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# ABSTRACT

Despite the very long history of research on heritable traits, we still know very little about genetic effects on judgment and choice, including consumer decision making. Building on recent advances in epigenetics, we hypothesize that people inherit a general prudence tendency, which affects their predisposition to choose options that vary on the prudence dimension. We use a classic twins study design whereby greater similarity between monozygotic twins than between dizygotic twins indicates a heritable trait. Unlike most prior studies that have focused on one or few characteristics, our study examines a broad range of judgment and choice phenomena simultaneously in order to gain insights into heritable tendencies (representing individual differences) and nonheritable tendencies. Consistent with our "prudence hypothesis," we find a significant heritable effect on (a) preferences for compromise (but not perceptually dominating) options, (b) choosing a sure gain over a gamble, (c) preferences for a feasible though dull assignment (in the near distance), (d) maximizing (versus satisficing), and (e) preferences for utilitarian (versus hedonic) options. Conversely, non-prudence problems (e.g., relating to discounting, highlighting, variety) as well as judgment heuristics (availability, representativeness, anchoring) do not appear to reflect heritable individual differences. We discuss the implications of our research with respect to the determinants of preferences, the interpretation of rationality and of BDT effects, the notion of constructive predispositions, and directions for future research regarding the role of genetics in decision making.

The currently accepted view in the consumer, behavioral decision theory (BDT), and social psychology fields regarding the origins of attitudes, preferences, and decisions appears inconsistent with the well-established effects of people's genetic makeup on traits, behavior, and certain attitudes (for reviews, see, e.g., Marcus 2004; Olson et al. 2001; Plomin et al. 2008; Ridley 2003). Thus, for example, building on a great deal of prior BDT research regarding task effects (e.g., Tversky, Sattath, and Slovic 1988), context effects such as asymmetric dominance and compromise (e.g., Huber, Payne, and Puto 1982; Simonson 1989), and framing effects (e.g., Levin and Gaeth 1988; Tversky and Kahneman 1981), Bettman, Luce, and Payne (1998, Abstract) concluded that "Consumer choice is inherently constructive." Similarly, Schwarz (2007, Abstract) writes, "Most theories treat attitudes as enduring evaluative tendencies; … Attitude construal theories conceptualize the context sensitivity of evaluative judgment and provide a parsimonious account of core findings of the attitude literature without assuming enduring dispositions." In a different era and from a very different perspective, John Watson famously wrote (1930), "Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train them to become any type of specialist I might select – doctor, lawyer, artist, …". While few psychologists today will agree with Watson's strong behaviorist position, it is noteworthy that even social psychologists who may disagree with the strong constructive perspective tend to view attitudes and attitude tendencies as formed only after encountering the evaluated objects, mostly based on experience (e.g., Eagly and Chaiken 1998; McGuire 1969).

It is thus not surprising that the suggestion that we may conceive of dormant inherent preferences or predispositions that are determined and evolve even prior to the existence of an object which embodies these preferences (e.g., a preference for the Nintendo Wii's motion sensitive remote before the Wii was invented) has generated some controversy (Bettman, Luce, and Payne 2008; Dhar and Novemsky 2008; Kivetz, Netzer, and Schrift 2008; Simonson 2008a,

2008b; Smith 2008). Similarly, the proposition in the social psychological literature that attitudes may have a genetic basis (Tesser 1993) has been controversial.

Yet, research on behavior genetics, which has so far played a rather limited role in the evolution of the BDT, consumer behavior, and social psychology fields, has demonstrated strong and robust effects on various traits and behaviors. In particular, starting in the 19th century (Galton 1875), but especially over the past 40 years or so, behavior genetics studies have demonstrated genetic effects on behaviors such as divorce, drug addiction, voting, and altruism, and on attitudes toward targets such as religion, death penalty, roller coasters, and jazz (e.g., Fowler, Baker, and Dawes, 2008; Martin et al. 1986; Olson et al. 2001). These findings go well beyond earlier findings regarding genetic effects on intelligence, personality, and behavior (see, e.g., Bouchard et al. 1990; Plomin et al. 2008).

A limitation of most prior behavior genetics studies is their focus on the heritability of behaviors and attitudes within a rather narrow range or a specific category, such as a study of genetic effects on IQ, well-being, or income. The tendency to focus piecemeal on certain behaviors and attitudes has limited our ability to learn more generally about the genetically-sensitive psychological, behavioral responses, that is, those that are characterized by the most and least genetic-based individual differences (i.e., heritable characteristics). It is also noteworthy that there has been surprisingly little research about genetic effects pertaining to decision making, and we are not aware of any prior empirical research that specifically focused on genetic effects as they apply to consumer judgment and choice.

In the present research we adopt a broad view and present a preliminary investigation of a wide range of previously demonstrated judgment and decision phenomena, many of which have been regarded as biases and, in some cases, as reflecting irrational decision making and examples of preference construction (for reviews, see, e.g., Bettman et al. 1998; Simonson and Tversky 1992; Tversky and Kahneman 1974). We propose a general heritable tendency, referred to as the

degree of *prudence*, which leads to specific predictions concerning heritable responses in decisions between options varying on the prudence dimension; these heritable tendencies are expected to be observed in choice problems where responses are not overridden by automatic heuristics, impulses, or visceral reactions. We further propose that, although genetics probably affects judgment heuristics and various other responses (e.g., availability, variety seeking), such automatic responses are less likely to represent heritable individual differences.

We begin with a brief overview of key prior findings in the vast and rapidly evolving field of behavior genetics. As explained later, unlike research on evolution and evolutionary psychology, the term "heritable" is used in the behavior genetics field (including the present research) more narrowly than the term "genetic," referring only to genetic-based traits and responses that are not shared by all humans and thus produce individual differences. We then develop a framework for analyzing the heritability of prudent choice tendencies. Next, considering that our study (like most prior research in this area) is based on a comparison of monozygotic (referred to also as "identical") twins and dizygotic (fraternal) twins, we discuss the logic and methodology of such studies as well as the evidence pertaining to criticisms of the methodology. We then describe our study's methodology, the specific problems that were tested, and the findings. The article concludes with a discussion of the implications of this research as well as directions for future research.

## A BRIEF OVERVIEW OF RESEARCH ABOUT THE HERITABILITY OF TRAITS, BEHAVIORS, AND ATTITUDES, AND OF RECENT ADVANCES IN EPIGENETICS

A newcomer to the area known as behavior genetics is struck by the ubiquity and scope of documented genetic effects on traits, attitudes, and behaviors. Moreover, while the field was marred by controversy for a large part of its history, particularly as it relates to the link between

genes and intelligence as well as the age-old nature versus nurture debate, it has rapidly evolved in recent years, building on work in different disciplines.

The behavior genetics field started with the pioneering work of Francis Galton in the 19th century. For example, in his 1875 article, titled "The history of twins as a criterion of the relative powers of nature and nurture," Galton (using what would be considered today as nonscientific methods) was the first to rely on comparisons between monozygotic and dizygotic twins, concluding that, "Nature is far stronger than nurture with the narrow range that I have been careful to assign to the latter." In his 1869 book, anticipating strong opposition to his work, Galton wrote, "My only fear is that my evidence seems to prove too much and may be discredited on that account, as it seems contrary to all experience that nurture should go for so little." Indeed, the belief in the power of nurture and that the mind of an infant is a blank slate on which experience writes its script goes back to Locke, Hume, and Mill (see Ridley 2003).

It should be noted that, the generally accepted view today is captured by the terms "nurturing nature" or "nature *via* nurture" (e.g., Meaney 2001; Ridley 2003), suggesting that nature versus nurture represents a false dichotomy and pitting one against the other is not more sensible than asking if length or width contribute more to the area of a rectangle. As Dawkins illustrated (1979, p. 192), "You cannot break the finished cake up into its component crumbs and map each crumb on to a particular word or letter of the recipe. But if you *change* one word in the recipe, the cake may come out different as a result. The *difference* between two cakes might well be due to a one word difference in their two recipes." Still, although the influences of nature and nurture are inseparable, research over the past 20 years or so has emphasized the former. For example, Eric Turkheimer (2000) summarized a great deal of "nearly unanimous" prior behavior genetics findings by the following "Three laws of behavior genetics":

1. All human behavioral traits are heritable.
2. The effect of being raised in the same family is smaller than the effect of genes.

3. A substantial portion of the variation in complex human behavioral traits is not accounted for by the effects of genes or families" (referred to as 'unshared environment').

It is noteworthy that, although evolution, in general, and evolutionary psychology, in particular, are related in many ways to behavior genetics (see, e.g., Pinker 1997), as two leading evolutionary psychology researchers pointed out (Cosmides and Tooby 1997, p. 14):

> "Evolutionary psychology is not behavior genetics. Behavior geneticists are interested in the extent to which *differences* between people in a given environment can be accounted for by *differences* in their genes. EPs [evolutionary psychologists] are interested in individual differences only insofar as these are the manifestation of an underlying architecture shared by all human beings. Because their genetic basis is universal and species-typical, the heritability of complex adaptations (of the eye, for example) is usually low, not high."

This latter point is particularly pertinent to the current and similar behavioral genetic investigations – our focus is on heritability, that is, differences across people, although we also consider and test judgment and decision phenomena (e.g., availability, anchoring, discounting) that we expect (and find) to be nonheritable (but possibly influenced by genes).

Without describing in detail the numerous heritable traits and behaviors that have been identified, as indicated, the range of such effects has rapidly evolved, especially in recent decades. Going well beyond the initial focus on the link between genes and intelligence as well as personality (particularly extroversion and neuroticism), (a) researchers in political science have shown that political orientations, party affiliation and the decision to vote have a significant genetic component (Alford, Funk, and Hibbing 2005; Fowler and Schreiber 2008; Settle, Dawes, and Fowler, in press); (b) researchers also identified two specific genes that appear to predict voter turnout (Fowler and Dawes 2008); (c) research in areas related to economics have shown

genetic effects on income, behavior in a dictator game, entrepreneurship, and risk aversion in the domain of gains (e.g., Cesarini et al. 2009; Nicolaou et al. 2008; Taubman 1976); and (d) behavior geneticists have shown various other effects, including for example, divorce likelihood, drug addition, altruism, tendency to be religious, and anti-social behavior (e.g., Moffitt 2005).

Of particular interest to the present investigation is research in social psychology. For example, using a standard twins design, Olson et al. (2001) tested 30 attitude items (e.g., crossword puzzles, death penalty, capitalism, looking my best, reading books, roller coasters), which were reduced to nine underlying attitude factors. Tesser (1993) argued that heritable attitudes should be responded to more quickly and be more resistant to change. Instead of using the standard twins methodology (as described below), he conducted several experiments using methods that were similar to prior attitude studies (e.g., Fazio and Williams 1986); the obtained effects were small. Tesser's research has been somewhat controversial in social psychological literature. As one review noted (Petty, Wegener, and Fabrigar 1997, p. 615), "First, methodological challenges make exact estimates of the genetic versus environmental basis of attitudes controversial. … A second limitation is a lack of clearly articulated or empirically verified mediating process."

Of course, even with the standard twins design typically relied upon in the behavior genetics field, a requirement that a researcher would clearly articulate and empirically verify the mediating process will greatly limit the scope of phenomena that might be studied. For example, there is little doubt that the well-established genetic effects on IQ and personality (and resulting effects on well-being, for example; see Weiss, Bates, and Luciano 2008) involves numerous, perhaps hundreds of genes, and thousands of proteins, neurons, and other things that affect gene expression. Accordingly, it seems futile and counterproductive to wait with further research until one can verify the mediating processes involved in each such link.

Having said that, at this point after over 100 years of research, there are still many more findings of various heritable differences than there are explanations as to underlying mechanisms. Moreover, many specific heritable differences cannot be easily explained based on well-defined relations to broader categories of heritable traits. For example, the heritable tendencies to vote, be religious, and enjoy jazz cannot be easily accounted for by IQ, extroversion, or neuroticism. It is also highly unlikely that specific preferences, such as jazz, hybrid cars, or compromising, could be linked to specific genes or gene expressions.

However, recent advances in molecular genetics do provide a window into how interactions between nurture and nature (referred to as "nurturing nature," or "nature via nurture") might operate (for reviews of earlier work, see, e.g., Marcus 2004; Ridley 2003; Turkheimer 1998). For example, Caspi et al. (2003; but see also Risch et al. 2009) identified a gene-by-environment interaction whereby a genetic disposition to depression produces depression only among those experiencing great stress.

Probably the most promising area of research pertaining to interactions between nature and nurture is the rapidly developing field of epigenetics (for a review, see, e.g., Szyf, McGowan, and Meaney 2008). Epigenetics refers to heritable alterations in gene expression caused by mechanisms other than changes in DNA sequences. More specifically, a recently proposed definition reads as follows (Berger et al. 2009): "An epigenetic trait is a stably inherited phenotype resulting from changes in the chromosome without alterations in the DNA sequence." Whereas early epigenetic research has focused on the impact of exposure to certain substances on genetic susceptibility to disease (e.g., cancer), more recent research has demonstrated epigenetic effects of social interactions on specific behaviors while providing precise insights into how such effects operate.

For example, the licking and nursing of mother rats with their pups affect the long term behavior of the (female) pups, and these behavior patterns are then inherited by their own pups

(for a review, see Champagne 2008). Those changes have been linked to changes in DNA methylation and histone acetylation at a glucocortcoid receptor gene promoter in the pup's hippocampus. Such changes are not limited to rats and fruit flies. In particular, recent research has demonstrated the impact of child abuse on epigenetic changes that affect the likelihood of suicide (McGowan et al. 2009).

More generally, epigenetic researchers have proposed that "DNA methylation is dynamic in postmitotic tissues. … It is possible that the dynamic equilibrium is altered by either pathological or adaptive mechanisms in response to extra and intracellular signaling. This will lead to a change in either gene silencing or activation" (Szyf et al. 2008; p. 49). Szyf et al. further argue (p. 53) that, "Although the idea that a behavioral exposure might result in a physical change to chromatin or DNA of specific loci seems far-fetched at first glance, basic concepts of how epigenetic programming event are targeted to specific loci point toward a possible working hypothesis. The basic idea being that behavioral exposure fire signaling pathways in the brain which in turn activate sequence specific factors that target HATs to specific targets facilitating DNA demethylation." They go on to conclude that (p. 56), "The realization that the genome is programmed by the epigenome and this programming might be as important as the sequence itself in executing genome functions offers a new approach to the long-standing mystery of gene-environment interactions."

Although epigenetic research has focused so far on very specific social interactions and other environmental influences, the identification of the precise underlying biological mechanisms represents a major contribution of this rapidly evolving area. Other investigations of heritable traits and behaviors have tended to focus on particular traits that cannot be easily studied using epigenetic methods, such as altruism, religion, and certain personality characteristics. Thus, while prior research has established the heritability of a wide range of traits, behaviors, and attitudes, the processes underlying most such heritable differences cannot

be determined at the present time or even in the foreseeable future. Furthermore, a limitation of most prior studies is the lack of systematic investigations of the types of responses or effects that show heritable differences across people. In particular, in the domain of consumer judgment and choice, and decision making more generally, we know very little about the role of genetics in accounting for individual differences. We turn to that subject next.

## HYPOTHESIS: DEGREE OF CHOICE PRUDENCE IS A HERITABLE INDIVIDUAL DIFFERENCE (WHEREAS HEURISTICS ARE NOT)

The present research examines heritable choice and judgment characteristics, namely, those that account for individual differences. As explained below, the hypothesis we test is that individuals vary in the degree to which they are predisposed to making what we call "prudent choices," a dimension that plays a role in a wide range of decision types (but not in heuristics or reflexes). That is, we propose that prudence predisposition affects the probability of making specific choices from options sets that consumers and decision makers encounter in everyday life. Unlike the epigenetic research reviewed above, we cannot offer any evidence or even hypotheses regarding the specific biological mechanisms underlying the prudence hypothesis. However, while our basic proposition certainly represents a far-reaching extrapolation based on still limited evidence, we believe that the evidence that has already accumulated in the field of epigenetics suggests that specific implications of our hypothesis may be susceptible to biological testing in the future. That is, heritable epigenetic changes may generate certain tendencies that affect the likelihood of particular responses to a wide range of choice problems that involve prudence dilemmas (as explained below).

Before describing our basic proposition in more detail, it should be noted that evolutionary psychology does not appear to explain heritable differences in judgment and

decision making. In particular, the principle that "Our neural circuits were designed by natural selection to solve problems that our ancestors faced during our species' evolutionary history" (Cosmides and Tooby 2002) does not lead to predictions of heritable differences. However, the notion that certain instincts or reflexes tend to be universal is relevant to our analysis, because certain judgment and decision making (JDM) heuristics are likely to be similar in many respects to reflexes, impulses, or instincts. Although the exact definition of instincts and reflexes has been a matter of debate (see Ridley 2003), there is little doubt that reflexes or instincts evolved much before our capacity for deliberate decisions. Consistent with recent distinctions between "two systems" (Kahneman and Frederick 2002; Sloman 1996; Stanovich and West 2000), Marcus (2008, p. 51) points out,

> "Our thinking can be divided into two streams, one that is fast, automatic, and largely unconscious, and another that is slow, deliberate, and judicious. The former stream, which I will refer to as the ancestral system, or the reflexive system, seems to do its thing rapidly and automatically, with or without our conscious awareness. The latter stream I will call the deliberate system, because that's what it does; it deliberates, it considers, it chews over the facts – and tries (sometimes successfully, sometimes not) to reason with them. The reflexive system is clearly older, found in some form in virtually every multicellular organism. … The two systems rely on fairly different neural substrates. …"

Marcus illustrates the mental contamination created by the fast automatic system based on previously demonstrated phenomena such as anchoring and adjustment, the focusing illusion, and the halo effect. Consistent with these observations, we do not expect JDM heuristics to be heritable (i.e., differentiating). Further, as first suggested by James (1890), we expect that responses that come to resemble instincts or reflexes, including judgment heuristics (e.g., Slovic et al. 2002; Tversky and Kahneman 1974), become automatic and universal.

By contrast, as indicated, we do expect certain choice tendencies involving dilemmas that are related to prudence to be heritable. Such inherited differences in choice tendencies might reflect a combination of epigenetic (gene expression) characteristics pertaining to prudence. Thus, consistent with the emerging notion that exposure to certain environmental or social conditions triggers specific epigenetic, heritable changes (i.e., epigenetic programming, as reviewed above) that affect behavior, we propose that people are born with a generic tendency whose "side-effects" pertain to decisions involving prudence. In particular, many decisions that consumers and people more generally make involve options varying on this dimension. For example, the decision whether to select a compromise or a locally "extreme" option, choices between a sure small gain and a gamble, choices between indulgence and utilitarian options, and choices between a dull but feasible task and an interesting but challenging task (Liberman and Trope 1998), all involve options that vary on the dimension of prudence.

The label prudence comes with some "baggage," because it has been used in different ways across different fields. Haslam and Baron (1994) provide a detailed review of the meaning of prudence and its relation to intelligence and personality (going back to Aristotle). Their emphasis is on positive aspects of prudence as an indicator of rationality and far-sightedness, though as shown below, recent research has highlighted significant negative consequences of prudence and being overly calculated or reason-driven (e.g., Kivetz and Kainan 2006; Kivetz and Simonson 2002; Wilson and Schooler 1991). Elsewhere (Hogan and Hogan 1990), prudence was used as another label for the conscientiousness personality factor (one of the Big Five). Also, philosophers (e.g., Simpson 1998, Abstract) have discussed the "fear and hope about the future [that] help create a sense of prudence, although the inability to find safety will produce resignation," and other researchers discussed various manifestations of prudent choices.

Consistent with several dictionary definitions of prudence, as used here, the term prudence encompasses aspects such as cautiousness, carefulness, discretion, moderation, being

mindful, and getting prepared. It is a broad continuum that cannot be captured, accounted for, or measured by any single factor, but it is meaningful and, we believe, useful for analyzing heritable aspects of response tendencies concerning a wide range of decision problems.

We may think about such a generic prudence disposition as a cloud with different thickness or consistency across a wide range of somewhat related behavioral/response tendencies and preferences. While we cannot know how such a heritable tendency "operates" or is created, we can be rather certain that a person's choice patterns (e.g., choosing fruit salads over chocolate cakes or sure gains over gambles) do not produce genetic changes. Instead, a tendency for prudence may reflect more fundamental epigenetic experiences, akin perhaps to the significance of rat pups being licked or susceptible children being abused (as discussed above). Although the underlying combination of genetic characteristics that determines the center of gravity, shape, and influence mechanisms of the prudence cloud is unobservable, we can observe resulting heritable individual differences as they emerge in prudence-related responses. The hypothesized prudence cloud may overlap with potentially related heritable tendencies, such as neuroticism (or "emotional stability") and anti/social behavior (e.g., Moffitt 2005; Plomin et al. 2008).

Thus, a great deal of "noise" notwithstanding, such a heritable tendency will increase the likelihood of certain responses for different manifestations of the underlying prudence dilemma. That is, the heritable prudence predisposition is not deterministic, but it is assumed to affect the probability of certain choices. Of course, since the prudence predisposition is represented to varying degrees in different types of choice problems, and considering the "noise" associated with each particular choice problem and other individual differences, a prudence tendency is just one of various factors contributing to observed choices.

Importantly, unlike heuristics that usually (but not always) offer efficient and effective responses or estimates, prudence dilemmas (and prudence more generally) do not typically offer a dominant response. While prudence often has some advantages, a chronic tendency to avoid

any risk, go the extra mile for the best option, compromise, and choose the utilitarian option over indulgence, for example, can have some significant limitations. Thus, unlike availability and representativeness, for example, that likely reflect basic characteristics of the human brain and therefore tend to be virtually universal ("noise" notwithstanding), we expect heritable individual differences along the prudence dimension.

## PRUDENCE PREDISPOSITION AND DECISION MAKING: PREDICTIONS

Before we describe and motivate the particular tests we conducted in the present research, it is important to elaborate further on the role of "noise," in general, and what might be called "genetic noise," in particular. First, as pointed out, most judgment and choice problems, in real life and those tested in psychological experiments, involve more than prudence. For example, although the most widely accepted explanations of the endowment effect (Kahneman et al. 1990) and the status quo bias (Samuelson and Zeckhauser 1988) implicate loss aversion, these phenomena have various other components, which may interact with individual differences such as prior experiences, transient states (e.g., mood), and other interactions between the person and the task (e.g., selling mugs in a class environment).

But beyond such conventional "noise," there is often likely to be a problem of "genetic noise," because nonfocal aspects of the problem or task may also activate or trigger a genetic effect. For example, while theorists have identified loss aversion as a unifying account for a wide range of phenomena (Tversky and Kahneman 1991), genetically speaking, it is not at all obvious that all "loss aversion phenomena" are influenced by the same genetic characteristics and to the same degree. Moreover, an endowment effect experiment, for example, may very well involve other genetic effects and heritable individual differences, such as those pertaining to

buying and selling, the social/public aspect of such experiments, and the translation of liking to a specific monetary value.

Accordingly, the ideal JDM problem for the current investigation is simple, bare-bone, and focused on the dilemma of interest and nothing else. However, as shown below, certain problems are harder to simplify (e.g., balancing versus highlighting). Also, in some cases, we tested some well-known JDM problems, even though they have several components and/or they do not involve a clear choice between options that are a priori at different points on the prudence continuum. Most of the problems that we tested are presented in Appendix A.

*Compromise versus asymmetric dominance effects*. The contrast between the compromise (Simonson 1989) and asymmetric dominance (Huber et al. 1982) effects is well-suited for the current study. First, the decision whether to compromise or select an "extreme option" is a straightforward illustration of a prudence dilemma. Furthermore, prior research has shown that decisions whether to compromise often involve a conscious, prudent, and even effortful process (e.g., Dhar and Simonson 2003; Simonson 1989; see also Pocheptsova et al. 2009). By contrast, asymmetric dominance is more of a perceptual effect, not involving prudence, because choosers are usually unaware that the contrast between the inferior and dominating option affects their perception of the latter (when compared with the third option).

The compromise effect can be tested by comparing the choices in two sets in which the same option is either a compromise or an "extreme" (see the Portable Grill problem in Appendix A, which involved a within subject test; see also Simonson 1989 and Simonson and Tversky 1992). However, prior research has also tested the tendency to compromise based on just one choice set with a middle option and two extremes. In the current research we had one such test involving a set of flashlights. Another set, pertaining to payments, had the structure of a compromise problem, but it belonged to the category of sets in which respondents usually avoid the middle option (see Drolet, Simonson, and Tversky 2000; Simonson and Tversky 1992; only

8% chose the middle option in the current study); accordingly, it likely tested preference for discounting and impatience more than compromising.

It is noteworthy that a systematic preference for a compromise option represents (under very general assumptions) a violation of value maximization (Tversky and Simonson 1993). In other words, to the extent that our prediction concerning compromise is supported, it would mean that some people are predisposed to "irrational" choices that violate value maximization.

Asymmetric dominance is often tested by contrasting two sets (i.e., a within-subject test). In this research, we used two sets in the car category (see also Huber et al. 1982) that were separated in the questionnaire. In hindsight, considering that the differentiating car attributes were comfort and miles per gallon, the car problems also tested preferences between hedonic and utilitarian options. Thus, while we do not expect susceptibility to asymmetric dominance to be heritable, as discussed below, we do expect preferences between hedonic and utilitarian options to be partially heritable. As a result, we cannot a priori predict the results pertaining to the car choice problems. Susceptibility to asymmetric dominance may also be approximated based on the choices from just one set with an asymmetrically dominating option. The current study included two problems of this type involving cordless phones and mutual funds.

*Loss aversion*. Loss aversion has been used as the explanation for a wide range of JDM phenomena. In the present research, we use a relatively simple (within-subject) task (previously used in Simonson and Nowlis 2000) that consists of two choices between a sure gain and a gamble (the two choices were separated within the questionnaire). In one of the two problem sets used for this test, respondents chose between $30 in cash and a gamble with 50% chance to lose $100 and 50% chance to win $300. The other set was created by adding $200 to each amount – $230 for sure or a gamble with 50% chance to win $100 and 50% chance to win $500. A classic loss aversion pattern is represented by selections of the sure gain from the former set and the gamble in the latter. Both of the component problems in this test of loss aversion involve

a choice between a more prudent option (the sure gain) and a gamble, though only the one in which loss is a possibility directly pertains to a tendency to avoid losses. It is noteworthy that while similar risky choice problems have often been used in the JDM field (e.g., Mellers, Schwartz, and Ritov 1999), we are not aware of a prior test of the heritability of preferences between a sure gain and a gamble with the possibility of a loss (whereas, as noted, the heritability of risk aversion in the domain of gains has been shown; e.g., Zyphur et al. 2009).

*Choosing between utilitarian and hedonic options*. A great deal of prior research has examined choices between hedonic and utilitarian options, such as between batteries and Godiva chocolate (e.g., Dhar and Wertenbroch 2000; Kivetz and Keinan 2006). In general, choosing utilitarian options is more prudent, because there is little doubt that they are useful and necessary (e.g., Kivetz and Simonson 2002). Accordingly, we predict that preferences between utilitarian and hedonic options have a significant heritable component. This prediction was tested in three problems, including the "Car problem" mentioned earlier in which options varied in terms of a hedonic dimension, comfort, and a utilitarian dimension, miles per gallon.

*Choosing between desirability and feasibility for the near and distant future*. Liberman and Trope (1998) compared choices for the near and distant future (in connection with Temporal Construal Theory). For example, a student may have a choice between an interesting, rewarding assignment that is more challenging and a less interesting, less rewarding assignment that is easier to complete. Liberman and Trope showed that people tend to select the more desirable option when making choices for the distant future and the more feasible option when making a selection for the near future. Arguably, selecting a feasible option is more prudent than choosing a challenging though more desirable option.

In the present research, we tested two similar problems (each using a within-subject test), including one problem in which respondents chose between reviewing a long but interesting

book or a short but dull book. In one question, respondents were asked to assume that they would have to start the review the next day, whereas in the other question (appearing elsewhere in the questionnaire) the assignment was due in a year. One might conjecture that the prudence dilemma is more acute in the near future, which would suggest that the heritable prudence tendency plays a greater role in choices between feasibility and desirability for the near future.

*Maximizing-satisficing*. Schwartz and his colleagues (2002) identified an individual difference pertaining to the degree to which a person is a "satisficer" or a "maximizer;" a short form maximization of the maximization scale was subsequently introduced (Nenkov et al. 2008). The maximization tendency is measured with items such as, "I often find it difficult to shop for a gift for a friend," and "I never settle for second best" (see Appendix A). In general, maximizers want the best option and tend to search more in order to make sure they identify that option, yet despite their perfectionism, they are prone to subsequent regret over their choices. Conversely, satisficers want something that crosses the acceptability threshold and is just good enough. In the context of the present research, maximizers are likely to be generally more prudent than satisficers, because they work harder to avoid mistakes. Accordingly, we expect the scores on the maximization scale to reflect a heritable component.

Given our prediction concerning the maximization scale, we might also expect people's response to the well-known "jacket and calculator" problem (Tversky and Kahneman 1981) to be partially heritable. Although that problem has been used to illustrate mental accounting (e.g., Thaler 1999), the question that respondents are asked is whether they would drive to another store to obtain a better price. Accordingly, maximizers, and prudent shoppers more generally, might be more inclined to drive to the other store in an attempt to decrease the likelihood of regret over price. The problem tested in this research was essentially the same as the original problem (with backpack and phone replacing jacket and calculator).

## Nonheritable Judgments and Decisions

Some studies regarding genetic influences may lead one to conclude that most attitudes and behaviors are heritable (e.g., Martin et al. 1986; Olson et al., 2001; Plomin et al. 2008; Cesarini et al. 2009). Accordingly, in addition to identifying heritable preferences, such as those involving prudence, it is important to examine JDM responses that are not expected to have a significant heritable component. Regarding nonheritable judgment and decisions, we should reiterate the distinction between heritable and genetic influences. Heritability, as used here and in most research in the behavior genetics area, refers to (heritable) individual differences. Genetic effects represent a more inclusive category that includes also characteristics that are universal, such as walking on two legs and various shared instincts.

It is also important to note that, whereas findings of no differences between experimental groups are regarded as weak evidence concerning the non/existence of the aspect being tested, because such non-differences may reflect merely ineffective experimental manipulations, that limitation may not apply, or at least has a different meaning in the context of research concerning heritability. In particular, while it is certainly possible that any particular problem does not adequately test or measure the characteristic of interest, concerns about the strength of the "manipulation" (i.e., genetic differences) appear less pertinent in this context.

*Prediction: Judgment heuristics are not heritable*. Although judgment heuristics (Tversky and Kahneman 1974) may not be equivalent to the basic instincts first discussed by Darwin (Darwin 1873; see also James 1890; Pinker 1997; Ridley 2003), they are likely to be universal. For example, it appears reasonable to assume that people make judgments and assess probabilities based on what is available and salient when making those evaluations. Accordingly, we do not expect such judgment heuristics to be heritable, even though they probably do reflect the manner in which the brain operates, which, in turn, reflects the human

genetic makeup. Of course, the notion that such heuristics are universal does not mean that every individual will provide heuristic-consistent responses to every problem that happens to be selected for a study. That is, there is always likely to be "noise" pertaining to individual differences, problem characteristics, and the interaction between the two. In the present research, we tested the representativeness heuristic, the availability heuristic, and anchoring, using primarily problems that had been used by Kahneman and Tversky (see Appendix A).

One test of the representativeness heuristic examined susceptibility to the so-called base-rate fallacy, using a problem involving a sample of engineers and lawyers and a problem relating to the description of a professor. We also tested the conjunction fallacy (Tversky and Kahneman 1983), using the version of the well-known "Linda problem" in which respondents are asked to rank-order the likelihood of eight statements. We tested availability using a problem in which respondents are asked to estimate whether there are more words that start with an "r" than words that have "r" in the third position.

Following the work of Epley and Gilovich on the anchoring (and adjustment) heuristic (e.g., 2001; see also Tversky and Kahneman 1974), we tested susceptibility to anchoring using both problems with experimenter provided anchor and self-generated anchors. In the former category, (a) respondents were led to produce an arbitrary anchor (last two digits of their graduation year) that was expected to influence their estimate of the percentage of African countries in the United Nations; (b) respondents generated another arbitrary anchor (last two digits of their social security number) to estimate their willingness to pay for a toaster (Simonson and Drolet 2004); and (c) respondents considered a provided anchor and then estimated the population of Chicago. Using problems previously used by Epley and Gilovich, tests involving self-generated anchors asked for estimates of (a) when the second European explorer landed in the West Indies, and (b) the number of days it takes Mars to orbit the sun.

*Other (non-prudence related) choice problems*. We tested several other problems that were the subject of previous JDM studies, even though they did not involve options that varied on the prudence dimension. An important fundamental problem that people often face in everyday life relates to discounting or choices between receiving less of something (e.g., money) sooner or more of it later. In such problems, neither option is clearly more or less prudent, though both have an element of prudence. On the one hand, a bird in a hand is prudent, yet being patient and willing to wait for more may also be considered prudent.

In addition to two problems with just two options (the "Grocery voucher" and "Future payments" problems in Exhibit A), we also included a problem with three options. Although the set design resembles a "compromise set" (as discussed earlier), the options varied in terms of timing (tomorrow, in a year, and in two years) and amount to be received ($1,000, $1,300, and $1,700, respectively). As noted, previous research (and the current research) showed that most respondents select one of the extreme options rather than the middle option. Thus, this problem appears more suitable for assessing preferences between receiving less now versus more later than as an indicator of the tendency to select middle options.

We also tested the tendency for variety seeking (in the categories of snacks and soups) when making simultaneously multiple choices for several periods (using the method previously tested in Simonson 1990, Study 1). In such problems, it is unclear whether selecting variety or sticking to one's most preferred option is more prudent. On the one hand, variety allows one to hedge against a change in taste, but selecting the option known to be one's favorite can also be seen as prudent. It is noteworthy that prior research has established that sensation seeking has a significant heritable component (e.g., Koopman et al. 1995), but that research relied on a very different measure of sensation seeking (Zuckerman 1971). In the present study, in addition to testing the tendency to choose variety, we included selected items from two somewhat related scales: an innovativeness scale (Manning et al. 1995) and "Change seeking" scale (Steenkamp

and Baumgartner 1995). However, neither one of these scales revealed significant heritable differences (nor do they moderate any of the results reported below).

Another form of variety relates to situations in which consumers need to decide whether to pursue one goal consistently within a consumption episode (i.e., exhibit "highlighting"; see Dhar and Simonson 1999) or pursue two different goals ("balancing"). For example, a person may fly in economy class on some occasions and in first class on other occasions. Each time, that person also needs to select transportation to the airport, which may be the more expensive (and more convenient) taxi or the less expensive shuttle bus. The question is whether the consumer is more likely to take the taxi when flying coach or when flying in first class. Similar to the above variety problem, there is no a priori reason to expect that pursuing one goal consistently within a consumption episode is more or less prudent than pursuing two goals.

We also tested one version of the well-known "Theater ticket" problem (used to illustrate mental accounting; see Thaler 1999; Tversky and Kahneman 1981) in which a person lost the ticket and needs to decide whether to buy another ticket. In this case, neither decision (buy or not buy another ticket) appear more prudent.

*Specific product and experience preferences*. As described in more detail in (authors, in preparation), we measured respondents' liking for a number of products and experiences (using a 7-point, Love it - Hate it scale). For example, we measured liking for various foods (e.g., mustard, chocolate, licorice), music, movies, and art (jazz, opera, horror and sci-fi movies, abstract art), experiences and self expression (e.g., roller coasters, extreme sports, tattoos, and Facebook), and other products. In several cases, our choice of items was motivated by prior findings. For example, prior twins research found that attitude toward jazz has a significant heritable component (Martin et al. 1986), and Tesser and his colleagues reached a similar conclusion using attitude response measures (e.g., Tesser 1993; Crelia and Tesser 1996).

## Covariates

We included a number of covariates in order to account for possible rival accounts. Given prior evidence that IQ is partially heritable, we included a proxy for IQ – the 3-item cognitive reflection test or CRT (see Frederick 2005). Most IQ measures are too long and thus not suitable for the current study, whereas the CRT measure (see Appendix A) consists of just three short questions and was thus selected as an efficient proxy for intelligence.

Another scale included in the questionnaire was the short form need for cognition scale (Cacioppo, Petty, and Kao 1984). Need for cognition refers to people's motivation to engage in issue-relevant thinking. Unlike the Maximization scale, prior research regarding this individual difference do not lead to any predictions regarding prudence-tendencies, because the mere fact that a person tends to enjoy thinking more does not indicate a greater or lesser tendency to select prudent options.

In addition to a standard series of items used to confirm whether twins are monozygotic or dizygotic, we also measured (a) the frequency of interaction between the two, (b) geographic proximity, (c) education, (d) the degree to which respondents considered themselves conservative or liberal, and (e) income. Regarding income, prior research (e.g., Taubman 1976) has already established that income has a significant heritable component.

## Using Comparisons of Monozygotic and Dizygotic Twins to Study Judgment and Choice

Considering that this may be the first empirical study in the marketing and consumer behavior literatures that relies on comparisons between monozygotic and dizygotic twins to identify heritable effects, it might be useful to review briefly the basic assumptions and concerns that have been raised regarding that approach (see also Alford et al. 2005; Fowler et al. 2008;

Plomin et al. 2008). Twin studies have been shown to be very effective and are by far the most common approach for identifying heritable effects; they also provide estimates of the variance in observed traits and responses that is accounted for by genetics, the "shared environment" (e.g., growing up in the same family), and "unshared environment" (e.g., unique relationships and life experiences).

Monozygotic (MZ) twins (about 0.35% of all human births, which is higher than in other species; Wright 1997) develop from a single egg and sperm and are thus genetically identical, whereas dizygotic (DZ) twins, like any siblings, share on average just 50% of their genes. Thus, if we assume that the environment has a similar effect on both MZ twins and DZ twins, then any finding of a higher correlation within MZ pairs compared to DZ pairs with respect to a particular trait, behavior, or response indicates a genetic effect. Accordingly, the assumption of equivalent environments (and/or that any environmental differences are randomly distributed or, at least, do not account for the observed average concordance differences between twin types) is critical. It is therefore not surprising that this assumption has received a great deal of attention.

By and large, but not in all cases, there is evidence that the assumption holds. Two primary arguments have been raised concerning the assumption of equal environment. First, there is consistent evidence (also in our study) that MZ twins tend to interact more often (after leaving the home) and live closer. Second, the parents and others may treat MZ twins differently than they treat DZ twins.

With respect to the first concern, there is no evidence that frequency of contact between twins increases attitude correlations (Martin et al. 1986). Furthermore, and perhaps even more persuasive is the finding that MZ twins reared apart (i.e., without any contact) show about the same high correlations (at least for the tested traits) as those reared together with respect to a wide range of measures (Bouchard 1998; Bouchard et al. 1990). These findings also suggest that the environment appears to play a smaller role with respect to those indicators. As an aside,

there is some evidence that, compared to those who grew up together and are in contact, twins reared apart may become even more similar as they age (e.g., Bouchard and McGue 2003). It is noteworthy, however, that this and some of the other findings regarding twins reared apart appear potentially inconsistent with the emerging view that interactions with the environment play a critical role in gene expression.

There is also evidence that is inconsistent with the concern relating to different social treatment of MZ twins and DZ twins (e.g., Morris-Yates et al. 1990). First, parents sometimes mistakenly believe that their DZ twins are MZ twins, in which case they are likely to treat them as such. However, even in such cases, the similarity between the misidentified (DZ) twins is lower than that between true MZ twins (e.g., Bouchard and McGue 2003; Bouchard et al. 1990; Plomin et al. 2008). Furthermore, the above cited evidence regarding twins reared apart is inconsistent with a significant effect of different MZ/DZ treatments (see also Segal 1999).

Still, there are some documented cases where relaxing the assumption of equivalent environment (or inconsequential environmental differences) does make a difference. For example, Björklund, Jäntii, and Solon (2005) demonstrated that estimates of the variance components in predicting income change significantly if one relaxes the equal environment assumption. And Rose et al. (1988) showed that social contact enhances similarity on the extroversion and neuroticism personality factors, though the genetic influences remain significant even after removing the social contact effect.

As indicated, one of the advantages of the twins design is that it allows for an approximate estimation of the variance in a given behavior or response accounted for by genetic factors. Behavioral genetic analysis typically focuses on four sources of variance: additive genetic effects (A), non-additive genetic effects such as genetic dominance (D), environmental effects shared by people living in the same family (C), and environmental effects that are unique to each individual (E). Researchers have demonstrated that additive genetic effects (A), non-

additive genetic effects (D), and shared environmental effects (C) cannot be estimated simultaneously if information is only available from twins reared together (Neal and Maes 2004). Most investigations therefore focus on the additive genetic (A), shared environmental (C), and nonshared environmental (E) components. These three components form the basis for the ACE model, which is considered the standard estimation approach in behavioral genetics (Neale and Cardon 1992). However, in certain cases there may be reason to suspect that non-additive (e.g., dominance) genetic effects play a role in a certain response (for example, when the MZ twin correlation is more than twice the DZ correlation. See Olson et al. 2001; Plomin et al. 2008). In such cases, estimating an ADE model may be more appropriate.

When an ACE model is assumed, the heritability of a response can be estimated by comparing correlations between MZ and DZ twins (see Alford et al. 2005; for derivation of the formulae, see also Plomin et al. 2008, pp. 374-399). Specifically, the formula for an approximate estimate of the variance accounted for by heritability is 2 * (Corr (MZ) – Corr (DZ). The formula for an approximate estimate of the variance accounted for by the shared environment is (2* Corr (DZ) – Corr (MZ). And the formula for an approximate estimate of the variance accounted for by the Unshared environment is 1– Corr (MZ). It is noteworthy that separating the variance accounted for by genetic and (un/shared) environmental influences is an oversimplification, and a controversial one at that. As Meaney pointed out (2001, p. 52), separating the determinants of gene expression (i.e., a gene's activity level) and related traits is not more meaningful than separating the contributions of length and width to the area of a rectangle, given that gene and environment do not operate independently.

A simple comparison of correlations for MZ and DZ twins can indicate that a behavior or response is influenced by genetic factors. However, such correlation transformations are limited in that they are only valid if the ACE model is indeed an accurate representation of reality. Correlation comparisons do not allow for model fitting (testing whether genetic influences can

be removed from the model without reducing model fit) or calculation of confidence intervals for the estimated parameters. Further, they assume that the latent distribution of the observed response is normal (Hannagan and Hatemi 2008; Settle et al., in press). Thus, a model fitting approach using structural equation modeling (SEM) has been the most commonly used method for estimating the relative importance of the genetic and environmental components underlying correlations between MZ and DZ twins.

This approach allows us to estimate confidence intervals around the estimated genetic and environmental effects and to test and compare different types of models (see Plomin et al. 2008 for a discussion of additional properties of this approach). Figure 1 illustrates the general path models tested by this approach. The observed behavior or response of each twin is assumed to be predicted by the three latent variables A, C, and E (or A, D, and E, if an ADE model is used). Because MZ twins share the same genes whereas DZ twins share only half of their additive genes, the model assumes that the correlation between the latent additive genetic factors (A) is 1.0 for MZ pairs and 0.5 for DZ pairs. Further, because MZ and DZ twins share the same common environment (C), the correlation between their latent shared environmental factors is 1.0 for MZ and DZ. Finally, the correlation between MZ twins' non-additive genetic effects (D) is 1.0, whereas that of DZ twins is 0.25.

Under the ACE model, the maximum-likelihood parameter estimates generated can be interpreted as estimates of the variance components attributed to the latent genetic (A), shared environmental (C), and nonshared environmental effects (E). In the present context, our key parameter or interest is the genetic effect (A). When the latent variable (A) is estimated to be significant, we conclude that the dependent variable (e.g., choosing the compromise option) is influenced by a heritable component. The contributions of A, C, and E to the total variance are evaluated by first estimating the full ACE model and then removing each of its components and testing whether the fit provided by the nested, more parsimonious model is significantly different

from that provided by the full (saturated) model. Model fit is estimated using a chi-square goodness-of-fit test, with nonsignificant results indicating that the fit provided by the nested model is not significantly worse than that provided by the saturated model.

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Insert figure 1 about here

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## SAMPLE CHARACTERISTICS AND RESULTS

### Data Collection and Sample Characteristics

Most of our respondents were members of the SRI International Northern California Twin Registry. The remaining respondents were recruited through the Business School Internet (nonstudent) subject pool. A total of 110 MZ and 70 DZ same-sex twin pairs completed a 30-minute questionnaire (via the Internet), in exchange for $10 in cash or a chance to win $50. Participants completed their session independently of their sibling.

As shown in Appendix B, we used a standard battery of measures (based on Eaves, Eysenck, and Martin 1989; Sarna et al. 1978; Heath et al. 2003. See, e.g., Swan et al. 2005, 2007) to confirm the twin zygosity (MZ or DZ). Tables 1 and 2 summarize the demographic characteristics of the sample for MZ and DZ twins. The analysis indicates, consistent with prior twin studies, that the two twin types differed significantly in terms of the extent of interpersonal closeness and the frequency of meeting (MZ twins being closer and meeting more frequently). Also consistent with prior research (e.g., Taubman 1976), the average income correlation for MZ

twins (.523) was much higher than for DZ twins (.156; $p < .01$), and there was also a significantly higher MZ correlation with respect to education (.720 vs. .444, respectively; $p < .01$), though the MZ-DZ difference was smaller than for income.

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Insert tables 1 and 2 about here

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Prudence Tests: Results

We next turn to the results for problems related to prudence. In each case we report (a) the raw (mean), (b) the inter-twin correlation (consistent with prior research, we report tetrachoric correlations for items with binary dependent variables), and (c) the full ACE model (or ADE model, where appropriate) for items with relatively large MZ-DZ differences. We used the software package MX 1.68 to estimate this model (Neale et al. 2006). Table 3 summarizes the raw (means), and table 4 summarizes the correlations and SEM results for these problems. Although we do not report separately the results obtained after controlling for the various covariates listed above (e.g., CRT, income), in all cases, the findings reported below remain virtually unchanged (and the qualitative conclusions are not affected).

*Preferences for compromise options*. The mean shares of compromise options suggest that MZ twins are slightly (but consistently) more likely to compromise than DZ twins, though the difference is statistically significant in only one case (BBQ-set 1). For example, 40% of the MZ respondents made choices from the BBQ sets that were consistent with the compromise effect (i.e., choosing the compromise option on both BBQ grill sets, within-subject) compared to

32% of the DZ twins, although this difference is not statistically significant. More importantly, the results indicate that the tendency to select the compromise/middle option, which served as the dependent variable, has a significant and robust heritable component, at least for the problems tested. In other words, people appear to be genetically predisposed to selecting/ avoiding compromises, which, according to the value maximization criterion, means that they are born with varying susceptibility to exhibiting "irrationally" (Tversky and Simonson 1993).

*Preferences for asymmetrically dominating options*. We did not expect susceptibility to the asymmetric dominance effect to reflect a heritable individual difference. Indeed, the results of the mutual funds and cordless phones problems suggest that the tendency to choose the asymmetrically dominating option, which served as the dependent variable, does not appear to be influenced by a heritable component. With respect to the "Car problem" sets that had previously been used to test the asymmetric dominance effect (Huber et al. 1982; Simonson 1989), deriving a prediction was less clear. Specifically, while perceptions of relative advantage may not be heritable, a tradeoff between miles per gallon and comfort represents a straightforward choice between a utilitarian option and a hedonic option (accordingly, we list the car choice sets under both problem categories). Perhaps reflecting the two conflicting effects, the Car problem results were not conclusive – choices from the Car-1 set, but not from the Car-2 set, indicate a significant (and large) heritable effect. The within-subject pattern of choice across both sets (i.e., choosing the asymmetrically dominating option on both car sets) does not appear to have a significant heritable component. Overall, the current evidence is consistent with the prediction that susceptibility to asymmetric dominance is not heritable.

*Loss aversion*. As indicated, we used two pairs of problems in which respondents chose between a sure gain and a gamble; in one problem, the gamble included the possibility of a loss. These problems allowed us to test the heritability of risky choice preferences, and the pattern of

choices across both problems tested for loss aversion (i.e., whether a respondent chose the gamble in the gain domain and avoided the corresponding gamble that involved a possible loss.

For one of the two two-problem sets (previously tested in Simonson and Nowlis 2000), the results suggested a heritable effect on risk aversion in both losses and gains, though the heritable contribution was smaller when the gamble included the possibility of a loss. The susceptibility to loss aversion, as demonstrated by the (within-subject) choice pattern across both component problems, also suggested a significant heritable effect. As indicated earlier, this result may not extend to other problems and other manifestations of loss aversion (e.g., the endowment effect), which could involve other genetic or idiosyncratic factors. Indeed, we did not find a heritable effect for the other test of loss aversion included in the current study.

*Choices between utilitarian and hedonic options*. In two of the hedonic versus utilitarian (or vice versus virtue) choice problems – batteries vs. chocolate and car-set 1 (see Appendix A) – the results showed a significant heritable effect. However, the effect was not significant in a third problem (groceries vs. massage; see Table 4).

*Desirability versus feasibility in the near and distant future*. The analysis indicates that the tendency to focus on outcome feasibility versus desirability has a significant genetic component when making choices for the near future (e.g., tomorrow), but not necessarily when making choices for the distant future (e.g., one year from now). This result is consistent with the notion that feasibility and prudence play a greater role in near-distance decisions.

*Maximizing versus satisficing*. As discussed above, the tendency to "maximize" may reflect an underlying prudence tendency because maximizers, as opposed to satisficers, are willing to exert greater effort to avoid mistakes. Accordingly, the analysis indicates that participants' scores on the Maximization scale (Nenkov et al. 2008) were influenced by a significant heritable component. Further, "driving the extra mile" to avoid overpaying in the

phone and backpack problem (adapted from Tversky and Kahneman's calculator/jacket problem) appears to be influenced by a heritable tendency (albeit, a relatively small effect).

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Insert tables 3 and 4 about here

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Judgment Heuristics and Other Non-Prudent Items: Results

Table 5 summarizes the raw findings for all problems that do not involve prudence dilemmas, including judgment heuristics and other problem types. Table 6 summarizes the correlations and genetic analysis for these items. These findings indicate that various non-prudence responses, including judgment heuristics, are not influenced by heritable individual differences. Specifically, consistent with our hypothesis that judgment heuristics employ mechanisms that are more universal than those employed in certain prudence dilemmas, the analysis suggests that the tendencies to rely on the availability heuristic, representativeness, and anchoring (both self-generated and provided anchors) are not heritable individual differences. In the well known "Linda problem" (used to demonstrate the conjunction fallacy; Tversky and Kahneman 1983), the responses of DZ twins were significantly correlated whereas those of MZ twins were not – an anomalous result without an obvious explanation. Other representativeness problems did not show significant differences between MZ and DZ twins.

Also consistent with the prudence hypothesis, the analysis indicates that responses to a number of choice problems that do not involve a prudence dilemma are unlikely to be heritable. Problems involving temporal discounting, variety seeking, highlighting, and mental accounting

did not seem to have a heritable component. Furthermore, responses to personal differences scales that were designed to measure innovativeness, change-seeking, and need for cognition did not appear to have a significant heritable component, even though correlations among MZ twins were directionally higher than among DZ twins.

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Insert tables 5 and 6 about here

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On the other hand, as discussed in more detail in (authors 2009), several specific nonprudence-related product/experience preferences, such as jazz (see also Martin et al. 1986), chocolate, sci-fi movies, and hybrid cars, appear to have a significant heritable component. Finally, though we used the CRT as a covariate and proxy for intelligence, it is noteworthy that, consistent with prior research, the overall score on that test has a significant heritable component. As an aside, the CRT score is related to other responses, including a negative correlation between the CRT score and the likelihood of selecting a compromise option.

## GENERAL DISCUSSION

The potential implications of this research are far-reaching. But before we delve into those, we must begin with a word of caution. Although the wide scope of our study can provide more general insights than studies that examine just one or a couple of potentially heritable traits, the generalizations derived from the pattern of findings and the hypothesis that fits them cannot be verified or tested directly. Indeed, while the recent advancements in the evolving field of epigenetics suggest that, in principle, our basic proposition is possible, the scope of our

investigation and the extension to judgment and choice require a significant extrapolation of current epigenetic research. With so many moving parts, including perhaps hundreds of interacting epigenetic and other factors, it is highly unlikely that we would be able to show how the prudence tendency, or another construct that may fit even better, is determined.

Beyond the inability to see in the epi/genetic dark or use standard process measures, as explained earlier, the problem of random noise is particularly severe with the kind of problems studied here. This includes noise related to the selection of JDM problem types and specific examples. It also refers to "genetic noise," that is, the high likelihood that many consumer and JDM problems contain more than one element that elicits heritable traits. For example, one of the problems we tested (cars) had the surface structure of an asymmetric dominance problem, but it also involved preferences between hedonic and utilitarian dimensions (comfort and MPG). While we did not expect susceptibility to asymmetric dominance to be heritable, preferences between hedonic and utilitarian options were expected to be partially heritable. Thus, the derived heritability estimates depend on which of the two factors plays a greater role in observed preferences (which, in turn, might depend on situational factors such as primes, task and contextual features, goals, and cognitive load). Similarly, the "Linda problem" contains various elements, which might account for the unexpected reversal we observed.

Having said that, and despite the obvious interpretation challenges and need for replications, extensions, future refinements of the prudence hypothesis, and gaining insights from related fields, we do believe that testing many potentially related phenomena simultaneously has significant advantages. In fact, precisely because understanding the exact underlying mechanisms of heritable judgment and choice tendencies is challenging, broad-base investigations may offer the most promising available route for gaining insights into underlying heritable aspects of judgment and decision making. Indeed, while genetics and epigenetics research methods are more precise and conclusive for what they can test, they may not be as

suitable (in the foreseeable future) for identifying heritable patterns that play a role in many of the decisions that consumers and other decision makers face. Thus, we may have to settle on broad-based, if vague and imprecise, investigations regarding predisposition "clouds" that may one day be clarified and perhaps shown to correspond to specific epi/genetic combinations.

## The Prudence Cloud and Its Boundaries

We proposed a heritable cloud, which covers with varying consistency a wide range related tendencies, and labeled it as the prudence hypothesis. In the context of the present research, prudence is hypothesized to play a role in a wide range of heritable decisions and dilemmas that consumers and other decision makers face in everyday life (and in the BDT lab). Prudence-related decision problems that were tested in the current research and received at least partial support include (a) choices from sets with a compromise option; (b) choices between a hedonic option and utilitarian option; (c) choices between a sure gain and a gamble on the domain of gains; (d) choices between a rewarding but challenging task and a less rewarding but easier task; and (e) the propensity to try harder to find a better (or more economical) option as opposed to satisficing. It should be noted that a prudence tendency does not mean that the same person always selects the prudent option or demonstrates similar prudence scores across all prudence-related problems. For example, while we found in the current study that individuals who score high on the Maximization scale were more likely to choose the compromise option (in two of three problems), maximizers may not be consistently more inclined to select utilitarian over hedonic options.

There does not appear to be a previously identified heritable difference that might account for our various findings, though it is quite possible that we included under the prudence umbrella JDM tendencies that belong under separate clouds. Neither intelligence nor

personality, which were previously shown to have a significant heritable component, can account for our various findings. Regarding personality, among the Big Five factors, conscientiousness is potentially the closest to our conception of prudence. Conscientiousness has been measured using items such as: organized, responsible, conscientious, practical, thorough, hardworking, and thrifty (Goldberg 1992). However, as indicated, most studies have not found a significant heritable effect on conscientiousness (unlike extroversion and neuroticism; but see Bouchard 1994). From a conceptual perspective, it is hard to see how conscientiousness could explain our findings. Another personality dimension, neuroticism (also referred to as "emotional stability"), which has a large heritable component (e.g., Floderus-Myrhed, Pedersen, and Rasmuson 1980), might be related to prudence. However, neuroticism cannot account for the findings we observed. Indeed, all indications are that the age-old conclusion that personality, by and large, does not predict choice behavior (e.g., Kassarjian 1971; Mischel 1968) still holds. We are not aware of any other rival account for the pattern of results observed in this research.

In addition to identifying decision problems that are covered by the proposed prudence cloud, it is important to examine, in part by trial and error, areas that it does not cover. Probably the most obvious category that is unrelated to prudence, but is important in its own right, is judgment heuristics. As expected, key judgment heuristics (Tversky and Kahneman 1974), like reflexes, instincts, and unconscious automatic responses, do not appear to be heritable (as this term is used in behavior genetics), though they likely reflect the (universal) genetic makeup that produces the human brain. Thus, susceptibility to the representativeness, availability, and anchoring (both self-generated and experimenter-provided) heuristics does not appear to be a heritable characteristic. Future research may examine whether the degree of susceptibility to the affect heuristic (Slovic et al. 2002) is a heritable individual difference.

Susceptibility to asymmetric dominance also appears to be nonheritable, though this result can be confounded by the specific attributes on which options differ (as shown in the Car

problem). Furthermore, we tested several problems that do not involve a prudence dilemma and, correspondingly, did not find evidence for heritable differences. In particular, in choices between receiving more later or less sooner (i.e., the discount rate), neither option is more prudent, so one would not expect to observe differences. Related dilemmas, however, may have a genetic component. For example, the finding that addiction is partially heritable (see Plomin et al. 2008) may indicate that choices between temptations and more prudent alternatives (e.g., not drinking) are heritable. We would also not expect and did not observe that the tendency to select variety when making multiple choices for several periods is heritable.

We further proposed that the prudence tendency plays a significant role when people carefully consider both the prudent and less prudent alternatives. Conversely, when one option looms much larger than the other, as is likely to be the case when considering a distant future rewarding assignment, the heritable prudence dimension does not come into play and does not affect the resulting response. In that respect, more superficial and abstract choices seem to behave more like heuristics than like decisions involving difficult tradeoffs and conflicts.

## Heritable Preferences, BDT Effects, and the Definition of Irrationality

If we were born with no heritable preferences and never acquired stable preferences later in life, it would have been possible to interpret almost any decision or response in terms of construction. If, on the other hand, we were born with a complete set of hard-wired, heritable, stable, unchanging preferences, then it would not be meaningful to rely on construction as an explanation for observed responses. Importantly, even in the latter scenario, observed responses may behave as if preferences are constructed based on the context, task, and/or frame, despite the fact that these responses were genetically "constructed." That is, preferences that meet the economic criterion for irrationality but are due in part to inherited tendencies can be regarded as "constructive predispositions," which may seem like a name consisting of contradictory terms.

However, the evidence that people have a predisposition to "construct" (i.e., be influenced by context, framing, and task features) suggests that constructive dispositions can exist.

The tendency to select a compromise option, which appears to have a significant heritable component, illustrates the point. A question that arises, assuming people are born with the tendency to prefer or avoid middle options, is whether it is meaningful to treat their observed preferences for/against middle options as evidence for construction. That is, if people are (partially) genetically predisposed to compromising, with little sensitivity to absolute values, can we interpret their choices of middle options as evidence for irrationality merely because a certain field assumes that absolute values determine utility? We think that the answer is No, because "construction" refers to what was not there before the problem or decision was considered. In fact, it is preferences for absolute values that often do not preexist, whereas preferences for relative values and other construction mechanisms can be rather stable and, as suggested by the current research, even heritable (see also Simonson 2008a).

Genetic influences on preferences also raise questions about our previous interpretations of a wide range of BDT effects. Most demonstrations of BDT effects (e.g., preference reversals) are based on the inconsistent responses to two presumably equivalent versions of a problem. But, in many cases, the two versions may involve different genetic influences. For example, a loss frame and a gain frame (e.g., in the Asian Disease problem; Tversky and Kahneman 1981) may elicit different genetic predispositions. Thus, while we often rely on conceptual commonalities to classify phenomena, genetically speaking, they may be quite different.

Loss aversion is a noteworthy example, not only because it is important and fundamental, but because it has been used to explain a wide range of seemingly distinct phenomena. For example, the test of loss aversion used in this research is very different from endowment experiments and may very well involve different epi/genetic influences. And the preference invariance assumption notwithstanding, choice, separate option ratings, and matching may

involve different heritable tendencies. Since our genetic makeup is given and fixed, especially if it could be identified, perhaps it deserves priority over conceptual considerations that have no hard-wired basis. Thus, while parsimonious accounts often simplify and unify seemingly diverse phenomena and principles, the resulting generalizations may obscure the different genetic origins of these phenomena and lead to incorrect conclusions.

## Research Directions

As the above discussion suggests, and at the risk of getting carried away with the findings of one broad-base study (with the benefit of many related studies), the addition of a genetic dimension to our discussion about choice, judgment, and decision making more generally, could change some fundamental aspects of our analysis and perspective. We find it surprising that, despite the very long history of research on heritability and of twins studies, this area has received limited attention in the decision making and consumer behavior fields. Just as we have faulted certain unrealistic assumptions of economic theory, perhaps the still evident assumption in social psychology that people are born with little if any heritable attitudes and choice tendencies might have caused the neglect of this naturally important source of influence on decisions and consumer behavior. Also, as indicated, almost all twins studies have focused separately on just one or few heritable aspects, making it more difficult to see the big picture regarding the types of decisions and judgments that tend to have a significant heritable origin.

There are many interesting topics in this area, and the following are just a few promising directions. As noted, the currently predominant view is that our genetic makeup makes us more susceptible to specific interactions with the environment, thereby enhancing the likelihood of certain traits and behaviors. Research methods for studying such interactions have been identified (see McGowan et al. 2008; Moffitt, Caspi, and Rutter 2005). Such techniques, which require collaboration between decision researchers and experts in genetics, can be applied to the

study of decision tendencies and consumer behavior. Furthermore, using fMRI and other brain response measures (e.g., Knutson et al. 2007; Schmidt et al. 2009; Shiv et al. 2005), we may be able to observe whether prudence and other heritable predispositions influence the manner in which people process choice options, frames, and other judgments and decision stimuli.

Future research needs to provide better insight into the nature and scope of heritable influences on judgment and choice. First, while our investigation was broad in its scope, each problem type was tested with just a couple of examples, which, in some cases, produced inconsistent results (e.g., just one of two tests relating to loss aversion showed the predicted heritable pattern). Accordingly, future research might further examine the robustness of our results and identify moderating factors. Second, building on our and prior findings across many domains, we advanced the prudence cloud hypothesis. This view indicates that a broad class of problems people encounter in everyday life are susceptible, to varying degrees, to genetic influences that produce inherent individual differences in decision tendencies. Of course, this perspective offers one conceptually unifying view that generally fits the data; there are likely to be other perspectives that, with further research and attempts at replication, might prove to be more accurate depictions of the heritability of decisions.

Furthermore, we presented evidence that susceptibility to judgment and affective heuristics is not heritable, presumably because such tendencies are more universal and hard-wired into the genetics of most human beings. Of course, there are differences among people with respect to their response to problems that elicit affective reactions or involve availability, representative, and other heuristics. We attribute such differences to "noise," relating to other elements of these problems (e.g., the Linda problem that was tested) and the individual (e.g., prior experiences and beliefs). However, much more research is needed to determine whether indeed susceptibility to judgment heuristics and affective reactions is not heritable and, if so, the factors that make such reactions more universal.

The notion of a heritable prudence predisposition suggests that we should observe cross-generational (i.e., parent-child) similarities with respect to prudence dilemmas that are greater than similarities with respect to other choice and judgment responses. This proposition might be examined in future research. Also, although investigations regarding genetic differences among ethnic group have generated a great deal of controversy, going all the way to Galton's 19th century work on the genetics of geniuses, the prudence hypothesis suggests possible heritable cross-cultural differences. That is, in the domain of judgment and choice, an examination of heritable cross-cultural differences in heritable decision tendencies is a promising direction. Thus, prudence tendencies may very well vary across cultures, and such differences might be partially explained by genetic differences, perhaps reflecting interactions between people's genetic makeup and other characteristics of each culture's environment.

Gaining a better understanding of heritable, inherent differences may also contribute to the enhancement of the effectiveness of market research techniques (see also Simonson 2008b). It is probably not controversial to conclude that (properly conducted) market research can provide useful insights regarding consumers' preferences for variations of existing and familiar products, services, and technologies. On the other hand, market research tends to be rather ineffective with respect to new products, services, and technologies, in part because respondents have difficulty foreseeing and comprehending the implications and value of very different objects and environments.

However, while heritable preferences are certainly just one factor that may influence consumers' reactions to new objects (e.g., marketing strategies and their implementation often make a difference), understanding the genetic component can provide insights regarding new products and technologies that have a better chance of being well-received by particular genetic segments. For example, genetic research could potentially reveal that a videogame that uses a motion-sensitive remote (i.e., the Nintendo Wii) or a cell phone that has the features of the Apple

iPhone is likely to benefit from certain genetic predispositions, perhaps even suggesting the most promising target consumer segments. Furthermore, future research might provide insights with respect to any heritable traits that make people more likely to prefer certain brands (e.g., utilitarian versus luxury brands) or respond favorably to particular types of advertisements.

In the foreseeable future, future research, like the research reported here, will have certain limitations in terms of our ability to pinpoint the underlying biological effects and reach unambiguous conclusions regarding the genetics of decisions, as opposed to mere hypotheses that deserve further study. Although the recent advances in epigenetics and molecular genetics provide hints regarding possible mechanisms that could affect mental processes and resulting behaviors, concrete, precise, complete evidence is unlikely to be obtained any time soon. However, it would be a mistake to continue our neglect of the role of genetics and heritability in judgment and choice, given that there is little doubt that such effects represent a major influence that deserves a great deal more research.

# APPENDIXES

## APPENDIX A

## SELECTED QUESTIONNAIRE PROBLEMS

<table>
<tr><td>"Prudence" Items</td><td></td></tr>
<tr><td>Compromise</td><td>
PORTABLE BAR-B-Q GRILL (1)<br>
Imagine that you would like to buy a portable Bar-B-Q grill. The options you are considering differ in terms of their cooking area (in square inches) and weight (in pounds).
<table>
<tr><td></td><td>Option A</td><td>Option B</td><td>Option C</td></tr>
<tr><td>Cooking Area (250-650 sq. in)</td><td>Smaller size (350 sq. in)</td><td>Medium size (450 sq. in)</td><td>Larger size (550 sq. in)</td></tr>
<tr><td>Weight (lb) (7 lb to18 lb)</td><td>Lighter weight (9 lb)</td><td>Medium weight (12 lb)</td><td>Heavier weight (15 lb)</td></tr>
</table>
Which option would you choose?<br><br>
PORTABLE BAR-B-Q GRILL (2)<br>
Imagine that you would like to buy a portable Bar-B-Q grill. The options you are considering differ in terms of their cooking area (in square inches) and weight (in pounds).
<table>
<tr><td></td><td>Option A</td><td>Option B</td><td>Option C</td></tr>
<tr><td>Cooking Area (250-650 sq. in)</td><td>Smaller size (650 sq. in)</td><td>Medium size (550 sq. in)</td><td>Larger size (450 sq. in)</td></tr>
<tr><td>Weight (lb) (7 lb to18 lb)</td><td>Lighter weight (18 lb)</td><td>Medium weight (15 lb)</td><td>Heavier weight (12 lb)</td></tr>
</table>
Which option would you choose?<br><br>
FLASHLIGHTS<br>
Imagine that you are going to the store to buy a flashlight. The three models that you are considering differ only in light power (in Lumen units) and burn time (in hours):
<table>
<tr><td></td><td>Flashlight A</td><td>Flashlight B</td><td>Flashlight C</td></tr>
<tr><td>Power (80 to 400 Lumen)</td><td>110 Lumen</td><td>230 Lumen</td><td>350 Lumen</td></tr>
<tr><td>Burn Time (10 to 50 hours)</td><td>45 hours</td><td>30 hours</td><td>15 hours</td></tr>
</table>
Which option would you choose?
</td></tr>
<tr><td>Asym. Dominance<br>/ Vice vs. Virtue</td><td>
CARS (1)<br>
Imagine that you are planning to buy a car. The three models that you are considering are by the same manufacturer and differ only in ride quality and miles per gallon:
<table>
<tr><td></td><td>Model A</td><td>Model B</td><td>Model C</td></tr>
<tr><td>Ride quality (on a 1-100 scale)</td><td>83</td><td>73</td><td>70</td></tr>
<tr><td>Miles per gallon</td><td>24</td><td>30</td><td>30</td></tr>
</table>
Which option would you choose?<br><br>
CARS (2)<br>
Imagine that you are planning to buy a car. The three models that you are considering are by the same manufacturer and differ only in ride quality and miles per gallon:
<table>
<tr><td></td><td>Model A</td><td>Model B</td><td>Model C</td></tr>
<tr><td>Ride quality (on a 1-100 scale)</td><td>73</td><td>83</td><td>80</td></tr>
<tr><td>Miles per gallon</td><td>30</td><td>24</td><td>24</td></tr>
</table>
Which option would you choose?
</td></tr>
</table>

**Asymmetric Dominance (cont.)**

MUTUAL FUNDS

Imagine you are considering investment in mutual funds. The funds differ by risk level (range: 1 to 10) and by average 3-year return (range: 3% to 27%). You are considering the following three options:

| | Option A | Option B | Option C |
|---|---|---|---|
| Risk level | 2 (low) | 5 (moderate) | 8 (high) |
| Average return | 5% | 13% | 14% |

Which option would you choose?

CORDLESS PHONES

Imagine you are shopping for a cordless phone.
The cordless phones you are considering differ by reception range and by price:

| | Option A | Option B | Option C |
|---|---|---|---|
| Range | 100 feet | 70 feet | 40 feet |
| Price | $90 | $85 | $50 |

Which option would you choose?

**Utilitarian vs. Hedonic**

SHOPPING REWARD

Imagine that are eligible for a reward after spending $50 at your local drug store, and have to choose between the following two rewards:

| Reward A | Reward B |
|---|---|
| Alkaline Batteries (value = $3.99 ) | Govida Chocolate (value = $3.99 ) |

Which reward would you choose?

LOTTERY PRIZES

Imagine that you have won a contest and can now choose between the following two prizes:

| Prize A | Prize B |
|---|---|
| Pampering Massage ($100 value) | Gift Card for Grocery Purchases ($100 value) |

Which prize would you choose?

**Risk Aversion (Loss)**

BET

Imagine that you are offered one of the following two alternatives:

| Bet A | Bet B |
|---|---|
| Receive $30 for sure | 50% chance to lose $100<br>50% chance to win $300 |

Which option would you choose?

**Risk Aversion (Gain)**

BET

Imagine that you are offered one of the following two alternatives:

| Bet A | Bet B |
|---|---|
| Receive $230 for sure | 50% chance to win $100<br>50% chance to win $500 |

Which option would you choose?

**Desirability vs. Feasibility (Near vs. Distant)**

BOOK REVIEW

Assume that you have agreed to review one book.
You will receive the book and start reviewing it tomorrow. You can select one of two books to review:

| Book 1 | Book 2 |
|---|---|
| 980 pages long<br>Promised to be interesting and inspiring | 22 pages long<br>Promised to be technical and dull |

Which book would you prefer to start reviewing tomorrow?

BOOK REVIEW

Assume that you have agreed to review one book. You will receive the book and start reviewing it one year from now. You can select one of two books to review:

| Book 1 | Book 2 |
|---|---|
| 980 pages long<br>Promised to be interesting and inspiring | 22 pages long<br>Promised to be technical and dull |

Which book would you prefer to start reviewing in one year?

**Driving for Savings**

BACKPACK AND PHONE

Imagine that you are at the mall and are about to purchase a backpack for $375 and a new phone for $75. The phone salesman informs you that the phone you wish to buy is on sale for $50 at the other branch of the store, located 20 minutes drive away. Would you make a trip to the other store?

**Maximizing Scale**

SELF EVALUATION

1. When I am in the car listening to the radio, I often check other stations to see if something better is playing, even if I am relatively satisfied with what I'm listening to.
2. No matter how satisfied I am with my job, it's only right for me to be on the lookout for better opportunities.
3. I often find it difficult to shop for a gift for a friend
4. Renting videos is really difficult. I'm always struggling to pick the best one.
5. No matter what I do, I have the highest standards for myself.
6. I never settle for second best.

**Cognitive Reflection Test**

(CRT) MEASURES

Please answer the following questions as quickly and as accurately as you can.

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost (in cents)?
2. If it takes 5 machines 5 minutes to make 5 widgets, how many minutes would it take 100 machines to make 100 widgets?
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how many days would it take for the patch to cover half of the lake?

| | |
|---|---|
| **Judgment Heuristics** | |
| Availability<br><br>Representativeness<br><br>Anchoring | ENGLISH LANGUAGE<br>Suppose we sample a random English word of 3 letters or more.<br>Is it more likely that the word starts with R or that R is the third letter?<br><br>THE PROFESSOR<br>The author of this questionnaire has a friend who is a professor. He likes to write poetry, is rather shy, and is small in stature. In your judgment, which of the following is more likely to be his field?<br>Early Chinese History Psychology<br><br>UNITED NATIONS<br><br>Please enter the last 2 digits of the year in which you graduated from high-school:<br>Do you believe the number you entered above is lower or higher than the percentage of African countries out of all countries in the United Nations? (Lower/Higher)<br>Please estimate the percentage of African countries out of all countries in the United Nations: ___ |
| **Nonprudence Problems** | |
| Variety Seeking | SNACKS<br>Please list the four snacks (sweet or salty) that you like most, starting with your favorite snack, followed by the second favorite, and so on. Now suppose that, because of your diet, you eat only one snack each week; assume that you are going to the supermarket to buy three snacks for the next three weeks. Please write down below the three snacks you will buy for the next three weeks (choosing any of the four snacks you listed in the previous page or any other snack). |
| Highlighting<br>vs.<br>Balancing | ENTREES AND DESSERTS<br>Imagine that you are planning to go to your favorite restaurant this week and again next week. Each time you will order an entree and a dessert. For each course, you have one option that you like most and is less healthful. In planning your next two meals, you are considering the following two options:<br>Option A: In Week 1 you will order the more tasty and less healthful entree and the less tasty and more healthful dessert. In Week 2, you will order the less tasty and more healthful entree and the tastier and less healthful dessert. With this option, you will balance your enjoyment of the two courses and their healthfulness, because in each week you will have one thing that you like most but is less healthful and another that you like less but is more healthful.<br><br>Option B: In Week 1 you will order the less tasty and more healthful entree and also the less tasty and more healthful dessert. In Week 2, you will order the tastier and less healthful entree and also the more tasty and less healthful dessert. With this option, you will have the two healthful items that you like less in the first week, whereas in the second week you will go “all the way”.<br><br>Which option would you prefer? |

<table>
<tr>
<td>Highlighting<br><br>vs.<br><br>Balancing (cont.)</td>
<td>
<u>AIRPORT TRANSPORTATION</u><br>
Assume you are a frequent traveler from New York to Chicago. To get to the airport, you take the taxi on some trips and the shuttle bus on other trips.<br>
Consider your next two trips to Chicago: For one trip, you purchased a coach, round-trip flight ticket for $269. For another trip, you purchased a first-class, round-trip ticket for $899.<br>
For your trip to the airport, you are thinking of taking the taxi on one trip and the shuttle bus on another trip. The taxi costs $65 and takes one hour to arrive at the airport. The shuttle costs $20 and takes two hours to arrive at the airport.<br>
When are you more likely to take the taxi to the airport – when you are flying coach or first class?
</td>
</tr>
<tr>
<td>Mental Accounting/<br><br>Sunk cost</td>
<td>
<u>THEATER</u><br>
Imagine that you have decided to see a play and paid the admission price of $40 per ticket.<br>
As you enter the theater, you discover that you have lost the ticket. The seat was not marked, and the ticket cannot be recovered. Would you pay $40 for another ticket?
</td>
</tr>
<tr>
<td>Temporal Discounting</td>
<td>
<u>GROCERY VOUCHERS</u><br>
Imagine you are offered gift vouchers toward buying groceries at your local store.<br>
Which of these two options would you prefer?
<table>
<tr><th>Option A</th><th>Option B</th></tr>
<tr><td>A $50 voucher tomorrow</td><td>A $65 voucher in one month</td></tr>
</table>
<u>FUTURE PAYMENTS</u><br>
Suppose you can receive one of the following risk-free payments. Which option would you prefer?
<table>
<tr><th>Option A</th><th>Option B</th></tr>
<tr><td>$900 in one year</td><td>$600 in one week</td></tr>
</table>
<u>FUTURE PAYMENTS</u><br>
Imagine that you can receive one of the following future payments: Which option would you prefer?
<table>
<tr><th>Option A</th><th>Option B</th><th>Option C</th></tr>
<tr><td>$1,000 tomorrow</td><td>$1,300 in 1 year</td><td>$1,700 in 2 years</td></tr>
</table>
</td>
</tr>
</table>

# APPENDIX B

## ZYGOSITY IDENTIFICATION QUESTIONNAIRE

Please complete the questions on this page.

1. Are you and your twin the same sex, either both male or both female? (Yes/No)
2. When you and your twin were children, were you as alike as “two peas in a pod,” or did you have only normal family physical similarity, like ordinary sisters or brothers? (Like “Two peas in a Pod”/Only family likeness/Don't Know)
3. Between the ages of 6 and 13, how often did the following individuals have difficulty telling you and your twin apart? (Always/Usually/Sometimes/Rarely/Never/Don't Know)
    a. Mother (or mother figure)
    b. Father (or father figure)
    c. Teachers
    d. Friends
    e. Strangers
4. Do you and your twin have the same eye color? (Yes/No/Unsure)
5. Do you and your twin have the same natural hair color? (Yes/No/Unsure)
6. Do you and your twin have the same complexion or skin tone? (Yes/No/Unsure)
7. In your opinion, are you and your twin...? (Definitely identical/ Probably identical/ Probably fraternal [not identical]/ Definitely fraternal [not identical]/ Not sure)
8. How did you reach that conclusion?
9. Did you also base your conclusion on how similar or different you look? (Yes/No/Unsure)
10. Did you and your twin ever have a blood test that could tell what kind of twins you were?
11. If you answered "Yes," what was the result of the blood test? (The test indicated that we are identical twins/ The test indicated that we are not identical twins/ Unsure)
12. At your birth, were your parents told what kind of twins you were? (Yes/No/Unsure)
13. If you answered "Yes," what were your parents told? (We are identical twins/ We are NOT identical twins/ Unsure)
14. Were your parents told later by a doctor what kind of twins you were? (Yes/No/Unsure)
15. If you answered "Yes," what were your parents told? (We are identical twins/ We are NOT identical twins/ Unsure)
16. How many afterbirths (placentas) were reported at your birth?
17. During your entire life, how close do you feel that you and your twin have been compared with your impression of closeness between ordinary siblings? (Less close than ordinary siblings/As close as ordinary siblings/Somewhat closer than ordinary siblings/Much closer than ordinary siblings)
18. How far away (in miles) do you live from your twin now?
19. How frequently do your and your twin get together now? (Almost daily/ 1-4 times per week/ 1-3 times per month/ Occasionally during the year/ Less than once per year)

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# TABLES

TABLE 1
SUMMARY DEMOGRAPHICS

| | | MZ (n = 220) | DZ (n = 140) | p-value |
|---|---|---|---|---|
| Demographics | Age | 46.6 | 49.0 | 0.10 |
| | Females | 77% | 79% | 0.77 |
| | Closeness (1-4) | 3.8 | 3.3 | 0.00 |
| | Distance in miles | 845 | 469 | 0.20 |
| | Infrequency[1)] | 2.9 | 3.2 | 0.04 |
| | Family Income[2)] | 6.4 | 6.3 | 0.68 |
| | Education[3)] | 4.6 | 4.8 | 0.10 |
| | Liberal (1-7) | 4.5 | 4.7 | 0.31 |

[1)] 1=Daily, 2=1-4 per week, 3=1-3 per month, 4=Occasionally, 5=Less than once per year
[2)] 1= <$30k, 2=$30k-$40k, 3=$40k-$50k, 4=$50k-$60k, 5=$60k-$75k, 6=$75-$90k, 7=$90-$110k, 8=$110-$150k, 9= >$150k
[3)] 1=Less than high-school, 2=High-school, 3=Some college, 4=2-year college, 5=4-year college, 6=Post-graduate

TABLE 2
GENETIC ANALYSIS OF DEMOGRAPHIC ITEMS

| | Correlations | | p-value | | Parameter Estimates | | | | | | p-value [2)] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MZ | DZ | (difference) | Model [1)] | a2 | c2 | e2 | -2LL | $\Delta\chi^2$ | $\Delta$df | (base model) |
| Family Income | 0.523*** | 0.156 | 0.01 | AE | .29 (.23, .34) | 0.00 | .71 (.66, .77) | 2578.1 | 0.00 | 1 | 1.00 (ACE) |
| Education | 0.720*** | 0.444** | 0.01 | AE | .62 (.53, .69) | 0.00 | .38 (.31, .47) | 1109.6 | 0.27 | 1 | .60 (ACE) |
| Liberal | 0.628*** | 0.534*** | 0.36 | CE | 0.00 | .40 (.33, .46) | .60 (.54, .67) | 1613.8 | 1.56 | 1 | .21 (ACE) |

[1)] Only best fitting models are reported
[2)] p-values greater than .05 indicate *good* model fit

TABLE 3
SUMMARY OF RESULTS (MEANS AND DIFFERENCES)

| "Prudence" Items | | MZ (n = 220) | DZ (n = 140) | p-value |
|---|---|---|---|---|
| Compromise | BBQ1 | 47% | 36% | 0.04 |
| | BBQ2 | 52% | 44% | 0.13 |
| | Overall Pattern (BBQ) | 40% | 32% | 0.13 |
| | Flashlights | 68% | 62% | 0.27 |
| Asym. Dom. | Cars1 | 69% | 74% | 0.25 |
| | Cars2 | 50% | 46% | 0.48 |
| | Overall Pattern (Cars) | 28% | 27% | 0.90 |
| | Mutual Funds | 77% | 71% | 0.21 |
| | Cordless Phones | 66% | 74% | 0.15 |
| Vice & Virtue | Batteries/Chocolate | 65% | 59% | 0.22 |
| | Groceries/Massage | 33% | 36% | 0.47 |
| | Cars1 | 69% | 74% | 0.25 |
| | Cars2 | 50% | 46% | 0.48 |
| Loss Aversion | Risky Choice (loss) | 69% | 68% | 0.88 |
| | Risky Choice (gain) | 74% | 77% | 0.56 |
| | Loss Aversion Pattern | 16% | 12% | 0.32 |
| Temporal | Near Future | 25% | 27% | 0.58 |
| | Far Future | 82% | 75% | 0.12 |
| Framing | Phone and Backpack | 42% | 45% | 0.67 |
| Individual Differences | Maximizing | 4.05 | 3.98 | 0.52 |
| | CRT | 0.66 | 0.78 | 0.25 |

(1) Tetrachoric correlations are reported for dichotomous (choice) variables
(2) * = $p<.05$; ** = $p<.01$; *** = $p<.001$; † = $p<0.1$

TABLE 4

GENETIC ANALYSIS OF "PRUDENCE" ITEMS

| | | Correlations | | p-value | | Parameter Estimates | | | | | | | p-value[2)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MZ | DZ | (difference) | Model[1)] | a2 | c2 | e2 | d2 | -2LL | $\Delta\chi^2$ | $\Delta$df | (base model) |
| Compromise | BBQ1 | 0.543*** | -0.198 | 0.01 | AE | .46 (.20, .68) | — | .54 (.32, .80) | 0.00 | 479.59 | 2.24 | 1 | .14 (ADE) |
| | BBQ2 | 0.469** | -0.019 | 0.01 | AE | .41 (.15, .64) | — | .59 (.36, .85) | 0.00 | 489.48 | 1.10 | 1 | .29 (ADE) |
| | Overall Pattern (BBQ) | 0.585*** | -0.254 | 0.01 | AE | .49 (.23, .71) | — | .51 (.29, .77) | 0.00 | 461.48 | 2.75 | 1 | .10 (ADE) |
| | Flashlights | 0.389* | -0.029 | 0.01 | AE | .32 (.03, .58) | — | .68 (.42, .97) | 0.00 | 457.15 | 0.96 | 1 | .33 (ADE) |
| Asym. Dom. | Cars1 | 0.537** | -0.393† | 0.01 | AE | .42 (.14, .66) | — | .58 (.34, .86) | 0.00 | 426.32 | 2.43 | 1 | .12 (ADE) |
| | Cars2 | 0.254† | 0.258 | 0.98 | CE | 0.00 | .26 (.03, .46) | .74 (.54, .97) | — | 493.27 | 0.00 | 1 | 1.00 (ACE) |
| | Overall Pattern (Cars) | 0.149 | 0.387† | 0.10 | E | 0.00 | 0.0 | 1.00 | — | 419.55 | 3.35 | 2 | .19 (ACE) |
| | Mutual Funds | 0.127 | 0.271 | 0.34 | E | 0.00 | 0.00 | 1.00 | — | 404.88 | 2.13 | 2 | .34 (ACE) |
| | Cordless Phones | 0.312† | 0.381† | 0.61 | CE | 0.00 | .34 (.09, .55) | .66 (.45, .91) | — | 437.42 | 0.00 | 1 | 1.00 (ACE) |
| Vice & Virtue | Batteries/Chocolate | 0.489** | 0.199 | 0.03 | AE | .47 (.20, .69) | — | .53 (.31, .80) | — | 463.02 | 0.00 | 1 | 1.00 (ACE) |
| | Groceries/Massage | 0.468** | 0.451* | 0.89 | CE | 0.00 | .43 (.20, .62) | .57 (.38, .80) | — | 449.32 | 0.25 | 1 | .62 (ACE) |
| | Cars1 | 0.537** | -0.393† | 0.01 | AE | .42 (.14, .66) | — | .58 (.34, .86) | 0.00 | 426.32 | 2.43 | 1 | .12 (ADE) |
| | Cars2 | 0.254† | 0.258 | 0.98 | CE | 0.00 | .26 (.03, .46) | .74 (.54, .97) | — | 493.27 | 0.00 | 1 | 1.00 (ACE) |
| Loss Aversion | Risky Choice (loss) | 0.479** | 0.296 | 0.17 | AE | .49 (.22, .70) | 0.00 | .51 (.30, .78) | — | 437.56 | 0.08 | 1 | .78 (ACE) |
| | Risky Choice (gain) | 0.391* | -0.104 | 0.01 | AE | .33 (.02, .60) | — | .67 (.40, .98) | 0.00 | 396.04 | 0.74 | 1 | .39 (ADE) |
| | Loss Aversion | 0.685** | 0.260 | 0.01 | AE | .69 (.40, .88) | 0.00 | .31 (.12, .60) | — | 282.98 | 0.00 | 1 | 1.00 (ACE) |
| Temporal | Near Future | 0.470** | -0.153 | 0.01 | AE | .37 (.06, .64) | — | .62 (.36, .94) | 0.00 | 401.52 | 1.36 | 1 | .24 (ADE) |
| | Far Future | 0.058 | 0.219 | 0.29 | E | 0.00 | — | 1.00 | 0.00 | 368.45 | 0.94 | 2 | .63 (ACE) |
| Framing | Phone and Backpack | 0.312* | 0.141 | 0.25 | AE | .30 (.03, .54) | 0.00 | .70 (.46, .97) | — | 487.38 | 0.00 | 1 | 1.00 (ACE) |
| Indiv. Diff. | Maximizing | 0.389*** | 0.124 | 0.07 | AE | .43 (.26, .56) | 0.00 | .57 (.44, .74) | — | 942.42 | 0.00 | 1 | 1.00 (ACE) |
| | CRT | 0.581*** | 0.363** | 0.07 | AE | .61 (.49, .69) | 0.00 | .39 (.31, .51) | — | 944.21 | 0.64 | 1 | .43 (ACE) |

[1)] Only best fitting models are reported

[2)] p-values greater than .05 indicate *good* model fit

TABLE 5

SUMMARY OF NON-PRUDENCE RESULTS (MEANS AND DIFFERENCES)

| Judgment Heuristics | | MZ (n = 220) | DZ (n = 140) | p-value |
|---|---|---|---|---|
| Availability | R-words | 57% | 59% | 0.73 |
| Representativeness | Linda | 68% | 64% | 0.37 |
| | Engineer | 83% | 82% | 0.80 |
| | Professor | 53% | 52% | 0.91 |
| Anchoring | African in the UN (Δ) | 41.63 | 44.33 | 0.30 |
| | Chicago Population (2M) | 1894131 | 1894871 | 1.00 |
| | West Indies (1492) | 1585 | 1570 | 0.45 |
| | Mars Orbit (365) | 431.83 | 335.28 | 0.18 |
| | Toaster (Δ) | 29.11 | 26.07 | 0.18 |
| Other Items | | | | |
| Variety Seeking | Soups | 3.46 | 3.49 | 0.79 |
| | Snacks | 2.69 | 2.65 | 0.57 |
| Highlighting/Balancing | Meal | 67% | 67% | 0.94 |
| | Airport | 44% | 44% | 0.95 |
| Mental Accounting | Theatre Ticket | 55% | 53% | 0.74 |
| Temporal Discounting | Grocery Vouchers | 32% | 39% | 0.22 |
| | Two Future Payments | 48% | 49% | 0.88 |
| | Three Future Payments | 80% | 87% | 0.41 |
| Individual Differences | Innovation | 3.78 | 3.69 | 0.54 |
| | Change Seeking | 4.32 | 4.31 | 0.91 |
| | Need for Cognition | 3.43 | 3.40 | 0.68 |

TABLE 6

CORRELATIONS ANALYSIS OF NON-PRUDENCE PROBLEMS

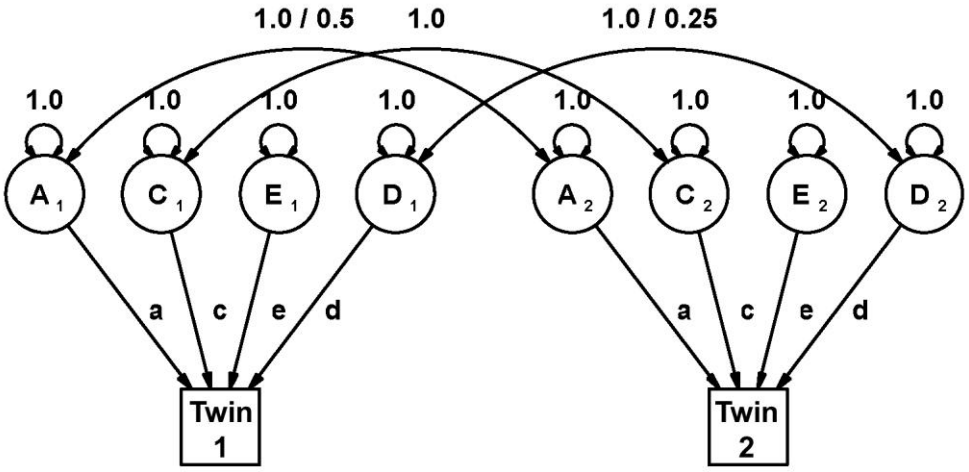
| | | Correlations | | p-value |
|---|---|---|---|---|
| | | MZ | DZ | (difference) |
| Judgment Heuristics | | | | |
| Availability | R-words | 0.095 | 0.291 | 0.19 |
| Representativeness | Linda | -0.082 | 0.451* | 0.01 |
| | Engineer | 0.152 | 0.159 | 0.96 |
| | Professor | 0.200 | -0.003 | 0.19 |
| Anchoring | Afric. countr. in UN | 0.436*** | 0.384** | 0.69 |
| | Chicago Population | 0.316*** | 0.239† | 0.59 |
| | West Indies | 0.346*** | 0.327* | 0.89 |
| | Mars Orbit | 0.022 | -0.008 | 0.85 |
| | WTP for Toaster | 0.000 | 0.186 | 0.23 |
| Other Items | | | | |
| Variety Seeking | Soups | 0.001 | 0.195 | 0.21 |
| | Snacks | 0.016 | 0.099 | 0.59 |
| Highlighting/Balancing | Meal | 0.016 | 0.146 | 0.40 |
| | Airport | 0.173 | -0.021 | 0.21 |
| Mental Accounting | Theatre Ticket | 0.348* | 0.335† | 0.93 |
| Temporal Discounting | Grocery Vouchers | 0.375* | 0.341† | 0.80 |
| | Two Future Payments | 0.396** | 0.323† | 0.59 |
| | Three Future Payments | 0.278** | 0.275* | 0.98 |
| Individual Differences | Innovation | 0.332*** | 0.218† | 0.43 |
| | Change Seeking | 0.446*** | 0.317** | 0.33 |
| | Need for Cognition | 0.403*** | 0.389*** | 0.92 |

(1) Tetrachoric correlations are reported for dichotomous (choice) variables

(2) * = $p<.05$; ** = $p<.01$; *** = $p<.001$; † = $p<0.1$

# FIGURES

FIGURE 1
GRAPHIC REPRESENTATION OF THE BASIC GENETIC MODEL




Source: Neale and Maes 2004