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

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Loss aversion, the principle that losses impact decision making 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_{total} = 17,720), we tested several moderators of loss aversion, which supported a preference construction account. Across studies, more domain knowledge and experience were associated with lower loss aversion, though people of all knowledge and experience levels were loss averse. 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. Additionally, older consumers were more loss averse across different loss aversion measures and studies. We discuss implications for several accounts of loss aversion, including accounts rooted in status quo bias, emotion, or ownership. In addition to discovering 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.

Keywords Judgment; Decision making and behavioral decision theory; Aging consumers; Learning; Knowledge and expertise; Economic psychology

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 (Van Boven, Dunning, & Loewenstein, 2000; Carmon & Ariely, 2000; Johnson, Häubl, & Keinan, 2007; Nayakankuppam & Mishra, 2005; Pachur &

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Scheibehenne, 2012) 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 might generate the opposite prediction. Because ownership experience and some other types of experience (e.g., driving experience) lead to stronger feelings of ownership and a more firmly rooted status quo, these theories would predict that these types of experience would increase rather than decrease loss aversion (Ariely, Huber, & Wertenbroch, 2005; Eidelman & Crandall, 2012; Strahilevitz & 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 examine what moderates loss aversion, discuss implications for different theories of loss aversion, 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 value, 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 when the stakes are small (Ert & Erev, 2013; Harinck, van Dijk, van Beest, & Mersmann, 2007; Kühberger, Schulte-Mecklenbeck, & Perner, 1999; 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 & Giblin, 2015; 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 & 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 has 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 has 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 Appendix S1). 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. 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, people with less domain knowledge, experience, and education would likely be more loss averse.

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 are 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 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; 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 yielded mixed results (Mikels & Reed, 2009; Pachur, Mata, & Hertwig, 2017; Seaman, Green, Shu, & Samanez-Larkin, 2018; Weller, Levin, & Denburg, 2011). 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 other alternative explanations.

Data Overview

We examined moderators of loss aversion using unique data from large, diverse samples. 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 nonstudent participants provides substantial variance on many of the variables of interest, such as age and experience.

Studies 2A–2D were four separate large field surveys of U.S. households conducted by Strategic Business Insights, Inc (SBI). These four surveys 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 (e.g., Bibby & Ferguson, 2011), 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 et al., 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 nonmonotonic 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 nonmonotonic responses or when using an alternative mapping of choices to λ (see Appendix S1). 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 et al., 1964). For each participant, a price and condition (WTA or WTP) were 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 et al., 1990, Kahneman et al., 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, Shu, Gilbert, & Wilson, 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 attribute endowment

We also assessed λ across four car attributes. We elicited WTA and WTP prices for each of four attributes using a 4 (attribute: safety, comfort, fuel economy, and navigation systems) × 2 (frame: selling and 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 S1 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 Methodological Details Appendix (Appendix S1).

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 overemphasizing 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 × 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 attribute (safety, comfort, and navigation system), there should be an Attribute Knowledge × 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 attribute 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 = 0.55, $p < .001$) and car attributes measures (r = 0.48, $p < .001$). 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

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	0.55	--					
3. Car Attribute Endowment	0.48	0.41	--				
4. Driving Experience	–0.48	–0.35	–0.46	--			
5. General Car Knowledge	–0.48	–0.38	–0.51	0.58	--		
6. Education	–0.07	–0.14	0.06	0.03	–0.05	--	
7. Age	0.34	0.34	0.48	–0.37	–0.43	0.13	--

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.

between the car attributes and model car measures was moderate in size (r = 0.41, 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).

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

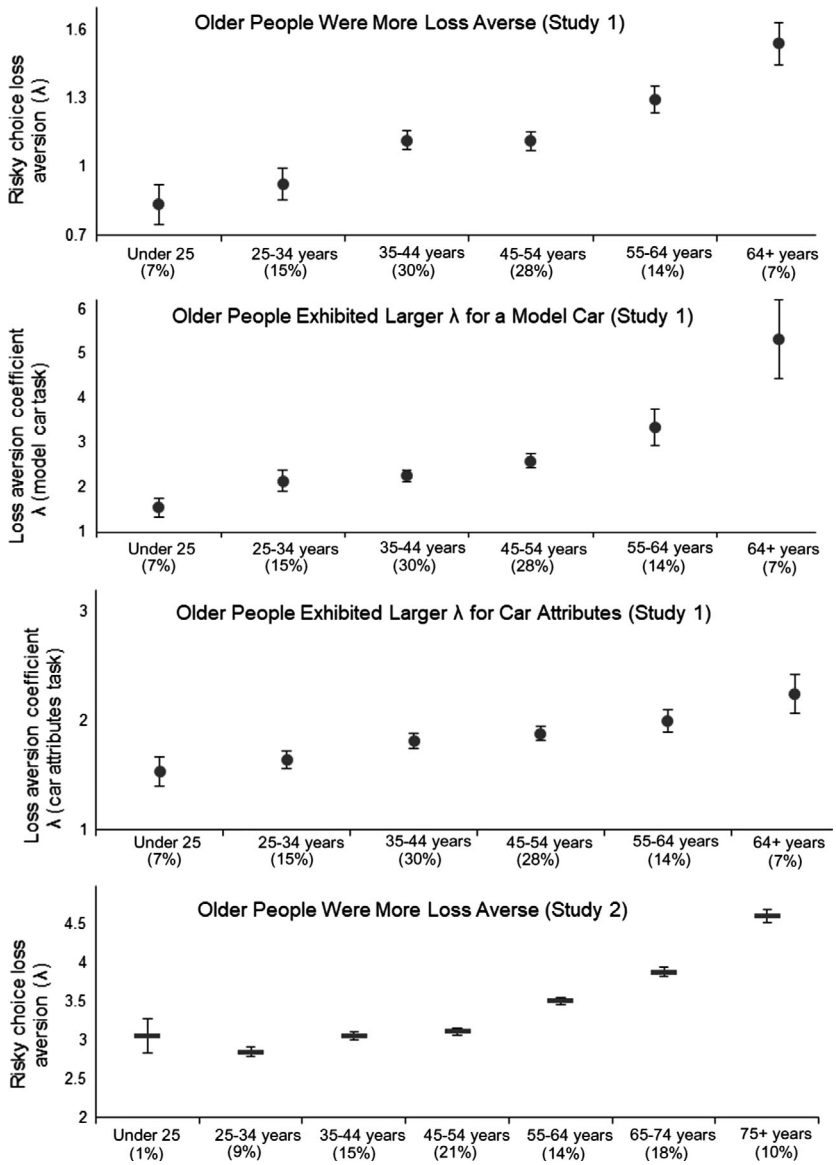

Figure 1. Older people were more loss averse in the context of risky investment choices (top and bottom panels). Older people also displayed larger (incentivized) λ for model cars (second panel) and λ for car attributes (third panel). Error bars depict +/− 1 standard error.

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[a] (0.022)
Attribute-Specific Car Knowledge	–0.155[a] (0.015)
Same Attribute (contrast-coded, ½ = same, –½ = different)	0.000 (0.027)
Attribute-Specific Car Knowledge × Same Attribute	–0.528[a] (0.027)
General Car Knowledge	–0.091[a] (0.025)
Driving Experience	–0.124[a] (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.
[a]$p < .01$. All predictors were standardized unless noted otherwise.

effect size estimates across the three measures were similar (Table 2).

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, ½ = same attribute, –½ = different attribute), and the Attribute Knowledge × 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 × 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].

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 large when the knowledge measure was about the specific car attribute for which λ was assessed, as evidenced by the Attribute Knowledge × 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

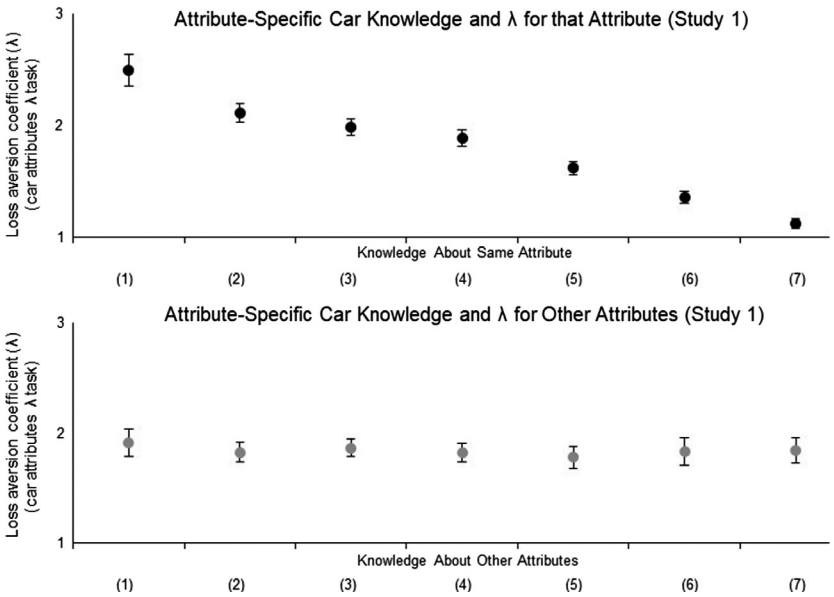

Figure 2. People with more knowledge about a specific car attribute were less loss averse for that attribute (top panel) but not any less loss averse for other car attributes (bottom panel). Though loss aversion for car attributes was lower among those with more knowledge about those attributes, λ was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

among experienced drivers than experienced drivers, though consistent with a preference construction account, seems less consistent with accounts rooted in status quo bias, because drivers with more ownership experience and driving experience should have a more firmly rooted status quo.

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. These 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 Studies 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 and 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; 0.5 = 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, namely "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 et al., 2016). Two other items from the survey were similar to items on a standard financial literacy scale (Fernandes, Lynch, & Netemeyer, 2014); on page 2 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 Appendix S1). 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.

Age

As in Study 1, older respondents were more loss averse (Figure 1). 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 (Studies 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).

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).

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.

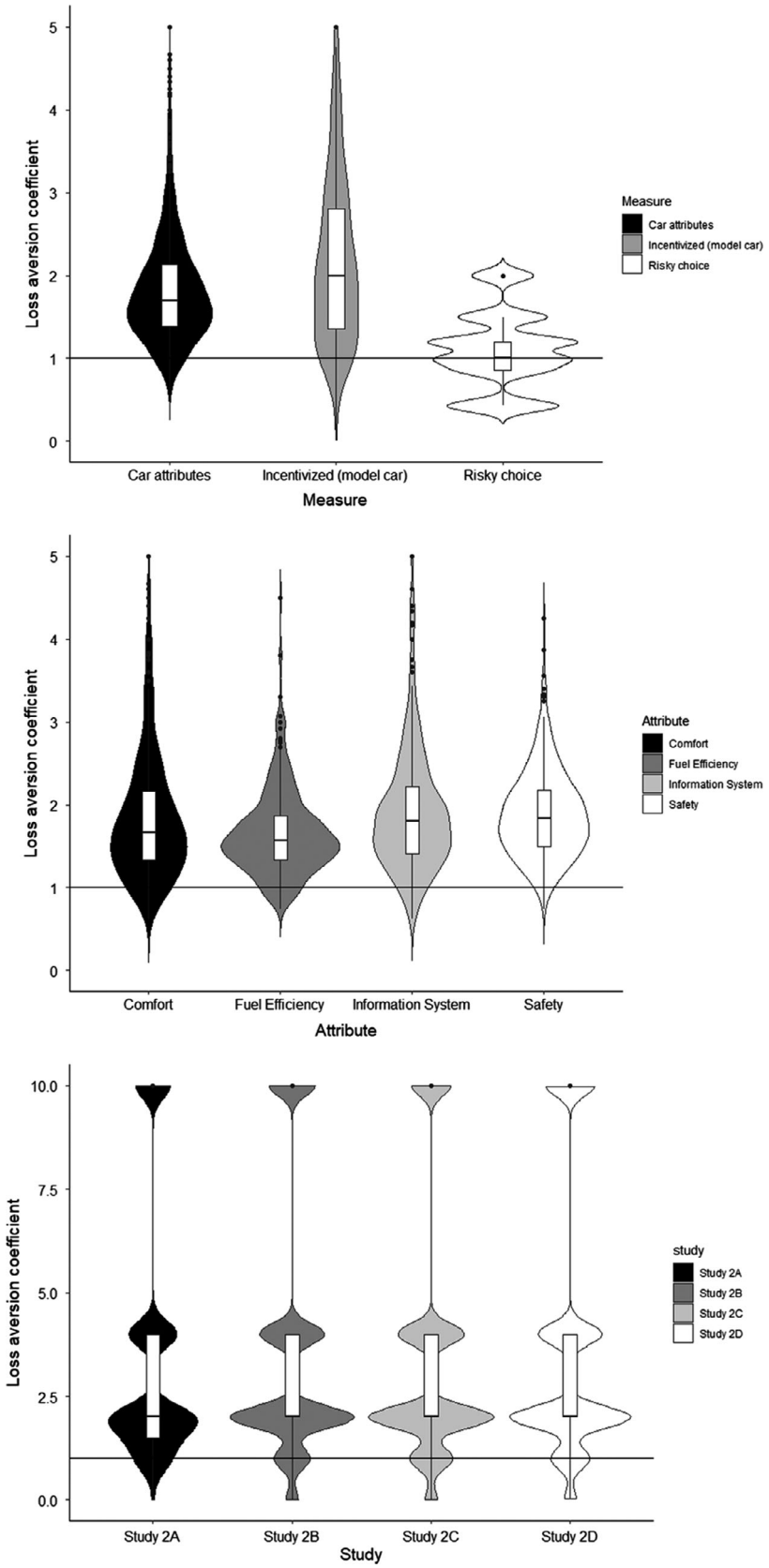
Loss aversion coefficient
0
1
2
3
4
5
Car attributes
Incentivized (model car)
Risky choice
Measure
Measure
Car attributes
Incentivized (model car)
Risky choice
Loss aversion coefficient
0
1
2
3
4
5
Comfort
Fuel Efficiency
Information System
Safety
Attribute
Attribute
Comfort
Fuel Efficiency
Information System
Safety
Loss aversion coefficient
0.0
2.5
5.0
7.5
10.0
Study 2A
Study 2B
Study 2C
Study 2D
Study
study
Study 2A
Study 2B
Study 2C
Study 2D

Figure 3. Violin plots displaying the distribution of λ across the three λ measures in Study 1 (top panel), the four car attribute 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 λ > 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]).

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 SE	5.294 (*df* = 3,924)	5.688 (*df* = 3,741)	5.341 (*df* = 3,881)	5.679 (*df* = 3,782)
F Statistic	22.260***	49.907***	82.073***	93.821***

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

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 attempted to adjust for the risk aversion measure by adding it as a covariate. When adjusting 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 adjusting for several covariates. As in Study 1, we adjusted 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 adjusting 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 adjusted 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, Knetsch, & Thaler, 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 (Table 4). Several researchers have urged greater examination of moderators (Gal & Rucker, 2018; Higgins & Liberman, 2018; Rick, 2011; Simonson & Kivetz, 2018). Our results show 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.

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, and 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)

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, Bleichrodt, & L'Haridon, 2008; Brooks, Peters, & Zank, 2014; Brooks & Zank, 2005; Glöckner & Pachur, 2012; Kocher, Pahlke, & Trautmann, 2013; Li et al., 2015; Pahlke, Strasser, & Vieider, 2012; Toubia, Johnson, Evgeniou, & Delquié, 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).

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 et al., 2017). 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.

Author Contributions

All authors contributed to acquiring the data, analyzing the data, and writing the manuscript. KM wrote and revised the manuscript for submission and conducted most of the analyses in this paper. EJ provided critical comments and edits.

Appendix A: Risky choice measures of loss aversion used in Studies 1–2 (English Translation)

Car attribute 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

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, you win €6.	O	O
#2. If the coin turns up heads, then you lose €3; if the coin turns up tails, you win €6.	O	O
#3. If the coin turns up heads, then you lose €4; if the coin turns up tails, you win €6.	O	O
#4. If the coin turns up heads, then you lose €5; if the coin turns up tails, you win €6.	O	O
#5. If the coin turns up heads, then you lose €6; if the coin turns up tails, you win €6.	O	O
#6. If the coin turns up heads, then you lose €7; if the coin turns up tails, you win €6.	O	O

Note. As described in the main text, λ was computed as 6 ÷ 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	O	O
$100	$25	O	O
$100	$50	O	O
$100	$100	O	O

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.

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 ÷ 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 O	I am **not ready** to sell: O
If the price is **€ 0.5** . . .	. . . I am **ready** to sell O	I am **not ready** to sell: O
. . .[The above was repeated for each price from **€1 to €9.5**]		
If the price is **€ 10.0** . . .	. . . I am **ready** to sell O	I am **not ready** to sell: O

WTP: Model Car Endowment

We will offer you the chance 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 O	I am **not ready** to buy: O
If the price is € **0.5** . . .	. . . I am **ready** to buy O	I am **not ready** to buy: O
. . .[The above was repeated for each price from **€1 to €9.5**]		
If the price is € **10.0** . . .	. . . I am **ready** to buy O	I am **not ready** to buy: O

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.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

Appendix S1. Methodological details appendix.