Journal of Personality and Social Psychology
2007, Vol. 92, No. 5, 938–956

0022-3514/07/$12.00 DOI: 10.1037/0022-3514.92.5.938

Individual Differences in Adult Decision-Making Competence

Wändi Bruine de Bruin
Carnegie Mellon University

Andrew M. Parker
RAND Corporation

Baruch Fischhoff
Carnegie Mellon University

The authors evaluated the reliability and validity of a set of 7 behavioral decision-making tasks, measuring different aspects of the decision-making process. The tasks were administered to individuals from diverse populations. Participants showed relatively consistent performance within and across the 7 tasks, which were then aggregated into an Adult Decision-Making Competence (A-DMC) index that showed good reliability. The validity of the 7 tasks and of overall A-DMC emerges in significant relationships with measures of socioeconomic status, cognitive ability, and decision-making styles. Participants who performed better on the A-DMC were less likely to report negative life events indicative of poor decision making, as measured by the Decision Outcomes Inventory. Significant predictive validity remains when controlling for demographic measures, measures of cognitive ability, and constructive decision-making styles. Thus, A-DMC appears to be a distinct construct relevant to adults' real-world decisions.

Keywords: individual differences, decision making, judgment, competence, external validity

People face varied decisions every day. Behavioral decision researchers study how these decisions are made, traditionally focusing on deviations from normative standards. Because most of these decision errors have been found in seemingly unrealistic hypothetical decisions without real-world consequences, some recent research has questioned the external validity of this work (Gigerenzer, Todd, & the ABC Group, 2000; Klein, 1999) and sought more realistic accounts of how people master the skills needed for effective decision making (Baron, 2000; Dawes & Hastie, 2001; Kahneman, Slovic, & Tversky, 1982; Reyna, 2004; Yates, 1990).

Typically, decision-making processes have been studied in isolation in order to understand each in detail. The price paid for that depth is limited understanding of how individual decision-making skills are related to (a) other decision-making skills, (b) demographic characteristics such as socioeconomic status (SES) and age, (c) other cognitive abilities and decision-making styles, and (d) real-world outcomes. More recently, the understanding of individual decision-making skills has progressed to the point at which investigators have begun to address their interrelationships. Next, we briefly summarize relevant research on these topics.

Relationship Among Decision-Making Skills

Several studies have examined the internal consistency of performance on different decision-making tasks. For example, reliable individual differences have been found in the tendencies to avoid framing errors (Levin, Gaeth, Schreiber, & Lauriola, 2002), abandon sunk costs (Stanovich, 1999), apply decision rules (Bröder, 2000), and express appropriate levels of confidence (Blais, Thompson, & Baranski, 2005; Bornstein & Zickafoose, 1999; Klayman, Soll, González-Vallejo, & Barlas, 1999; Stankov & Crawford, 1996, 1997; West & Stanovich, 1997; Wolfe & Grosch, 1990). Few studies have examined correlations between multiple decision-making tasks. One important exception is Stanovich and West (1998, 2000), who report significant positive correlations between performance on tasks measuring, for example, hindsight bias, logical reasoning, and statistical reasoning. On the basis of these results, they argue that departures from normative standards reflect more than just random performance errors, but rather consistent shortcomings across decision-making skills.

Parker and Fischhoff (2005) introduced a battery of seven tasks chosen to represent skills needed by normatively competent decision makers: Resistance to Framing, Recognizing Social Norms, Under/overconfidence, Applying Decision Rules, Consistency in Risk Perception, Path Independence, and Resistance to Sunk Costs. This set of measures, referred to here as Youth Decision-Making Competence (Y-DMC; Parker & Fischhoff, 2005) and described more fully below, presents content suited to young people and was validated with 18- and 19-year-olds. Performance showed modest positive correlations among the seven tasks, with a single-factor solution accounting for 25% of the variance. This

Wändi Bruine de Bruin and Baruch Fischhoff, Department of Social and Decision Sciences, Carnegie Mellon University; Andrew M. Parker, RAND Corporation, Pittsburgh, Pennsylvania.

This research was funded by National Science Foundation Grant SES-0213782. We thank Michael DeKay, Julie Downs, and Eric Stone for their comments as well as Jónína Bjarnadóttir, Jacob Chen, YoonSun Choi, Rebecca Cornelius, Mandy Holbrook, Mark Huneke, Kathleen Pinturak, and Alanna Williams for their assistance.

Correspondence concerning this article should be addressed to Wändi Bruine de Bruin, Department of Social and Decision Sciences, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213. E-mail: wandi@cmu.edu

positive manifold suggests either a basic underlying decision-making ability that is measured with some degree of error or a multidimensional core of mutually supportive decision-making skills. For example, the ability to resist framing effects may allow the more systematic use of decision rules; having appropriate confidence may facilitate the development of consistent risk perceptions.[1]

Relationship With Demographic Characteristics

Disadvantaged SES, referring to limited material resources and education (Ensminger & Fothergill, 2003), increases exposure to uncontrollable and controllable negative life events (Brady & Matthews, 2002), with poor decisions playing a plausible, but undetermined, role. People with lower income are more likely to make errors in economic reasoning, such as honoring sunk cost (Larrick, Nisbett, & Morgan, 1993). Parker and Fischhoff's (2005) low-SES teens showed significantly worse performance on four tasks: Consistency in Risk Perception, Recognizing Social Norms, Applying Decision Rules, and Under/overconfidence.

Research has also revealed age differences in adults' ability to make consistent judgments across contexts, with older adults performing less well than younger ones (Finucane, Mertz, Slovic, & Schmidt, 2005; Finucane et al., 2002). Furthermore, older adults may be more likely than younger ones to be overconfident (Crawford & Stankov, 1996; Job, 1990) and use simple noncompensatory choice strategies (Johnson, 1990).

Relationship With Other Measures of Cognitive Ability and Style

Studies have found positive correlations between scores on tests of cognitive ability and resistance to decision-making biases, including overconfidence (Stanovich & West, 2000; Wolfe & Grosch, 1990), hindsight bias (Stanovich & West, 2000), inefficient use of decision rules (Bröder, 2003), statistical reasoning errors (Jepson, Krantz, & Nisbett, 1983; Stanovich & West, 1998), violation of "cost–benefit rules" such as ignoring sunk costs (Larrick et al., 1993), and the conjunction fallacy and framing errors (Stanovich & West, 1998). Recent research has also found connections between higher numeracy and resistance to framing errors (Peters et al., 2006). In addition, the cognitive style of "need for cognition," capturing the tendency to think hard about problems (Cacioppo & Petty, 1982), has been associated with having fewer framing errors (Smith & Levin, 1996), suggesting that it may facilitate discovering the deep structure shared by different decision problems. However, these beneficial effects of need for cognition have not been found in other studies looking at framing (LeBoeuf & Shafir, 2003; Levin et al., 2002) and confidence assessment (Jonsson & Allwood, 2003; Wolfe & Grosch, 1990). McElroy and Seta (2003) found fewer framing errors among people with a more analytical/systematic processing style, suggesting that more systematic thinkers could better see through irrelevant differences between normatively equivalent problem framings.

Correlations have been found between the ability to resist framing errors and such personality traits as low neuroticism, high agreeableness, and conscientiousness (Soane & Chmiel, 2005) as well as low impulsiveness and anxiety (Lauriola, Russo, Lucidi, Violani, & Levin, 2005). Overconfidence has showed mixed correlations with personality traits (Stankov & Crawford, 1996).

Parker and Fischhoff (2005) reported that performance on most Y-DMC component tasks, as well as their composite score, correlated positively with two measures of general cognitive ability and with measures of two constructive cognitive styles: endorsement of behavioral coping strategies (e.g., "When I realize I have made a mistake, I usually take immediate action to correct it") and self-monitoring (e.g., "There are many things that I would only tell to a few of my friends"). Decision-making competence correlated negatively with polarized thinking, the tendency to think in black-and-white terms (e.g., "I tend to classify people as either for me or against me"). These correlations generally remained statistically significant after controlling for scores on the two tests of cognitive ability.

Correlations With External Events

The internal validity of laboratory decision-making tasks has generally been inferred from participants' sensitivity to changes in task conditions (e.g., monetary incentives, learning opportunities)—based on investigators' hypotheses regarding what changes should matter. Tests of external validity have been rare. In one indirect test, Larrick et al. (1993) found correlations between disciplinary background (economics, biology, humanities) and scores on tests of cost–benefit thinking. A stronger test of external validity revealed lower scores on a test of adherence to cost–benefit rules among high school students with multiple school suspensions, compared with their peers (Stanovich, Grunewald, & West, 2003).

Parker and Fischhoff's (2005) young adult sample is unique in having been recruited at ages 10–12 for a longitudinal study conducted by the Center for Education and Drug Abuse Research (CEDAR). Its members are assessed in terms of multiple measures of real-world experience, including putative antecedents and consequents of decision-making competence. Youths with higher scores on the Y-DMC test battery showed fewer risk behaviors (at various points in the longitudinal study) and came from more intact social environments. These relationships remain statistically significant after controlling for cognitive ability, suggesting that Y-DMC represents a distinct construct relevant to adolescents' real-world experiences.

Defining the Domain of Decision-Making Competence

Normative models of decision making typically identify four fundamental skills: Belief assessment involves judging the likelihood of outcomes, value assessment involves evaluating outcomes, integration involves combining beliefs and values in mak-

[1] Because A-DMC components were selected to address specific aspects of the decision-making process, one might expect the overall A-DMC score to reflect a single, unified competency. In this conceptualization, the A-DMC would be treated as a second-order construct, called a *scale* (Streiner, 2003) or a *reflective measure* (Edwards & Bagozzi, 2000). However, it may be more appropriate to treat A-DMC components as measuring relatively distinct decision-making processes. Overall, the A-DMC would then be an "index" (Streiner, 2003) or "formative measure" (Edwards & Bagozzi, 2000), defined by its separate components. In this conceptualization, an individual might excel in one component skill while being deficient in others. Although recognizing the merits of each conceptualization, we refer to overall A-DMC as an *index*. Its individual component scores are treated as reflective, representing indicators of latent skill constructs.

Table 1
A-DMC Component Measures

A-DMC component	General decision-making skill	Criterion	Score	Response scale
Resistance to Framing	Value assessment Integration	Consistency	Absolute difference between ratings of related frames	1–6 rating
Recognizing Social Norms	Belief assessment Value assessment	Accuracy	Rank correlation between judged proportion and actual proportion	(a) 0%–100% (b) yes/no
Under/overconfidence	Belief assessment Metacognition	Accuracy	1 − absolute difference between mean confidence and percentage correct	(a) true/false (b) 50%–100%
Applying Decision Rules	Integration	Accuracy	Percentage of correct answers	Multiple choice
Consistency in Risk Perception	Belief assessment	Consistency	Percentage of consistent risk judgments	0%–100%
Resistance to Sunk Costs	Value assessment	Accuracy	Average rating across items	1–6 rating
Path Independence	Value assessment Integration	Consistency	Percentage of consistent choice pairs	Multiple choice

Note. A-DMC = Adult Decision-Making Competence.

ing decisions, and metacognition means knowing the extent of one's abilities (W. Edwards, 1954; Finucane & Lees, 2005; Parker & Fischhoff, 2005; Raiffa, 1968).[2] Thus, these models judge the quality of a decision by its process rather than by its outcome, although it is assumed that a person who uses better decision processes will be more likely to experience good decision outcomes (e.g., W. Edwards, 1984; Keren & Bruine de Bruin, 2003).

Parker and Fischhoff (2005) selected their seven tasks to fit the theoretical categorization of normative decision-making skills. Here, we use versions of these tasks adapted for adults and for increased reliability. Table 1 characterizes each task in terms of the general decision-making skill that it taps. It also shows whether performance is evaluated in terms of *accuracy*, relative to an external criterion (e.g., Applying Decision Rules, Recognizing Social Norms), or *consistency* with related judgments or choices (e.g., resisting framing effects across varying problem descriptions, estimating higher risks as the time period increases). The tasks use different combinations of response mode and criteria (explained in the Method section below.) If tasks measure related constructs, then scores on the different components should be correlated despite these measurement variations.

Addressing Potential Limitations of the Y-DMC

Parker and Fischhoff's (2005) results suggest that scores on conventional behavioral decision research tasks are meaningfully related to each other, to other cognitive abilities and styles, and to plausible real-world antecedents and consequents of decision making. However, the research had several limitations that the present article aims to address. First, the available CEDAR sample of 110, which Parker and Fischhoff (2005) exhausted, is too small to meet the conventions for developing individual-differences measures, even though Parker, Fischhoff, and Bruine de Bruin (2004) found a similar pattern of results using a confirmation sample of later respondents from the same longitudinal study. Here, we report on a much larger sample.

Second, some components of Parker and Fischhoff's (2005) measure showed only moderate internal consistency. Cronbach's (1951) alpha was especially low for Resistance to Framing, Consistency in Risk Perception, and Resistance to Sunk Costs. Each of these tasks had relatively few items (5, 2, and 5, respectively) and used a binary choice response mode, rather than a rating scale, further restricting the range of scores. Consistency in Risk Perception and Applying Decision Rules proved to be very easy, with the limited variation in performance limiting the size of correlations. Here, we develop the battery more systematically, using larger item sets and rating scale response modes, while seeking better measures of each component skill.

Third, in order to take advantage of the unique longitudinal sample, with its extensively documented lives, the content of Parker and Fischhoff's (2005) Y-DMC measure is tailored to adolescents. Many of its items are less appropriate for adults. For example, the Y-DMC includes items on sexual behavior and alcohol use but none on employment and family finances. Here, we present a battery of tasks developed for adults, measuring adult decision-making competence (the A-DMC).

Fourth, some of CEDAR's behavioral covariates play very different roles in the lives of young people and adults (e.g., delinquency, drug and alcohol use, sexual behavior). Relating adults' decision-making skills to real-world experiences requires more relevant measures of adults' decision-making outcomes. Here, we present a Decision Outcomes Inventory (DOI), which assesses experiences with life events influenced by adults' decisions. As noted above, although good decision-making processes can lead to poor outcomes, that should happen less often than with poor decision-making processes (e.g., W. Edwards, 1984; Keren & Bruine de Bruin, 2003).

Aims

Our study has three aims, following suggestions made in previous research (Finucane & Lees, 2005; Parker & Fischhoff, 2005):

> Aim 1: Assess the reliability of A-DMC's component measures, in terms of (a) internal consistency, (b) test–retest reliability, and (c) correlations with each other.

[2] Finucane and Lees (2005) also identified decision makers' need to comprehend information about options. Here, we treat it as a more general cognitive ability not limited to decision making.

Aim 2: Assess the nomological validity[3] of the A-DMC, that is, the degree to which it correlates as expected with other relevant constructs, including (a) SES, (b) age, and measures of (c) cognitive ability and (d) decision-making styles.

Aim 3: Assess the predictive validity of the A-DMC, as expressed in correlations with experienced real-world decision outcomes, as measured by the DOI.

Method

Participants

Three hundred sixty people were recruited through varied social service organizations (46.1%) and other community groups (53.9%) in the greater Pittsburgh metropolitan area. They were aged 18–88 ($M = 47.7$, $SD = 17.0$). Among those responding to demographic questions, 73.8% were women, 65.5% self-identified as White and the remainder as African American (28.2%) or other racial minorities (6.3%). Of those who reported education they had completed, 2.8% reported no degree, 44.6% a high school degree, 13.0% an associate's degree, 29.1% a bachelor's degree, 9.5% a master's degree, and 0.9% a doctorate degree.[4]

When asked to participate in a follow-up mail survey, 151 (41.9%) volunteered. Because of an administrative error, the test battery was mailed to just 138. It was returned by 106, for a 76.8% response rate, on average 17.6 days after the initial survey session ($SD = 5.06$). The retest included 29.4% of the original sample. Participants recruited through social service organizations were more likely to complete a retest survey than those recruited at other sites (39.2% vs. 21.1%), $\chi(1) = 13.99$, $p < .001$. The retest sample did not differ from the remaining sample in terms of age, $t(312) = 0.60$, $p = .55$; proportion of women, $\chi(1) = 1.21$, $p = .27$; non-Whites, $\chi(1) = 0.44$, $p = .51$; and highest education level, $\chi(5) = 5.51$, $p = .36$.

Materials

The A-DMC. The new A-DMC battery has seven component tasks: Resistance to Framing, Recognizing Social Norms, Under/Overconfidence, Applying Decision Rules, Consistency in Risk Perception, Resistance to Sunk Costs, and Path Independence. Each component is discussed below, focusing on how it differs from its related Y-DMC component (Parker & Fischhoff, 2005). All new items were pilot tested to improve comprehensibility and internal consistency. Sample items for each component appear in Appendix A.[5]

Resistance to Framing measures whether value assessment is affected by irrelevant variations in problem descriptions. Parker and Fischhoff (2005) found relatively low internal consistency for this task. As mentioned, scores showed low variability. To address that problem, we increased the number of items and shifted from dichotomous choice to a strength-of-preference rating scale, with endpoints reflecting a strong preference for each of the two original choice options, following Levin et al. (2002). Because the 6-point scale lacks a midpoint, it forces respondents to express a relative preference between options, if only weakly. A second possible threat to the internal consistency of the original tasks is that they included several kinds of framing problem. The new task is limited to valence framing problems, specifically risky-choice framing and attribute framing (Levin et al., 2002; Levin, Schneider, & Gaeth, 1998).

The seven risky-choice framing tasks have formally equivalent gain and loss versions of decision problems, each presenting a sure-thing option and a risky-choice option (Fischhoff, 1983; Levin et al., 1998; Tversky & Kahneman, 1981). For example, the first item, taken from Schneider (1992), describes a pesticide threatening the lives of 1,200 endangered animals. The gain version poses a choice between (a) saving 600 endangered animals for sure and (b) a 75% chance that 800 animals will be saved, and a 25% chance that no animals will be saved. The corresponding loss frame presents a choice between (a) losing 600 animals for sure and (b) a 75% chance that 400 animals will be lost, and a 25% chance that 1,200 animals will be lost. Subsequent items involve choices between a sure thing and a risky option in the contexts of income tax (Highhouse & Paese, 1996), dropping out of school (Fagley & Miller, 1990), an unusual disease (Tversky & Kahneman, 1981), cancer (Tversky & Kahneman, 1988), stock market investments (Roszkowski & Snelbecker, 1990), and soldiers suffering leg injuries (Svenson & Benson, 1993).

Additionally, seven attribute framing items ask participants to rate positively and negatively described versions of seven normatively equivalent events. These include judging the effectiveness of a condom with a 95% success rate or a 5% failure rate (Linville, Fischer, & Fischhoff, 1993), the quality of ground beef labeled 80% lean or 20% fat (Levin & Gaeth, 1988), cheating at a university where students' self-reports indicate that 65% have cheated or 35% never have (Levin, Schnittjer, & Thee, 1988), funding a team that had 30 successful or 20 unsuccessful projects among its last 50 (Dunegan, 1993), counseling a student who received either 90% correct on the midterm exam and 70% correct on the final exam or 10% and 30% incorrect, respectively (Levin, Johnson, Russo, & Deldin, 1985), fining a woman with a 20% chance of not knowing that she had parked illegally or an 80% chance of knowing that she had (Dunegan, 1996), and advising a family member about a cancer treatment with a 50% success rate or a 50% failure rate (Levin et al., 1988).

The positive frames and negative frames appear in separate sets with different item orders and are separated by other A-DMC tasks, as recommended by LeBoeuf and Shafir (2003). Perfor-

[3] Broadly speaking, nomological validity can be defined as the extent to which "the measure fits lawfully into a network of expected relationships" (Nunnally & Bernstein, 1994, p. 91; see also Cronbach & Meehl, 1955).

[4] Our convenience sample resembles the 2000 U.S. Census data for Pittsburgh (U.S. Census Bureau, 2003) regarding racial composition (67.6% White, 27.1% African American, and 5.3% other minorities) and education (18.7% of Pittsburghers over 25 years old have no high school degree, 48.9% have a high school degree, 6.1% have an associates degree, 13.7% have a bachelor's degree, and 12.5% have a graduate degree). Our sample is more African American than the U.S. population, which is 75.1% White, 12.3% African American, and 12.6% other minorities. Our sample's educational attainments resemble those of the U.S. population over 25 years old, in which 19.6% have no high school degree, 49.7% have a high school degree, 6.3% have an associates degree, 15.5% have a bachelor's degree, and 8.9% have a graduate degree (Bauman & Graf, 2003).

[5] The entire measure is available from the authors or online at http://sds.hss.cmu.edu/risk/ADMC.htm.

mance is measured by the mean absolute difference between ratings for the loss and the gain versions of each item.

Recognizing Social Norms measures how well participants assess peer social norms, which is based on studies by Jacobs, Greenwald, and Osgood (1995) and Loeber (1989). This task is unchanged from the Y-DMC (Parker & Fischhoff, 2005) because it addresses social norms that apply to all ages. Participants first judge whether "it is sometimes OK" to engage in each of 16 undesirable behaviors (e.g., to steal under certain circumstances). Later in the test battery, participants estimate how many "out of 100 people your age" would endorse each behavior. The first set of responses allowed us to compute the percentage of participants who endorsed each behavior. For each participant, performance is measured by the rank-order correlation (from −1 to +1) between the actual percentage and the estimated percentage of peers' endorsements across the 16 behaviors.

Under/overconfidence assesses how well participants recognize the extent of their own knowledge. Respondents indicate whether each of a set of statements is true or false, then assess their confidence in that answer, on a scale from 50% (*just guessing*) to 100% (*absolutely sure*). Under/overconfidence equals one minus the absolute difference between mean confidence and percentage correct across items so that higher scores reflect better performance.[6]

To provide question content relevant to a diverse adult audience, we created items from 17 *Complete Idiot's* guides about such topics as romantic relationships, finances, health, and organizing one's life (Bauer, 2003; Charland, 1997; Davidson, 1997; Fisher & Shelley, 2002; Ireland, 2002; Kleinman & Messina-Kleinman, 2000; Koch & DeSalvo, 2003; Kuriansky, 2002; Kurland & Lupoff, 1999; Lockwood, 2003; McClain & Levert, 2000; O'Hara & Warner, 2000; Rich & Kravitz, 2001; Rosen, 2000; Strauss & Jaffe, 2003; Toropov, 1997; Tullier, 1999). We randomly selected 10 chapters from each book and one piece of advice from the text boxes and bullet-pointed closing statements in each chosen chapter. The text of each selected piece of advice was rewritten as a true/false statement, with a random generator assigning half to be phrased as true and half as false. Two independent judges selected statements that were decision relevant and falsifiable, reaching agreement for 71%. We pilot tested the 60 items selected by both coders. Nine items were excluded because a pilot study suggested that they were potentially misleading, showing performance that was substantially below chance. After removing items with low item-total correlations, 34 were selected for the final measure.

Applying Decision Rules asks participants to indicate, for hypothetical individual consumers using different decision rules, which of five DVD players they would buy (e.g., "Lisa wants the DVD player with the highest average rating across features," describing an equal weights rule). Each consumer chooses from a different set of five equally priced DVD players with varying ratings of picture quality, sound quality, programming options, and brand reliability (from 1 [*very low*] to 5 [*very high*]). The decision rules are taken from Payne, Bettman, and Johnson (1993) and include elimination by aspects, satisficing, lexicographic, and equal weights rules. The present task uses more complex rules than the Y-DMC, which, in pretests, proved too easy for adults. Performance is measured by the percentage of items for which the correct DVD players are chosen, given the decision rule to be applied.

Consistency in Risk Perception assesses the ability to follow probability rules. Twenty items ask participants to judge the chance of an event happening to them on a linear scale ranging from 0% (*no chance*) to 100% (*certainty*). Ten events are judged twice: for the next year and for the next 5 years. Each time frame pair is scored as correct if the probability for the event happening the next year is no larger than for it happening in the next 5 years. In each time frame, three item pairs present nested subset and superset events (e.g., dying in a terrorist attack is a subset of the superset dying from any cause). To be scored as correct, the probability of a subset event should not exceed that of its superset event. In each time frame, two item pairs also present complementary events (e.g., getting into a car accident while driving vs. being accident free). Responses to each pair are scored as correct if their combined probability is 100%. Scores thus reflect the percentage of corresponding item pairs with consistent responses, including (a) 10 time-frame pairs, (b) six subset–superset pairs, and (c) four complementary pairs.

Resistance to Sunk Costs measures the ability to ignore prior investments when making decisions (Arkes & Blumer, 1985). Normatively, unrecoverable past expenditures should be ignored so that decisions reflect only possible future consequences. The Y-DMC battery had two items with a choice format, limiting response variation. The A-DMC has 10 items, using a rating scale ranging from 1 (*most likely to choose* [*the sunk-cost option*]) to 6 (*most likely to choose* [*the normatively correct option*]). Items address varied contexts, with some adapted from the sunk-cost literature (Arkes & Blumer, 1985; Baron, Granato, Spranca, & Teubal, 1993; Bornstein & Chapman, 1995; Frisch, 1993), and others created for this project. Performance is measured by the average rating across the 10 items.

Path Independence presents item pairs posing normatively equivalent choices between gambles, testing adherence to the axiom that a choice between gambles should not be affected by normatively irrelevant changes in how they are played. In particular, respondents should give consistent responses, regardless of whether options are presented as single-stage or two-stage gambles. This task uses Y-DMC items because their abstract content and level of difficulty are appropriate for all ages. Six items pose a choice between a sure thing (e.g., win $50 for sure) and a coin flip (e.g., if heads, then win $100; if tails, then win $0). Each is paired with an item posing the same choice, presenting irrelevant information about the outcome of an earlier coin flip. An additional six items pose a choice between a gamble involving two coins (e.g., if two heads, then win $100, otherwise $0) and a gamble involving one coin (e.g., if heads, then win $50, otherwise $0). Each is paired with an item presenting the same gambles as two consecutive steps. The first step is a coin flip, which will lead to the second step only if heads come up. The second step involves a choice between a gamble (e.g., if heads, then win $100, otherwise $0) and a sure thing (e.g., win $50 for sure). Performance is measured by the percentage of consistent choices across item pairs.

[6] We report Under/overconfidence because it has modest metric assumptions (unlike the Brier score) and because it does not condition on confidence (unlike the calibration and discrimination indices), making it less prone to regression-to-the-mean.

The DOI. We further developed a self-report measure of decision-making success in terms of avoiding negative decision outcomes. On the basis of pilot research, a list of negative decision outcomes, sampled across a wide variety of domains and varying in severity (e.g., threw out food or groceries you had bought, got divorced, had a mortgage or loan foreclosed), was reduced to a shorter list with good internal consistency. Appendix B shows the DOI, with its 41 negative decision outcomes. Thirty-five of these outcomes are preceded by a question asking whether participants had made decisions that would make that outcome possible (e.g., bought food or groceries, got married, had a mortgage or loan). This question was omitted for the final six outcomes, as all individuals made related decisions: been in a jail cell overnight for any reason; been in a public fight or screaming argument; declared bankruptcy; forgotten a birthday of someone close to you and did not realize until the next day or later; been diagnosed with Type 2 diabetes; and broke a bone because you fell, slipped, or misstepped.

As a proxy for severity, we weighted decision outcomes by the proportion of participants who reported not experiencing them (among those who had the opportunity) because, generally speaking, more severe outcomes are also less frequent than less severe ones (e.g., a night in jail vs. loaning more than $50 without getting it back). These weighted outcomes were averaged and then subtracted from zero so that higher scores reflect better outcomes. Thus, the DOI score reflects the weighted number of negative outcomes respondents had avoided out of those they had the opportunity to experience (i.e., the final six were included for everyone).

Decision-making styles. Respondents' decision-making styles were measured with four scales. Two scales were from Schwartz et al. (2002). One is a five-item measure of the tendency to feel regret (e.g., "When I think about how I'm doing in life, I often assess opportunities I have passed up"); the other is a 13-item measure of the tendency to maximize when only satisficing is needed (e.g., "When I watch TV, I channel surf, often scanning through the options even while attempting to watch one program"). Schwartz et al. (2002) found that people with higher scores on both scales were less satisfied with their consumer choices. Because both measures reflect ineffective decision making, less regret and less inappropriate maximizing should be related to better A-DMC scores.

The third scale is the 15-item behavioral coping component of the Constructive Thinking Inventory (Epstein & Meier, 1989; Katz & Epstein, 1991). It measures the extent to which people attach positive thoughts to their decisions, even in the face of negative outcomes (e.g., "When I realize I have made a mistake, I usually take immediate action to correct it"). Because this decision-making style reflects effective decision making, more behavioral coping should be related to better A-DMC scores, as was found with the Y-DMC (Parker & Fischhoff, 2005).

Finally, we used Scott and Bruce's (1985) measures of five decision-making styles, all relying on self-reports: making decisions rationally (e.g., "I make decisions in a logical and systematic way"), basing decisions on intuitions (e.g., "I generally make decisions that feel right to me"), depending on others (e.g., "I often need the assistance of other people when making important decisions"), avoiding decisions (e.g., "I postpone decision making whenever possible"), and making decisions spontaneously (e.g., "I generally make snap decisions"), using five items for each. There is some evidence that both rational (Crossley & Highhouse, 2005; Leong & Morris, 1989; Russ, McNeilly, & Comer, 1996) and intuitive (Crossley & Highhouse, 2005) decision-making styles are effective, in the sense of being related to positive career outcomes (although see Phillips & Strohmer, 1982; Singh & Greenhaus, 2004). Thus, they should be related to better A-DMC scores. Conversely, dependent, spontaneous, and avoidant styles may be maladaptive (Loo, 2000; Russ et al., 1996; Singh & Greenhaus, 2004). Lower scores on these styles should be related to better A-DMC scores.

Cognitive ability. Our strategy for measuring general cognitive abilities was informed by theories of fluid and crystallized intelligence (Cattell, 1963, 1987; Horn, 1985). We used Raven's standard progressive matrices (SPM; Raven, Raven, & Court, 2003), which loads highly on Spearman's *g* (Carroll, 1993), to assess general fluid, nonverbal cognitive ability and Form G of the Nelson-Denny Reading Comprehension subtest (Brown, Fishco, & Hanna, 1993) to assess crystallized, verbal ability. Thus, these measures cover the two main aspects of general cognitive abilities, with general fluid intelligence reflecting innate ability and crystallized intelligence reflecting acquired knowledge (e.g., Cattell, 1963). To reduce participants' workload, both scales were shortened to half their normal length. Our Raven measure had one randomly selected item from each sequential pair on the full test (first and second, third and fourth, etc.) to retain the increasing difficulty of the test items. We reduced the time restriction for the Nelson-Denny from 20 to 10 min. On both measures, performance is measured by the number of items answered correctly.

Procedure

After providing consent, participants were given 10 min to complete Form G of the Nelson-Denny Reading Comprehension subtest (Brown et al., 1993). Participants were then given an envelope with the remaining tasks, to be completed at their own pace. The envelope began with the A-DMC tasks, in the following sequence: (a) positive-item versions of Resistance to Framing, (b) Recognizing Social Norms questions asking whether "it is sometimes OK" to engage in different behaviors, (c) Under/overconfidence, (d) Applying Decision Rules, (e) Consistency in Risk Perception, (f) Path Independence, (g) Resistance to Sunk Costs, (h) negative-item versions of Resistance to Framing, and (i) Recognizing Social Norms questions asking for estimates of other people's social norms. This order maximized the distance between related tasks (e.g., for Resistance to Framing and Recognizing Social Norms). The shortened version of Raven SPM (Raven et al., 2003) was completed next, followed by the measures of decision-making styles, the DOI, and demographic information.

Participants left contact information if they were interested in completing "a shorter mail survey with some of the same questions" intended for test–retest reliability. The retest repeated the same A-DMC measures. Forms were mailed 9 days after the initial session and followed up with at most two reminder phone calls. Participants received $35 for the initial survey session (with the option to donate part of it to the organization through which they were recruited) and $15 for returning the mail survey.

Table 2
Descriptive Statistics of Nonstandardized A-DMC Components

A-DMC component	Potential range	Observed range	*Mdn*	*M*	*SD*	Cronbach's α	Test–retest
Resistance to Framing	.00–5.00	1.00–4.92	3.83	3.72	0.61	.62	.58***
Recognizing Social Norms	−1.00–1.00	−.59–.84	0.34	0.33	0.26	.64	.46***
Under/overconfidence	.00–1.00	.50–1.00	0.93	0.91	0.08	.77	.47***
Applying Decision Rules	.00–1.00	0.00–1.00	0.44	0.44	0.24	.73	.77***
Consistency in Risk Perception	.00–1.00	.20–1.00	0.70	0.70	0.16	.72	.51***
Resistance to Sunk Costs	1.00–6.00	1.00–6.00	4.50	4.40	0.77	.54	.61***
Path Independence	.00–1.00	.00–1.00	0.67	0.67	0.25	.75	.28***

Note. All Adult Decision-Making Competence (A-DMC) components are scored so that higher numbers reflect better performance.
*** $p < .001$, two-sided.

Results

Aim 1: Assess the Reliability of the A-DMC's Component Measures

Aim 1a: Internal consistency. Table 2 shows descriptive statistics for the seven A-DMC component measures, with higher scores on each representing better performance. Because a typo changed the intended meaning of one Resistance to Framing item, scores for that task reflect only 13 items. Skipped items are treated as missing rather than as incorrect.[7] Scores on each measure span much of the possible range, showing the variability necessary to assess reliability and validity.

Cronbach's alpha, the mean of all split-half correlations, is one measure of internal consistency (Cronbach, 1951). It is above .60 for all component measures except for Resistance to Sunk Costs. Compared with the Y-DMC, internal consistency is higher for the two components that were poorest there, Resistance to Framing (.62 vs. .30) and Resistance to Sunk Costs (.54 vs. .03), suggesting that their redesign improved them. Cronbach's alpha for Recognizing Social Norms uses item-level scores on the basis of Spearman's rank correlation between predicted and actual social norms.[8] Parker and Fischhoff (2005) report Cronbach's alpha separately for personal social norms ($\alpha = .79$) and predicted peer social norms ($\alpha = .88$), similar to this study (αs = .75 and .93, respectively).

Aim 1b: Test–retest reliability. The last column of Table 2 shows test–retest reliability of the different component measures. All are significant at the $p < .001$ level. Path Independence is the weakest, despite its relatively high Cronbach's alpha.

Aim 1c: Correlations of tasks with each other. Table 3 shows bivariate correlations between the A-DMC component scores. Most correlations in Table 3 are significant and positive ($M = .16$, $Mdn = .17$), indicating a positive manifold of tasks, with relative consistency in performance across measures.

With the Y-DMC, the mean and median correlations were both .12. For simplicity sake, all reported p values (throughout this article) are two-sided, even where we have directional predictions. The strongest correlations involve Applying Decision Rules, Consistency in Risk Perception, and Recognizing Social Norms. Path Independence has no significant correlations.

Table 4 shows exploratory factor analyses on z scores of the seven component measures, using the principal factors method. A one-factor model explains 30.1% of the variance—compared with 25.1% with the Y-DMC (which showed a generally similar pattern of loadings). Except for Path Independence and Resistance to Sunk Costs, the factor loadings are at least .35, suggesting internal consistency, in the sense of A-DMC components capturing an underlying construct of decision-making ability. Path Independence and Resistance to Sunk Costs also load weakly on the Y-DMC (.31 and .35, respectively). Consistency in Risk Perception has higher loadings here (.49 vs. .29).

Table 4 further shows a two-factor solution using the principal factors method with oblimin rotation, which allows nonorthogonal factors. The two factors account for 46.2% of the variance and are correlated ($r = .30$, $p < .001$). Except for Resistance to Sunk Costs and Path Independence, all tasks have loadings of at least .30 on the first factor. These loadings resemble those of the one-factor solution. Recognizing Social Norms, Resistance to Sunk Costs, and Path Independence have a higher loading on the second factor, but the latter remains under .30. The two-factor solution does not correspond to the three-factor solution reported for the Y-DMC (Parker & Fischhoff, 2005). Nor does either factor solution correspond to any of the three task characteristics highlighted in Table 1: response mode, criterion, or general decision-making skills.

The analyses below use both A-DMC component scores and a composite index of the A-DMC. The overall index reflects the unweighted average of standardized scores for the six components, excluding Path Independence. This index is highly correlated with

[7] For Applying Decision Rules, Consistency in Risk Perception, and Path Independence, missing responses can be treated as incorrect. The resulting scores are similar to those ignoring missing responses ($r = .98$, $p < .001$ for Applying Decision Rules; $r = .81$, $p < .001$ for Consistency in Risk Perception; $r = .92$, $p < .001$ for Path Independence).

[8] For each participant, the overall score for Recognizing Social Norms reflects the Spearman rank correlation between their estimated number of people "out of 100 people your age" endorsing each behavior and the actual percentage of endorsements observed across all participants, spanning all ages. Comparing estimated numbers with the actual percentage of endorsements observed in a respondent's age group (teens, 20 somethings, 30 somethings, etc.) produces similar performance scores ($r = .92$, $p < .001$). For the sole purpose of computing Cronbach's alpha, item-level scores for Recognizing Social Norms are based on the calculation of Spearman's rank correlation before correction for ties, which is $1-[6 \times \Sigma d^3 / n(n^3-1)]$, with d being the difference between the rank of the estimated proportion and the actual proportion of participants who would condone the behavior mentioned in the item and n being the number of items (here, 16). The individual item-level scores are then calculated as $1/n - [6 \times d^3 / n(n^3-1)]$.

Table 3
Correlations Among A-DMC Component Scores

A-DMC component	1	2	3	4	5	6	7
1. Resistance to Framing	—						
2. Recognizing Social Norms	.15**	—					
3. Under/overconfidence	.23***	.17**	—				
4. Applying Decision Rules	.39***	.28***	.31***	—			
5. Consistency in Risk Perception	.25***	.25***	.17**	.43***	—		
6. Resistance to Sunk Costs	−.01	.23***	−.01	.20***	.18**	—	
7. Path Independence	.02	.07	−.05	.05	.03	.09	—

Note. All p values represent two-sided tests. A-DMC = Adult Decision-Making Competence.
** $p < .01$. *** $p < .001$.

the unweighted average score, including Path Independence ($r = .96$, $p < .001$). We use the unweighted average rather than the Anderson-Rubin factor score, the aggregate measure reported by Parker and Fischhoff (2005), because of its simplicity and robustness (it is highly correlated with the one-factor solution using Anderson-Rubin factor scores; $r = .92$, $p < .001$), recognizing that specific weights may depend on the sample. Each of these aggregate measures produces a similar pattern of results in the subsequent analyses.

Overall, the A-DMC demonstrates good internal consistency. Cronbach's alpha is .85 across the z scores for the A-DMC's 103 individual items and .83 across the z scores for the seven A-DMC components, using Nunnally and Bernstein's (1994) computation for linear combinations of measures. Excluding Path Independence leaves these values unchanged. The unweighted average across z scores for the seven A-DMC components scores also shows good test–retest reliability ($r = .68$, $p < .001$). Without Path Independence, the aggregate measure has a test–retest reliability of .73 ($p < .001$).

Aim 2: Assess the Nomological Validity of the A-DMC

Aim 2a: SES. Our two measures of SES are (a) whether (1) or not (0) participants were recruited through a social service organization serving low-SES communities and (b) participants' highest level of education completed. These two measures are negatively correlated ($r = -.42$, $p < .001$).

Table 4
Factor Analyses of the A-DMC Measures

A-DMC component	One-factor model	Two-factor model (oblimin rotation structure matrix)	
Resistance to Framing	.48	.51	.15
Recognizing Social Norms	.40	.35	.38
Under/overconfidence	.35	.41	.01
Applying Decision Rules	.80	.79	.35
Consistency in Risk Perception	.49	.46	.30
Resistance to Sunk Costs	.23	.14	.50
Path Independence	.10	.05	.20
Eigenvalue	2.11	2.11	1.13
Variance explained	30.1%	30.1%	16.1%

Note. For each variable, underlined values indicate the factor with the largest loading in the two-factor solution. A-DMC = Adult Decision-Making Competence.

The first row in Table 5 shows that participants recruited through social service organizations had lower scores on each A-DMC task, except on Path Independence. The second row shows that those who had completed more education perform significantly better on each A-DMC component, except on Path Independence and Resistance to Sunk Costs. Both sets of correlations are in the expected direction (shown as + or −). To examine whether the overall relationship between the A-DMC components and SES is in the expected direction, and to reduce the number of statistical tests necessary to evaluate Aim 2a, we report Strube's analysis for combining two or more nonindependent statistics (Strube, 1985).[9] The result, in the third row, indicates that, overall, higher SES is linked with better A-DMC component scores, except for Path Independence.

The overall A-DMC score is also significantly lower for participants recruited through social service organizations and higher for those reporting more education. The overall Strube analysis suggests that the A-DMC is positively related with SES.

Aim 2b: Age. The fourth row of Table 5 shows correlations of A-DMC components with participants' age.[10] Age is not significantly correlated with performance on Under/overconfidence, Consistency in Risk Perception, or Path Independence. Older adults show lower scores on Resistance to Framing and Applying Decision Rules. However, performance on Recognizing Social Norms and Resistance to Sunk Costs improves with age. Perhaps as a result, there is no significant correlation between overall A-DMC and age.

Aim 2c: Cognitive ability. Although Raven SPM is designed to measure general fluid intelligence and the Nelson-Denny Reading Comprehension subtest crystallized intelligence, performance on their abbreviated versions is significantly correlated ($r = .57$, $p <$

[9] Strube (1985) proposed an analytic method for combining nonindependent hypothesis tests. This method is based on the logic of meta-analysis, but unlike traditional meta-analysis does not assume independent hypothesis tests from separate samples/studies. Instead, it recognizes and corrects for the covariation among tests.

[10] Part correlations with age, controlling for SES, show similar results ($\alpha = .05$) for overall A-DMC and component scores, except for Under/overconfidence ($r = .13$, $p < .05$). (See Footnote 13 for information about part correlations.)

Table 5
Correlations Between A-DMC Tasks and Cognitive Ability, Decision-Making Styles, and Experienced Decision Outcomes

Measure	Framing (+)	Social Norms (+)	Under/ overconf. (+)	Decision Rules (+)	Risk Perception (+)	Sunk Costs (+)	Path Indep. (+)	Overall A-DMC (+)	DOI (+)
Socioeconomic status (SES)									
Using social services (−)	−.29***	−.26***	−.33***	−.50***	−.38***	−.14*	−.05	−.54***	−.28***
Education (+)	.35***	.18**	.32***	.45***	.28***	.04	.09	.47***	.08
Overall	$p < .001$	$p < .001$	$p < .001$	$p < .001$	$p < .001$	$p < .05$	*ns*	$p < .001$	$p < .001$
Age (−)	−.20***	.12*	.07	−.18**	−.01	.28***	.10	−.03	.33***
Cognitive ability									
Raven (+)	.37***	.29***	.29***	.65***	.40***	.17***	.10	.61***	.13*
Nelson-Denny (+)	.30***	.22**	.27***	.51***	.33***	.04	.02	.50***	.15**
Overall	$p < .001$	$p < .001$	$p < .001$	$p < .001$	$p < .001$	$p < .05$	*ns*	$p < .001$	$p < .01$
Decision-making styles									
To feel regret (−)	−.09	.04	−.09	−.06	−.08	−.14*	.01	−.14*	−.13*
To needlessly maximize (−)	−.10	−.03	−.21***	−.09	−.13*	−.02	.00	−.19***	−.26***
To use behavioral coping (+)	.05	.15**	.15**	.14*	.26***	.29***	.04	.28***	.35***
To decide rationally (+)	−.08	.17**	.13*	.14*	.21**	.27***	.05	.22***	.21***
To decide intuitively (+)	−.12*	.13*	.07	−.06	.08	.20***	−.02	.09	.16***
To depend on others (−)	−.09	.08	.07	.03	.00	.01	−.01	.03	.01
To avoid decisions (−)	−.08	−.07	−.06	−.14*	−.15**	−.18**	.01	−.21***	−.29***
To decide spontaneously (−)	−.15**	−.07	−.20***	−.28***	−.17**	−.12*	−.08	−.29***	−.33***
Overall	*ns*	$p < .05$	$p < .001$	$p < .01$	$p < .001$	$p < .001$	*ns*	$p < .001$	$p < .001$
Experienced decision outcomes									
DOI (+)	.03	.25***	.17**	.26***	.20***	.22***	−.06	.29***	-
DOI, controlling for cognitive ability (+)	−.03	.22***	.13*	.19**	.15**	.21***	−.07	.26***	-
DOI, controlling for age (+)	.06	.19***	.18***	.33***	.23***	.14*	−.08	.31***	-
DOI, controlling for SES (+)	−.05	.19**	.12*	.15**	.11	.17**	−.07	.20***	-
DOI, controlling for decision-making styles (+)	.00	.19***	.06	.16**	.08	.13*	−.08	.14**	-

Note. All p values represent two-sided tests, including overall p values, which were computed using the Strube's analysis for combining significance levels from nonindependent hypothesis tests. The sign printed next to the name of each variable indicates whether higher scores reflect better (+) or worse (−) performance. A-DMC = Adult Decision-Making Competence; overconf. = overconfidence; Indep. = Independence; DOI = Decision Outcomes Inventory; *ns* = nonsignificant; dashes indicate data that are not applicable.
* $p < .05$. ** $p < .01$. *** $p < .001$.

.001). Descriptive statistics are $M = 18.7$ out of 30, $SD = 6.52$ for Raven; $M = 10.4$ out of 38, $SD = 5.67$ for Nelson-Denny.[11]

Table 5 shows that each cognitive ability score is higher for participants who perform better on each A-DMC component. The weakest correlations are with Resistance to Sunk Costs and Path Independence, the two tasks most weakly related to overall A-DMC. The overall Strube analysis indicates that, except for Path Independence, higher A-DMC component scores are related to better cognitive ability.[12]

Table 5 also shows that participants with higher overall A-DMC performance have better Raven SPM and Nelson-Denny scores. The Strube analysis across these correlations is also significant, supporting the nomological validity of the A-DMC measures.

Aim 2d: Decision-making styles. On a 5-point scale, mean self-ratings are 3.00 ($SD = .78$) for experiencing regret about decisions, 2.93 ($SD = .65$) for needlessly maximizing, 3.75 ($SD = .61$) for using behavioral coping strategies, 3.84 ($SD = .79$) for making decisions rationally, 3.65 ($SD = .84$) for deciding intuitively, 3.38 ($SD = .88$) for depending on others when making decisions, 2.59 ($SD = 1.00$) for avoiding decisions, and 2.63 ($SD = .93$) for making spontaneous decisions. Thus, there is enough variance in these responses to make correlations with other measures possible.

The next section of Table 5 shows modest correlations between decision-making styles and the A-DMC, both for the component measures and overall. Strube analyses measure the extent to which A-DMC scores (both components and overall) correlate in the expected directions with decision-making style scores (shown as + or −). Recognizing Social Norms, Under/overconfidence, Applying Decision Rules, Consistency in Risk Perception, and Resistance to Sunk Costs are significantly related to effective decision-making styles, but Resistance to Framing and Path Independence are not.

Most constructive decision-making styles are associated with better overall A-DMC component scores. The exception is the

[11] Because participants received half the items on the Raven SPM and half the standard time of the Comprehension subtest of the Nelson-Denny Reading Test, we use raw scores for each. These raw scores are highly correlated with normed scores reflecting doubled raw scores ($r = .76$, $p < .001$ for Raven; $r = .96$, $p < .001$ for Nelson-Denny). The pattern reported here is unaffected by which score is used for these cognitive ability measures.

[12] Part correlations with Raven, controlling for SES, show similar results ($\alpha = .05$) for overall A-DMC and component scores, except for Under/overconfidence ($r = .06$, $p = .21$) or for Consistency in Risk Perception ($r = .06$, $p = .18$). For Nelson-Denny, changes include Recognizing Social Norms ($r = .08$, $p = .09$), Under/overconfidence ($r = .05$, $p = .35$), and the DOI ($r = .03$, $p = .52$). (See Footnote 13 for information about part correlations.)

tendency to depend on others when making decisions was demonstrated, which shows no significant correlation with any A-DMC component. The overall Strube analyses indicate significant relationships, again supporting the validity of the A-DMC measures.

Aim 3: Assess the Predictive Validity of the A-DMC

Appendix B shows the percentage of participants who report decisions that create the opportunity to experience each negative outcome on the DOI as well as the percentage who report experiencing each outcome, given the opportunity. The least common outcome is "gotten more than 5 speeding tickets," reported by 3.9% out of the 89.1% who had driven a car in the last 10 years. The most common outcome is "threw out food or groceries you had bought because they went bad," reported by 80.8% out of the 99.4% who reported shopping for food or groceries in the last 10 years.

On average, participants report decisions that could have produced 78.7% ($SD = 17.1$) of the DOI's 35 outcomes. As mentioned, six additional outcomes are not limited to one specific decision (e.g., declared bankruptcy) and are counted as possible for all participants. Overall, participants self-report 28.3% ($SD = 16.3$) of the negative outcomes they could have experienced. Only 7 (of the 360) participants reported opportunities for all negative outcomes. Because Cronbach's alpha and factor analyses require complete data for every participant, we computed them across the DOI's decision outcomes, regardless of whether participants had reported decisions that created an opportunity to experience them. Only for these analyses, we treat participants who never made the relevant decision as having avoided the negative outcome. Cronbach's alpha is .88 across the 41 possible negative outcomes, suggesting reliable individual differences in the tendency to experience negative decision outcomes. All 41 outcomes load above .30 on a one-factor solution, except for three items asking participants whether they had (a) broken a bone because you fell, slipped, or misstepped; (b) been diagnosed with Type 2 diabetes; and (c) lost more than $1,000 on a stock market investment. Removing these items does not change Cronbach's alpha (=.88) and barely affects the aggregate DOI score ($r = .99$, $p < .001$). They are retained in the analyses.

As mentioned, the overall DOI score is calculated by weighting each negative outcome that a respondent could have experienced by the proportion of participants who have not experienced it (as a proxy for outcome severity). The average score across items is then subtracted from zero so that higher scores reflect better outcomes. The mean DOI score is $-.15$ ($SD = .11$). It is highly correlated with the unweighted percentage of negative decision outcomes ($r = -.92$, $p < .001$) but not with the percentage of decisions that could have produced them (Part a of each DOI item; $r = -.08$, $p = .18$).

With the exception of Resistance to Framing and Path Independence, Table 5 reveals significant positive correlations between A-DMC component scores and its overall score with the DOI. That pattern generally remains in part correlations, controlling, separately, for cognitive ability, age, SES, and decision-making styles.[13,14] However, Under/overconfidence and Consistency in Risk Perception are no longer significant after controlling for decision-making styles.

The final column of Table 5 shows correlations between DOI scores and our other measures, showing patterns similar to those for A-DMC scores. DOI scores are worse for participants recruited through social service sites but are not significantly related to education.[15] Overall, the Strube analysis shows a significant relationship between the DOI and these SES measures. Older participants report better decision outcomes on the DOI. Furthermore, participants with higher DOI scores have better Raven and Nelson-Denny scores as well as a significant Strube analysis result across these cognitive ability measures. More constructive decision-making styles are generally associated with better overall A-DMC and DOI scores. The exception is the tendency to depend on others when making decisions. The overall Strube analyses also reveal highly significant relationships.

To examine the A-DMC's overlap with other measures, Table 6 shows hierarchical regressions adopted from Finucane et al. (2005). The first set predicts DOI scores from measures of cognitive ability and A-DMC, entered in separate steps. Analysis 1a suggests that A-DMC alone explains 16% of DOI variance. Entering cognitive ability in Step 2 explains 1% of additional variance. Analysis 1b, which reverses these steps, shows that cognitive ability alone accounts for 4% of the variance in the DOI, with A-DMC components entered in Step 2 adding 12% of explained variance. Thus, the A-DMC may mediate the relationship between cognitive ability and the DOI.

A comparison of ΔR^2 measures in Step 1 of Analyses 1a and Step 2 of Analysis 1b reveals that A-DMC's explanation of DOI variance decreases from 16% to 12% after controlling for cognitive ability. Thus, cognitive ability accounts for 25% (4% out of 16%) of A-DMC-related variance in the DOI. The converse analysis reveals that the A-DMC accounts for 75% (3% out of 4%) of the variance because of cognitive ability in the DOI.

A second set of hierarchical regressions (in Table 6) predicts DOI scores from measures of decision-making styles and A-DMC components. Analysis 2a shows that decision-making styles add 15% to the 16% of DOI variance explained by the A-DMC alone; Analysis 2b shows that the A-DMC adds 8% to the 23% of DOI variance explained by decision-making styles. Thus, decision-

[13] Part correlations reflect the reduction in a regression's beta coefficient, after adding a mediating variable to the model. Whereas part correlations remove the variance shared between predictors (e.g., A-DMC and age), partial correlations also remove the variance shared with the predicted variable (e.g., the DOI). All part correlations reported here are virtually identical to the corresponding partial correlations.

[14] Because Applying Decision Rules shows the strongest correlation with the DOI and the highest loading on the single-factor score of A-DMC components, it is possible that the results are driven solely by this A-DMC component. However, controlling for Applying Decision Rules did not reduce the significance levels of correlations of the DOI with other A-DMC component scores and overall A-DMC, except for Consistency in Risk Perception ($r = .14$, $p < .05$).

[15] A moderation test using hierarchical regression (Baron & Kenny, 1986) shows that adding the interactions of the A-DMC with recruitment site and with highest level of education completed to the main effects improves predictions of the DOI ($\Delta R^2 = .02$), $F(2, 310) = 3.37$, $p < .05$. Only the first interaction was significant ($\beta = .27$), $t(310) = 2.55$, $p < .05$, with the A-DMC being more strongly related to the DOI for users of social services than for others.

Table 6
Hierarchical Regressions on the DOI

Independent variable	Total R^2	Adjusted R^2	ΔR^2	Test of ΔR^2
Analysis 1a				
Step 1: A-DMC components	.16	.13	.16	$F(7, 270) = 7.13, p < .001$
Step 2: Cognitive ability	.16	.13	.01	$F(2, 268) = 0.93, p = .40$
Analysis 1b				
Step 1: Cognitive ability	.04	.03	.04	$F(2, 275) = 5.60, p < .01$
Step 2: A-DMC components	.16	.13	.12	$F(7, 268) = 5.60, p < .001$
Analysis 2a				
Step 1: A-DMC components	.16	.14	.16	$F(7, 268) = 7.21, p < .001$
Step 2: Decision-making styles	.31	.27	.15	$F(8, 260) = 6.99, p < .001$
Analysis 2b				
Step 1: Decision-making styles	.23	.21	.23	$F(8, 267) = 9.94, p < .001$
Step 2: A-DMC components	.31	.27	.08	$F(7, 260) = 4.19, p < .001$

Note. DOI = Decision Outcomes Inventory; A-DMC = Adult Decision-Making Competence.

making styles account for 50% (i.e., 8% out of 16%) of A-DMC-related variance in the DOI, whereas A-DMC accounts for 35% (i.e., 8% out of 23%) of variance related to decision-making styles in the DOI.

A third set of hierarchical regressions (not shown) similarly compared the A-DMC with all other measures used in this study: cognitive ability, age, SES, and decision-making styles. These measures add 23%, $F(13, 243) = 7.14$, $p < .001$, to the 17% explained by the A-DMC when entered in Step 1, $F(7, 256) = 7.48$, $p < .001$. The reverse also holds, with the A-DMC adding 5%, $F(7, 243) = 2.72$, $p < .05$, to the 35% of DOI variance accounted for by the other measures, $F(13, 250) = 10.45$, $p < .001$. Thus, the other measures explain 71% (12% out of 17%) of A-DMC-related variance in the DOI, and the A-DMC explains 34% (12% out of 35%) of the variance in the DOI because of the other measures.

Discussion

Our initial aim was to develop a measure of adult decision-making competence (the A-DMC) that built on a normative approach to decision making and improved on the measure developed for young people (the Y-DMC). When administered to a diverse sample of adults, the new measure showed greater internal consistency for the component tasks, test–retest reliability for the overall measure, and intertask correlations than had the youth version. Thus, the A-DMC skill set, long identified as central to decision making (W. Edwards, 1954; Raiffa, 1968), reflects a unified construct (or a set of related, mutually supportive constructs). These results further support the proposal (Stanovich & West, 2000) that performance on conventional behavioral decision-making tasks reflects a positive manifold rather than random performance errors. Moreover, it shows promise for the development of a normed psychometric test of decision-making competence.

Our second aim was to assess the nomological validity of the A-DMC, in terms of its relationships to SES, age, cognitive ability, and decision-making styles. As predicted, participants recruited through social service organizations and having less education had worse A-DMC scores. Of course, correlation does not imply causality. Lower decision-making abilities could lead to more difficult life experiences, while the stress of bad outcomes could undermine the quality of people's decisions. More direct tests of causal relationships include prospective studies examining the effects of training in decision making on the outcomes that people experience later (Beyth-Marom, Fischhoff, Quadrel, & Furby, 1991; Downs et al., 2004). Indeed, decision making may be a teachable skill (Baron & Brown, 1991), with correlational evidence suggesting that people who have received formal training in decision making may obtain better life outcomes (Larrick et al., 1993). If so, then teaching decision making may improve quality of life, especially in low-SES communities.

A-DMC components did not show consistent relationships with age. Whereas older adults performed significantly worse on Resistance to Framing and Applying Decision Rules, they did significantly better on Recognizing Social Norms and Resistance to Sunk Costs. These inconsistent results perhaps reflect the two competing views on everyday problem solving and aging, described by Finucane et al. (2002). One view argues that everyday problem solving relies on cognitive abilities that decline with age (cf. Willis, 1991), whereas the other view posits that older individuals have knowledge and experience that allows them to be more selective, domain specific, and automatized in their problem solving (cf. Baltes & Baltes, 1990; Denney, 1989; Salthouse, 1991), which may make up for any impaired cognitive abilities. Possibly, Resistance to Framing and Applying Decision Rules require cognitive skills that decrease with age (Finucane et al., 2005, 2002), whereas Recognizing Social Norms and Resistance to Sunk Costs rely on experiences that increase with age.

The nomological validity of the A-DMC was underscored by predicted associations with measures of (a) general fluid and crystallized cognitive ability (Raven SPM and the Comprehension subtest of the Nelson-Denny Reading Test, respectively) and (b) constructive and maladaptive decision-making styles, including tendencies to experience regret and maximize needlessly (Schwartz et al., 2002); to engage in behavioral coping (Epstein & Meier, 1989; Katz & Epstein, 1991); and to engage in avoidant, rational, and spontaneous decision making (Scott & Bruce, 1985).

Our third aim was to assess the relationship between A-DMC components and experienced real-world decision outcomes. In the absence of direct measures of real-world decision-making experi-

ence, we developed a generally applicable measure of self-reported decision outcomes. Our DOI showed good internal consistency, with a single-factor solution having high loadings of almost all items. The frequency with which respondents reported poor decision outcomes reflects some (perhaps surprising) candor in admitting to negative life experiences. Nonetheless, any measure relying on self-reports must be treated cautiously.

Using the DOI as a standard, the A-DMC shows good predictive validity: Overall performance on the A-DMC and most of its component tasks is associated with better decision outcomes. Although some A-DMC components (such as Applying Decision Rules) have strong correlations with measures of cognitive ability, the relationship between the A-DMC and DOI remains significant after controlling for these measures. In fact, the A-DMC appears to mediate the relationship between cognitive ability and the DOI. The A-DMC may measure specific cognitive skills that go beyond general cognitive ability in terms of their relevance to avoiding negative real-world decision outcomes, perhaps suggesting that the domain of cognitive ability could be expanded to include decision-making competence.

Limitations

Not all of the selected A-DMC component tasks perform equally well. Path Independence, an axiom of normative decision making, does particularly poorly. Although internally consistent, performance on it is relatively unreliable over time, suggesting that it may be a reliable measure of a temporary state. However, performance on Path Independence is unrelated to performance on the other A-DMC components or to any of the covariate measures, including SES, real-world decision outcomes, and cognitive ability. A similar pattern was observed with adolescents, in which Path Independence scores were unrelated to risk behaviors and social background (Parker & Fischhoff, 2005). This is notable, given Path Independence's central role in normative decision making. If Path Independence does indeed reflect an unstable ability, then it may vary too much to affect real-world decision outcomes that evolve over time. It is also possible that the abstract formulation of the paper-and-pencil task tapped some skill other than decision-making ability. Finally, Path Independence may not be relevant to real-world choices, which may consistently appear with the same structure.

Despite being sensibly related to other decision-making tasks and to measures of SES and cognitive ability, performance on Resistance to Framing is unrelated to real-world decision outcomes and effective decision-making styles. Here, too, as with Path Independence, experiences with real-world outcomes may be buffered by conventions for frame choice. That is, real-world choices may typically appear in a common frame, perhaps conveying the communicator's norms about how to view the choice (Fischhoff, 1993; Fischhoff, Slovic & Lichtenstein, 1980; McKenzie, 2004; McKenzie & Nelson, 2003; Schwarz, 1999). It is also possible that our within-subject design relied on an ability to recognize similar frames, unrelated to Resistance to Framing in between-subject designs (LeBoeuf & Shafir, 2003).

Our study presented all tasks in the same order, mostly for administrative reasons. Doing so may have led to later measures being disproportionately affected by participant fatigue or learning, reducing the reliability and validity of tasks presented later. Because all participants completed the tasks in the same order, the present results do not allow examining possible order effects. Future research should vary presentation order.

Future research should also expand the set of covariates. The present study used one set of measures for cognitive ability, decision-making styles, and SES. Although they were selected with care, in order to cover different aspects of the construct each is meant to represent, other measures might yield different results.

Similarly, results may vary with different tasks representing these decision-making skills. The tasks that we chose for the A-DMC reflect the traditional normative approach to decision-making competence (W. Edwards, 1954; Finucane & Lees, 2005; Raiffa, 1968) and the original Y-DMC (Parker & Fischhoff, 2005). However, researchers have studied many other judgment and decision-making skills, including consistency in judgments over time (Fischhoff, 1975), consistency in choice over time (Loewenstein & Elster, 1992), and resistance to biases arising from heuristics such as representativeness and availability (Tversky & Kahneman, 1974). Future research should examine their external validity in terms of relevance to avoiding the DOI's negative real-world outcomes.

In summary, we have created and evaluated two new measures, one for adult decision-making skills (the A-DMC) and one for decision-making outcomes (the DOI). The present results, combined with those from Parker and Fischhoff (2005), support the overall construct validity of decision-making competence as well as the external validity of tasks drawn from the behavioral decision research repertoire. Although some researchers have raised questions about these tasks' external validity (Gigerenzer et al., 2000; Klein, 1999), most show good internal consistency, test–retest reliability, and validity—as seen in significant, predicted correlations with real-world decision outcomes, cognitive ability, decision-making styles, and SES. The psychometric properties revealed in this systematically developed battery and large, diverse sample suggest that the A-DMC and its component tasks have promise for use as individual-differences measures. Additionally, the DOI appears to elicit internally consistent experiences of real-world outcomes, in a short, easily administered self-report format similar to that used for life-event scales (e.g., Miller, 1996).

Future research might examine relationships of performance on other decision-making tasks with the A-DMC and DOI. If decision-making skills reflect a positive manifold, then positive correlations should be observed. Our two scales may also be used for understanding the role of decision-making competence in everyday life and how it can be illuminated by behavioral decision research—recognizing that each such study tests the construct validity of the measures.

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Appendix A

Sample DMC Items

Resistance to Framing

Part I

Imagine that recent evidence has shown that a pesticide is threatening the lives of 1,200 endangered animals. Two response options have been suggested:

If Option A is used, 600 animals will be saved for sure.

If Option B is used, there is a 75% chance that 800 animals will be saved and a 25% chance that no animals will be saved.

Which option do you recommend to use?

1 2 3 4 5 6

Definitely would choose A — Definitely would choose B

Part II

Imagine that recent evidence has shown that a pesticide is threatening the lives of 1,200 endangered animals. Two response options have been suggested:

If Option A is used, 600 animals will be lost for sure.

If Option B is used, there is a 75% chance that 400 animals will be lost and a 25% chance that 1,200 animals will be lost.

Which option do you recommend to use?

1 2 3 4 5 6

Definitely would choose A — Definitely would choose B

Recognizing Social Norms

Part I

Do you think it is sometimes OK . . .

. . . to steal under certain circumstances?

Yes No

Part II

Out of 100 people your age, how many would say it is sometimes OK . . .

. . . to steal under certain circumstances?

0 10 20 30 40 50 60 70 80 90 100

No one — Everyone

(*Appendixes continue*)

Under/overconfidence

Alcohol causes dehydration.

This statement is [True/False].

50% 60% 70% 80% 90% 100%

just guessing absolutely sure

Applying Decision Rules

		Features				
		Picture Quality	Sound Quality	Programming Options	Reliability of Brand	Price
DVD	A	3	5	5	1	$369
	B	1	2	1	2	$369
	C	5	5	4	4	$369
	D	5	3	4	2	$369
	E	4	5	2	2	$369

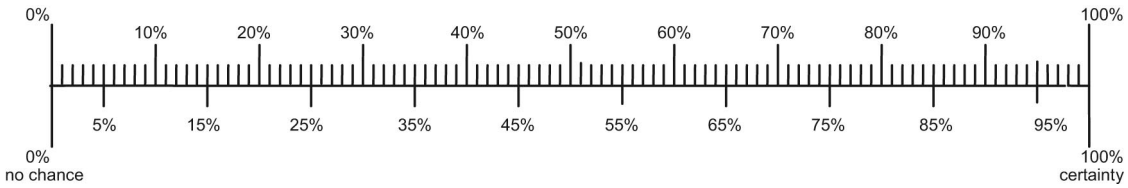
LaToya only wants a DVD player that got a "Very High" rating on Reliability of Brand.

Which **one** of the presented DVD players would LaToya prefer?

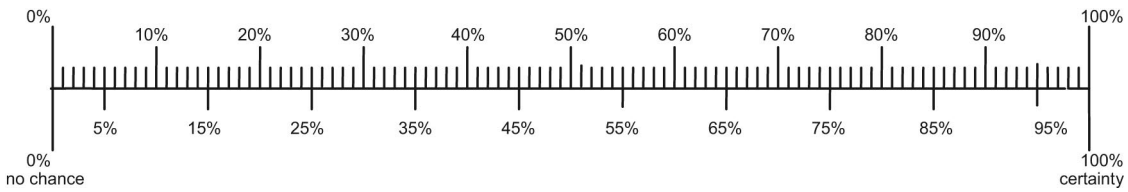
_____

Consistency in Risk Perception

What is the probability that you will get into a car accident while driving during the next year?



What is the probability that your driving will be accident-free during the next year?



Resistance to Sunk Costs

After a large meal at a restaurant, you order a big dessert with chocolate and ice cream. After a few bites, you find you are full and you would rather not eat any more of it.

Would you be more likely to eat more or to stop eating it?

1	2	3	4	5	6
Most likely to eat more					Most likely to stop eating

Path Independence

Which do you like best, (1), (2), or (3)?

(1)	(2)	(3)
Flip a Coin	*Sure Win*	*Doesn't Matter to Me.*
If Heads, win **$100**	Win **$50** for sure	If Tails, win **$0**
____	____	____

If you had already flipped once and it came up heads, which do you like best, (1), (2), or (3)?

(1)	(2)	(3)
Flip Second Coin	*Sure Win*	*Doesn't Matter to Me*
If Heads, Win **$100**	Win **$50** for sure	If Tails, win **$0**
____	____	____

Appendix B
DOI Items and Response Frequencies

In the last 10 years, have you ever . . .	Percentage who made the decision	Percentage who experienced the outcome (given the decision)
1. a. Rented a movie	89.3	
b. Returned a movie you rented without having watched it at all		61.4
2. a. Bought new clothes or shoes	96.9	
b. Bought new clothes or shoes you never wore		52.5
3. a. Gone shopping for food or groceries	99.4	
b. Threw out food or groceries you had bought because they went bad		80.8
4. a. Done your own laundry	96.3	
b. Ruined your clothes because you didn't follow the laundry instructions on the label		44.2
5. a. Been enrolled in any kind of school	57.0	
b. Been suspended from school for at least one day for any reason		10.0
6. a. Had any kind of job	83.3	
b. Quit a job after a week		9.4
7. a. Had a driver's license	84.6	
b. Had your driver's license taken away from you by the police		6.9
8. a. Driven a car	89.1	
b. Been accused of causing a car accident while driving		14.2
c. Gotten more than 5 parking tickets		7.2
d. Gotten more than 5 speeding tickets		3.9
e. Gotten lost or gone the wrong way for more than 10 minutes while driving		53.9
f. Locked your keys in the car		43.6
9. a. Bought any kind of car	67.9	
b. Had to spend at least $500 to fix a car you had owned for less than half a year		22.5

(*Appendixes continue*)

Appendix B (*continued*)

In the last 10 years, have you ever . . .	Percentage who made the decision	Percentage who experienced the outcome (given the decision)
10. a. Taken a trip by airplane	76.6	
b. Missed a flight		6.9
11. a. Taken the train or the bus	63.1	
b. Taken the wrong train or bus		8.3
12. a. Had any form of ID (driver's license, passport, birth certificate)	92.3	
b. Had your ID replaced because you lost it		20.6
13. a. Lived in a rented apartment or other rental property	40.3	
b. Been kicked out of an apartment or rental property before the lease ran out		5.8
14. a. Carried a key to your home	88.2	
b. Had the key to your home replaced because you lost it		19.7
c. Locked yourself out of your home		36.7
15. a. Been responsible for electricity, cable, gas or water payments	83.1	
b. Had your electricity, cable, gas or water shut off because you didn't pay on time		11.9
16. a. Been responsible for a mortgage or loan	64.6	
b. Foreclosed a mortgage or loan		4.4
17. a. Been responsible for rent or mortgage payments	72.6	
b. Paid a rent or mortgage payment at least 2 weeks too late		17.2
18. a. Used checks	88.5	
b. Had a check bounce		31.7
19. a. Had a credit card	84.7	
b. Had more than $5,000 in credit card debt		29.7
20. a. Invested in the stock market	47.2	
b. Lost more than $1,000 on a stock market investment		21.7
21. a. Been to a bar, restaurant, or hotel	92.5	
b. Been kicked out of a bar, restaurant, or hotel by someone who works there		7.8
22. a. Loaned more than $50 to someone	57.1	
b. Loaned more than $50 to someone and never got it back		35.6
23. a. Had a romantic relationship that lasted for at least 1 year	67.6	
b. Cheated on your romantic partner of 1 year by having sex with someone else		11.4
24. a. Been married	66.8	
b. Been divorced		10.6
25. a. Had sex	83.4	
b. Been diagnosed with an STD		6.4
c. Had an unplanned pregnancy (or got someone pregnant, unplanned)		13.3
26. a. Had sex with a condom	46.5	
b. Had a condom break, tear, or slip off		14.7
27. a. Had an alcoholic drink	78.5	
b. Consumed so much alcohol you vomited		27.8
c. Received a DUI for drunk driving		5.0
28. a. Been out in the sun	89.9	
b. Got blisters from sunburn		22.2
29. Been in a jail cell overnight for any reason		6.7
30. Been in a public fight or screaming argument		17.5
31. Declared bankruptcy		7.8
32. Forgotten a birthday of someone close to you and did not realize until the next day or later.		50.6
33. Been diagnosed with Type 2 diabetes		6.1
34. Broke a bone because you fell, slipped, or misstepped		14.7

Note. DOI = Decision Outcomes Inventory; STD = sexually transmitted disease; DUI = driving under the influence.

Received April 14, 2006
Revision received December 4, 2006
Accepted December 14, 2006 ■