustration, we should expect decision modes to evolve, often according to the following developmental sequence:

Analytic \rightarrow Rule-Based \rightarrow Automatic.

That is, when untutored decision makers first encounter a particular kind of decision problem, they must deal with it analytically. After seeing similar situations repeatedly, they develop a rule for handling them, which is then invoked in the rule-based mode as pertinent cases arise. Alternatively, those rules might be provided by others, for example, mentors, as in medical training. Regardless of their original source, after those rules have been applied many times, they become automatized, and the automatic decision making mode takes the stage, that is, a habit develops (cf. Ronis, Yates, & Kirscht, 1989).

We should also anticipate a characteristic episodic sequence:

Automatic \rightarrow Rule-Based \rightarrow Analytic.

Thus, in a particular decision episode, given its nature, if the automatic mode can be applied, it will be applied. If it cannot, for reasons of cognitive economy (cf. Payne, 1982), because rule-based decision making is faster and less demanding than analytic, the decision maker will attempt rule-based decision making. Only as a last resort will the analytic mode be invoked.

Does reliance on different decision modes change systematically over the life span? We have seen no evidence that the issue has been addressed directly as such in the literature. This is unsurprising in view of the fact that mainstream decision researchers themselves are only presently coming to appreciate mode distinctions

in general (cf. Klein, 1993). So we can only speculate about plausible age differences in mode use and suggest specific issues that future work should pursue.

It seems reasonable to expect that, as people age, they will depend less on the analytic mode and more on the rule-based and automatic modes. This expectation in part derives from the nature of the analytic mode. That mode imposes especially heavy demands on working memory, for example, in making comparisons among the strengths and weaknesses of available alternatives. Numerous studies have demonstrated convincingly the degradation of working memory functioning with advancing age (e.g., Salthouse & Babcock, 1991). Such work has also shown how declines like these interact with the slowing of cognitive operations to attenuate performance on complex tasks not unlike those required in analytic decision making (e.g., Salthouse, 1992, 1996). Now, older adults could simply continue to attempt analytic decision making as their cognitive abilities diminish, blithely accepting the resulting poor decisions. Previous decision work on cognitive economics (cf. Payne, 1982) suggests that this is unlikely, though. Instead, older adults can be expected to respond strategically to their limits, by reducing their dependence on the costly analytic mode. Indeed, some studies revealing older decision makers' abbreviated cognitive analyses have been interpreted in precisely this way, as illustrating deliberate attempts to conserve diminished resources (e.g., Meyer, Russo, & Talbot, 1995).

The anticipated changes in decision mode reliance could be simply the logical consequence of the developmental sequence we described, along with the mere fact that older adults have made more decisions than younger adults. Research on experience effects on decision behavior agrees with this expectation. Consider, for instance, the work of Myles-Worsley, Johnston, and Simons (1988). These investigators examined the abilities of radiologists to detect abnormalities in chest X-rays. They found that, as experience increased, there was a greater tendency for senior radiologists ($M = 22$ years experience) to approach the abnormality recognition task in the same way that we all recognize faces, automatically, and to accomplish it more effectively. It is interesting that greater experience appeared to diminish the radiologists' abilities to remember normal X-rays. This might be an instantiation of a more general principle whereby, with age, we lose our skills at performing unpracticed analytic decision tasks that have minimal significance to us.

Suppose the speculation about how decision mode reliance changes over the life span is true. What are its practical implications? It says that older adults (and those affected by their decisions) will profit from the usual benefits of rule-based, and especially automatic, decision making and will suffer from their drawbacks. The advantages include (ironically?) their speed (as perhaps illustrated by the unusually fast breast cancer treatment choices made by the older respondents of Meyer et al., 1995). The disadvantages include the fact that the decision maker might be more poorly prepared to accommodate novel circumstances. This then places a premium on mode control. Thus, from the perspective of a given older adult, the problem is how to ensure the appropriate application of the decision rules and action sequences acquired over the years. From the point of view of a group to which an older adult

belongs (e.g., a medical practice, an executive committee, or a family), the problem is how to make certain that that member's rules and sequences are exploited to their fullest extent when applicable and are not called forth when they are inapplicable. As noted by Salthouse (1982, chapter 5), research on aging and cognitive flexibility suggests that mode control is indeed problematic for older adults when left to their own devices. For instance, at least one well-known study (Heglin, 1956) found that older adults exhibit the Einstellung effect more strongly than younger individuals. This is the phenomenon such that, when a complicated procedure for solving a class of problems has been learned, one persists in attempting that procedure on problems that are superficially similar but are actually solvable by a simpler procedure (Luchins, 1942).

AGENCY: YET ANOTHER MODE?

Curley, Eraker, and Yates (1984) presented hospital outpatients and their spouses with the following scenario:

Suppose you find it hard to walk after going several blocks. To keep walking leads to stiffness and a dull pain in your legs. So you come to the clinic. A treatment is available, but it is risky. The treatment may work well, or it may make you worse. If the treatment works, you will be able to walk about twice as far before the stiffness begins. And the pain will be less than before the treatment.

If the treatment does not work, you will always have stiffness in your legs when you walk. And you will begin to feel the dull pain after only a block of walking. If you do not choose to have the treatment, you will stay as you are. (p. 505)

The purpose of the study was to determine whether and to what degree patients' treatment choices in such situations are affected by the nature of the uncertainty, for example, whether the patient is told by a physician that the chances of treatment success are 5 in 10 or could range anywhere between 3 in 10 and 7 in 10 because the procedure is new. The interest here, however, is in how subjects responded to another option presented to them, to indicate: "I would rather not make the choice at all. I would prefer that the doctor decide if I would have the treatment" (p. 506).

About one third of all the subjects in the Curley et al. (1984) study deferred to the physician. But this tendency was much stronger for older than for younger respondents. For instance, whereas fewer than 20% of those in ages ranging from 16 to 39 deferred, more than 45% of those between ages 50 and 86 did so. This result provides a good illustration of a potentially important age variation in decision making—reliance on agents. It suggests that, as people advance in age, they are more likely to "commission" others to make their decisions for them. In a sense, such commissioning constitutes another decision mode beyond the analytic, rule-based, and automatic forms. Note that decision agents are not necessarily real

people; they could be any of the computerized decision aids that are becoming increasingly common.

Surprisingly, we have been unable to find systematic research on the decision agency-age connection as such. Nevertheless, several issues that should be pursued by future work on the problem are apparent. First of all, there is the question of whether older adults do indeed tend to assign their decision-making chores to others more often than do younger adults. There are tantalizing suggestions that the Curley et al. (1984) results are not anomalous. For instance, other research also reveals an inclination for older adults to forego risky decision-making opportunities when they can (e.g., Calhoun & Hutchison, 1981). Or consider Deber, Kraetschmer, and Irvine's (1996) finding that older patients tend to ask for less information from their doctors. If the treatment decision is to be turned over to the physician, it makes sense to ask few questions about it. Studies also indicate that older adults tend to have higher "powerful others" scores than younger adults on locus of control scales. This might be especially significant in that other research reveals a negative association between "powerful others" scores and inclinations to request medical information (see Rogers, 1997).

Suppose that older adults are in fact strongly inclined to call upon decision agents. Why is this so? Several possible answers to this question should be pursued:

- One potential explanation is that the age-agency association is a cohort artifact. Participative health care decision making is somewhat popular now. But when today's older adults first came in contact with the health care system, paternalistic health care was the norm. Thus, those individuals' strong inclination to defer to physicians might reflect mere ingrained custom rather than a deliberate metadecision to assign decision-making functions to others.
- A second possibility is that older adults—rightly or wrongly—suspect that their personal decision skills are diminishing. They hence quite sensibly seek to compensate for this loss by deferring to those with better skills.
- A third reason might focus on effort. Even if an older adult believes he or she is fully capable of performing some decision task, he or she might not have or wish to expend the energy required to do so (an implicit recognition of the process cost form decision deficiencies can assume).
- Yet another alternative is also economic in the broad sense. In direct and opportunity costs, it is less expensive to have a mechanic repair one's car than to try to do it oneself. Similarly, especially in terms of opportunity costs, it is far more cost effective to have a clerk who makes \$15,000 a year sort \$70,000-a-year professors' mail than to have the professors do it for themselves. The typical older adult has had many opportunities to gain an appreciation for such principles. Moreover, many older adults have risen on the economic ladder such that they are quite accustomed to delegating various functions. Therefore, for them, commissioning the services of a decision agent is anything but an admission of diminished abilities, but is instead merely an exercise in intelligent executive action.

• A final possibility is mindful of variations observed in cross-cultural psychology. In the culture of the United States, the ability to decide is regarded as a fundamental right that should be protected at all costs. Witness, for instance, how debates about abortion and managed care are often couched, that is, in terms of a woman's right to choose what happens to her body and a patient's ability to select his or her own doctor, respectively. The preoccupation in the United States with making one's own choices is often interpreted as simply one element of a more general Western value for an independent construal of the self. (Parents exhort their children to be self-reliant, to "stand on your own two feet.") It is significant that this value is not universally shared, with numerous non-Western cultures regarding interdependence with others more positively (cf. Markus & Kitayama, 1991). In the same way, it may be that the significance of personal involvement in making decisions diminishes in later adulthood. Indeed, the sharply reduced vigor with which older adults invest themselves in decision tasks (e.g., Meyer et al., 1995) is consistent with such a value change. Perhaps they reason, "I just no longer think it's all that important."

The practical questions raised by older adults' greater use of decision agents mainly center on the management problems that occupy the attention of agency theory (cf. Eisenhardt, 1989). One of those problems is selection: How do older adults choose their decision agents, and how effectively do they do that? Are they, for instance, so eager to defer that they are insufficiently vigilant in screening the potential agents who just happen to come along? The other big problem is the central concern of formal agency theory: How can older adults assure that an agent, once chosen, attempts to make decisions that are truly in their interests? Put another way, how can such a principal compensate the agent such that it is in the agent's interests to make decisions that are good from the principal's perspective? There are plenty of stories in the news describing how unscrupulous entrepreneurs victimize older adults by exploiting their vulnerabilities. Why should we not expect similar attempts in the arena of decision agency?

CARDINAL DECISION ISSUES

A careful examination of real-life, practical decision episodes reveals a limited set of fundamental issues that tend to recur (cf. Yates, 1998). Careful analysis also suggests that the quality of the eventual decision that is made depends on how well those issues are resolved. Their frequency and significance thus justify calling these issues "cardinal." At minimum, cardinal decision issues provide a framework for examining systematically the potential differences in how two populations, such as older and younger adults, decide. But they also provide a defensible means of getting at quality issues. To the extent that particular issues are handled well, we can be reasonably confident that the resulting decisions will exhibit few serious

deficiencies. Here we review several of the cardinal issues distinguished in Yates's (1998) analysis, focusing on those for which age differences in how they are addressed are most plausible.

Options

In the voice of the decision maker, the options issue is this: "What are the actions I could take in this situation?" This issue speaks most directly to the competitors form of decision deficiency. That is, in mishandling the options issue, the decision maker fails to even consider an available alternative whose aggregate outcomes are superior to those of the option ultimately selected. Conversely, decision makers handle the options issue well if they do, in fact, bring to mind (or create) a set of alternatives that includes those that actually are most suitable. Of course, effective handling of the options issue also requires that the collection of options presented for careful deliberation does not also include an overwhelming variety of unsuitable options.

How should we expect older and younger adults to compare in their handling of the options issue? At least superficially, the literature that is most directly relevant to this question is that concerning age differences in divergent thinking, the generation of large numbers of distinct yet acceptable solutions to a given problem. There have been repeated, careful examinations of the inevitable declines in divergent thinking in varied domains. Work by McCrae, Arenberg, and Costa (1987) is illustrative. These authors found sizable differences in the ages at which declines in scores on six different divergent thinking tests began, as well as the rates at which those declines occurred. Nevertheless, the latest point of initial decline was at about age 50.

Taken at face value, results like those of McCrae et al. (1987) suggested that skill at handling the options issue should begin deteriorating rather early in the mature adult portion of the life cycle. This is probably an inappropriate conclusion, however. That is because, as will be recalled, proper handling of the options issue prohibits the generation of large numbers of options that eventually would prove inferior. As those who study decision making in a wide variety of natural settings submit (e.g., Klein, Orasanu, Calderwood, & Zsombok, 1993), one of the last things real-world decision makers, such as fire fighters, want to do is wade through large numbers of alternatives. Instead, they want to zero in immediately on the best option, or at least one that is "good enough." There have been numerous indicators that experience, which obviously increases with age, allows people to do that. Indeed, at least one study has provided fairly direct indications that younger adults might tend to waste their energy generating excessive numbers of options that do not ultimately yield better decisions (Streufert, Pogash, Piasecki, & Post, 1990).

The usual—and quite plausible—account for such effects is "perceptual" in a particular sense. That is, over time, experienced decision makers come to recognize characteristics of problem situations that lead them to call forth solutions that are especially likely to be good ones. (Recall that this is what is expected to happen in

the emergence of rule-based decision making in a given context.) Thus, brute-force chess computer programs clearly can generate and evaluate thousands of move sequences far faster than the best master. But even an old master would waste no time on most of those moves, but instead, would immediately narrow his or her attention to ones that are likely to be promising, so that the master can compete quite well against most of the best programs (cf. Charness & Bosman, 1990).

With advancing age, circumstances are likely to favor divergence, the strong suit of the young. Why? At least two reasons. First are the documented difficulties older adults have even with long-term memory retrieval (cf. Hasher & Zacks, 1988). Thus, even if older decision makers have, in fact, successfully solved an earlier decision problem similar to the current one, they might have great difficulty recalling the option pursued on that occasion—if not the decision problem itself. There is also the problem of interference. As decision makers age and accumulate more decision experiences, it becomes progressively easier for them to bring to mind at least one experience that seems somehow related to virtually any decision problem that arises. Unfortunately, the connections might be so tenuous that they mislead the decision makers, effectively leading them down blind alleys. And then, there is the fact that real life has a habit of presenting decision problems that are truly unique, in which case recognition of prior analogs is moot. In those circumstances, younger decision makers should be greatly advantaged by the “fluid intelligence” demands of the requisite analytic decision making (cf. Salthouse, 1992, 1996).

Many practical decisions are made collectively (e.g., in committees) rather than by individuals. The previous considerations suggest that such collectives would do well to seek the diversity of membership commonly recognized by group decision researchers as essential to good option generation (e.g., Valacich, Dennis, & Connolly, 1994). In particular, it is in the interests of those collectives to draw upon the option-generation efforts of both older and younger members because their contributions are likely to be quite different. Further, procedures should be developed whereby those special contributions are exploited to their fullest. For instance, in a policy decision situation, it might make sense to encourage older members to search their experiences for circumstances that are even remotely similar to the current problem. The options employed in those earlier instances might serve as useful starting points for deliberations. Given the difficulties older adults have with long-term memory retrieval, mnemonic devices—including simply the opportunity to take more time—should be provided to older group members to help them mine their experiences.

Possibilities

Again, as the decision maker might put it, the possibilities issue is the following: “What consequences could possibly result from various actions—consequences I care about?” People who make decisions they regard as disasters often report that they were “blind-sided.” That is, their decisions brought about bad outcomes that

never even crossed their minds when they were contemplating those decisions. In our terms, they mishandled the possibilities question.

Despite its obvious importance, the possibilities issue only rarely has been acknowledged as such in any decision literature. Thus, the best anyone can do is draw tenuous inferences from related research in speculating about age differences in how people address the possibilities problem. There are clear parallels between the options and possibilities issues. So most conclusions about the former should apply to the latter. Nevertheless, there do seem to be differences between the two issues that should imply nonidentical age effects. In particular, in a given situation, the possibilities problem seems more closely circumscribed. After all, in the possibilities stage of a decision episode, the decision maker needs to anticipate the outcomes each given option is capable of yielding, only one option at a time. This seems less daunting than trying to envision the more ill-defined (and probably generally larger) pool of options capable of producing some particular desired outcome.

There are two basic tacks a decision maker can take in addressing the possibilities issue. The first is to rely on memory. The decision maker could attempt to recall what happened in past instances when options similar to the one under consideration were pursued. In principle, older decision makers should have a marked advantage with this approach. They have directly experienced more decisions and their aftermaths. Moreover, they have had more opportunities to hear or read of cases they have not witnessed firsthand. Advantages like these should not be taken lightly. Every organization or enterprise routinely benefits from the informal institutional memory embodied almost exclusively in its older members. The psychological research community itself provides a good example. For well-known reasons, negative results are rarely published. Thus, every year new researchers routinely repeat essentially the same attempts to find plausible but nonexistent effects that earlier investigators tried and failed to find. There would be even more such futile attempts except for the advice passed along informally from older to younger colleagues.

It is unfortunate, as noted previously, that research (e.g., Hasher & Zacks, 1988) has suggested that older adults might have great difficulty exploiting the rich sources of possibilities contained in their long-term memories. Other research suggests that prospects are probably even bleaker for the alternative means of addressing the possibilities issue, that is, deductive inference. By this approach, the decision maker starts with the presumed nature of the decision circumstances and, via chains of arguments, derives the "logically feasible" potential outcomes of the options. As also noted, a variety of studies over a long period of time demonstrate how challenging comparable fluid intellectual tasks are for older adults.

Realization

In posing the realization issue, the decision maker asks: "Would the possibilities I have envisioned be realized? Would they actually occur?" The judgment tasks

examined in the well-known heuristics and biases tradition we mentioned before (Tversky & Kahneman, 1974) are perhaps the most easily appreciated exemplars of how people are presumed to address the realization question. A prototypical problem in that tradition would be judging how long it would take to complete a given project. Such an assessment could have particular decision significance because it would dictate whether and when to accept other projects. There have been repeated demonstrations that people routinely underestimate project completion times and that they do so because of their mismanaged reliance on particular heuristics (e.g., Buehler, Griffin, & Ross, 1994).

We have been struck—and puzzled—by the near-total absence of research examining age variations in how people approach the realization issue. This is surprising if for no other reason than the sheer size of the judgment literature and the importance of the issue. As is well recognized, judgment accuracy imposes a strict ceiling on decision quality. Accordingly, no matter how well a contractor handles other aspects of planning decisions, if the time it will take to complete his projects is repeatedly and grossly misjudged, the contractor will go broke. At any rate, Mutter and Pliske (1994) reported the only two recent studies concerning age variations in basic judgment processes of which we are aware. It is hence of some interest to examine them with some care.

In their first study, Mutter and Pliske (1994) considered age differences in covariation judgment, that is, assessments of whether, how, and to what extent two variables are related to each other. Such judgments are clearly fundamental to good decision making. For instance, suppose a loan officer predicts applicants' repayment behavior on the basis of information that in actuality has no reliable connection to such outcomes. Then, these predictions necessarily must be worthless. Research dating from the 1960s (e.g., Chapman & Chapman, 1967) has been interpreted as indicating that people—including professionals—often perceive "illusory correlations." Thus, imagine a subject being shown a collection of cases, each describing a characteristic of a psychiatric patient (e.g., whether or not he is homosexual) and a record of that patient's interpretation of a Rorschach card (e.g., whether or not it has anal connotations, such as "a horse's rear end"). The task of the subject is to judge the (possible) association of the patients' characteristics with their Rorschach interpretations—for the cases presented to the subject, not patients in general. In reality, there is no statistical association at all in those cases. Nevertheless, in situations like these, subjects often report seeing associations that are consistent with intuitive associations (e.g., homosexuality and anal interpretations). Mutter and Pliske found that older subjects were even more inclined to exhibit such illusory correlations than younger subjects.

Mutter and Pliske (1994) offered plausible accounts for the observed differences in terms of memory processes, the differential ease with which older and younger adults can retrieve information consistent and inconsistent with preexisting schemas. Future work should evaluate these hypotheses more directly. In addition, however, alternative or complementary hypotheses similar to those that have appeared in other work on contingency judgment should be considered.

One alternative perspective is similar in spirit to a normative Bayesian analysis of such problems (cf. Yates, 1990, p. 182, Problem 6). Suppose that subjects failed to recognize correctly their task as judging the contingency present solely in the data presented in the experiment. Instead, suppose they thought their task was to assess the contingency based on both their prior beliefs as well as the current data. Because the older subjects would have held their prior beliefs longer, they could be expected to hold those beliefs more strongly. A Bayesian analysis would prescribe that the new data should have less impact on their assessments, as was indeed the case. (Incidentally, studies have shown that illusory correlation does in fact diminish upon exposure to large numbers of observations.)

Another alternative take on the illusory correlation-age connection entails an entirely different class of accounts for contingency judgments, one that rests on psychological association strength (cf. Price & Yates, 1995). In this view, people's reports of their judgments about event contingencies are actually translations of how strongly those events are associated psychologically. There is quite good evidence that association models often provide more parsimonious explanations for contingency judgments than the general class of models implicit in Mutter and Pliske's (1994) interpretation of their results. Those models could also comfortably account for the observed connection between age and illusory correlation. These observations further highlight the very real need for studies that examine more directly possible age variations in contingency judgment under broad conditions. Of special interest would be studies that consider contingency judgments in completely novel situations, where subjects have no prior expectations. An initial analysis suggests that the kinds of rule-based models presumed by Mutter and Pliske would predict substantial age differences because of the heavy memory demands those models entail. Association strength models would not.

Overconfidence is a topic that has attracted intense scrutiny in the decision research community. This is the phenomenon whereby people seem to believe that their judgments are more accurate than they actually are. The subject has been considered important, among other reasons, because of its presumed metacognitive implications (cf. Russo & Schoemaker, 1989). After all, if a decision maker believes that the quality of his or her judgment is better than it really is, he or she should be overly content with his or her abilities, foregoing efforts to improve those skills. Pliske and Mutter (1996) pursued the question of whether there are age differences in overconfidence, focusing on general knowledge (e.g., answers to questions of the form, "Which city is farther north: (a) London or (b) New York?"). Contrary to their expectations, Pliske and Mutter found no solid evidence that older adults were less overconfident than younger adults.

What should we make of a negative result like this? This is not entirely clear, on several grounds. Pliske and Mutter found that their older subjects successfully answered more questions than did their younger subjects. It is well known that confidence judgments exhibit a "hard-easy effect," such that people tend to exhibit overconfidence for hard items but underconfidence for easy ones (e.g., Lichtenstein & Fischhoff, 1977). This therefore raises the question of whether Pliske and Mutter

would have observed a difference in overconfidence had they been able to control for item difficulty. There is also the question of exactly why such overconfidence differences may or may not occur. Pliske and Mutter anticipated that older adults would be less overconfident than younger ones on the basis of previous "adult wisdom" research suggesting that older adults should have improved recognition of their limitations. The most promising contemporary accounts for the general phenomenon of overconfidence are quite different. Contrary to common lay and scholarly beliefs (cf. Yates, Lee, & Shinotsuka, 1996), there is little evidence that overconfidence rests on people's self-assessments of their abilities. Instead, it appears to result from peculiarities of the purely cognitive mechanisms by which people arrive at their responses to individual questions, for example, their failure to bring to mind arguments contrary to their chosen answers. Only additional research can establish whether those mechanisms differ over the life span.

Value

The value issue presents this question from the decision maker's perspective: "How much would I really care about various decision consequences, were they to actually occur?" As we noted before, the values implicit in this question are at the heart of what makes decision making special. When we inquire about age differences in how the value issue is resolved, we are actually asking about two different things. The first is whether values tend to change systematically as people age. To the best of our knowledge, this question has not been addressed in the scholarly literature. But it has been considered and answered in the affirmative repeatedly in various practical contexts. Thus, marketing demographers have firmly established that age groups differ in their tastes for various goods and services. (Why such variations exist is another story, with changing physical and financial needs as well as simple cohort effects being leading explanatory candidates.)

The more interesting side of the age-value question concerns self-insight, the essence of the value issue as articulated earlier. Decision makers are said to exhibit good *self-insight* into their values to the extent that they know what those values actually are. It stands to reason that when self-insight is weak, poor decisions are inevitable. That such insight can be systematically (and sometimes surprisingly) deficient has been demonstrated in a variety of ways (e.g., Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Kahneman & Snell, 1992). Here, we can ask whether, how, and why such self-insight would vary across the life span.

It seems intuitively compelling that people would learn more and more about their values as they grow older. A long life provides ample opportunities for "experimentally testing" one's value system to determine how it is "wired." Thus, even if you are childless, you surely have some notion of how you would respond to the various aspects of what parenthood entails (e.g., total responsibility for another life). But it is only through direct experience with your first child that you can begin to understand how nature really has equipped you to react to those elements of parenthood, to say nothing of learning what those elements actually are

(cf. Yates & Stone, 1992a, pp. 63–67). You might discover that you are indifferent to (or even embrace) things you expected to find repugnant, or the other way around.

Is there any evidence that people do indeed exploit the value of learning opportunities that age provides them? As we have been forced to acknowledge so often in this review, there has been virtually no research on the question, only hints from limited related work. In the aging literature per se, studies of wisdom seem most pertinent. There have been suggestions that a significant part of wisdom is *value relativism*, as Baltes and Smith (1990) put it, an appreciation for (among other things) the widely divergent value systems that different people tend to possess. Empirical research (e.g., Baltes, Staudinger, Maercker, & Smith, 1995) shows that wisdom measures, including measures of value relativism, do not exhibit the age declines so common in other contexts. It is perhaps not too much of a stretch to infer from such findings that value self-insight itself might be relatively immune to age declines as well. So, if one recognizes that people's values in general can be surprising, one might suspect that one's own could be surprising as well and therefore scrutinize them more carefully.

Cast against such optimistic, even if tenuous, conclusions, there are pessimistic findings as well. Decision researchers have studied various forms of self-insight since the 1970s (e.g., Reilly & Doherty, 1992; Wilson et al., 1993; Zedeck & Kafry, 1977). One of the most influential self-insight studies was among the first, by Slovic, Fleissner, and Bauman (1972). That study focused on self-insight into judgment policies rather than values per se. Specifically, it examined how respondents made predictions of changes in the prices of financial securities on the basis of various characteristics of the securities, for example, price-to-earnings ratios. Subjects reported how they thought they went about the task, including the emphasis they placed on particular features. The investigators constructed models that described quite well how each respondent did indeed accomplish the task. Self-insight limitations were revealed to the extent that there were discrepancies between a given respondent's model and his or her report of how he or she made his or her judgments. For our purposes, the most significant aspect of the findings was that self-insight was inversely related to experience, with professional brokers exhibiting worse insight than master's of business administration (MBA) students.

How should we interpret findings like these, and what is their significance for the value issue? First of all, note that analogous conclusions are anticipated and found in other domains. Indeed, common conceptions of the development of expertise (e.g., Anderson, 1990) propose that we should routinely expect that, as competence emerges, our procedures for accomplishing a task become automated, and we thus lose our access to those operations. The key question is this, however: When we make repeated decisions in a certain class and then experience the consequences of those decisions, do we lose access to the polarity and intensity of our evaluative experiences of those consequences? To the degree that the underlying processes are the same as those supporting more purely cognitive judgment tasks, that is indeed what we should expect. Unfortunately, we do not yet know enough about those processes to tell for sure. Nevertheless, we have seen nothing in the

literature to suggest that conclusions about judgment self-insight do not generalize to value self-insight.

Conflict

The final cardinal issue we examine concerns conflict. As before, in the decision maker's voice, that issue is this: "Suppose that some considerations favor one action but others favor a competitor. How should I resolve this conflict?" In most nontrivial decision episodes, the conflict issue inevitably arises in some form or another. Imagine, for instance, a patient pondering whether to accept some new medicine prescribed by a physician. Using a commonly recommended strategy for making good decisions, the patient lists the pros and cons as follows:

<i>Pros</i>	<i>Cons</i>
Shorter periods of pain	High cost
Ability to work longer	Loss of appetite
	Occasional drowsiness

The patient feels that the list helps reveal the nature of the problem more clearly. But the patient is still left with the task of concluding whether the pros outweigh the cons, or vice versa. How do people work through conflicts like this, and do their resolution schemes depend on their ages?

There are actually two distinct aspects to the conflict issue, which we might call the *procedure* and *parameter* questions (Yates, 1998). Let us first consider the procedure question, which is the one most often (and most satisfactorily) addressed in the decision literature, even though it is not labeled as such. The most frequently discussed procedure distinction is that between compensatory and noncompensatory schemes. In a *compensatory* procedure, it is possible in principle for any weakness to be offset (i.e., compensated for) by one or more strengths, and vice versa. Thus, suppose our medical patient's mechanism for resolving the conflicts between the pros and cons of a newly prescribed medicine is compensatory. Then, even though the medicine is expensive, this does not rule out the possibility that the benefits of the medicine are so great that it is still acceptable. On the other hand, suppose the patient's scheme entails a budget limit and that the medicine's cost exceeds that limit. Then no matter how good the medicine might be, it cannot be used; nothing can compensate for the excessive price.

Compensatory decision schemes generally require quite thorough processing of all the information available about every option. Hence, in our example, the patient would probably contemplate all five of the pros and cons in the list if the conflict resolution approach were compensatory. In contrast, *noncompensatory* schemes often demand minimal information processing. Continuing the previous illustration, once our budget-limited patient observes that the new medicine exceeds the

budget allowance, there is no need to consider anything else; it is eliminated from consideration. Careful analyses (e.g., Payne, Bettman, & Johnson, 1988) have demonstrated that noncompensatory strategies really are generally less demanding than compensatory strategies. Such analyses have also indicated that people tend to shift between the two classes of procedures adaptively in response to the constraints placed upon them, for example, calling on noncompensatory schemes when time is short.

These observations lead quite naturally to the prediction that older adults would rely more heavily on noncompensatory rather than compensatory procedures than would younger adults. This follows from the assumption that older adults are cognizant of the special difficulties they seem to have with operations that make such heavy demands on resources like working memory. And at least one study, that by Johnson (1990), reports the predicted age dependency. Besides the fact that the Johnson study is just that, one study, there are several reasons for caution in immediately accepting the conclusion that older adults' conflict resolution schemes tend toward the noncompensatory and for reasons of cognitive economy.

One especially intriguing alternative potential account for the kinds of data reported by Johnson (1990) involves a radically different perspective on conflict resolution. Pennington and Hastie's (1993) story model of juror decision making illustrated the idea nicely. These authors provide convincing evidence that one way jurors reach their decisions is by trying (typically with prompting from attorneys) to create coherent stories that account for as much of the testimony as possible, elements of which superficially appear to be inconsistent. The verdict is prescribed by whether the story that does the best job of explaining the testimony agrees with the defendant's guilt or innocence. Now, it is plausible that, as a person grows older, he acquires more and more strongly held story schemas, in a wide variety of life circumstances. Thus, we should expect greater reliance with age on story-like means of resolving the conflict issue. Effectively, such schemes will bear closer resemblance to classical noncompensatory rather than compensatory routines. But the details and the motivation are markedly different. It is hoped that research in the near future will determine whether there is anything more than plausibility to this speculation.

The parameter aspect of the conflict issue concerns precisely *how* a particular resolution procedure will be applied in a given decision episode, to dictate whether option A or option B is the one that is actually pursued. Consider yet again the plight of our medical patient. Suppose that, for whatever reason, she settles upon a compensatory conflict resolution scheme. For concreteness, imagine that that scheme can be described by an additive rule as follows. The scheme says that the medicine should be accepted if the score S is greater than 0 and rejected otherwise, and S is given by

$$S = wRv(R) + wWv(W) - wCv(C) - wAv(A) - wDv(D) \quad (1)$$

where R = Relief of Pain and W = Work Allowed are the pros (which contribute positively to S) and C = Cost, A = Appetite Loss, and D = Drowsiness are the cons

(which affect S negatively). In Equation 1, we assume that all the considerations have been evaluated on similarly bounded value scales (the v 's, ranging, say, between 0 and 100). We also assume that the coefficients applied to those evaluations (the w 's) index the relative importance of those considerations (e.g., the w 's range from 1 for the least important factor to 10 for the most). In this form, it is clear what remains unsettled: Exactly what are the coefficients, or "importance weights," in the given instance. It is also apparent how intimately wedded are the value and conflict issues. That is, how the conflict will be resolved (whether S is positive) depends directly on how the various factors are valued relative to one another. So, if loss of appetite is highly important (i.e., the w_A parameter is large, say, 7), then rejection of the medicine (S is 0 or smaller) is more likely than if it is less important (e.g., $w_A = 2$). It is a curious and sad fact that decision research has had little to say about how people ought to settle upon the parameters implicit in their conflict resolution schemes (e.g., "How much should I care about loss of appetite?" or, equivalently, "How big should w_A be for me?"). The field has also been silent on how people in fact arrive at their parameter conclusions; it has only considered how to determine what those conclusions are (e.g., how much a patient believes that appetite loss really matters to him or her). A corollary is that the field has had almost nothing principled to say about the basis for possible age differences in such parameters and has offered only occasional suggestions about whether particular differences might actually exist.

No discussion of age and decision making would be complete without considering risk-taking. The topic fits quite naturally into the present perspective on the conflict issue. That is because every risk taking situation can be framed as entailing a conflict between risk, on the one hand, and everything else, on the other. At its most general level, *risk* is "the possibility of loss" (Yates & Stone, 1992b). Loss being unappealing by definition, any seriously considered option that contains risk must also entail positive aspects as well; otherwise, it would be dismissed out of hand. For example, no one would entertain investing in a high-risk junk bond unless it offered an exceptionally high interest rate. Now, a commonly shared intuition is that older adults are more risk averse than younger adults. Is this true, and if so, why is it true?

The literature on the possible connection between age and risk taking is perhaps surprisingly inconsistent. Some studies find the expected increase in risk aversion with age (e.g., Wallach & Kogan, 1961) whereas others do not (e.g., Holliday, 1988), with perhaps the consensus being consistent with the expectation (e.g., MacCrimmon & Wehrung, 1986). Why do the studies accord with one another so poorly? Relatedly, how can the various effects and absences of effects be explained?

In part, the inconsistency is undoubtedly due to the generally established conclusion that risk-taking behavior is highly situation specific (e.g., Bromiley & Curley, 1992). Thus, to the extent that different researchers demand different tasks of their subjects, they have a good chance of reaching different conclusions. Nevertheless, at least a cursory comparison of various studies suggests several hypotheses that should be pursued more carefully in future research. One of the

most appealing concerns data sources. It appears that most studies rely on subjects' responses to hypothetical, paper-and-pencil situations, often involving people other than themselves (e.g., the advice they would give to an engineer about whether he should change jobs). On the other hand, some studies (e.g., those of MacCrimmon & Wehrung, 1986) provide direct or indirect reports of respondents' own personal risk-taking behavior. And it is the latter which seem most believable and also indicate greater risk aversion by older adults.

Why would risk taking decrease with age? In discussions of financial risk taking, the general assumption is that the various age groups are responsive to the reality (which is also emphasized by financial planners) that, in the event they suffer major financial setbacks, younger adults have years to recover whereas older adults do not. In effect, the real risk facing young and old adults in superficially identical situations is not really the same; it is higher for older adults. Such a risk-perception basis for age differences in risk taking is also suggested by research on driving. For instance, Sivak, Soler, Trankle, and Spagnhol (1989) found that younger drivers saw significantly less risk in identical slide-projected traffic scenes than did middle-aged and older drivers.

Yet another possible "reality" basis for the age-risk aversion connection might be implicit in research on decision making and stress. There have been numerous demonstrations that time pressure tends to increase risk aversion. Ben Zur and Breznitz (1981) provided evidence about how this effect actually occurs. Specifically, time pressure induces people to pay relatively greater attention to potential losses and less to potential gains. Implicit is perhaps a strategic effect. If decision makers realize that there might be insufficient time to attend to everything, then they should pay attention to the most important things. And a wide variety of studies (e.g., Kahneman & Tversky, 1979) indicate that people are generally more sensitive to losses than to gains. Now, suppose that, in a given risky decision situation, older subjects feel compelled to decide rapidly (e.g., subjects are in a timed session) and recognize that they process information more slowly than they used to. Then, we should expect them to do what people generally do under time-pressured conditions—avoid the risks.

CONCLUDING REMARKS

Changes in basic decision processes over the life span—including declines of various sorts—are inevitable. After all, people rarely just sail along in their lives and then simply and suddenly die. We set out to create a synthesis of what has been established about the specific nature of the changes that tend to occur. As we got deeper into this enterprise, it became obvious how precious few solid facts researchers have actually determined. Thus, one of the few things that are crystal clear is how much work lies ahead. Achieving deep understanding in any given area depends heavily on having well-formed questions and a framework in which to conceptualize and pursue answers to those questions. We hope that the present effort represents at least a start in that direction.

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REFERENCES

- Anderson, J. R. (1990). *Cognitive psychology and its implications* (3rd ed.). New York: Freeman.
- Baltes, P. B., & Smith, J. (1990). Toward a psychology of wisdom and its ontogenesis. In R. J. Sternberg (Ed.), *Wisdom: Its nature, origins, and development* (pp. 87-120). New York: Cambridge University Press.
- Baltes, P. B., Staudinger, U. M., Maercker, A., & Smith, J. (1995). People nominated as wise: A comparative study of wisdom-related knowledge. *Psychology and Aging, 10*, 155-166.
- Baron, J., & Brown, R. V. (Eds.). (1991). *Teaching decision making to adolescents*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Ben Zur, H., & Breznitz, S. J. (1981). The effect of time pressure on risky choice behavior. *Acta Psychologica, 47*, 89-104.
- Bettman, J. R., Johnson, E. J., Luce, M. F., & Payne, J. W. (1993). Correlation, conflict, and choice. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 931-951.
- Bromiley, P., & Curley, S. P. (1992). Individual differences in risk taking. In J. F. Yates (Ed.), *Risk-taking behavior* (pp. 87-132). Chichester, England: Wiley.
- Buehler, R., Griffin, D., & Ross, M. (1994). Exploring the "planning fallacy": Why people underestimate their task completion times. *Journal of Personality and Social Psychology, 67*, 366-381.
- Calhoun, R. E., & Hutchison, S. L. (1981). Decision-making in old age: Cautiousness and rigidity. *International Journal of Aging and Human Development, 13*(2), 89-98.
- Chapman, L. J., & Chapman, J. P. (1967). Genesis of popular but erroneous psychodiagnostic observations. *Journal of Abnormal Psychology, 72*, 193-204.
- Charness, N., & Bosman, E. A. (1990). Expertise and aging: Life in the lab. In T. M. Hess (Ed.), *Aging and cognition: Knowledge organization and utilization* (pp. 343-385). Amsterdam: Elsevier.
- Curley, S. P., Eraker, S. A., & Yates, J. F. (1984). An investigation of patients' reactions to therapeutic uncertainty. *Medical Decision Making, 4*, 501-511.
- Deber, R. B., Kraetschmer, N., & Irvine, J. (1996). What role do patients wish to play in treatment decision making? *Archives of Internal Medicine, 156*, 1414-1420.
- Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *Academy of Management Review, 14*, 57-74.
- Frost, R. O., & Shows, D. L. (1993). The nature and measurement of compulsive indecisiveness. *Behavioral Research Theory, 31*, 683-692.
- Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. *Psychology of Learning and Motivation, 22*, 193-225.
- Heglin, H. J. (1956). Problem solving set in different age groups. *Journal of Gerontology, 11*, 310-317.
- Holliday, S. G. (1988). Risky-choice behavior: A life-span analysis. *International Journal of Aging and Human Development, 27*, 25-33.
- Janis, I. L., & Mann, L. (1977). *Decision making*. New York: Free Press.
- Johnson, M. M. S. (1990). Age differences in decision making: A process methodology for examining strategic information processing. *Journal of Gerontology: Psychological Sciences, 45*, P75-P78.
- Kahneman, D., Fredrickson, B. L., Schreiber, C. A., & Redelmeier, D. A. (1993). When more pain is preferred to less: Adding a better end. *Psychological Science, 4*, 401-405.

- Kahneman, D., & Snell, J. (1992). Predicting a changing taste: Do people know what they will like? *Journal of Behavioral Decision Making*, 5, 187-200.
- Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-291.
- Klein, G. A. (1993). A recognition-primed decision (RPD) model of rapid decision making. In G. A. Klein, J. Orasanu, R. Calderwood, & C. E. Zsombok (Eds.), *Decision making in action: Models and methods* (pp. 138-147). Norwood, NJ: Ablex.
- Klein, G. A., Orasanu, J., Calderwood, R., & Zsombok, C. E. (Eds.). (1993). *Decision making in action: Models and methods*. Norwood, NJ: Ablex.
- Lichtenstein, S., & Fischhoff, B. (1977). Do those who know more also know more about how much they know? The calibration of probability judgments. *Organizational Behavior and Human Performance*, 20, 159-183.
- Luchins, A. (1942). Mechanization in problem solving. *Psychological Monographs*, 54, (Whole No. 248).
- MacCrimmon, K. R., & Wehrung, D. A. (1986). *Taking risks: The management of uncertainty*. New York: Free Press.
- Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98, 224-253.
- Marson, D. C., Ingram, K. K., Cody, H. A., & Harrell, L. E. (1995). Assessing the competency of patients with Alzheimer's disease under different legal standards. *Archives of Neurology*, 52, 949-954.
- McCrae, R. R., Arenberg, D., & Costa, P. T., Jr. (1987). Declines in divergent thinking with age: Cross-sectional, longitudinal, and cross-sequential analyses. *Psychology and Aging*, 2, 130-137.
- Meyer, B. J. F., Russo, C., & Talbot, A. (1995). Discourse comprehension and problem solving: Decisions about the treatment of breast cancer by women across the life span. *Psychology and Aging*, 10, 84-103.
- Mutter, S. A., & Pliske, R. M. (1994). Aging and illusory correlation in judgments of co-occurrence. *Psychology and Aging*, 9, 53-63.
- Myles-Worsley, M., Johnston, W. A., & Simons, M. A. (1988). The influence of expertise on X-ray image processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 14, 553-557.
- Payne, J. W. (1982). Contingent decision behavior. *Psychological Bulletin*, 92, 382-402.
- Payne, J. W., Bettman, J. R., & Johnson, E. J. (1988). Adaptive strategy selection in decision making. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 14, 534-552.
- Pennington, N., & Hastie, R. (1993). The story model of juror decision making. In R. Hastie (Ed.), *Inside the juror* (pp. 192-221). New York: Cambridge University Press.
- Pliske, R. M., & Mutter, S. A. (1996). Age differences in the accuracy of confidence judgments. *Experimental Aging Research*, 22, 199-216.
- Poses, R. M., Cebul, R. D., & Wigton, R. S. (1995). You can lead a horse to water—improving physicians' knowledge of probabilities may not affect their decisions. *Medical Decision Making*, 15, 65-75.
- Price, P. C., & Yates, J. F. Associative and rule-based accounts of cue interaction in contingency judgment. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 1639-1655.
- Reilly, B. A., & Doherty, M. E. (1992). The assessment of self-insight in judgment policies. *Organizational Behavior and Human Decision Processes*, 53, 285-309.
- Rogers, W. A. (1997). Individual differences, aging, and human factors: An overview. In A. D. Fisk & W. A. Rogers (Eds.), *Handbook of human factors and the older adult* (pp. 151-170). San Diego, CA: Academic Press.
- Ronis, D. L., Yates, J. F., & Kirscht, J. P. (1989). Attitudes, decisions, and habits as determinants of repeated behavior. In A. R. Pratkanis, S. J., Breckler, & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 213-239). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Russo, J. E., & Schoemaker, P. H. (1989). *Decision traps*. New York: Doubleday.

- Salthouse, T. A. (1982). *Adult cognition*. New York: Springer-Verlag.
- Salthouse, T. A. (1992). Why do adult age differences increase with task complexity? *Developmental Psychology*, 28, 905-918.
- Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review*, 103, 403-428.
- Salthouse, T. A., & Babcock, R. L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology*, 27, 763-776.
- Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review*, 84, 1-66.
- Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review*, 84, 127-190.
- Sivak, M., Soler, J., Trankle, U., & Spagnhol, J. M. (1989). Cross-cultural differences in driver risk-perception. *Accident Analysis & Prevention*, 21, 355-362.
- Slovic, P., Fleissner, D., & Bauman, W. S. (1972). Analyzing the use of information in investment decision making: A methodological proposal. *Journal of Business of the University of Chicago*, 45, 283-301.
- Streufer, S., Pogash, R., Piasecki, M., & Post, G. M. (1990). Age and management team performance. *Psychology and Aging*, 5, 551-559.
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185, 1124-1131.
- Valacich, J. S., Dennis, A. R., & Connolly, T. (1994). Idea generation in computer-based groups: A new ending to an old story. *Organizational Behavior and Human Decision Processing*, 57, 448-467.
- Wallach, M. A., & Kogan, N. (1961). Aspects of judgment and decision making: Interrelationships and changes with age. *Behavioral Science*, 6, 23-36.
- Wilson, T. D., Lisle, D., Schooler, J., Hodges, S. D., Klaaren, K. J., & LaFleur, S. J. (1993). Introspecting about reasons can reduce post-choice satisfaction. *Personality and Social Psychology Bulletin*, 19, 331-339.
- Yates, J. F. (1982). External correspondence: Decompositions of the mean probability score. *Organizational Behavior and Human Performance*, 30, 132-156.
- Yates, J. F. (1990). *Judgment and decision making*. Englewood Cliffs, NJ: Prentice Hall.
- Yates, J. F. (1998). *Decision tools*. Manuscript submitted for publication.
- Yates, J. F., Lee, J.-W., & Shinotsuka, H. (1996). Beliefs about overconfidence, including its cross-national variation. *Organizational Behavior and Human Decision Processes*, 65, 138-147.
- Yates, J. F., & Stone, E. R. (1992a). Risk appraisal. In J. F. Yates (Ed.), *Risk-taking behavior* (pp. 49-85). Chichester, England: Wiley.
- Yates, J. F., & Stone, E. R. (1992b). The risk construct. In J. F. Yates (Ed.), *Risk-taking behavior* (pp. 1-25). Chichester, England: Wiley.
- Zedeck, S., & Kafry, D. (1977). Capturing rater policies for processing evaluation data. *Organizational Behavior and Human Performance*, 18, 269-294.

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