

Moderating Loss Aversion:
Loss Aversion Has Moderators, But Reports of its Death are Greatly Exaggerated

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Abstract

Loss aversion, the principle that losses impact decisions more than equivalent gains, is a fundamental idea in consumer behavior and decision making, though its existence has recently been called into question. Across five unique samples ($N_{\text{total}} = 17,720$), we tested predictions about what moderates loss aversion, which were derived from a preference construction account. Across studies, more domain knowledge, experience, and education were associated with lower loss aversion. Among car buyers, those who knew more about a particular car attribute (e.g., fuel economy) were less loss averse for that attribute but not other attributes (e.g., comfort), consistent with the idea that people with less attribute knowledge are more likely to construct preferences, thereby increasing loss aversion. Older consumers were more loss averse across different loss aversion measures and studies. We discuss implications for several accounts of loss aversion, including alternative accounts rooted in status quo bias, emotion, or feelings of ownership. In addition to discovering key loss aversion moderators, we cast doubt on recent claims that loss aversion is a fallacy or is fully explained by status quo bias, risk aversion, or the educated laboratory samples often used to study loss aversion.

Loss aversion implies that losses have a greater impact on decision making than gains of the same magnitude (Kahneman & Tversky, 1979; Tversky & Kahneman, 1991). It has been an important postulate of behavioral decision theory and has influenced theories and research in marketing, psychology, economics, and many other fields (Benartzi & Thaler, 1995; Hardie, Johnson, & Fader, 1993; Kahneman, 2011; Shefrin & Statman, 1985).

To fully understand loss aversion and its psychological underpinnings, it is important to understand how individual differences moderate loss aversion. Who is most loss averse? What characteristics amplify and attenuate loss aversion? We examine these questions across five unique field surveys, consisting of four separate stratified random samples of US households and a sample of experienced European car buyers. This allows us to test moderators of loss aversion, discover their effect sizes, and replicate findings across several diverse samples.

Identifying moderators of loss aversion can help determine which accounts of loss aversion are most viable, because different theories suggest different moderators. Loss aversion probably has multiple causes, but theories that attribute loss aversion to memory, attention, or selective information processing (Carmon & Ariely, 2000; Johnson, Häubl, & Keinan, 2007; Nayakankuppam & Mishra, 2005; Pachur & Scheibehenne, 2012; Van Boven, Dunning, & Loewenstein, 2000) predict different moderators than do theories that attribute loss aversion to emotion (Peters, Slovic, & Gregory, 2003; Zhang & Fishbach, 2005), status quo bias (Gal, 2006; Gal & Rucker, 2018), or feelings of ownership (Beggan, 1992). As we will explain, an account of loss aversion rooted in preference construction predicts that loss aversion increases with age and decreases with experience. In contrast, theories rooted in status quo bias or feelings of ownership would predict that people who are more experienced with products and prospects would exhibit more loss aversion because more experience leads to stronger feelings of

ownership and a more firmly-rooted status quo (Ariely, Huber, & Wertenbroch, 2005; Eidelman & Crandall, 2012; Strahilevetz & Loewenstein, 1998).

Examining the robustness and moderators of loss aversion is especially timely and important given several recent critiques of loss aversion research (e.g., Ert & Erev, 2013; Gal & Rucker, 2018; Yechiam, 2018) and a claim that loss aversion is a “fallacy” (Gal, 2018). These critiques are based on at least five different claims addressed by the present investigation.

First, many critiques have questioned the existence or robustness of loss aversion partly because loss aversion research typically uses samples that are relatively homogenous and have few participants who are wealthy, old, or have experience with the relevant products and decisions (e.g., samples of college students). Relatedly, loss aversion research has been criticized for using monetary amounts that are large for college students and thus could confound loss aversion with rational risk aversion (Brookshire & Coursey, 1987; Coursey, Hovis, & Schulze, 1987; Ert & Erev, 2013; Gal & Rucker, 2018; List, 2004). Addressing this critique, the present studies include over 3,000 millionaires and many experienced car buyers, as well as diverse samples varying in age, education, and socioeconomic background. Second, some have criticized loss aversion research for failing to examine moderators of loss aversion across multiple studies or for examining moderators in an atheoretical way (Gal & Rucker, 2018; Simonson & Kivetz, 2018). In the present investigation, we generate predictions about what moderates loss aversion using a theory-driven approach and replicate patterns of moderation across several diverse samples. Third, some have suggested that researchers exaggerate loss aversion by using options that all have similar expected values, options that have difficult-to-calculate expected values, or no incentives (Brookshire & Coursey, 1987; Ert & Erev, 2013). Addressing this critique, we include some choices that have incentives and some that have options with vastly

different expected values and easy-to-calculate expected values. Fourth, some have argued that status quo bias accounts for apparent loss aversion (Gal, 2006; Gal & Rucker, 2018). The results of the present investigation and some previous research are not readily explained by status quo bias, as detailed later. Finally, several researchers have argued that loss aversion either reverses or is attenuated with small stakes (Ert & Erev, 2013; Harinck, van Dijk, van Beest, & Mersmann, 2007; Prelec & Loewenstein, 1991; Weber & Chapman, 2005). To address this concern, the present investigation uses small stakes (maximum of €6 in Study 1 and \$20 in Study 2A). By addressing each of these critiques, our research confronts the recent claim that loss aversion is a “fallacy” (Gal, 2018) and advances understanding not only of what moderates loss aversion, but also how pervasive, generalizable, and robust loss aversion is.

Moderating Loss Aversion: Different Theories Predict Different Moderators

There is substantial disagreement about the processes that explain loss aversion (Ariely et al., 2005; Bateman, Kahneman, Munro, Starmer, & Sugden, 2005). Researchers have proposed a variety of explanations of loss aversion including that it is caused by feelings of ownership (Beggan, 1992), tendencies to think about losses prior to gains (Johnson et al., 2007), tendencies to focus on losses more than gains (Carmon & Ariely, 2000), confirmatory search and biased hypothesis testing (Morewedge & Gliblin, 2011; Pachur & Scheibehenne, 2012), or emotion (Lerner, Small, & Loewenstein, 2004; Peters et al., 2003; Zhang & Fishbach, 2005). Some have suggested that loss aversion is rooted in relatively stable psychophysical or physiological tendencies to respond to losses more strongly than gains (Arkes, 1991; Ito, Larsen, Smith, & Cacioppo, 1998), while others have emphasized the malleability of loss aversion and asserted that it is shaped by preference construction (Willemsen, Böckenholt, & Johnson, 2011). Additionally, some investigations have fundamentally questioned whether losses loom larger

than gains, by proposing that apparent loss aversion is explained by status quo bias (Gal, 2006; Gal & Rucker, 2018), aversion to bad deals (Isoni, 2011; Weaver & Frederick, 2012), attentional biases (Yechiam & Hochman, 2013), or affective forecasting errors in which people overestimate how much losses will influence their feelings (Kermer, Driver-Linn, Wilson, & Gilbert, 2006).

These different accounts of loss aversion generate different predictions about what will moderate loss aversion. Previous research on moderators of loss aversion have provided some support for many of these accounts. For example, research supporting accounts rooted in emotion has found that loss aversion is larger when negative emotions are strong and is larger for hedonic goods than utilitarian goods (Dhar & Wertenbroch, 2000; Peters et al., 2003). Research supporting accounts rooted in memory and preference construction have found that loss aversion is moderated by the order that people consider gains and losses; people typically consider losses first, however prompting people to consider gains first reduces loss aversion (Johnson et al., 2007). Many other moderators have been identified (see Neumann & Böckenholt, 2014; Sayman & Öncüler, 2005 for meta-analyses; see also Table M2 in MDA). Unlike much of this previous research, we identify moderators using a theory-driven approach, use more representative samples, focus on individual difference moderators rather than situational moderators, and replicate our results across several different samples and different loss aversion measures.

Preference Construction Shapes Loss Aversion

The present investigation tests moderators derived from research on preference construction and its role in loss aversion (Lichtenstein & Slovic, 2006; Slovic, 1995; Willemsen et al., 2011). When people face a risky choice or are asked about their willingness to pay for a good, their preferences are constructed as they make these judgments (Willemsen et al., 2011). This does not mean that preferences are fully constructed for all people; individuals with more

knowledge and experience about a domain, product, or attribute exhibit less preference construction (Hoch & Ha, 1986; Hoeffler & Ariely, 1999; Levin & Gaeth, 1988; Warren, McGraw, & Van Boven, 2011).

Recent research has also delineated more specifically how these values are constructed in the context of loss aversion, namely, through a set of sequential queries (Johnson et al., 2007; Willemsen et al., 2011). People considering prospective losses, such as the possibility of losing a Super Bowl ticket, focus first on value-enhancing aspects of the item and on negative consequences associated with losing. In contrast, people who do not own an object focus on value-diminishing aspects, such as what could be done with the money. Because of memory interference, later queries receive less weight; though people sometimes think about both value-enhancing and value-diminishing aspects, the aspects they consider first get more weight, so that the first query has a larger impact on choice (Johnson et al., 2007; Weber et al., 2007).

This line of research suggests some plausible moderators of loss aversion. First, because loss aversion is largely the result of constructed preferences, people who are most susceptible to preference construction should be most loss averse. Research on preference construction has repeatedly found that people with less knowledge, less education, and less experience (especially less knowledge or experience about the specific attribute, domain, or product class being considered) construct their preferences more than people with more domain knowledge, education, and experience (Bettman & Sujan, 1987; Fazio & Zanna, 1981; Hoch & Ha, 1986; Hoeffler & Ariely, 1999; Levin & Gaeth, 1988; Morwitz, Johnson, & Schmittlein, 1993; Simmons, Bickart, & Lynch, 1993; Warren et al., 2011). Therefore, we predicted that people with less domain knowledge, experience, and education would be more loss averse. This prediction is contrary to what accounts of loss aversion rooted in status quo bias or feelings

of ownership would suggest. Specifically, these accounts suggest that more experience with a product or prospect would increase loss aversion because it would lead to formation of a stronger status quo and stronger feelings of ownership (Ariely et al., 2005; Eidelman & Crandall, 2012).

Some previous research has considered whether domain experience moderates loss aversion, although the results are mixed. In the context of real estate ownership, some have claimed that investors exhibit less loss aversion than condominium owners (who presumably have less experience; Genesove & Mayer, 2001), while others have found no association between experience and loss aversion in this domain (Bokhari & Geltner, 2011). Other research suggests that loss aversion is lower among experienced compared to inexperienced trading card and sports memorabilia dealers (List, 2003, 2004). However, another paper in this line of research found that loss aversion is larger among experienced stock and option traders compared to inexperienced ones (Haigh & List, 2005). Pope and Schweitzer (2011) found that experienced professional golfers including Tiger Woods exhibit loss aversion when putting, though they did not compare the size of loss aversion between experienced and inexperienced individuals.

A preference construction account also suggests that knowledge and experience about a specific attribute, product, or domain is more relevant than knowledge or experience in other domains (e.g., Hoeffler & Ariely, 1999). For example, knowing more about hockey memorabilia may reduce loss aversion for hockey memorabilia more than for football memorabilia, and knowing more about the safety features of cars or the value of these features may reduce loss aversion for attributes related to car safety more than for unrelated attributes. Note that several different accounts of loss aversion rooted in memory, information processing, or attentional processes (e.g., Johnson et al., 2007; Nayakankuppam & Mishra, 2005; Pachur & Scheibehenne, 2012) might generate this same prediction because people with more relevant knowledge and

experience have well-structured knowledge, exhibit less interference when retrieving knowledge (Alba & Chattopadhyay 1985; Alba & Hutchinson, 1987; Chase & Ericsson, 1981; Lewis & Anderson, 1976), and attend to information more adaptively (Reingold & Sheridan, 2011).

We also test whether older people are more loss averse than younger people. Older individuals are more susceptible to primacy effects (Knauper, 1999) and memory interference (Hasher, Zacks, & May, 1999; Hedden & Park, 2001), such that they focus more on the first piece of information or query considered and give the first more weight. In the context of the endowment effect, this could mean that older sellers focus on the first information they consider, which is usually a value-increasing aspect (Carmon & Ariely, 2000; Johnson et al., 2007). Therefore, this could make them more averse to selling products than younger sellers who exhibit smaller primacy effects and give more equal weight to several considerations (Knauper, 1999). In the context of risky choice loss aversion, this could mean that older individuals are less likely to fully consider both the loss and the gain (along with experiences, values, and chances of each), so they focus on the first aspect considered, which is usually about the loss (i.e., value-diminishing aspects of the gamble; Carmon & Ariely, 2000; Johnson et al., 2007). There are other reasons that older individuals might be more loss averse. Because older individuals often retain less specific knowledge about details including prices and probabilities (Castel, Farb, & Craik, 2007; Healey & Hasher, 2009), they may construct preferences more than younger individuals, all else equal. Unlike a preference construction account of loss aversion, some other accounts of loss aversion, such as those rooted in emotion, would appear to make the opposite prediction. These accounts might suggest that older individuals would be less loss averse because emotion regulation improves with age (Gross et al., 1997). Previous research on age and loss aversion has been sparse; one previous study

reported a non-significant relationship between age and loss aversion (Seaman, Green, Shu, & Samanez-Larkin, 2018). Across the five samples, we examined whether age is associated with loss aversion. Though the nature of the surveys prevented us from investigating specific psychological processes underlying the relationship between age and loss aversion, we sought to rule out income effects, wealth effects, and several other alternative explanations.

Data Overview

We examined moderators of loss aversion using unique data from large field surveys. Study 1 was a study of European adults conducted via personal interviews by a professional market research company. These consumers had recently purchased a mid-sized family sedan. Using data like these has several advantages: All consumers had just made a substantial purchase in the product class, and the use of non-student participants provides substantial variance on many of the variables of interest, such as age and experience.

Studies 2A–2D were four separate large syndicated studies of U.S. households conducted by Strategic Business Insights, Inc (SBI). These four studies each contained a separate sample of households drawn randomly from the U.S. population. In Study 2, we test whether the results of Study 1 generalize to these larger, diverse samples, and whether the moderators of loss aversion replicate across each of the four samples.

Study 1: Moderators of Loss Aversion Among European Auto Buyers

Method

European adults (N = 360) participated in a market research study in exchange for €50. All participants were German-speaking and resided in one of thirty cities in Austria, Germany, or Switzerland. The survey was conducted via two interviews administered two weeks apart. The

portion of the survey that we analyzed included measures of loss aversion, car knowledge, and driving experience, as well as demographic items (age, education, gender, income, and wealth).

Risky choice loss aversion. We included three measures to assess loss aversion, including risky and riskless measures. The risky choice measure, which was adapted from previous research (Bibby & Ferguson, 2011; Hermann, 2017), asked participants to choose whether they would accept or reject several different lotteries (displayed in Appendix A). Each lottery represented a 50/50 gamble that, if accepted, would result in the identical gain if they won the coin flip (€6) and a different loss if they lost the flip (€2, €3, €4, €5, €6, and €7). Several researchers have shown that tasks like this with gambles of this magnitude measure loss aversion, not risk aversion (Fehr & Goette, 2007; Rabin, 2000; Schmidt & Zank, 2005). The loss aversion coefficient λ was estimated for each participant by dividing 6 by the smallest loss for which the gamble was not accepted (Gächter, Johnson, & Herrmann, 2010; Hermann, 2017). For example, respondents who accepted the €6 gain €2 loss coin flip, but not the €3 loss coin flip were coded as having a λ of 2. Thus, λ was computed as the lowest value consistent with the individual's choices. We excluded participants who provided non-monotonic responses (e.g., accepting the €6 gain €4 loss coin flip, but rejecting the €6 gain €3 loss coin flip). All effects remained similar in size when including non-monotonic responses or when using an alternative mapping of choices to λ (see Tables M4–4 and M4–24 in MDA). Section 5 of the Methodological Details Appendix (MDA) shows the results are robust across different assumptions about probability weighting and diminishing sensitivity.

Model car endowment. We also collected an incentivized measure of λ using indifference prices for a metal model car. Participants were shown a miniature model car and viewed a list of prices varying from €0 to €10 in €0.50 increments (Appendix B). They

completed both a willingness-to-pay (WTP) and willingness-to-accept (WTA) indifference price procedure (i.e., as both buyer and seller in a within-subjects design), with the order counterbalanced. To prevent respondents from anchoring on the first price they provided (Tversky & Kahneman, 1974), the WTP and WTA conditions were spaced far apart in the interview. For the WTA procedure, respondents were given the miniature model car and told it was theirs. They then indicated for each price whether they would be willing to sell the car. For the WTP procedure, respondents were asked whether they would be willing to buy the model car at each of the same prices from €0 to €10. To give respondents an incentive to report their true valuation, we applied the Becker-deGroot-Marschak mechanism (Becker, deGroot, & Marschak, 1964). For each participant, a price and condition (WTA or WTP) was selected randomly; the respondent either sold, kept, or bought the model car, depending on their answers for the selected price and condition. The loss aversion coefficient λ was calculated as WTA divided by WTP. Thirteen participants had WTP of €0 for the model car, so that λ was undefined; undefined values were excluded. The endowment effect is classically interpreted as the result of loss aversion (Kahneman, Knetsch, & Thaler, 1990, 1991), and has been called “the purest and most robust instantiation of loss aversion” (Rozin & Royzman, 2001). However, some researchers have suggested that processes other than loss aversion partially or fully account for the endowment effect (Gal & Rucker, 2018; Isoni, 2011; Morewedge et al., 2009; Reb & Connolly, 2007; Weaver & Frederick, 2012). For that reason, we include a risky choice measure of loss aversion in Studies 1–2, to ensure that findings are robust across different measures.

Car attributes endowment. We also assessed λ across four car attributes. We elicited endowment and no endowment prices for four attributes using a 4 (attribute: safety, comfort, fuel economy, and navigation systems) \times 2 (frame: selling, choosing) within-subjects factorial design.

For each attribute, respondents gave indifference prices for changes in attribute levels (Appendix A). The order of the two frames was counterbalanced. To prevent respondents from anchoring on the first price they provided (Tversky & Kahneman, 1974), the questions asking about each frame were spaced far apart in the interview. Note that participants were not able to look back to check their prior answers given that responses were collected via interviews. For robustness, we used three different levels of each attribute, as shown in Appendix 2 in the MDA.

Knowledge of specific car attributes. Just as we assessed λ across four car attributes, we assessed participant knowledge across these same four car attributes (safety, comfort, fuel economy, and navigation system). Specifically, for each attribute participants reported their agreement with the statement that they have a great deal of knowledge about that particular attribute (1 = *do not agree at all*, 7 = *agree without reservation*).

General car knowledge, experience, and demographics. The car knowledge item asked participants to rate their agreement with the statement that they have a great deal of knowledge about cars (1 = *do not agree at all*, 7 = *agree without reservation*) and the driving experience item asked participants how frequently they drive cars (1 = *less than once per month*, 5 = *every day*). Participants also completed demographic items asking for their age, education, gender, income, and wealth. In Study 1, each of these provided response ranges, which are reported in the MDA (Appendix 1).

Analytical Approach

Across all analyses, we report effect sizes and 95% confidence intervals of the effect sizes. This was intended to make effect size information salient rather than over-emphasizing dichotomous judgments of whether or not an effect was significant (Cumming, 2014; Cumming & Fidler, 2009). For the risky choice and model car measures of λ , we used simple linear

regressions because there was only one measure of λ per participant for each. The predictors in these models were age, attribute-level car knowledge (averaged across the four attributes), general car knowledge, driving experience, and education.

For the car attributes λ measure, we computed a hierarchical model with participant as a random factor. The predictors in this model were age, attribute-level car knowledge, general car knowledge, driving experience, and education, all mean-centered. We also included an indicator of whether the attribute-level car knowledge was about the same attribute as the loss aversion measure or about a different attribute, and we included the Attribute Knowledge \times Same Attribute interaction. If knowledge about a specific attribute (e.g., fuel economy) reduces loss aversion for that attribute (fuel economy) more than for other car attributes (safety, comfort, and navigation system), there should be an Attribute Knowledge \times Same Attribute interaction. Alternatively, if attribute-level knowledge is simply a proxy for general knowledge or intelligence, attribute-level knowledge should predict loss aversion to the same extent regardless of whether knowledge was about the same attribute or a different one, implying no interaction.

For all three dependent measures, we also computed robustness checks using the same models while adding income, gender, and wealth as covariates. Results with the covariates, which are provided in section 3 of the MDA, were similar to the models without covariates.

Results

Correlations among three λ measures. First, we analyzed the correlations between the three kinds of λ measures: loss aversion in risky choice, the model car endowment measure, and the car attributes endowment measure. Our belief that these three measures reflect loss aversion entails that they should have at least some positive correlation.

The risky choice measure of loss aversion had moderate to large correlations with the model car ($r = .55, p < .001$) and car attributes measures ($r = .48, p < .001$). In other words, though the risky choice measure was a much different task than the other two measures, correlations across the measures were sizable (Table 1). The correlation between the car attributes and model car measures was moderate in size ($r = .41, p < .001$). These three measures may thus share a common underlying construct such as loss aversion, though each surely captures noise and task-specific variance as well.

Only 4% of the sample had λ less than 1 for the model car task and only 4% of car attribute λ observations were less than 1. About 52% of participants had λ greater than 1 for the risky choice task (52% rejected the €6 gain €5 loss gamble).

[INSERT TABLE 1 HERE]

Age. Older respondents were more loss averse, and this was true across all three λ measures (Figure 1). For the model estimating attribute-specific loss aversion, older individuals exhibited higher λ , Cohen's $d = 0.14$, 95% CI [0.09, 0.18]. Similarly, older respondents had higher λ according to the incentivized model car measure, $d = 0.18$, 95% CI [0.07, 0.28], and according to the risky choice measure, $d = 0.12$, 95% CI [0.01, 0.22]. Note that the effect size estimates across the three measures were similar (Table 2).

[INSERT FIGURE 1 HERE]

Car knowledge, experience, and education. Car knowledge, especially specific knowledge about the relevant car attribute, predicted lower loss aversion. We estimated attribute-specific λ as a function of attribute-specific car knowledge, whether or not the knowledge item assessed the same attribute or another attribute (contrast-coded, $\frac{1}{2}$ = same attribute, $-\frac{1}{2}$ = different attribute), and the Attribute Knowledge \times Same Attribute interaction. Knowledge about

a specific car attribute was associated with much lower λ for that attribute but weaker associations for other attributes, as indicated by the Attribute Knowledge \times Same Attribute interaction, $d = -0.53$, 95% CI $[-0.58, -0.48]$. This is consistent with a preference construction account, in which people with specific knowledge about an attribute construct values less for that attribute, resulting in lower λ . Figure 2 displays the relationship between attribute-specific knowledge and loss aversion for the same attribute and for other attributes.

Respondents who had higher general car knowledge and driving experience also had lower attribute-specific λ (respectively, $d = -0.09$, 95% CI $[-0.14, -0.04]$, and $d = -0.12$, 95% CI $[-0.17, -0.07]$). These effects of general car knowledge and experience were much smaller than the simple effect of attribute-specific car knowledge on λ for the same attribute ($d = -0.42$, 95% CI $[-0.47, -0.37]$). There was no appreciable effect of education, $d = 0.01$, 95% CI $[-0.03, 0.04]$.

[INSERT FIGURE 2 HERE]

[INSERT TABLE 2 HERE]

For the model car and risky choice λ measures, most of the effects were smaller in size, especially the effects of car attribute knowledge which is less relevant in these contexts. Specifically, for model car endowment, respondents who were more educated and who reported more specific attribute car knowledge were somewhat less loss averse (respectively $d = -0.16$, 95% CI $[-0.26, -0.07]$, and $d = -0.23$, 95% CI $[-0.35, -0.10]$). The effects of driving experience and general car knowledge on model car λ were not discernably different from zero (respectively $d = -0.07$, 95% CI $[-0.19, 0.05]$, and $d = -0.12$, 95% CI $[-0.25, 0.01]$).

For risky choice loss aversion, driving experience, general car knowledge, and attribute car knowledge were associated with lower loss aversion (respectively, $d = -0.18$, 95% CI $[-0.30, -0.06]$; $d = -0.16$, 95% CI $[-0.28, -0.05]$; and $d = -0.28$, 95% CI $[-0.41, -0.16]$). There was a

small association between education and risky choice λ , $d = -0.09$, 95% CI $[-0.18, 0.00]$ and income was positively associated with loss aversion, $d = 0.23$, 95% CI $[0.11, 0.35]$.

Discussion

Loss aversion was moderated by age, education, car knowledge, and experience. The effect of knowledge on λ was especially strong when the knowledge measure was about the specific car attribute for which λ was assessed, as evidenced by the Attribute Knowledge \times Same Attribute interaction. Because this is a within-persons interaction, person-level variables such as numeracy or general intelligence would not produce this interaction. However, person-level variables such as general intelligence might account for the smaller effects of education and general car knowledge on loss aversion. Indeed, general intelligence and numeracy reduce many decision biases such as overconfidence (Bruine de Bruin, Parker, & Fischhoff, 2007; Cokely et al., 2018; West, Toplak, & Stanovich, 2008) and might reduce loss aversion as well. Another possibility is that education may be associated with lower loss aversion for risky financial choices because people who are educated may also be more knowledgeable about financial choices or risky prospects, which could explain why they are less loss averse. The finding that loss aversion was lower among experienced drivers than experienced drivers, though consistent with a preference construction account, seems less consistent with accounts rooted in status quo bias, because experienced drivers should have a more firmly-rooted status quo for car attributes.

Though there are many advantages to using a sample of car buyers for whom the decisions were especially relevant, one limitation is that some demographics were underrepresented among the sample of car buyers in Study 1. We next examined data from four stratified probability samples of U.S. households. Using these samples, we examined whether

moderators of loss aversion replicate across samples and domains. This data also allowed us to examine alternative explanations of our results and address recent claims about loss aversion.

Studies 2A–2D: Moderators of Loss Aversion in Stratified Probability Samples

In Studies 2A–2D, we acquired data on loss aversion and the hypothesized moderators from Strategic Business Insights. Specifically, we used data from their MacroMonitor survey, a large syndicated commercial survey about consumer finance. The surveys contained a risky investment choice measure of loss aversion as well as many questions about household finances.

We were able to acquire four surveys, each sampling different American households, each providing a unique test of these hypotheses. We tested whether household financial experience, self-reported investment knowledge, education, and age moderated loss aversion in these surveys. If the findings from Study 1 generalize, it implies that people who are older, less educated, and those who have less knowledge and experience within relevant financial domains would be more loss averse in the context of risky investment choices. These data have several advantages, including that they rely on stratified probability samples of U.S. households based on an enumeration of all residential addresses, including those without listed phone numbers. The surveys also included continuous measures of net worth and income, allowing us to examine whether the effects of experience, age, and education are explained by wealth or income.

Method

We used data from four SBI surveys: 2010, 2012, 2014, and 2016. We subsequently refer to these as Study 2A, 2B, 2C, and 2D, respectively. Each sample included a different set of 4000–4500 American adults (total $N = 17,360$). They reported detailed information about their finances, including wealth, income, several assets (e.g., investments in stocks, bonds, and savings), and several liabilities (e.g., loans, credit card debt).

A measure of loss aversion in the context of risky investment choices was included in the survey, near the middle. The loss aversion measure asked participants, “Suppose you were offered an opportunity to make an investment where you had a 50% chance of winning \$100 and a 50% chance of losing various amounts” (\$10, \$25, \$50, and \$100). For each, participants were asked “Would you make this investment?” and they indicated “Yes” or “No” (Appendix A). Note that this design makes expected value computation simple and includes prospects where the expected value is much different from \$0. This addresses claims that loss aversion is amplified when all options have similar expected values and difficult-to-calculate expected values (Ert & Erev, 2013). The survey in Study 2A used smaller amounts and six choices, rather than four (gains of \$20, rather than \$100; losses of \$2, \$5, \$10, \$15, \$20, and \$25).

The loss aversion coefficient, λ , was estimated for each participant by dividing the gain (i.e., \$20 or \$100) by the smallest loss for which the gamble was not accepted (Gächter et al., 2010). For example, respondents who accepted the \$20 gain with a \$5 loss, but not with the \$10 loss were coded as having a λ coefficient of 2. In the MDA, we conduct several robustness checks, including with an alternative λ estimation procedure. For the main text analyses, we excluded the 4.5% of participants who had missing values as well as the 3.2% of participants who provided inconsistent responses or multiple switch-points (e.g., rejecting the \$10 loss gamble but accepting the \$20 loss gamble). The effects were robust when including these individuals (see sections 6–7 of the MDA for these robustness tests).

Participants also completed an item henceforth referred to as household financial experience, in which they answered, “Overall, who handles most of the major financial affairs in your household?” (1 = respondent; 0 = spouse or other adult; .5 = both adults handle financial affairs about equally). Handling most household financial affairs gives people experience with a

wide variety of financial decisions including whether and how to investment in stocks, bonds, and savings (Ward & Lynch, 2018); thus, it is an appropriate measure of financial experience (Morgan, 1986). After the general household financial experience item, respondents also indicated who handles different types of household financial affairs in their household, including “retirement savings or investing,” “other savings or investing,” and “bills”. This allowed us to test whether investment experience predicts loss aversion (in the context of risky investment choices) better than less relevant experience (i.e., experience paying bills). The survey also had items assessing financial transaction experience (e.g., times per month using walk-up windows at a bank), which we examine as less relevant experience, for robustness.

Participants also completed one item assessing self-reported investment sophistication, in which they reported their agreement with the statement “I consider myself a sophisticated investor” (1 = *mostly agree*, 4 = *mostly disagree*, which we reverse-coded so that higher numbers reflect more agreement). Though the surveys did not include the standard measures of investment knowledge, this item has been used in the past to assess investment sophistication or knowledge (Sikarwar, Chauhan, Maheshwari, & Jain, 2016). Two other items from the survey were similar to items on a standard financial literacy scale (Fernandes, Lynch, & Netemeyer, 2014); on page 3 of the MDA, we show that these two other survey items, like the self-report investment sophistication item, predict lower loss aversion.

Participants also completed a subjective risk aversion item (Loibl & Hira, 2009) which asked, “[W]here would your household prefer to put most of its savings and investments?” (1 = *very low return/very low risk*; 5 = *very high return/very high risk*). This item assesses subjective risk aversion (Lin & Lee, 2004). About 0.9% of participants did not answer the risk aversion item and 11.0% selected “don’t know”; they were excluded from this analysis.

Participants also reported age, education, income, wealth, and several other demographics during the survey. For all measures, we excluded participants with missing values on a measure only for models involving that measure. Of participants completing the survey, 0.2% did not report education, three participants (0.002%) did not report age, 4.6% did not answer self-report investment sophistication, and 0.2% did not answer the household financial experience item. Large positive skews were present for all of the monetary variables (e.g., income, wealth, as well as amount of money in stocks, savings, and bonds), so they were \log_{10} -transformed.

Results

The vast majority of respondents exhibited loss aversion. Among respondents who viewed the \$20 win gambles, 14% accepted the coin flip with equal likelihood of winning \$20 or losing \$15. Approximately 5% accepted the coin flip with equal likelihood of winning or losing \$20. Among respondents who viewed the \$100 win gambles, only 25% took the gamble with equal likelihood of winning \$100 or losing \$50. Approximately 4% accepted the gamble with equal chance of winning \$100 or losing \$100. Median λ was 2.0 in Studies 2A, 2B, 2C, and 2D. Though most respondents exhibited loss aversion, we expected the degree of loss aversion to vary depending on age, financial experience, investment sophistication, and education.

Figure 3 compares λ across studies and measures. Though the average λ was significantly larger than 1 across all studies and measures, it was larger for Studies 2A–2D ($3.3 < M_\lambda < 3.7$) and the Study 1 endowment measures ($1.8 < M_\lambda < 2.7$) than for the Study 1 risky choice measures ($M = 1.12$, 95% CI [1.07, 1.17]). This suggests there was substantial variation in loss aversion coefficients across tasks. Study 1 used smaller gamble amounts than Study 2, which might partly explain this difference (Ert & Erev, 2013; Harinck et al., 2007). This was also reflected in Study 2 by the observation that average λ was significantly smaller in Study 2A

which used \$20 gains, compared to Studies 2B–2D, which used \$100 gains (see Table M4–3). Study 1 also had a sample that was younger on average, which could partly account for this difference. It might also reflect the larger diversity of the samples in Study 2.

[INSERT FIGURE 3 HERE]

Age. As in Study 1, older respondents were more loss averse (Figure 4). We computed a linear regression with age, household financial experience, self-reported investment sophistication, and education predicting loss aversion. The model included three dummy-coded study identifiers (Study 2A, 2B, and 2C). Older individuals were more loss averse than younger individuals, $d = 0.16$, 95% CI [0.14, 0.17]. This association between age and loss aversion was present in all four surveys (Studies 2A–2D; all d s between 0.11 and 0.19). Note that the effect sizes were similar in each survey despite using different samples of participants (Table 3).

[INSERT FIGURE 4 HERE]

Education, financial experience and self-reported investment sophistication.

Educated individuals were less loss averse, $d = -0.17$, 95% CI [-0.19, -0.15]. Additionally, respondents with more household financial experience were less loss averse than those with less experience managing their household’s financial affairs, $d = -0.03$, 95% CI [-0.05, -0.01], and respondents who reported higher investment sophistication were less loss averse, $d = -0.04$, 95% CI [-0.05, -0.02]. Table 3 presents these effects separately for each of the four surveys.

We also examined whether loss aversion (for risky investment choices) would be associated with relevant financial experience involving investments more than irrelevant financial experience (specifically, experience paying bills). Household financial experience with investments had an association with lower loss aversion, $d = -0.05$, 95% CI [-0.07, -0.03], which was similar in size to the small association between loss aversion and overall household

financial experience. In contrast, household financial experience with bills was not associated with lower loss aversion, $d = 0.02$, 95% CI [0.00, 0.04]. In other words, not all experience is associated with loss aversion in the same way; relevant experience within the same domain (making financial investments) is associated with investment choice loss aversion more than irrelevant experience (paying bills). As robustness tests, we examined alternative items that seemed to also assess relevant and irrelevant experience, respectively. Relevant financial experience consistently predicted lower loss aversion ($d_{\text{relevant average}} = -0.10$), whereas irrelevant experience had smaller effects on average ($d_{\text{irrelevant average}} = -0.01$) and less consistent effects (the direction and size varied across 11 irrelevant experience items, see Section 2 of MDA).

[INSERT TABLE 3 HERE]

Addressing alternative explanations. We conducted additional analyses to examine possible alternative explanations for the results. Gal and Rucker (2018) recently critiqued loss aversion research in part because it sometimes uses large amounts of money that may be substantial for college students and others with low income and low wealth. Thus, they argued it might actually reflect risk aversion rather than loss aversion. We addressed this possibility in two ways. In one analysis, we examined whether loss aversion was present and whether it had the same moderators even among rich individuals who have over \$1 million in net worth, for whom the largest losses of \$20 or \$100 would be relatively trivial. Most millionaires were loss averse, with only 21% accepting the gamble with equal likelihood of winning \$20 or losing \$15 and 22% accepting the gamble with equal likelihood of winning \$100 or losing \$50 (median $\lambda = 2$). Additionally, the same moderators influenced loss aversion even among these millionaires. Specifically, older age, $d = 0.20$, 95% CI [0.16, 0.23], less household financial experience, $d = -$

0.06, 95% CI [-0.09, -0.03], less investment sophistication, $d = -0.07$, 95% CI [-0.10, -0.04], and less education, $d = -0.09$, 95% CI [-0.12, -0.06], were associated with higher loss aversion.

In a second analysis, we controlled for the risk aversion measure. When controlling for risk aversion, the effect sizes remained similar for age, $d = 0.14$, 95% CI [0.12, 0.15], education, $d = -0.10$, 95% CI [-0.12, -0.08], and household financial experience, $d = -0.03$, 95% CI [-0.05, -0.02], though the effect size for self-reported investment sophistication reduced to approximately zero, $d = 0.01$, 95% CI [-0.01, 0.03], suggesting that effect is potentially attributable to risk aversion rather than (or in addition to) loss aversion.

Additionally, we estimated the primary model controlling for several covariates. As in Study 1, we controlled for wealth, income, and gender, to address the alternative explanation that wealth or income effects account for our results. Unlike Study 1, which contained few covariate measures, Study 2 contained many covariates and continuous (rather than categorical) measures of wealth and income. These included many covariates that are potentially associated with age and represent alternative explanations of the age effect. Specifically, we adjusted for 27 covariates which included 10 demographic covariates (whether retired, AARP membership, marital status, religion, occupation, number of hours worked per week, race, ethnicity, number of children, and census region) and 17 covariates about respondents' finances (net worth, income, balance in retirement accounts, balance in savings accounts, balance in checking accounts, balance in CDs, balance in money market accounts, balance in mutual funds, value of home, value of other real estate, value of vehicles, value of life insurance, credit card balances, vehicle loans, and value of first mortgage, junior mortgages, and other mortgages). When controlling for these 27 covariates, the effect size of the association between age and loss aversion was about the same as in the model without covariates, $d = 0.18$, 95% CI [0.15, 0.20]. The effect sizes for

household financial experience, $d = -0.06$, 95% CI $[-0.07, -0.04]$ and self-reported investment sophistication, $d = -0.02$, 95% CI $[-0.04, -0.01]$ also remained similar to the model without covariates, although the effect of education did not, $d = -0.02$, 95% CI $[-0.04, 0.01]$ (see section 3 of MDA for full results). Income was associated with lower loss aversion, $d = -0.05$, 95% CI $[-0.08, -0.03]$, unlike in Study 1 but consistent with previous research (Andrikogiannopoulou & Papakonstantinou, 2016). This difference across studies could reflect the diverse Study 2 sample, or income may have been confounded with an unobserved variable in Study 1.

Does loss aversion predict meaningful outcomes? Finally, we examined the predictive validity of the loss aversion measure. Researchers have theorized that people who are loss averse put more of their wealth in savings and bonds, put less of their wealth in stocks, and make fewer stock trades, because stocks are perceived as more likely to result in losses than savings and bonds (Benartzi & Thaler, 1995, Odean, 1998; Thaler, Tversky, Kahneman, & Schwartz, 1997).

We estimated each outcome variable in separate linear regressions with loss aversion and risk aversion as predictors. People who were more loss averse put a higher proportion of their wealth in bonds, $d = 0.04$, 95% CI $[0.02, 0.06]$, and a higher proportion in savings, $d = 0.02$, 95% CI $[0.00, 0.04]$. Higher loss aversion did not predict a significantly lower proportion of assets in stocks, $d = -0.01$, 95% CI $[-0.03, 0.00]$. Loss aversion did predict fewer stock transactions per year, $d = -0.02$, 95% CI $[-0.04, -0.01]$. These effect sizes, though small, remained similar when wealth, income, and gender were added as covariates.

Discussion

In Study 2, age, household financial experience, self-reported investment sophistication, and education moderated loss aversion. These results were robust across four different field surveys with different participants sampled randomly from the U.S. population. This suggests

that the patterns observed for age, experience, knowledge, and education are robust and were not specific to the sample of car buyers used in Study 1. The effect sizes were similar for age in Studies 1 and 2A–2D ($0.11 < d < 0.20$ across all surveys and measures). The relationship between age and loss aversion was robust even when we controlled for a large list of covariates including retirement status and several financial assets and liabilities. Though this addresses several alternative explanations, it is always possible that we are missing an unmeasured variable that accounts for the relationship between age and loss aversion. Because emotion regulation improves with age (Gross et al., 1997), the finding that older individuals are more loss averse seems less consistent with loss aversion accounts rooted in emotion compared to other accounts.

Importantly, age, household financial experience, self-reported investment sophistication, and education moderated loss aversion even among millionaires. In the Supplemental Material (MDA sections 1–8), we show that these moderators are also robust when we adjust for noisy and inconsistent responses and incorporate different assumptions about probability weighting and value functions. The effect sizes for experience and knowledge were smaller in Study 2 than in Study 1. This could reflect the greater specificity of measures in Study 1.

General Discussion

We demonstrated several consistent moderators of loss aversion. Specifically, individuals who had less knowledge and experience within a domain, as well as those who were older and less educated, were more loss averse. In Study 1, age moderated loss aversion across three different measures which had moderate positive correlations with one another (Cohen, 1992). Additionally, specific knowledge about a car attribute reduced loss aversion for that attribute but not for other attributes. In Study 2, the results that age, self-reported investment sophistication, and education moderate loss aversion were remarkably consistent across four different large field

surveys (Studies 2A–2D). While age, domain experience, and other variables moderated the degree of loss aversion, even the youngest and most experienced groups exhibited loss aversion.

The present research had some limitations. First, some measures in Study 1 assessed λ using a procedure with WTA and WTP prices. Though the classic interpretation of WTA/WTP discrepancies is loss aversion (Kahneman et al., 1990), others have suggested that loss aversion does not account for these discrepancies (e.g., Isoni, 2011; Morewedge et al., 2009; Reb & Connolly, 2007; Weaver & Frederick, 2012). These other accounts suggest that the endowment effect is explained by aversion to bad deals (Isoni, 2011), aversion to selling on unfavorable terms (Weaver & Frederick, 2012), or feelings of ownership (Morewedge et al., 2009; Reb & Connolly, 2007) rather than loss aversion. However, these accounts only concern the endowment effect, and do not apply to risky choice loss aversion (Isoni, 2011; Weaver & Frederick, 2012). Therefore, they cannot explain any of the results in Study 2, which used a risky choice measure of loss aversion. Neither do they apply to risky choice loss aversion findings in Study 1, though they could potentially account for the results of the endowment measures. Additionally, the present studies are correlational; therefore, inferences of causality should be avoided.

Finally, the studies did not include measures of general knowledge, numeracy, general crystallized intelligence, or general fluid intelligence. Future research should examine the relative contributions of these variables in moderating loss aversion. Given the results of Study 1, in which knowledge about a car attribute influenced loss aversion for that attribute much more than loss aversion for other attributes, we suspect that domain-specific knowledge about an attribute influences loss aversion more than more general crystallized intelligence. However, general fluid intelligence might reduce loss aversion as well, because people with greater fluid intelligence are better able to consider multiple queries simultaneously or quickly switch from

one consideration to another without interference (Engle, Tuholski, Laughlin, & Conway, 1999). And it is possible that general crystallized intelligence reduces loss aversion as well, considering that intelligence reduces many other decision biases (e.g., Bruine de Bruin et al., 2007).

Addressing Critiques of Loss Aversion Research

Recently, loss aversion research has been criticized on several fronts. Our results help address these critiques. Several researchers have urged greater examination of moderators (Gal & Rucker, 2018; Higgins & Liberman, 2018; Rick, 2011; Simonson & Kivetz, 2018). Our results show clearly that loss aversion is not the same size across every individual. Rather, it is larger for some individuals than others, for example larger for older and less educated individuals (Studies 1–2). Some textbooks and researchers have expressed loss aversion as a constant. For example, Thaler (2000) wrote that “losses hurt about twice as much as gains make us feel good”. In reality, of course, loss aversion varies depending on the person and context.

Additionally, loss aversion research has been criticized for using artificial laboratory settings, student samples, stakes that are too large for student samples, or no incentives (Brookshire & Coursey, 1987; Coursey et al., 1987; Ert & Erev, 2013; Gal & Rucker, 2018; Horowitz & McConnell, 2002). Our field studies used more diverse samples, containing substantial variation in age, education, income, and other demographics. In Study 1, we used a hypothetical measure with low stakes and an incentivized measure with low stakes, which were highly correlated with one another. People were loss averse across these different measures, and age moderated these measures of loss aversion in the same way. Researchers have also claimed that loss aversion is exaggerated when options with similar expected values or difficult-to-calculate expected values are used (Ert & Erev, 2013). Our choices included options with much different expected values, such as the choice between \$0 and \$45 expected value options in

Studies 2B–2D. We also used dollar amounts that made expected value easy to calculate.

Nonetheless, the vast majority of participants were loss averse.

Finally, some have suggested that loss aversion disappears when it is isolated from the status quo (Gal, 2006; Gal & Rucker, 2018). Specifically, Gal and Rucker (2018), critique that some measures of loss aversion ask participants to either accept or reject a lottery (such that “reject” is also the status quo) or ask participants whether they would like to sell an endowment (such that not selling is the status quo). However, at least ten articles have isolated loss aversion from status quo bias by using choices between two lotteries in which neither option is the status quo (Abdellaoui et al., 2008; Brooks, Peters, & Zank, 2014; Brooks & Zank, 2005; Glöckner & Pachur, 2012; Kocher, Pahlke, & Trautmann, 2013; Li et al., 2015; Pahlke, Strasser, & Vieider, 2012; Toubia et al., 2013; Webb & Shu, 2017). Across these studies, people were loss averse even though loss aversion was isolated from the status quo. It is also unclear how status quo bias could explain some of our results. For example, more experienced drivers likely have a stronger status quo for car attributes, yet experienced drivers were less loss averse rather than more loss averse in Study 1. Additionally, loss averse individuals had larger investments in bonds, which suggests that they made a choice to buy bonds or funds that over-represent them compared to stocks. Because buying bonds usually requires an active decision, this result is not readily explained by status quo bias. It is possible that loss aversion is somewhat larger when the option with no loss is the status quo (Ert & Erev, 2013), but loss aversion certainly does not disappear when neither option is the status quo (Abdellaoui et al., 2008; Brooks et al., 2014; Brooks & Zank, 2005; Kocher et al., 2013; Pahlke et al., 2012; Toubia et al., 2013; Webb & Shu, 2017).

[INSERT TABLE 4 HERE]

Understanding Who is Most Loss Averse

These results have several important implications. Much of the existing loss aversion literature has been done with young, educated people in college. Some have suggested that this results in exaggerated estimates of loss aversion (e.g., Coursey et al., 1987). Our data suggest the opposite: Respondents who are older and less educated are *more* loss averse, suggesting that research using students may *underestimate* the size and importance of loss aversion.

Our results also extend research on moderators of loss aversion in a few ways. Unlike most previous research, we examined loss aversion moderators in the context of consumer products and product attributes (Study 1). Additionally, while past research typically focuses on contextual moderators (Sayman & Öncüler, 2005), we focused on individual difference variables that moderate loss aversion. We also tested several moderators in unique, diverse field surveys.

The finding that older people are more loss averse has substantial implications, considering that the average age of the world's population is rising rapidly. Between 2020 and 2055, forecasts project that the number of people worldwide over 80 years old will more than triple (United Nations, 2017). Understanding the relationship between age and consumer decision making is therefore extremely important. Older individuals may avoid small losses, for example holding onto items that provide little real value to them. Indeed, hoarding increases with age (Cath, Nizar, Boomsma, & Mathews, 2001). This pattern of loss aversion, expressed over many decisions, could add up to large financial consequences and decreases in well-being.

Future research should continue to investigate moderators of loss aversion. The basic finding that people are usually loss averse tells us little about how much it varies across individuals and contexts. If our studies are any indication, different people exhibit vastly different levels of loss aversion, and this variation is systematic. In other words, people are predictably loss averse.

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Table 1.*Pairwise correlations between measures in Study 1.*

Measure	1	2	3	4	5	6	7
1. Risky Choice Loss Aversion	--						
2. Model Car Endowment	.55	--					
3. Car Attributes Endowment	.48	.41	--				
4. Driving Experience	-.48	-.35	-.46	--			
5. General Car Knowledge	-.48	-.38	-.51	.58	--		
6. Education	-.07	-.14	.06	.03	-.05	--	
7. Age	.34	.34	.48	-.37	-.43	.13	--

Note. There were four observations per participant for the car attributes λ measure (one for each attribute), so we averaged the four observations before testing these correlations.

Table 2.

Effects of age, attribute-specific car knowledge, general car knowledge, driving experience, education, and whether the knowledge is about the same or different car attribute in Study 1.

	Specific Car Attributes λ
Intercept	0.000 (0.028)
Age	0.137*** (0.022)
Attribute-Specific Car Knowledge	-0.155*** (0.015)
Same Attribute (contrast-coded, $\frac{1}{2}$ = same, $-\frac{1}{2}$ = different)	0.000 (0.027)
Attribute-Specific Car Knowledge \times Same Attribute	-0.528*** (0.027)
General Car Knowledge	-0.091*** (0.025)
Driving Experience	-0.124*** (0.026)
Education	0.006 (0.020)
Log Likelihood	-7636.205
Akaike Inf. Crit.	15,292.410
Bayesian Inf. Crit	15,359.000

Note. Coefficients are standardized (Cohen's d). Standard errors are in parentheses. *** $p < .01$. All predictors were standardized unless noted otherwise.

Table 3.

Effect sizes of four loss aversion moderators (age, self-reported investment sophistication, household financial experience, and education) on risky investment choice loss aversion across Studies 2A–2D.

	Risky Investment Choice Loss Aversion			
	Study 2A	Study 2B	Study 2C	Study 2D
Intercept	–0.006 (0.021)	0.084*** (0.021)	0.001 (0.019)	0.073*** (0.020)
Age	0.112*** (0.015)	0.142*** (0.016)	0.173*** (0.014)	0.188*** (0.015)
Self-Reported Investment Sophistication	–0.021 (0.017)	–0.002 (0.018)	–0.073*** (0.016)	–0.039** (0.018)
Household Financial Experience	–0.069*** (0.024)	–0.070*** (0.016)	0.022 (0.016)	–0.042*** (0.016)
Education	–0.068*** (0.017)	–0.183*** (0.019)	–0.186*** (0.018)	–0.234*** (0.019)
Observations	3,929	3,746	3,886	3,787
R ²	0.022	0.051	0.078	0.090
Adjusted R ²	0.021	0.050	0.077	0.089
Residual Std. Error	5.294 (df = 3924)	5.688 (df = 3741)	5.341 (df = 3881)	5.679 (df = 3782)
F Statistic	22.260***	49.907***	82.073***	93.821***

Note. Coefficients are standardized (Cohen's *d*). Standard errors are in parentheses. ** $p < .05$; *** $p < .01$.

Table 4.

Loss aversion is robust, even after addressing critiques.

Critique	How our data addresses
Not enough focus on moderators	Focuses on moderators and identifies four (domain knowledge, domain experience, education, age)
Uses college students who have little money	1. Uses diverse samples 2. Shows that even millionaires are loss averse
Stakes are too large or measures risk aversion rather than loss aversion	1. Uses small stakes (max €6 in Study 1 risky investment choice measure; max \$20 in Study 2A) 2. Measures and controls for risk aversion
Status quo bias	Addressed most directly in other research. Loss aversion predicts more investments in bonds in our data, a pattern not readily explained by status quo bias
Uses options that all have similar expected value	Includes some choices between options with much different EV (e.g., \$45 vs. \$0 in Studies 2B–2D)
Uses questions where EV calculation is hard	Includes some questions with simple EV calculation (e.g., 50/50 gamble for \$20 gain and \$20 loss)
No incentives	Includes one incentivized measure (Study 1)

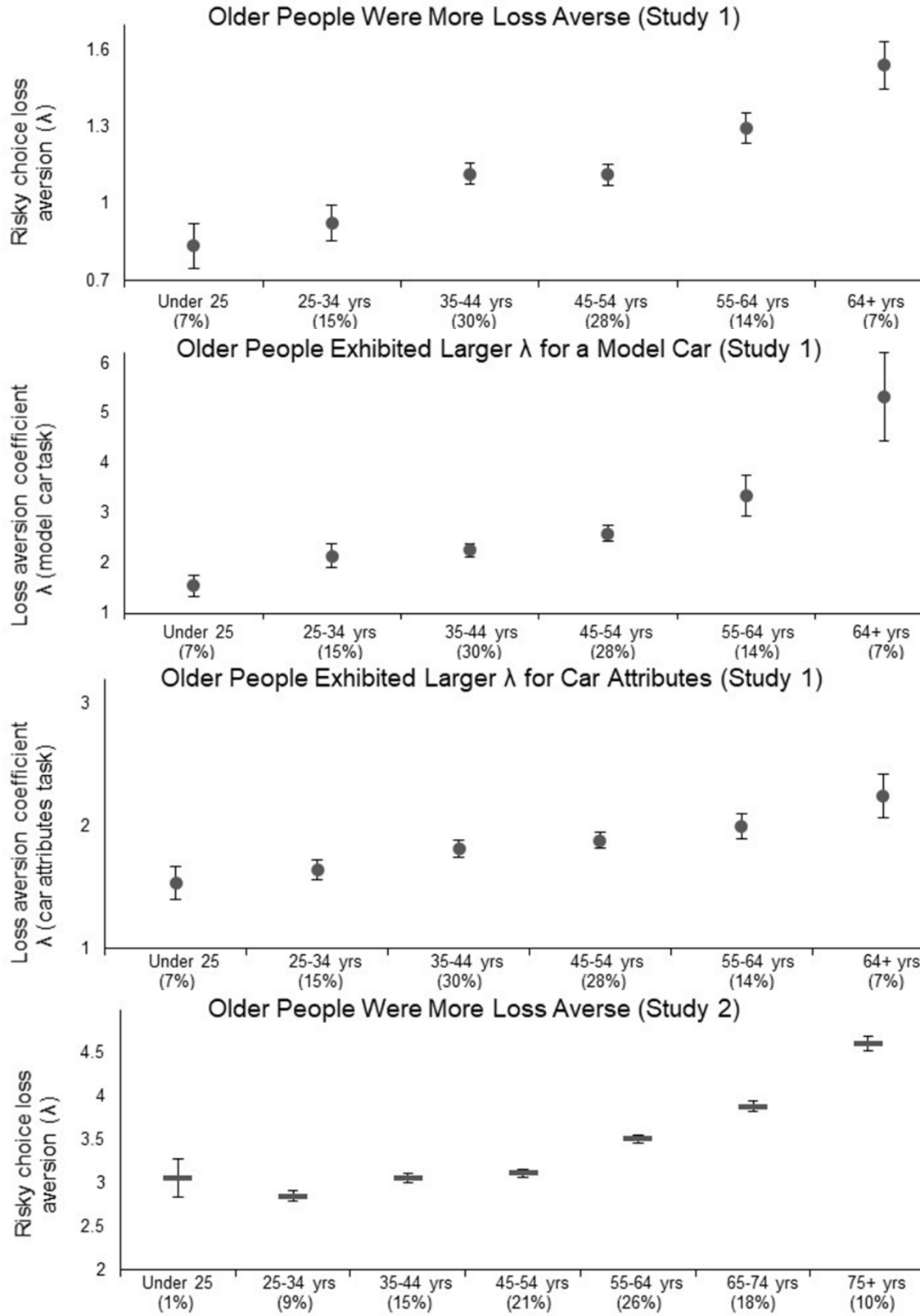


Figure 1. Older people were more loss averse in the context of risky investment choices (top panel). Older people also displayed larger (incentivized) λ for model cars (middle panel) and λ for car attributes (bottom panel). Error bars depict ± 1 standard error.

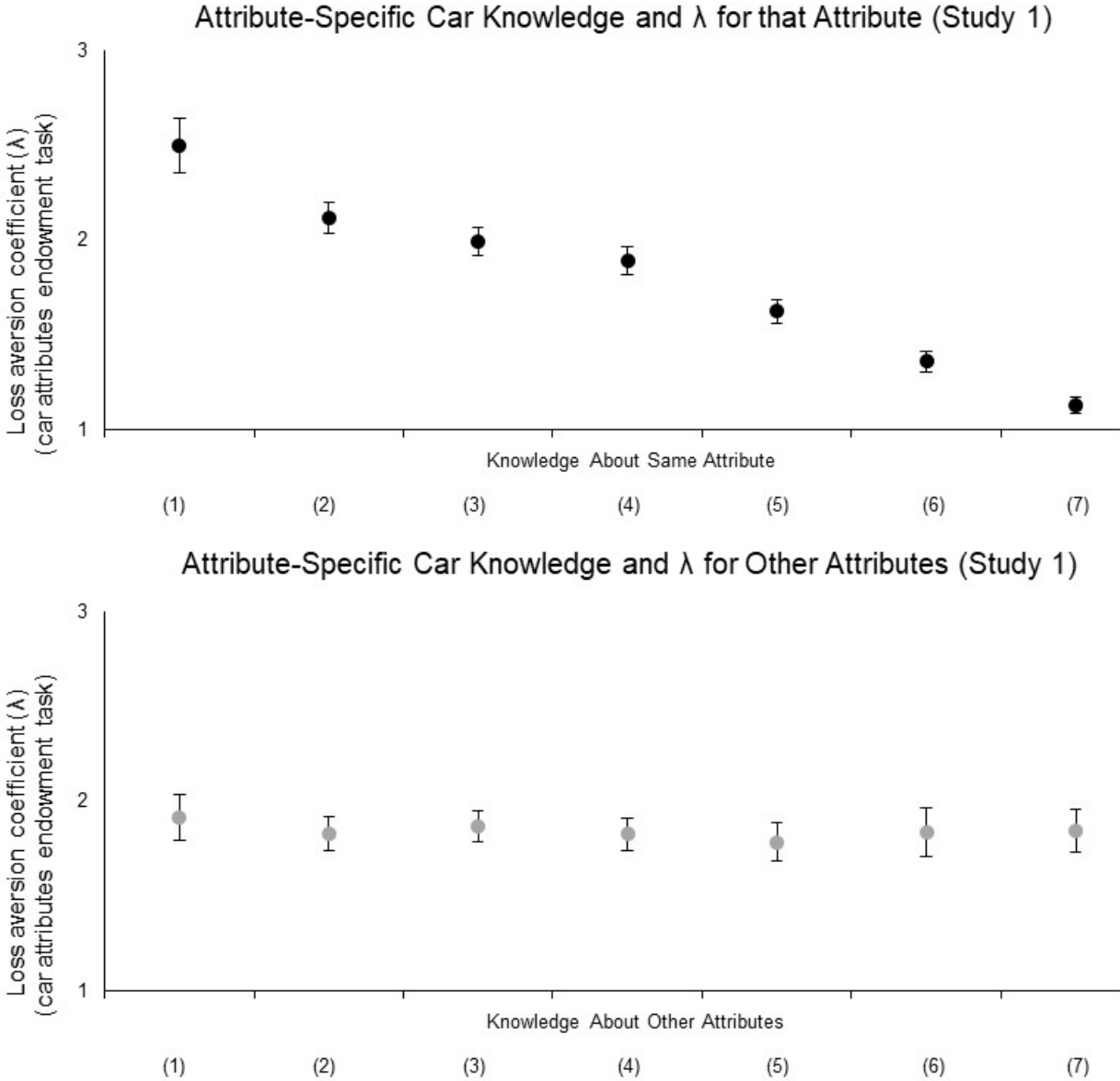


Figure 2. People with more knowledge about a specific car attribute were less loss averse for that attribute (top panel) but not any less loss averse for other car attributes (bottom panel). Though loss aversion for car attributes was lower among those with more knowledge about those attributes, λ was greater than 1 for all groups. Error bars depict \pm 1 standard error.

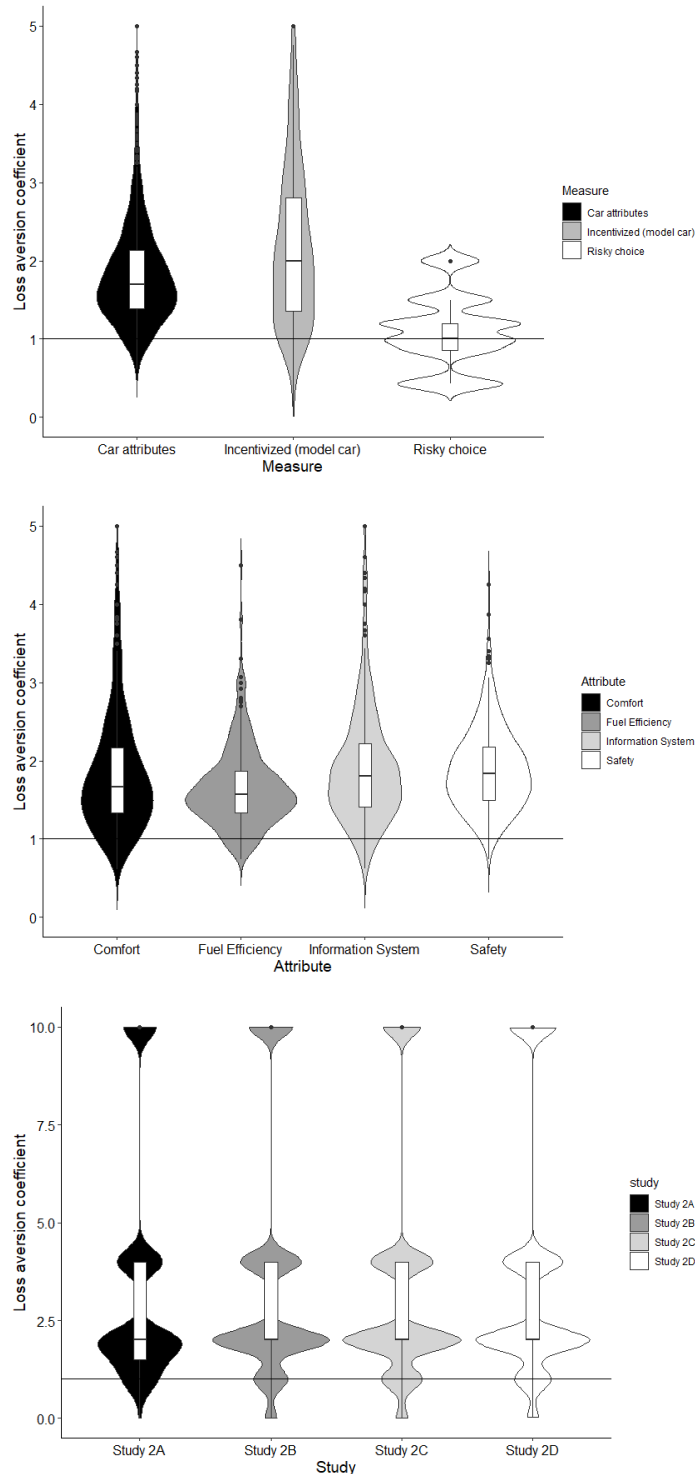


Figure 3. Violin plots displaying the distribution of λ across the three λ measures in Study 1 (top panel), the four car attributes endowment task (middle panel), and across Studies 2A–2D (bottom panel). Box plots provide the median and interquartile range for each measure. Wider areas of each violin indicate more participants with that λ coefficient. The horizontal line displays where the λ of 1.0 (loss neutrality) is. The vast majority of participants had $\lambda > 1.0$, except in the Study 1 risky choice measure for which average λ was only slightly above 1 (95% CI [1.07, 1.17]).

Appendix A: Risky Choice and Car Attribute λ Measures (English Translation)

Table A1.

Risky choice measure of loss aversion used in Study 1.

Lottery	Accept	Reject
#1. If the coin turns up heads, then you lose €2; if the coin turns up tails, win €6.	<input type="radio"/>	<input type="radio"/>
#2. If the coin turns up heads, then you lose €3; if the coin turns up tails, win €6.	<input type="radio"/>	<input type="radio"/>
#3. If the coin turns up heads, then you lose €4; if the coin turns up tails, win €6.	<input type="radio"/>	<input type="radio"/>
#4. If the coin turns up heads, then you lose €5; if the coin turns up tails, win €6.	<input type="radio"/>	<input type="radio"/>
#5. If the coin turns up heads, then you lose €6; if the coin turns up tails, win €6.	<input type="radio"/>	<input type="radio"/>
#6. If the coin turns up heads, then you lose €7; if the coin turns up tails, win €6.	<input type="radio"/>	<input type="radio"/>

Note. As described in the main text, λ was computed as $6 \div$ smallest loss the person accepted.

Table A2.

Risky investment choice measure of loss aversion used in Studies 2B–2D (SBI MacroMonitor)

Suppose you were offered an opportunity to make an investment where you had a 50% chance of winning \$100 and a 50% chance of losing various set amounts. Would you make any of the investments? Please answer every row. (Select one answer from each row.)

		Would you make this investment?	
50% chance you could earn	50% chance you could lose	Yes	No
\$100	\$10	<input type="radio"/>	<input type="radio"/>
\$100	\$25	<input type="radio"/>	<input type="radio"/>
\$100	\$50	<input type="radio"/>	<input type="radio"/>
\$100	\$100	<input type="radio"/>	<input type="radio"/>

Note. As mentioned in the main text, the measure had smaller amounts in Study 2A (2010), with maximum wins of \$20 and losses of \$2, \$5, \$10, \$15, \$20, and \$25. The instructions of Study 2A also referred to a coin flip, similar to Study 1 and unlike Studies 2B–2D.

Car attributes endowment measure used in Study 1.

Scenario text for navigation system attribute, endowment condition

You are about to buy a new [name of car]. You have a specific vehicle (A) in view, in addition to the driver information system, the on-board computer, the check package and the radio clock also has a navigation system with voice and pictogram on the display in the cockpit. Another [name of car] (B) is completely identical to your previous favorite, but has only a driver information system, an on-board computer, a check package and a radio clock. By how many euros would this vehicle (B) have to be cheaper in price, so that you prefer it to the other (A)?

Note. The coefficient λ was endowment price \div no endowment price. See MDA for other versions with different attributes and with no endowment.

Appendix B: Incentivized Model Car Measure of λ Used in Study 1 (English Translation)

WTA: Model Car Endowment

We will give you the following toy car which you can keep. This toy car is yours! If you do not want to keep the toy car, you can **sell** it to the organizers of this study. Please indicate in the table for each respective price if you are ready to sell the toy car.

- If at the price for which we buy the toy car from you, you have indicated that you are ready to sell, you will receive this amount in cash instead of the toy car.
- If at the price for which we buy the toy car from you, you have indicated that you are not ready to sell, you will keep your toy car.

The price at which we will buy your toy car will be randomly determined by us and for sure be between €0 and €10. That is, our buying price will be determined by rolling dice after you have filled in the table below. All prices are equally likely. Since you cannot influence the buying price, which we will determine randomly, you have an incentive to state the price that corresponds to your **true preference**. Once you have made your choice, you cannot change it anymore. We will also not be able to negotiate the randomly determined buying price.

Price in €	Please make a cross in each line depending on whether you are ready or not to sell the toy car at the respective price to us.	
If the price is € 0 ...	... I am ready to sell <input type="radio"/>	I am not ready to sell: <input type="radio"/>
If the price is € 0.5 ...	... I am ready to sell <input type="radio"/>	I am not ready to sell: <input type="radio"/>
...[The above was repeated for each price from €1 to €9.5]		
If the price is € 10.0 ...	... I am ready to sell <input type="radio"/>	I am not ready to sell: <input type="radio"/>

WTP: Model Car Endowment

We will offer you to buy the following toy car. This toy car can be yours! If you want to acquire this toy car, you can buy it from the organizers. Please indicate in the table for each respective price if you are ready to buy the toy car.

- If at the price for which we sell the toy car to you, you have indicated that you are ready to buy, you will receive the toy car from us at this price, which you have to pay to us.
- If at the price for which we sell the toy car to you, you have indicated that you are not ready to buy, you do not receive the toy car.

The price at which we will sell the toy car to you will be randomly determined by us and for sure be between €0 and €10. That is, our selling price will be determined by rolling dice after you have filled in the table. All prices are equally likely. Since you cannot influence the selling price, which we will determine randomly, you have an incentive to state the price that corresponds to your **true preference**. Once you have made your choice, you cannot change it anymore. We are also not able to negotiate the randomly determined selling price.

Price in €	Please make a cross in each line depending on whether you are ready to buy the toy car at the respective price from us.	
If the price is € 0 ...	... I am ready to buy <input type="radio"/>	I am not ready to buy: <input type="radio"/>
If the price is € 0.5 ...	... I am ready to buy <input type="radio"/>	I am not ready to buy: <input type="radio"/>
...[The above was repeated for each price from €1 to €9.5]		
If the price is € 10.0 ...	... I am ready to buy <input type="radio"/>	I am not ready to buy: <input type="radio"/>

Note. The loss aversion coefficient was computed as WTA/WTP. Participants completed the WTA and WTP condition (within-subjects), as explained in the main text.

Methodological Details Appendix

MDA Section 1: Study 1 Methodological Details**Model car WTA and WTP supplementary details**

One participant had WTA of €0 for the model car; that participant had WTP of €1, so that participant was included and had a λ of 0. None of the thirteen participants with €0 WTP (mentioned in the main text) had €0 WTA.

Risky choice λ supplementary details

In both Study 1 and Study 2, coherence was not forced. So, participants could reject the €6 gain €2 loss gamble and accept the €6 gain €3 loss gamble. These non-monotonic responses were excluded from primary analyses, though we report robustness tests that include these participants in section 7 of the MDA.

Risky choice λ values were small in Study 1 ($M = 1.12$, $SD = 0.45$), but were still significantly larger than 1 on average, 95% CI [1.07, 1.17]. On average, participants were thus loss averse. Values of λ were much larger for the other two Study 1 tasks and the Study 2 risky investment choice task. Study 1 used smaller gamble amounts than Study 2, which might partly explain this difference (Ert & Erev, 2013; Harinck et al., 2007). This was also reflected in a λ difference in Study 2, such that average λ was significantly smaller (though still much larger than 1) in Study 2A which used \$20 gains, compared to Studies 2B–2D, which used \$100 gains (see Table M4–3). Study 1 also had a sample that was younger on average, which could partly

account for this difference. It might also reflect that Study 2 had a higher proportion of older respondents and had larger diversity in other respects as well.

No order effects for WTA and WTP

As mentioned in the main text, WTA and WTP prices were obtained within-subjects and the two conditions were spaced very far apart in the interview to prevent anchoring or carryover effects (Tversky & Kahneman, 1974). The interview format also prevented participants from reviewing their earlier responses. Therefore, we did not predict carryover or anchoring effects in WTA and WTP valuations. Consistent with this assumption, neither WTA, WTP, nor the ratio of WTA to WTP were influenced by the order in which participants completed WTA and WTP questions (all $|t|s < 1$, all $ps > .25$). If participants had anchored on initial answers, one might expect higher WTP among those who received the WTA condition first compared to those who received the WTP condition first, which we did not observe.

MDA Section 2: Study 2 Methodological Details

Alternative financial knowledge measure

For robustness, we also examined another question that assesses financial knowledge. Though the SBI surveys used in Study 2 did not include any typical measures of financial literacy or financial knowledge, one item from the SBI surveys was nearly identical to an item from a standard financial literacy measure (Fernandes et al., 2014). The item asked, “Over the long run, say 10 or 20 years, stocks will be a very good investment” (1 = *mostly agree*, 4 = *mostly disagree*, which we reverse-coded so that higher numbers reflect greater agreement). Because this item may assess stock or risk preferences in addition to financial literacy, we examined a second item which was not correlated with higher stock and risk preferences. The item asked, “Investments such as CDs or money market accounts are a good protection against

losing money” (1 = *mostly agree*, 4 = *mostly disagree*, which we reverse-coded). Agreement with each of these two statements, which we believe reflects higher financial literacy, was associated with lower loss aversion (stocks item: $d = -0.10$, 95% CI [-0.17, -0.13]; CD item: $d = -0.08$, 95% CI [-0.10, -0.07]). Whereas agreement with the first item had a positive correlation with higher proportion of investments in stocks ($r = .10$) and a small correlation with lower risk aversion ($r = -.24$), agreement with the second item had associations in the opposite directions with proportion of investments in stocks ($r = -.11$), and risk aversion ($r = .08$). The effects of each item on loss aversion were slightly smaller when controlling for risk aversion, proportion of investments in stocks, wealth, income, and the other covariates from the main text robustness model with 27 covariates (stocks item: $d = -0.06$, 95% CI [-0.08, -0.04]; CD item: $d = -0.05$, 95% CI [-0.07, -0.03])

Alternative items measuring (relevant and irrelevant) financial experience

The two items of irrelevant and irrelevant financial experience emphasized in the main text were chosen because they were worded in the same way as the overall household financial experience item and in the same way as one another, so that differences between the two items and the overall household financial experience item would not be attributable to differences in question format or response scale. To test the robustness of the difference between relevant and irrelevant financial experience, we examined several other items that also seemed to assess relevant and irrelevant financial experience, respectively.

We examined 11 irrelevant experience items. Table M1 below provides the effect sizes for each item’s association with risky investment choice λ . Relevant financial investment experience was consistently associated with lower λ across the different items. As mentioned in the main text, irrelevant financial experience had less consistent associations with λ , sometimes

negative and sometimes positive, though the average effect size for relevant investment experience was larger than the effect size for any of the 11 irrelevant financial experience items.

Table M1.

Robustness test: Cohen's d and correlations between loss aversion and items that seem to reflect relevant financial investment experience (R) and irrelevant financial experience (I) in Study 2.

Item	Association with risky investment choice λ	
	(Cohen's d)	(bivariate r)
1. Experience with investments (R); 1 = handle these investments, 0 = do not handle these; 0.5 = partially handle (with another adult)	-0.07***	-.02***
2. Number of stock/bond/MF transactions per year (R)	-0.10***	-.13***
3. Number of IRA/retirement/salary reduction plan/annuity transactions per year (R)	-0.11***	-.20***
4. Experience paying bills (I); 1 = handle bills, 0 = do not handle bills; 0.5 = partially handle bills (with another adult)	0.00	.01
5. Times per month make a phone call to a financial institution and use voice recognition or touch-tone phone (I)	0.00	.01
6. Times per month make a phone call to a financial institution and speak to a representative (I)	-0.02***	-.01
7. Times per month talk with a teller inside a financial institution per year (I)	-0.02*	.01
8. Times per month talk with a representative other than a teller inside a financial institution (I)	0.03***	.02***
9. Times per month use an ATM belonging to your financial institution (I)	-0.04***	-.07***
10. Times per month use a drive-through facility at a financial institution (I)	0.01	-.03***
11. Times per month use a walk-up window (outside a financial institution) (I)	0.01	.00
12. Times per month use an ATM belonging to another financial institution (I)	-0.04***	-.06***
13. Times per month use the internet to connect to a financial institution (I)	-0.06***	-.12***
14. Times per month other ways to interact with your financial institution (I)	0.01	.00

Note. For the robustness tests, correlations are bivariate (i.e., no covariates), whereas the model to compute Cohen's d included the demographic, financial knowledge, and other experience items as covariates. *** $p < .01$ * $p < .10$

MDA Appendix 3 provides the full measure. These items asked, “How many times in a typical month do you or anyone in your household do any of the following to make a financial transaction,” with an example item referring to “talk with a representative (other than a teller) inside a financial institution (face-to-face)”.

Survey weights

We included SBI MacroMonitor survey weights in all primary models and include robustness checks without those weights in section 2 of the MDA. Weights adjusted for an over-sample of affluent individuals whose income was over \$100,000 per year or whose assets excluding primary home were over \$500,000. Though the sample was randomly drawn (other than the over-sample), it is possible that the final sample is not representative because of non-response bias.

Additional missing value statistics

As described in the main text, SBI survey responses included some missing values. We excluded only participants who had missing values for one or more of the variables in the model, as mentioned in the main text. For example, we excluded the 0.9% of participants who did not answer the risk aversion item from models involving that risk aversion item. However, these individuals were not excluded from other models that did not involve the risk aversion item, among participants who completed the measures in that other model. About 1.0% of respondents chose not to answer any of the financial transaction experience items. There were no participants

who did not answer any of the loss aversion questions, though some participants did skip one or more of the items as detailed in section 6 of this MDA.

MDA Section 3: Primary Models with Robustness Tests

As described in the main text, the primary model in Study 1 estimated λ from age, education, attribute-specific car knowledge, general car knowledge, and driving experience. The model estimating attribute-specific λ was a mixed effects model with a random effect of participant and it included an indicator of whether the knowledge measure was the same or another attribute as the λ measure, as well as the Attribute-Specific Knowledge \times Same Attribute interaction. Study 2 estimated λ from age, education, self-reported investment sophistication, and household financial experience. Tables M4–1, M4–2, and M4–3 provide the full results of these models.

Robustness 1: Midpoint mappings of choice to λ

As described in the main text, the initial models computed λ for each participant as the lowest loss aversion coefficient that was consistent with that participant's choices. As a robustness test, we used an alternative mapping in which λ was the midpoint of the range of possible λ values that were consistent with that participant's choices. The effects of age, education, experience, and knowledge remained significant and similar in size when using these λ coefficients (see Tables M4–4 and M4–5).

Robustness 2: Removing SBI survey weights

Survey weights are used in SBI MacroMonitor data, to adjust for their over-sample of affluent households (with over \$100,000 annual income or over \$500,000 assets excluding primary home) and any other discrepancies between the final sample and U.S. household demographics (e.g., discrepancies due to differential attrition or non-response as a function of

demographics). We conducted robustness tests (below) that give each respondent equal weight. The effects of age, education, and household financial experience remained significant and similar in size when removing the survey weights (Table M4–6).

Robustness 3: Adjusting for covariates

As another robustness check, we added three covariates to the primary models to adjust for wealth, income, and gender. The results were similar when we added these three covariates to the model, although the effects of attribute-specific car knowledge were larger than the effects of general car knowledge, which were not discernably different from zero when controlling for wealth, income, and gender (Tables M4–7 and M4–8). In Study 2, the effects of age, education, and household financial experience all remained significant after we controlled for income, wealth, and gender (Table M4–9). It is also noteworthy that higher income was associated with higher loss aversion in Study 1 but with lower loss aversion in Study 2, though it is unclear what explains this difference. One possibility, as we mentioned in the main text, is that the sample in Study 2 was more diverse, and the greater variability in age could have allowed the negative relationship between income and loss aversion to emerge. We also had fewer measured covariates in Study 1, so income may have been confounded with an unmeasured covariate that was measured in Study 2 but not Study 1. In a model with a larger set of 27 covariates, the effects of age, household financial experience, and self-reported investment sophistication remained significant and similar in size to the model without covariates (Table M4–10). In contrast, the effect of education was greatly reduced and no longer discernably different than zero, suggesting the education effect on loss aversion could reflect differences in assets,

liabilities, or other demographics such as occupation, rather than purely reflecting education itself.

Some have expressed concern that loss aversion measures might partially measure risk aversion, because amounts like \$100 and \$20 might be substantial for some people who have very low levels of wealth. To address this concern, we ran a robustness test examining the effects of age, household financial experience, self-reported investment sophistication, and education only among people with at least \$1 million in net assets. The effects were significant even among this wealthier subset of the sample (Table M4–11).

Robustness 4: Log-transformed λ

As an additional robustness check, we used log-transformed measures of λ . All moderators reported in the main text remained similar when using log-transformed λ (Tables M4–12, M4–13, and M4–14).

Robustness 5: Different assumptions about probability weighting and diminishing sensitivity

We conducted several robustness tests to examine whether the effects of age, domain knowledge, domain experience, and education remain when using different assumptions about probability weighting and diminishing sensitivity. Our baseline analyses in the main text assume the same probability weighting for gains and losses, following Prelec (1998). They also assume a linear value function, which is a common assumption with small amounts of money, consistent with empirical findings for small amounts (Fehr-Duda, De Gennaro, & Schubert, 2006).

As a first robustness test, we relaxed the assumption of a linear value function, adding value function parameters of α (i.e., for gains) = 0.95 and β (i.e., for losses) = 0.92 (Booij & van de Kuilen, 2009). All of the effects that were significant in the primary models remained

significant when using these parameters for both Study 1 (Table M4–15) and Study 2 (Table M4–16). We next relaxed the assumption that gains and losses would have the same probability weighting. Instead, we used probability weighting parameters from Abdellaoui (2000), who found $\omega = 0.86$. All of the significant moderators of loss aversion in Study 1 (Table M4–17) and Study 2 (Table M4–18) remained significant with these parameters. We then used the probability weighting parameters from the previous analyses along with the value function parameters of $\alpha = 0.95$ and $\beta = 0.92$, described earlier. All of the moderators of loss aversion in Studies 1 and 2 remained significant with these parameters (Tables M4–19 and M4–20, respectively). Our primary interest is in moderators of λ , although mean λ estimates also change little when using different assumptions about probability weighting and value functions. This is portrayed in Table 1 of an unpublished manuscript which uses the Study 1 data (Gächter, Johnson, & Herrmann, 2010, p. 14).

We also conducted a robustness test using the parameters from Kahneman and Tversky (1992). Specifically, they estimate $\alpha = 0.88$, $\beta = 0.88$, and $\omega = 0.88$ (weighting of gains = 0.61; weighting of losses = 0.69; $0.61/0.69 = 0.88$). All significant moderators from Study 1 (Table M4–21) and Study 2 (Table M4–22) remained similar in size and significant when using these parameters as well.

Robustness 6: Imputing missing values

We also conducted a robustness check in which we imputed λ for participants with some missing values in the risky investment choice task. These participants did not provide an answer for one or more gambles rather than choosing “accept” or “reject”. Importantly, the effects of age, household financial experience, self-reported investment sophistication, and education

remained significant when including imputations of these missing values (Table M4–23).

Additionally, descriptive statistics for λ remained similar (median = 2; $M = 3.47$, $SD = 3.01$).

Missing value(s) were present among 4.5% of participants. In the main text, we excluded participants with missing values. In this robustness test, we imputed missing values by assuming consistency across any missing values. For example, for a participant who rejected the \$10 loss gamble but left the \$20 loss gamble blank, we assumed they would reject it since it was identical except for a larger loss. For a participant who accepted the \$50 loss gamble but left the \$20 loss gamble blank, we assumed they would accept it since it was identical except for a smaller loss. We left values missing if participants had only missing values across all gambles, if they rejected larger-loss gambles but did not answer the smaller-loss gamble, or if they accepted smaller-loss gambles but did not answer the larger-loss gamble blank.

Robustness 7: Inconsistent responses (multiple switch points)

As another robustness check, we included participants in the analysis who had inconsistent responses (e.g., rejecting the \$10 loss gamble but accepting the \$20 gain gamble). In Study 1, all moderators remained significant when including these individuals. In Study 2, the effects of age, household financial experience, investment sophistication, and education remained significant when including participants who had multiple switch points (Table M4–25).

In Study 1, 9.4% of participants had one or more inconsistent responses. Only 3.2% of participants had one or more inconsistent responses across Studies 2A–2D. In the main text, we excluded participants with inconsistent responses. For this robustness check, we estimated λ for those respondents by averaging their switch points. For example, a participant who accepted the \$10 loss gamble, rejected the \$15 loss gamble, accepted the \$20 loss gamble, and rejected the \$25 loss gamble had inconsistent responses. As described in the main text, someone with

consistent responses who accepted the \$10 loss gamble and rejected the \$15 loss gamble would be assigned a λ of $20/15 = 1.33$. Someone who accepted the \$20 loss gamble but rejected the \$25 loss gamble would be assigned a λ of $20/25 = 0.8$. We averaged the λ associated with these two switch points in this robustness check, such that they would be assigned a λ of 1.065.

Robustness 8: Adjusting for differential noisy and straight-line responses

In this section, we look, as a robustness check, at the effects of random responding and straight-lining on the moderators of loss aversion in the risky choice task. Given that only 3.2% of participants provided any inconsistent responses (e.g., rejecting the \$10 loss gamble but accepting the \$20 loss gamble), we think very few participants answered randomly. Yet it is possible that some participants did not take the task seriously but did so by selecting to accept or reject all the options (that is, answer in a straight line all the questions).

One concern would emerge if participants who were older, who were less educated, who reported lower investment sophistication, or who had less household financial experience exhibited more straight-lining or random responding. As an initial robustness test, we removed all participants who provided straight-line responses to the risky investment choice loss aversion task, including everyone who rejected all gambles and everyone who accepted all gambles. Then, we conducted the primary model from the main text, estimating risky choice loss aversion as a function of age, household financial experience, investment sophistication, and education. Even when excluding these straight-lining participants, the effects of age, household financial experience, self-reported investment sophistication, and education on loss aversion remained

significant (Table M4–26). (The same was true when excluding only the straight-lining participants who rejected all gambles, leaving those who accepted all gambles in the analysis).

Next, we examined whether age, household financial experience, self-reported investment sophistication, and education predicted higher likelihood of answering inconsistently (i.e., having multiple switch points or rejecting a lower loss gamble while accepting a higher loss gamble). As mentioned in section 7 above, 3.2% of participants provided one or more inconsistent responses. Household financial experience was not associated with likelihood of answering inconsistently, $d = -0.01$, 95% CI $[-0.03, 0.01]$. Participants who were more educated, younger, and who reported less investment sophistication were less likely to answer inconsistently (respectively, $d = -0.03$, 95% CI $[-0.05, -0.01]$; $d = 0.03$, 95% CI $[0.02, 0.04]$; and $d = 0.04$, 95% CI $[0.02, 0.06]$). Importantly though, the effects of age, household financial experience, self-reported investment sophistication, and education on loss aversion remained significant when controlling for whether or not the participant made inconsistent responses (Table M4–27). (As in section 7, those with multiple switch points were assigned a λ for each switch point and we averaged the λ for each of that participant’s switch points.)

Robustness 9: Adjusting for random responses in mean risky choice λ estimates

As mentioned in sections 7 and 8, few participants provided inconsistent responses, so we think random responding was low. However, it is possible that some participants provided straight-line responses, which would be internally consistent. Some of these straight-line responses may have been the result of not taking the task seriously. Consider the case where a respondent chose “reject” for all options. Rejecting all would result in a λ estimate of 10. Excluding respondents who rejected all four gambles, who could have inflated the mean λ estimate, results in a mean λ of 2.26 ($SD = 1.15$), median = 2. In reality, some of the straight-

lining participants might have accepted all gambles; excluding everyone who rejected all or accepted all gambles results in a higher mean λ of 2.35 ($SD = 1.08$), median = 2.

In the next two robustness tests, we assumed that some participants answered randomly, selecting one of the two answers to the first question at random (accept or reject). For the sake of simplicity, we describe how we conducted the robustness test in Studies 2B–2D below, though the λ estimates below included the data from the four surveys (2A–2D).

For the first gamble that participants faced, 15.6% (1860 participants) rejected it. If half the random respondents rejected the gamble (as opposed to accepting it), the maximum percentage of respondents guessing would be 31.2% ($2 * 1860 = 3720$ participants). This is conservative because it assumes 100% of those who rejected the first gamble were answering randomly. In the first robustness test, we assumed that 31.2% answered randomly for every gamble. In the second robustness test, we assumed that these 31.2% of participants answered randomly until they rejected one gamble and subsequently gave responses consistent with their previous response (i.e., rejecting the remainder of the gambles).

In this next robustness test, we assumed that there were 3720 guessers for each of the four gambles. (This is surely an overestimate because of how few participants provided inconsistent responses, which would have been common if this many participants were answering randomly.) Even when excluding 1860 participants who rejected the first gamble, 1860 who rejected the second, and 1860 who rejected the third, λ coefficients were still larger than 1 ($M = 1.85$, $SD = 1.05$, median = 2). The mean λ estimates would be slightly higher than 1.85 if we repeated this procedure for all four gambles rather than only for the three positive expected value gambles.

In another robustness test, we assumed that participants completed the task sequentially, guessing randomly at first, but were able to maintain internal consistency. We assumed that 50% of the random respondents chose each option for the first gamble, and that those who rejected it (i.e., not accepting the \$10 loss gamble), also rejected all subsequent gambles (which had larger losses and lower expected values). We assumed that random respondents who accepted the first gamble continued to answer randomly, such that they were split evenly between accepting and rejecting the second gamble. We again used the assumption that because 15.6% of respondents rejected the first gamble, the maximum of those likely to be guessing randomly would be ($2 * 15.6\% = 31.2\%$ or 3720 participants), which assumes that those who guessing were split evenly between accept and reject. Thus, 50% of them (1860 participants) would have rejected the first gamble because of guessing, 50% of the remainder (930 participants) would have rejected the second gamble because of guessing, 50% of the remainder (465 participants) would have rejected the third gamble because of guessing, and 50% of the remainder (233 participants) would have rejected the fourth gamble because of guessing. Therefore, as a robustness check, we excluded all participants who rejected the first gamble (15.6% of the sample; 1860 participants), and excluded 930 who rejected the second gamble, 465 who rejected the third gamble, and 233 who rejected the fourth gamble. After these exclusions, average λ across these samples was 2.09 (median = 2), consistent with loss aversion. In other words, the finding that λ was greater than 1 in Study 2 does not appear to be attributable to straight-lining nor random responding which could have inflated λ .

Table M2.*Moderators of loss aversion: What we know.*

Moderators associated with higher loss aversion	Paper
No similar products available as possible substitutes	(Sayman & Öncüler, 2005)
Exchanges for dissimilar rather than similar products	(Chapman, 1998)
Not a market exchange	(Novemsky & Kahneman, 2005a)
Larger amounts of hypothetical money	(Harinck et al., 2007; Weber & Chapman, 2005)
Lower incentives	(Sayman & Öncüler, 2005; cf. Horowitz & McConnell, 2002)
Difficult-to-calculate expected values	(Ert & Erev, 2013)
Options with similar expected values	(Ert & Erev, 2013)
Less experience	(List, 2003, 2004; Haigh & List, 2005)
Individualism	(Wang et al., 2017)
Western (compared to East Asian)	(Maddux et al., 2010)
Lower income	(Andrikogiannopoulou & Papakonstantinou, 2016; cf. Tanaka et al., 2010)
Female gender	(Prasad & Mohta, 2012)
Framing the safe option as the status quo	(Ert & Erev, 2013; see also Gal, 2006)
Using safe options that maximize chance of positive outcome	(Ert & Erev, 2013)
Inclusion of very attractive risky choice options that create a contrast effect	(Ert & Erev, 2013)
No feedback	(Ert & Erev, 2013; see also Yechiam & Hochman, 2013)
Encouraging direct comparison of gains and losses rather than separate response scales	(McGraw et al., 2010)
Owning for a longer duration	(Shu & Peck, 2011; Strahilevetz & Loewenstein, 1998)
Mere ownership	(Beggan, 1992; see also Morewedge et al., 2009)
Affective-laden goods	(Peters et al., 2003; see also Lerner et al., 2004; Shu & Peck, 2011)
Hedonic goods more than utilitarian goods	(Dhar & Wertenbroch, 2000)
No amygdala lesion	(De Martino et al., 2010)
Higher emotion regulation	(Sokol-Hessner et al., 2012)
Environmental attribute	(Sayman & Öncüler, 2005)
Health-related attribute	(Sayman & Öncüler, 2005)
Durable product categories	(Neumann & Böckenholt, 2014)
Single unit (compared to multiple units)	(Burson, Rottenstreich, & Faro, 2013)
Thinking about losses first	(Johnson et al., 2007)

Drawing attention to alternate uses of money	(Carmon & Ariely, 2000)
No experience with other's perspective (vs. experiencing other's point of view)	(Van Boven et al., 2000)
Making choices for self (rather than others)	(Polman, 2011)
Larger gaps between valuations and reference prices (vs. reduced gaps)	(Weaver & Frederick, 2012)
Longer time to deliberate (vs. shorter time constraint)	(Ashby et al., 2012)
Contrasts from other products which might increase attention to positive aspects (for buyers) or negative aspects (for sellers) which are otherwise unattended	(Nayakankuppam & Mishra, 2005)

Note. Several of the above findings have been demonstrated only in endowment effect paradigms, which is classically explained as loss aversion (Kahneman et al., 1990, 1991) but which according to some accounts does not reflect loss aversion (e.g., Isoni, 2011).

MDA Appendix 1: Key Items and Response Categories (English Translation)

Note. Wealth, income, and age were continuous measures in Study 2, but had ordered categories in Study 1 from which participants selected one category (categories provided below).

Wealth:

- ≤ 9.999 Euro (1)
- 10.000 – 29.999 Euro (2)
- 30.000 – 49.999 Euro (3)
- 50.000 – 99.999 Euro (4)
- 100.000 – 249.999 Euro (5)
- 250.000 – 499.999 (6)
- ≥ 500.000 Euro (7)

Household income

- ≤ 14.999 Euro (1)
- 15.000 – 29.999 Euro (2)
- 30.000 – 49.999 Euro (3)
- 50.000 – 69.999 Euro (4)
- 70.000 – 99.999 Euro (5)
- ≥ 100.000 Euro (6)

Age:

- ≤ 24 (1)
- 25 – 34 (2)
- 35 – 44 (3)
- 45 – 54 (4)
- 55 – 64 (5)
- 65+ (6)

Education (Study 1):

- No degree (1)
- High school degree (2)
- University degree or higher (3)

Education (Study 2):

- 8th grade or less (1)
- Some high school (2)
- High school degree (3)
- Some college or technical school (4)
- Four year college degree (5)
- Some postgraduate work (6)
- Master's degree (7)
- Professional doctorate in education, law, medicine, etc (8)
- PhD (9)

MDA Appendix 2: Attribute Text and Levels Used in Car Attributes λ Task (English translation)

Note. Scenarios for the high and medium levels of all four attributes are provided below. Table M3 provides the features corresponding to “low” levels of each attribute. The other versions and study 1 items are at https://osf.io/qrdf4/?view_only=2c9c7b91b9e04e1da6375f28a4f6966b. The loss aversion coefficient λ was computed as endowment price divided by the no endowment price. Participants received one of three versions of the questionnaire, which determined which of three levels participants received for each attribute. Each group was assigned to one of three levels for each of the four attributes (see Table M3) and completed the procedure in both a “endowment” and “no endowment” condition for each.

Scenario text for comfort attribute, endowment condition

You are interested in a new [name of car, which needs to be concealed] (A) equipped with [name of brand] sports seats (front) with electric seat adjustment, memory function and adjustable thigh support. Another [name of car] (B) is completely identical to your previous favorite (A), but has only standard sports seats with lumbar support and electric 4-way lumbar adjustment. By how many euros would this vehicle (B) have to be cheaper in price, so you prefer it to the other (A)?

Scenario text for fuel consumption attribute, endowment condition

You are about to buy a new [name of car] and have a specific vehicle (A) in mind, which requires an average of 8.1 liters of super unleaded per 100 km. Another [name of car] (B) is completely identical to your previous favorite, but consumes 9.5 liters of super unleaded per 100 km. How many euros would this vehicle (B) have to be cheaper in price, so you prefer it to the other (A)?

Scenario text for safety attribute, endowment condition

You are faced with the decision to buy a new [name of car] and are interested in a specific vehicle (A) with full-size and side airbags for front and front passengers, head airbags for all occupants and a side impact protection integrated into the doors. Another [name of car] (B) is completely identical to your previous favorite, but has only full-size and side airbags for front passengers, as well as side impact protection built into the doors. By how many euros would this vehicle (B) have to be cheaper in price, so that you prefer it to the other (A)?

Scenario text for navigation system attribute, endowment condition

You are about to buy a new [name of car]. You have a specific vehicle (A) in view, in addition to the driver information system, the on-board computer, the check package and the radio clock also has a navigation system with voice and pictogram on the display in the cockpit. Another [name of car] (B) is completely identical to your previous favorite, but has only a driver information system, an on-board computer, a check package and a radio clock. By how many euros would this vehicle (B) have to be cheaper in price, so that you prefer it to the other (A)?

Scenario text for comfort attribute, no endowment condition

You are interested in a new [name of car] (A) equipped with [brand name] sports seats (front) with electric seat adjustment, memory function and adjustable thigh support. You are faced with the decision to either choose this vehicle or another, completely identical (B), the only difference being that it has only standard sports seats (front) with lumbar support and electric 4-way lumbar adjustment. Both vehicles cost the same amount, but the dealer gives a discount on the vehicle with the normal sports seats (B). Please indicate the largest discount for the vehicle with normal sports seats (B) at which you still prefer the vehicle with the [brand name] sports seats (A).

Scenario text for fuel consumption attribute, no endowment condition

You are in the process of buying a new [name of car] and are considering a specific vehicle (A) consuming an average of 8.1 liters of super unleaded fuel per 100 km. You are faced with the decision to either choose this vehicle or another completely identical one (B), which, however, requires 9.5 liters of super unleaded per 100 km. Both vehicles cost the same amount, but the dealer grants a discount on the higher fuel consumption (B). Please indicate the largest discount for the vehicle (B) at which you would still prefer the vehicle with lower fuel consumption (A).

Scenario text for safety attribute, no endowment condition

You are faced with the decision to buy a new [name of car] and are interested in a specific vehicle (A) with full-size and side airbags for front and front passengers, head airbags for all occupants and a side impact protection integrated into the doors. You can choose this vehicle or a completely identical one (B), but with no airbags or side impact protection integrated in the doors. Please indicate the largest discount for Vehicle (B) at which you would still prefer the other (A).

Scenario text for navigation system attribute, no endowment condition

You are about to buy a new [name of car] and think about a particular vehicle (A), which has a navigation system with voice and pictogram on the cockpit display along with the driver information system, the on-board computer, the check package and the radio clock. You are faced with the decision to either choose this vehicle or another, completely identical (B), which has only a driver information system, an on-board computer, a Check package and a radio clock. Both vehicles cost the same amount, but the dealer grants a discount on the less equipped vehicle (B). Please indicate the largest discount for the worse equipped vehicle (B) for which you would still prefer the better equipped vehicle with the driver information system, the onboard computer, the check package, the radio clock and the navigation system with voice and pictogram on the cockpit display (A).

Table M3.

Levels of each attribute for participants receiving each of the three questionnaires.

Levels of comparison	Attribute			
	Fuel	Comfort	Safety	Navigation
Medium - low	Questionnaire 1	Questionnaire 2	Questionnaire 3	Questionnaire 2
High - medium	Questionnaire 2	Questionnaire 1	Questionnaire 2	Questionnaire 3
High - low	Questionnaire 3	Questionnaire 3	Questionnaire 1	Questionnaire 1
Low level features for each attribute	10.9 Liters per 100 km	Regular seats	No airbags nor built-in side impact protection	No information or telematics system

MDA Appendix 3: Financial Experience and Knowledge Measures Used in Studies 1-2

Note. Study 2 is a commercial, syndicated survey, but we received permission to post the pages of the questionnaire that contained measures we used in this paper to OSF; these pages are available at https://osf.io/fmk35/?view_only=2c9c7b91b9e04e1da6375f28a4f6966b.

General car knowledge: I know a great deal about automobiles (1 = *disagree without reservation*, 7 = *agree without reservation*)

Attribute-specific car knowledge (Study 1; self-reported; English translation; same scale as above)

- *Safety attribute:* I know a great deal about the safety and security features of automobiles.
- *Comfort attribute:* I know a great deal about the comfort features of automobiles.
- *Fuel efficiency attribute:* I know a great deal about the fuel consumption of automobiles.
- *Navigation system attribute:* I know a great deal about the information and navigation system features of automobiles.

Household financial experience (Study 2; similar to Ward & Lynch, 2018):

Overall, who handles most of the major financial affairs in your household?

- Adult 1
- Adult 2
- Both Adults
- Other

Note. We used this item, together with an item asking whether Adult 1 or Adult 2 completed the survey, coding responses so that 1 = adult completing the survey handles most of major financial affairs, 0 = other adult handles most of major financial affairs, and 0.5 = both adults or other.

Self-reported investment sophistication (Study 2; Sikarwar et al., 2016):

I consider myself a sophisticated investor” (1 = *mostly agree*, 4 = *mostly disagree*, which we reverse-coded so that higher numbers reflect more agreement)

Less relevant financial transaction experience (Study 2):

Approximately how many times in a typical month do you or anyone in your household do any of the following to make a financial transaction?

1. Talk with a representative (other than a teller) inside a financial institution (face-to-face)
2. Talk with a teller inside a financial institution for a routine transaction (face-to-face)
3. Use a drive-thru facility at a financial institution (such as for an ATM or teller)
4. Use a walk-up window (outside a financial institution)
5. Make a phone call to a financial institution and use voice recognition or a touch-tone menu
6. Make a phone call to a financial institution and speak with a representative
7. Use an ATM belonging to your financial institution
8. Use an ATM belonging to another financial institution
9. Use the Internet to connect to a financial institution
10. Use some other way to interact with your financial institution

MDA Appendix 4: Results of Models Estimating λ in Studies 1–2**Table M4–1**

Effects of age, attribute-specific car knowledge, general car knowledge, driving experience, education, same (whether the attribute-specific car knowledge was about the same attribute), and the key Attribute-Specific Car Knowledge \times Same Attribute interaction in Study 1.

	Specific Car Attributes λ
Intercept	0.000 (0.028)
Age	0.137*** (0.022)
Attribute-Specific Car Knowledge	–0.155*** (0.015)
Same Attribute (contrast-coded, $\frac{1}{2}$ = same, $-\frac{1}{2}$ = different)	0.000 (0.027)
Attribute-Specific Car Knowledge \times Same Attribute	–0.528*** (0.027)
General Car Knowledge	–0.091*** (0.025)
Driving Experience	–0.124*** (0.026)
Education	0.006 (0.020)
Log Likelihood	–7636.205
Akaike Inf. Crit.	15,292.410
Bayesian Inf. Crit.	15,359.000

Note. Standard errors are in parentheses. All variables were standardized unless noted otherwise.
*** $p < .01$.

Table M4–2*Effects of age, car knowledge, driving experience, and education on λ in Study 1.*

	Dependent Variable	
	Risky Choice Loss Aversion	Incentivized Model Car
	(1)	(2)
Intercept	–0.020*** (0.045)	0.470*** (0.142)
Age	0.115** (0.051)	0.179*** (0.053)
Attribute-Specific Car Knowledge	–0.283*** (0.064)	–0.225*** (0.065)
General Car Knowledge	–0.182*** (0.062)	–0.121* (0.065)
Driving Experience	–0.169*** (0.058)	–0.075** (0.061)
Education	–0.088* (0.046)	–0.266*** (0.076)
Observations	326	347
R ²	0.357	0.255
Adjusted R ²	0.347	0.244
Residual Std. Error	0.808 (df = 320)	0.869 (df = 341)
F Statistic	35.56*** (df = 5; 320)	23.378*** (df = 5; 341)

Note. Coefficients are standardized (Cohen's d). Standard errors are in parentheses. * $p < .10$ ** $p < .05$; *** $p < .01$.

Table M4–3*Effects of the four key moderators on risky investment choice λ in Study 2.*

	Risky Investment Choice Loss Aversion
Intercept	0.094*** (0.017)
Age	0.157*** (0.007)
Self-Reported Investment Sophistication	-0.035*** (0.009)
Household Financial Experience	-0.033*** (0.009)
Education	-0.169*** (0.009)
Study 2A	-0.120*** (0.024)
Study 2B	-0.011 (0.023)
Study 2C	-0.070*** (0.023)
Observations	15,348
R ²	0.057
Adjusted R ²	0.057
Residual Std. Error	5.515 (df = 15340)
F Statistic	133.045*** (df = 7; 15340)

Note. Standard errors are in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 1 Robustness Tests: Using Alternative (Midpoint) λ Coefficients

Table M4–4

Effects of age, car knowledge, experience, and education on risky choice λ in Study 1, using midpoint λ coefficients (as described in the MDA text).

	Risky Choice Loss Aversion
Intercept	0.243* (0.131)
Age	0.096** (0.049)
Attribute-Specific Car Knowledge	-0.274*** (0.060)
General Car Knowledge	-0.163*** (0.060)
Driving Experience	-0.183*** (0.057)
Education	-0.138** (0.070)
Observations	326
R ²	0.351
Adjusted R ²	0.341
Residual Std. Error	0.812 (df = 320)
F Statistic	34.599*** (df = 5; 320)

Note. Standard errors are in parentheses. All variables were standardized. ** $p < .05$; *** $p < .01$.

Table M4–5

Effects of the four key moderators on risky investment choice λ in Study 2, using the alternative midpoint λ coefficients (as described in MDA text).

	Risky Investment Choice Loss Aversion
Intercept	0.223*** (0.017)
Age	0.154*** (0.007)
Self-Reported Investment Sophistication	-0.031*** (0.008)
Household Financial Experience	-0.028*** (0.009)
Education	-0.174*** (0.009)
Study 2A	-0.622*** (0.024)
Study 2B	-0.013 (0.023)
Study 2C	-0.077*** (0.023)
Observations	15,348
R ²	0.109
Adjusted R ²	0.109
Residual Std. Error	5.457 (df = 15340)
F Statistic	269.119*** (df = 7; 15340)

Note. Standard errors are in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. *** $p < .01$.

Section 2 Robustness Tests: Removing SBI Survey Weights

Table M4–6

Effects of four moderators in Study 2, with survey weights removed.

	Risky Investment Choice Loss Aversion
Intercept	0.021 (0.016)
Age	0.171*** (0.008)
Self-Reported Investment Sophistication	–0.081*** (0.008)
Household Financial Experience	–0.035*** (0.008)
Education	–0.135*** (0.008)
Study 2A	–0.059*** (0.022)
Study 2B	0.007 (0.022)
Study 2C	–0.087*** (0.022)
Observations	15,348
R ²	0.058
Adjusted R ²	0.057
Residual Std. Error	0.956 (df = 15340)
F Statistic	133.866*** (df = 7; 15340)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 3 Robustness Tests: Adjusting for Income, Wealth, and Gender

Table M4–7

Effects of age, car knowledge, driving experience, and education on risky choice and model car λ measures in Study 1, when attempting to control for income, wealth, and gender (covariates).

	Risky Choice Loss Aversion	Incentivized Model Car
	(1)	(2)
Intercept	–0.019 (0.044)	0.000 (0.047)
Age	0.027 (0.054)	0.134*** (0.057)
Attribute-Specific Car Knowledge	–0.219*** (0.064)	–0.192*** (0.067)
General Car Knowledge	–0.105 (0.062)	–0.086 (0.067)
Driving Experience	–0.144*** (0.057)	–0.066 (0.061)
Education	–0.142*** (0.047)	–0.196*** (0.049)
Income	0.225*** (0.066)	0.129* (0.070)
Wealth	0.102** (0.051)	0.039 (0.055)
Gender	0.004 (0.044)	–0.012 (0.047)
Observations	326	347
R ²	0.398	0.266
Adjusted R ²	0.382	0.249
Residual Std. Error	0.786 (df = 317)	0.867 (df = 338)
F Statistic	26.14*** (df = 8; 317)	15.345*** (df = 8; 338)

Note. All estimates are standardized. Std errors are in parentheses. * $p < .10$ ** $p < .05$ *** $p < .01$.

Table M4–8

Effects on attribute-specific λ in Study 1, when adjusting for income, wealth, and gender (covariates).

	Specific Car Attributes λ
Intercept	0.000 (0.020)
Attribute-Specific Car Knowledge	-0.152*** (0.015)
Same Attribute (contrast-coded, $\frac{1}{2}$ = same, $-\frac{1}{2}$ = low)	0.000 (0.027)
Age	0.096*** (0.024)
Car Knowledge	-0.074*** (0.025)
Driving Experience	-0.085*** (0.026)
Education	-0.018 (0.020)
Income	0.087*** (0.029)
Wealth	0.057** (0.022)
Gender	0.003 (0.020)
Attribute-Specific Car Knowledge \times Same Attribute	-0.528*** (0.027)
Log Likelihood	-7633.673
Akaike Inf. Crit.	15,293.350
Bayesian Inf. Crit	15,379.910

Note. All variables were standardized unless otherwise noted. Std errors are in parentheses. ** $p < .05$ *** $p < .01$.

Table M4–9

Effects of the four key moderators on risky investment choice λ in Study 2, when adjusting for income, wealth, and gender (covariates).

	Risky Investment Choice Loss Aversion
Intercept	0.101*** (0.017)
Age	0.183*** (0.008)
Self-Reported Investment Sophistication	–0.013 (0.009)
Household Financial Experience	–0.070*** (0.009)
Education	–0.076*** (0.010)
Income	–0.176*** (0.010)
Wealth	–0.047*** (0.009)
Gender	0.011 (0.008)
Study 2A	–0.168*** (0.024)
Study 2B	–0.040* (0.023)
Study 2C	–0.086*** (0.023)
Observations	15,348
R ²	0.089
Adjusted R ²	0.088
Residual Std. Error	5.423 (df = 15337)
F Statistic	149.024*** (df = 10; 15337)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. Other variables were standardized. * $p < .10$ *** $p < .01$.

Table M4–10

Effects of the four key moderators on risky investment choice λ in Study 2, when attempting to control for numerous covariates.

	Risky Investment Choice Loss Aversion
Intercept	–0.024 (0.048)
Age	0.178*** (0.012)
Self-reported Investment Sophistication	–0.022** (0.009)
Household Financial Experience	–0.056*** (0.010)
Education	–0.016 (0.011)
Retired	0.017 (0.012)
Income	–0.053*** (0.012)
Wealth	0.008 (0.010)
Gender	0.015* (0.009)
Amount of Money in Checking Accounts	–0.065*** (0.009)
Amount of Money in Savings Accounts	–0.056*** (0.010)
Amount of Money in CDs	0.005 (0.010)
Amount of Money in Money Market Accounts	–0.006 (0.010)
Amount of Money in Mutual Funds	–0.083*** (0.011)
Amount of Money in Retirement Accounts	–0.080*** (0.011)
Value of Primary Home	0.012

	(0.011)
Value of Other Real Estate	-0.023*
	(0.012)
Value of Owned Vehicles	-0.058***
	(0.010)
Cash Value of Life Insurance	0.002
	(0.009)
Value of First Mortgage Loan on Primary Home	-0.017
	(0.012)
Value of Junior Mortgage Loans on Primary Home	-0.028***
	(0.010)
Value of Mortgages on Other Real Estate	0.011
	(0.012)
Value of Vehicle Loans	-0.012
	(0.010)
Total Balance on Credit Cards	-0.050***
	(0.009)
Hispanic (Ethnicity)	0.017*
	(0.010)
Asian (Race)	0.001
	(0.008)
Black (Race)	0.011
	(0.007)
Other (Race)	0.015**
	(0.007)
Hours Worked Per Week	0.058***
	(0.017)
Number of Children	-0.019**
	(0.008)
Divorced (Marital Status)	0.011
	(0.031)
Separated (Marital Status)	0.209***
	(0.053)
Widowed (Marital Status)	0.079*
	(0.041)

Married (Marital Status)	0.096*** (0.028)
Living Together, Not Married (Marital Status)	0.032 (0.039)
Other (Marital Status)	-0.012 (0.055)
Familial Relationship (Marital Status)	0.077 (0.106)
AARP Member	-0.019* (0.011)
Christian (Religion)	0.047*** (0.009)
Other (Religion)	0.020** (0.009)
None (Religion)	0.054*** (0.011)
Lutheran (Religion)	0.020** (0.010)
Methodist (Religion)	0.035*** (0.010)
Baptist (Religion)	0.008 (0.009)
Catholic (Religion)	-0.020** (0.010)
Manager or Administrator (Occupation)	0.024 (0.032)
Sales Worker (Occupation)	-0.114** (0.046)
Clerical Worker, e.g., secretary, teacher's aide (Occupation)	0.124*** (0.040)
Craftsworker, e.g., electrician, baker (Occupation)	0.097** (0.039)
Machine Operator or Laborer (Occupation)	0.116*** (0.038)

Farmer, Farm Manager, or Farm Laborer (Occupation)	0.474*** (0.100)
Service Worker, e.g., waiter, janitor (Occupation)	-0.001 (0.040)
Military, Active Duty (Occupation)	-0.013 (0.092)
Homemaker (Occupation)	0.317*** (0.070)
Student (Occupation)	0.108 (0.084)
Other (Occupation)	0.093*** (0.034)
Retired (Occupation)	0.168*** (0.043)
Unable to Work (Occupation)	0.335*** (0.049)
Middle Atlantic (Census Region)	-0.064 (0.042)
East North Central (Census Region)	-0.059 (0.042)
West North Central (Census Region)	-0.117** (0.048)
South Atlantic (Census Region)	-0.042 (0.041)
East South Central (Census Region)	0.061 (0.049)
West South Central (Census Region)	-0.054 (0.044)
Mountain (Census Region)	-0.050 (0.047)
Pacific (Census Region)	0.004 (0.042)
Study 2A	-0.124*** (0.025)
Study 2B	-0.059**

	(0.024)
Study 2C	-0.107***
	(0.027)
<hr/>	
Observations	14,860
R ²	0.135
Adjusted R ²	0.131
Residual Std. Error	5.255 (df = 14791)
F Statistic	33.887*** (df = 68; 14791)

Note. Standard errors are provided in parentheses. Reference groups are 2016 Survey, New England (Census Region), Professional or Technical (Occupation), and White (Race and Ethnicity). All continuous variables are standardized. * $p < .10$ ** $p < .05$ *** $p < .01$.

Table M4–11

Among respondents with 1 million or more in net worth (total assets minus total liabilities), effects of the four key moderators on risky investment choice λ in Study 2.

	Risky Investment Choice Loss Aversion
Intercept	–0.137*** (0.029)
Age	0.197*** (0.017)
Self-Reported Investment Sophistication	–0.072*** (0.016)
Household Financial Experience	–0.059*** (0.016)
Education	–0.088*** (0.015)
Study 2A	–0.063 (0.042)
Study 2B	0.113*** (0.042)
Study 2C	–0.020 (0.039)
Observations	3,638
R ²	0.060
Adjusted R ²	0.058
Residual Std. Error	3.137 (df = 3630)
F Statistic	32.958*** (df = 7; 3630)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 4 Robustness Tests: Log-transformed λ

Table M4–12

Effects of age, driving experience, education, general car knowledge, and attribute-specific car knowledge about same and other attributes on \log_{10} -transformations of attribute-specific λ measures in Study 1.

	Specific Car Attributes λ
Intercept	0.000 (0.019)
Age	0.147*** (0.020)
Attribute-Specific Car Knowledge	-0.185*** (0.015)
Same Attribute (contrast-coded, $-\frac{1}{2}$ = different, $\frac{1}{2}$ = same)	0.000 (0.026)
Attribute-Specific Car Knowledge \times Same Attribute	-0.611*** (0.026)
General Car Knowledge	-0.112*** (0.022)
Driving Experience	-0.138*** (0.023)
Education	0.004 (0.018)
Log Likelihood	-7537.885
Akaike Inf. Crit.	15,095.770
Bayesian Inf. Crit	15,162.360

Note. All variables were standardized unless otherwise noted. Outcome variable was \log_{10} -transformed prior to being standardized. Std errors are in parentheses. ** $p < .05$ *** $p < .01$.

Table M4–13

Effects of age, car knowledge, driving experience, and education on log₁₀-transformations of incentivized model car and risky choice λ measures in Study 1.

	Dependent Variable	
	Risky Choice Loss Aversion	Incentivized Model Car
	(1)	(2)
Intercept	–0.020 (0.042)	0.001 (0.043)
Age	0.120** (0.051)	0.179*** (0.049)
Attribute-Specific Car Knowledge	–0.275*** (0.063)	–0.345*** (0.060)
General Car Knowledge	–0.198*** (0.062)	–0.121* (0.059)
Driving Experience	–0.156*** (0.058)	–0.076 (0.056)
Education	–0.080* (0.046)	–0.156*** (0.043)
Observations	326	347
R ²	0.362	0.373
Adjusted R ²	0.352	0.363
Residual Std. Error	0.805 (df = 320)	0.798 (df = 341)
F Statistic	36.38*** (df = 5; 320)	40.515*** (df = 5; 341)

Note. All variables were standardized. Std errors are in parentheses. ** $p < .05$ *** $p < .01$.

Table M4–14

Effects of the four key moderators on log₁₀-transformed risky investment choice loss aversion in Study 2.

	Risky Investment Choice Loss Aversion (Log-transformed)
Intercept	0.088*** (0.017)
Age	0.159*** (0.007)
Self-Reported Investment Sophistication	−0.057*** (0.008)
Household Financial Experience	−0.045*** (0.008)
Education	−0.159*** (0.009)
Study 2A	−0.100*** (0.024)
Study 2B	−0.010 (0.023)
Study 2C	−0.060*** (0.023)
Observations	15,348
R ²	0.059
Adjusted R ²	0.059
Residual Std. Error	5.417 (df = 15340)
F Statistic	138.300*** (df = 7; 15340)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 5 Robustness Tests: Different Assumptions About Probability Weighting and Diminishing Sensitivity

Table M4–15

Effects of age, car knowledge, driving experience, and education on risky choice loss aversion in Study 1, with value function parameters of $\alpha = 0.95$ and $\beta = 0.92$ (Booij & van de Kuilen, 2009).

	Risky Choice Loss Aversion
Intercept	-0.020 (0.045)
Age	0.116** (0.051)
Attribute-Specific Car Knowledge	-0.283*** (0.064)
General Car Knowledge	-0.184*** (0.062)
Driving Experience	-0.161*** (0.058)
Education	-0.088* (0.046)
Observations	326
R ²	0.359
Adjusted R ²	0.349
Residual Std. Error	0.807 (df = 320)
F Statistic	35.877*** (df = 5; 320)

Note. Standard errors are provided in parentheses. All variables were standardized. *** $p < .01$, ** $p < .05$, * $p < .10$.

Table M4–16

Effects of the four key moderators on risky investment choice loss aversion in Study 2, with value function parameters of $\alpha = 0.95$ and $\beta = 0.92$ (Booij & van de Kuilen, 2009).

	Risky Investment Choice Loss Aversion
Intercept	0.113*** (0.017)
Age	0.158*** (0.007)
Self-Reported Investment Sophistication	-0.037*** (0.009)
Household Financial Experience	-0.034*** (0.009)
Education	-0.169*** (0.009)
Study 2A	-0.191*** (0.024)
Study 2B	-0.011 (0.023)
Study 2C	-0.070*** (0.023)
Observations	15,348
R ²	0.061
Adjusted R ²	0.060
Residual Std. Error	5.506 (df = 15340)
F Statistic	141.514*** (df = 7; 15340)

Table M4–17

Effects of age, car knowledge, driving experience, and education on risky choice loss aversion in Study 1, with probability weighting parameters of $\omega = 0.86$ (Abdellaoui, 2000).

	Risky Choice Loss Aversion
Intercept	–0.020 (0.045)
Age	0.115** (0.051)
Attribute-Specific Car Knowledge	–0.282*** (0.064)
Car Knowledge	–0.184*** (0.062)
Driving Experience	–0.160*** (0.058)
Education	–0.088* (0.046)
Observations	
	326
R ²	
	0.358
Adjusted R ²	
	0.348
Residual Std. Error	
	0.808 (df = 320)
F Statistic	
	35.623*** (df = 5; 320)

Note. Standard errors are provided in parentheses. All variables were standardized. *** $p < .01$, ** $p < .05$, * $p < .10$.

Table M4–18

Effects of the four key moderators on risky investment choice loss aversion in Study 2, with probability weighting parameters of $\omega = 0.86$ (Abdellaoui, 2000).

	Risky Investment Choice Loss Aversion
Intercept	0.097*** (0.017)
Age	0.157*** (0.007)
Self-Reported Investment Sophistication	-0.035*** (0.009)
Household Financial Experience	-0.033*** (0.009)
Education	-0.168*** (0.009)
Study 2A	-0.129*** (0.024)
Study 2B	-0.011 (0.023)
Study 2C	-0.070*** (0.023)
Observations	15,348
R ²	0.057
Adjusted R ²	0.057
Residual Std. Error	5.515 (df = 15340)
F Statistic	133.200*** (df = 7; 15340)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Table M4–19

Effects of age, car knowledge, driving experience, and education on risky choice loss aversion in Study 1, with value function parameters of $\alpha = 0.95$ and $\beta = 0.92$ (Booij & van de Kuilen, 2009) and probability weighting parameters of $\omega = 0.86$ (Abdellaoui, 2000).

	Risky Choice Loss Aversion
Intercept	–0.020 (0.045)
Age	0.116** (0.051)
Attribute-Specific Car Knowledge	–0.283*** (0.064)
General Car Knowledge	–0.184*** (0.062)
Driving Experience	–0.161*** (0.058)
Education	–0.088* (0.046)
Observations	
	326
R ²	
	0.359
Adjusted R ²	
	0.349
Residual Std. Error	
	0.807 (df = 320)
F Statistic	
	35.877*** (df = 5; 320)

Note. Standard errors are provided in parentheses. All variables were standardized. *** $p < .01$, ** $p < .05$, * $p < .10$.

Table M4–20

Effects of four key moderators on risky investment choice loss aversion in Study 2, with value function parameters of $\alpha = 0.95$ and $\beta = 0.92$ (Booij & van de Kuilen, 2009) and probability weighting parameters of $\omega = 0.86$ (Abdellaoui, 2000).

	Risky Investment Choice Loss Aversion
Intercept	0.113*** (0.017)
Age	0.158*** (0.007)
Self-Reported Investment Sophistication	-0.037*** (0.009)
Household Financial Experience	-0.034*** (0.009)
Education	-0.169*** (0.009)
Study 2A	-0.191*** (0.024)
Study 2B	-0.011 (0.023)
Study 2C	-0.070*** (0.023)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Table M4–21

Effects of age, car knowledge, driving experience, and education on risky choice loss aversion in Study 1, with value function parameters of $\alpha = 0.88$ and $\beta = 0.88$ and probability weighting parameters of $\omega = 0.88$ (Kahneman & Tversky, 1992).

	Risky Choice Loss Aversion
Intercept	–0.020 (0.045)
Age	0.116** (0.051)
Attribute-Specific Car Knowledge	–0.283*** (0.064)
General Car Knowledge	–0.184*** (0.062)
Driving Experience	–0.161*** (0.058)
Education	–0.087* (0.046)
Observations	
	326
R ²	0.360
Adjusted R ²	0.350
Residual Std. Error	0.806 (df = 320)
F Statistic	36.020*** (df = 5; 320)

Note. Standard errors are provided in parentheses. All variables were standardized. *** $p < .01$, * $p < .10$.

Table M4–22

Effects of four key moderators on risky investment choice loss aversion in Study 2, with value function parameters of $\alpha = 0.88$ and $\beta = 0.88$ and probability weighting parameters of $\omega = 0.88$ (Kahneman & Tversky, 1992).

	Risky Investment Choice Loss Aversion
Intercept	0.097*** (0.017)
Age	0.158*** (0.007)
Self-Reported Investment Sophistication	-0.039*** (0.009)
Household Financial Experience	-0.035*** (0.009)
Education	-0.168*** (0.009)
Study 2A	-0.129*** (0.024)
Study 2B	-0.011 (0.023)
Study 2C	-0.069*** (0.023)
Observations	15,348
R ²	0.058
Adjusted R ²	0.058
Residual Std. Error	5.501 (df = 15340)
F Statistic	135.356*** (df = 7; 15340)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 6 Robustness Tests: Imputing Missing Values

Table M4–23

Effects of four key moderators on risky investment choice loss aversion in Study 2, including λ imputations for those with missing values.

	Risky Investment Choice Loss Aversion
Intercept	0.092*** (0.017)
Age	0.154*** (0.007)
Self-Reported Investment Sophistication	-0.032*** (0.009)
Household Financial Experience	-0.027*** (0.009)
Education	-0.171*** (0.009)
Study 2A	-0.111*** (0.024)
Study 2B	-0.008 (0.023)
Study 2C	-0.073*** (0.023)
Observations	15,601
R ²	0.056
Adjusted R ²	0.055
Residual Std. Error	5.540 (df = 15593)
F Statistic	131.522*** (df = 7; 15593)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 7 Robustness Tests: Including Inconsistent Responses

Table M4–24

Effects of age, car knowledge, driving experience, and education on risky choice loss aversion in Study 1, including participants with inconsistent responses.

	Risky Choice Loss Aversion
Intercept	0.236*** (0.131)
Age	0.097** (0.049)
Attribute-Specific Car Knowledge	-0.279*** (0.059)
General Car Knowledge	-0.165*** (0.059)
Driving Experience	-0.184*** (0.056)
Education	-0.134* (0.070)
Observations	360
R ²	0.356
Adjusted R ²	0.346
Residual Std. Error	0.808 (df = 354)
F Statistic	39.059*** (df = 5; 354)

Table M4–25

Effects of four key moderators on risky investment choice loss aversion in Study 2, including participants with inconsistent responses.

	Risky Investment Choice Loss Aversion
Intercept	0.096*** (0.017)
Age	0.155*** (0.007)
Self-Reported Investment Sophistication	–0.033*** (0.008)
Household Financial Experience	–0.033*** (0.008)
Education	–0.164*** (0.009)
Study 2A	–0.137*** (0.024)
Study 2B	–0.011 (0.023)
Study 2C	–0.073*** (0.023)
Observations	15,896
R ²	0.056
Adjusted R ²	0.056
Residual Std. Error	5.510 (df = 15888)
F Statistic	134.606*** (df = 7; 15888)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$.

Section 8 Robustness Tests: Adjusting for Differential Straight-Lining and Noise

Table M4–26

Effects of four key moderators on risky investment choice loss aversion in Study 2, after excluding straight-lining participants who answered “reject” or “accept” for all gambles.

	Risky Investment Choice Loss Aversion
Intercept	0.085*** (0.018)
Age	0.097*** (0.008)
Self-Reported Investment Sophistication	–0.056*** (0.009)
Household Financial Experience	–0.046*** (0.009)
Education	–0.107*** (0.010)
Study 2A	–0.151*** (0.026)
Study 2B	0.038 (0.025)
Study 2C	0.008 (0.025)
Observations	12,556
R ²	0.031
Adjusted R ²	0.030
Residual Std. Error	5.257 (df = 12548)
F Statistic	57.247*** (df = 7; 12548)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. *** $p < .01$.

Table M4–27

Effects of four key moderators on risky investment choice loss aversion in Study 2, after adjusting for differential noise as a function of age, investment sophistication, household financial experience, and education (by adding as a covariate whether or not the participant had any inconsistent responses).

	Risky Investment Choice Loss Aversion
Intercept	0.090*** (0.017)
Inconsistent	0.045*** (0.008)
Age	0.151*** (0.007)
Self-Reported Investment Sophistication	–0.032*** (0.008)
Household Financial Experience	–0.027*** (0.008)
Education	–0.164*** (0.009)
Study 2A	–0.119*** (0.023)
Study 2B	–0.007 (0.023)
Study 2C	–0.073*** (0.023)
Observations	16,149
R ²	0.057
Adjusted R ²	0.056
Residual Std. Error	5.530 (df = 16140)
F Statistic	120.837*** (df = 8; 16140)

Note. Standard errors are provided in parentheses. Study 2A, 2B, and 2C were dummy-coded, so that Study 2D is the reference group. All other variables were standardized. *** $p < .01$, ** $p < .05$.