Risk Matters Less When Options Are Apples-to-Oranges: The Translate-and-Accommodate Model

Supplemental Material

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Part 1: Mathematical Model

1.1. Introduction

We formulate a *translate-and-accommodate* (TAA) model which formalizes the psychology elaborated in the main text and accounts for risk mattering less in crossmodal than unimodal choices. We show how different versions of the model generate the following empirical results.

- Studies 1a – 1d: Less crossmodal sensitivity to variation in the sure thing and gamble outcomes, in the form of a crossover interaction. That is, lesser crossmodal aversion to fair and unfavorable risk but greater crossmodal aversion to sufficiently favorable risk.
- Studies 1e – 1f: Less crossmodal sensitivity to variation in probabilities.
- Studies S2a and S2b (which appear in Part 2 of this Supplemental Material): Less crossmodal sensitivity to the value of outcomes that vary qualitatively.
- Three seemingly bizarre patterns of preference: The uncertainty effect (Gneezy, List, & Wu, 2006), by which by which a gamble is valued below its worst possible outcome; the reverse uncertainty effect (Shen, Fishbach, & Hsee, 2015; see also Goldsmith & Amir, 2010), by which a gamble is valued above its best possible outcome; and directionally-inverted preferences by which a gamble becomes *more* attractive as a sure thing against which it is pit improves. The uncertainty and reverse uncertainty effects have been documented in the literature, while directionally-inverted preferences have not.

To make this Supplemental Material largely self-contained, we repeat much of the formal development found in the main text. Furthermore, to facilitate mathematical derivations and proofs, some of the formal development is framed differently here than in the main text.

Preliminaries

We restrict attention to choices between sure things and binary gambles and to non-negative outcomes. Let X and Y denote qualitatively distinct dimensions. Let (s_x, s_y) be the

bundle offering sure quantities s_x of X and s_y of Y. Let $[x^*, x_*; y^*, y_*]$ denote the gamble offering possible quantities $x^* \geq x_*$ of X and $y^* \geq y_*$ of Y, with bundle (x^*, y^*) obtaining with some probability p, and (x_*, y_*) obtaining with the complementary probability.[1]

We consider *unimodal* and *crossmodal* choices. In a unimodal choice, either $x^* = x_* = s_x = 0$ or $y^* = y_* = s_y = 0$. In a crossmodal choice, if $s_x > 0$, then $y^* > y_* > 0$, and if $s_y > 0$, then $x^* > x_* > 0$. In Section 1.4, we generalize to more than two dimensions and show how the model can accommodate qualitative as well as quantitative differences.

We start with the following classical formulation:

$$[x^*, x_*; y^*, y_*] \succ (s_x, s_y) \Leftrightarrow \tag{S1}$$

$$f_x(x^*) + g_x(x_*) + f_y(y^*) + g_y(y_*) > f_x(s_x) + g_x(s_x) + f_y(s_y) + g_y(s_y).$$

This representation, which leaves outcome probabilities implicit, is quite general. It includes Expected Utility (where $f_x(x^*) = pu_x(x^*)$ and $g_x(x_*) = (1-p)u_x(x_*)$, etc.), and Cumulative Prospect Theory (where $f_x(x^*) = \pi(p)u_x(x^*)$ and $g_x(x_*) = (1-\pi(p))u_x(x_*)$, etc.).[2]

Without loss of generality, we scale functions such that $f_x(0) = g_x(0) = f_y(0) = g_y(0) = 0$. For unimodal choices (and letting $y^* = y_* = s_y = 0$), we get

$$[x^*, x_*; 0,0] \succ (s_x, 0) \Leftrightarrow \Delta_u =$$

$$[f_x(x^*) + g_x(x_*)] - [f_x(s_x) + g_x(s_x)] > 0, \tag{S2}$$

where Δ_u is the unimodal utility difference between the gamble and the sure thing.

For crossmodal choices (for simplicity, in which $x^* = x_* = s_y = 0$), we get

[1] We exclude instances in which (x^*, y_*) is received in one state and (x_*, y^*) is received in the other state. In such instances, a state of nature delivers the best outcome for one attribute and the worst outcome for the other, and hence accounts of multi-attribute risk aversion are needed (Richard, 1975; von Winterfeldt, 1980). Such accounts consider whether individuals prefer extreme outcomes on each attribute or moderate outcomes on all attributes.

[2] Some notable models are not special cases, e.g., weighted utility (Chew & MacCrimmon, 1983; Dekel, 1986).

$$[0,0; y^*, y_*] \succ (s_x, 0) \Leftrightarrow \Delta_c =$$

$$\left[f_y(y^*) + g_y(y_*)\right] - \left[f_x(s_x) + g_x(s_x)\right] > 0, \quad \text{(S3)}$$

where Δ_c is the crossmodal utility difference between the gamble and the sure thing.

We rewrite Equations (S2) and (S3) in terms of the gamble's "advantage" and "disadvantage" relative to the sure thing:

$$[x^*, x_*; 0,0] \succ (s_x, 0) \Leftrightarrow f_x(x^*) - f_x(s_x) > g_x(s_x) - g_x(x_*), \quad \text{(S4)}$$

and

$$[0,0; y^*, y_*] \succ (s_x, 0) \Leftrightarrow f_y(y^*) - f_x(s_x) > g_x(s_x) - g_y(y_*). \quad \text{(S5)}$$

Equations (S4) and (S5) can be interpreted as indicating that the gamble is preferred if its advantage compared to the sure thing, $f_x(x^*) - f_x(s_x)$ or $f_y(y^*) - f_x(s_x)$, exceeds its disadvantage, $g_x(s_x) - g_x(x_*)$ or $g_x(s_x) - g_y(y_*)$.

To reach a translate-and-accommodate (TAA) representation, we further rearrange (S5):

$$[0,0; y^*, y_*] \succ (s_x, 0) \Leftrightarrow \Delta_c = \left[\left(f_y(y^*) + g_y(y^*)\right) - \left(f_x(s_x) + g_x(s_x)\right)\right] -$$

$$\left[\left(f_x(s_x) + g_x(s_x)\right) - \left(f_y(y_*) + g_y(y_*)\right)\right] +$$

$$\left[\left(f_x(s_x) - f_y(y_*)\right) - \left(g_y(y^*) - g_x(s_x)\right)\right] > 0. \quad \text{(S6)}$$

Although Equation (S6) is just a mathematical rearrangement of Equations (S5), it suggests a different psychological interpretation. In particular, it can be thought of as comparing sure receipt of y^* to s_x, $\left[\left(f_y(y^*) + g_y(y^*)\right) - \left(f_x(s_x) + g_x(s_x)\right)\right]$, as well as sure receipt of y_* to s_x, $\left[\left(f_y(y_*) + g_y(y_*)\right) - \left(f_x(s_x) + g_x(s_x)\right)\right]$, and making allowance for the extent to which y_* and y^* are not in fact available with certainty, $\left[\left(f_x(s_x) - f_y(y_*)\right) - \left(g_y(y^*) - g_x(s_x)\right)\right]$. Each of the sure comparisons may be interpreted as a deterministic "translation" between outcomes. The remaining square-bracketed term may be interpreted as "risk accommodation." It reflects a

revision from the sure comparisons that places the overall assessment in line with the likelihood of receiving either the upside y^* or downside y_* rather than s_x.

We next generalize Equation (S6) to reflect two elements of psychology. First, translation may obscure or blur distinctions between outcomes. To capture this loss of acuity, that some things are lost in translation, we multiply the translation terms by $0 \leq \tau \leq 1$, where τ is mnemonic for translation. Second, risk accommodation may be diluted. The need for translation may draw attention away from risk information or distort the processing of it. In addition, translation may sometimes be primary, so that risk accommodation proceeds as an adjustment from this anchor; much research shows that adjustments from an anchor are typically insufficient. To capture dilution, we multiply the risk accommodation term by $0 \leq \alpha \leq 1$, where α is mnemonic for accommodation. We thus have

$$\begin{aligned}[0,0; y^*, y_*] \succ (s_x, 0) \Leftrightarrow \Delta_c = {} & \tau\left[\left(f_y(y^*) + g_y(y^*)\right) - \left(f_x(s_x) + g_x(s_x)\right)\right] - \\ & \tau\left[\left(f_x(s_x) + g_x(s_x)\right) - \left(f_y(y_*) + g_y(y_*)\right)\right] + \\ & \alpha\left[\left(f_x(s_x) - f_y(y_*)\right) - \left(g_y(y^*) - g_x(s_x)\right)\right] = \\ & \tau\left[\left(f_y(y^*) + g_y(y_*)\right) - \left(f_x(s_x) + g_x(s_x)\right)\right] + \\ & (\alpha - \tau)\left[\left(f_x(s_x) + g_x(s_x)\right) - \left(f_y(y_*) + g_y(y^*)\right)\right]. \end{aligned} \quad \text{(S7)}$$

Altogether, then, we have a dual model, with unimodal preferences represented by Equation (S4) and crossmodal translation-and-accommodation preferences represented by Equation (S7). Note that we could rearrange Equation (S4) to parallel Equation (S7) with $\tau = \alpha = 1$.

We next show how the translate-and-accommodate model is compatible with the theorizing and empirical results in the main text. We denote the percentage of participants choosing the gamble, $[x^*, x_*; y^*; y_*]$, over the sure thing, (s_x, s_y), as $C\left([x^*, x_*; y^*; y_*] \succ (s_x, s_y)\right)$. We assume,

as in strong utility models (e.g., Luce & Suppes, 1965), that choice shares are monotonic in the utility differences produced by Equations (S4) and (S7). For simplicity, we assume symmetry, $f_x(z) = f_y(z)$ and $g_x(z) = g_y(z)$ for all z, although the results below hold with asymmetric functions. We thus drop subscripts in the notation below. We also make the standard assumption that f and g are continuous and monotonically increasing.

With our simplified notation, we consider a unimodal choice between $[z^*, z_*; 0,0]$ and $(s, 0)$, and a crossmodal choice between $[z^*, z_*; 0,0]$ and $(0, s)$. The utility difference for unimodal choices is given by $\Delta_u = f(z^*) + g(z_*) - \big(f(s) + g(s)\big)$, while the utility difference for crossmodal choices is given by $\Delta_c = \tau\Delta_u + (\alpha - \tau)\big[(f(s) + g(s)) - \big(f(z_*) + g(z^*)\big)\big]$. Thus,

$$\Delta_u - \Delta_c = (1 - \tau)\big[f(z^*) + g(z_*) - \big(f(s) + g(s)\big)\big] + (\tau - \alpha)\big[f(s) + g(s) - \big(f(z_*) + g(z^*)\big)\big]. \quad \text{(S8)}$$

If $\tau = \alpha = 1$, then $\Delta_u - \Delta_c = 0$ and crossmodal and unimodal choices align.

Before proceeding to proofs, it is useful to illustrate the TAA model graphically. To do so, we for now restrict attention to 50-50 gambles. In Section 1.3, we generalize to gambles with different probabilities. For analytical tractability and illustrative purposes, we also follow prospect theory, setting $f(z) = \pi(p)v(z)$ and $g(z) = (1 - \pi(p))v(z)$, where $\pi(p)$ is a probability weighting function reflecting subcertainty, with $\pi(.5) = .40$, and $v(z) = z^{.7}$. Subcertainty of the probability weighting function, $\pi(.5) < .5$, with a concave value function implies unimodal risk aversion for actuarially fair gambles. Most results below are more general and do not depend on this specific parametric form.

Figure S1.1 plots the relative utility of a 50-50 gamble with outcomes $z^* = 100$ and $z_* = 50$ compared to a sure alternative, s. In other words, along the vertical axis is the utility of that gamble minus the utility of a sure thing s. Along the horizontal axis, s varies in descending order;

$s = 100$ on the left yields negative relative utility (the sure thing is preferred to the gamble) and $s = 0$ on the right yields positive relative utility (the gamble is preferred to the sure thing).

The light blue line plots unimodal preferences, which correspond to $\tau = \alpha = 1$. The upward slope of the line indicates greater preference for the gamble as the sure thing *decreases*. Note that, consistent with risk aversion, the actuarially fair sure thing, $s = 75$, is preferred to the gamble.

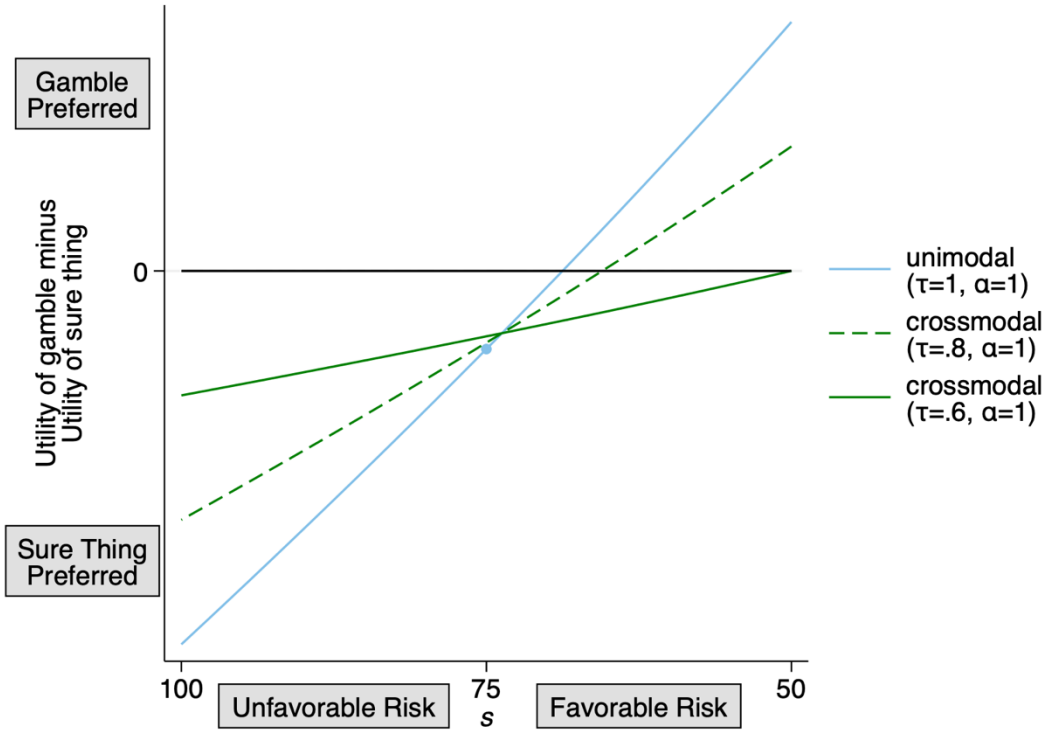


Figure S1.1. The figure illustrates how varying the acuity of translation, τ, affects crossmodal preferences. It depicts unimodal (Equation (S4)) and crossmodal (Equation (S7)) preferences as a function of the sure thing, s, where s is decreasing from left to right. The unimodal preferences in light blue correspond to $\tau = \alpha = 1$. The crossmodal preferences maintain $\alpha = 1$ but set $\tau = .8$ (dashed green) and $\tau = .6$ (solid green). Holding α constant, as τ decreases, crossmodal preferences become shallower, i.e., risk matters less in the sense of lesser crossmodal sensitivity to variation in s. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

The figure also includes two lines that depict crossmodal preferences with translation of less than perfect acuity. Holding $\alpha = 1$, the dashed green line reflects a relatively minor loss of acuity, $\tau = .8$, while the solid green line reflects a more severe loss of acuity, $\tau = .6$. In both

cases, $\tau < 1$ leads to a shallower slope than the light blue unimodal line. That is, diminished translation leads to lesser crossmodal sensitivity to variation in s. Indeed, both cases yield a crossover interaction by which there is less crossmodal risk aversion for unfavorable risk (large s) and less crossmodal risk seeking for favorable risk (small s).

Finally, at actuarially fair risk, $s = 75$, and given $\alpha = 1$, the two crossmodal lines are slightly above, but approximately equal to, the unimodal line, indicating a trivial lesser crossmodal aversion to fair risk. As we explain later on, this unimodal-crossmodal discrepancy follows from reasonable restrictions on $f(z)$ and $g(z)$. For instance, unimodal and crossmodal preferences would coincide at $s = 75$ if $f(z)$ and $g(z)$ were linear.

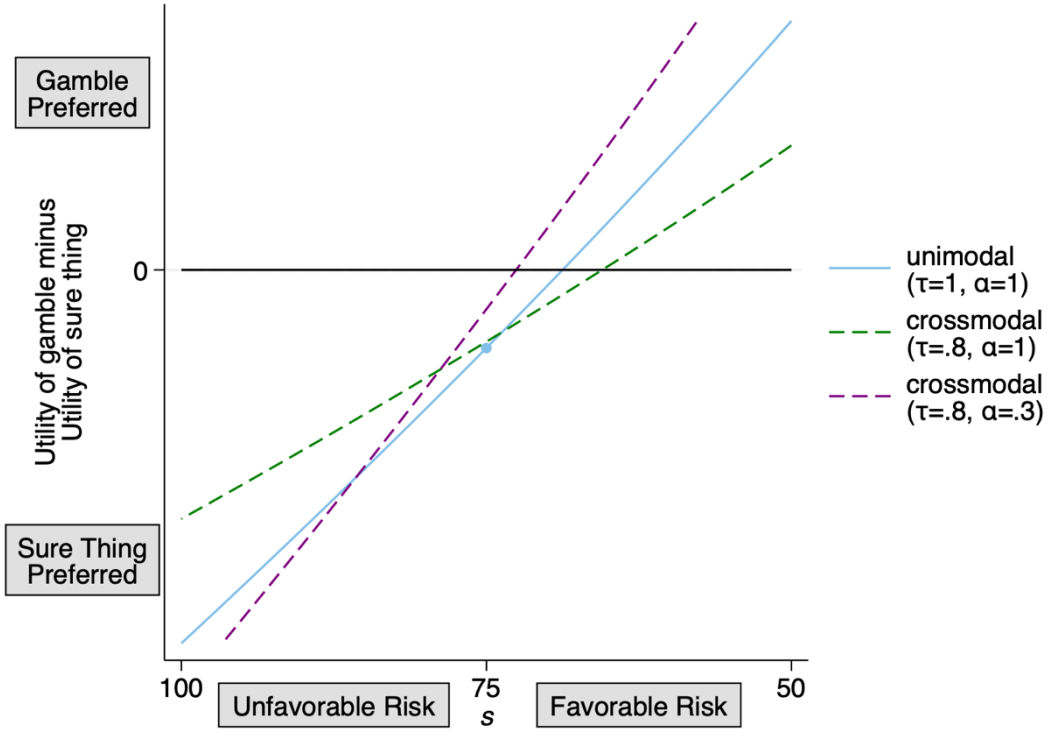


Figure S1.2. The figure illustrates how varying the extent of risk accommodation, α, affects crossmodal preferences. It depicts unimodal (Equation (S4)) and crossmodal (Equation (S7)) preferences as a function of the sure thing, s, where s is decreasing from left to right. The unimodal preferences in light blue correspond to $\tau = \alpha = 1$. The crossmodal preferences set τ to .8 but reflect $\alpha = 1$ (dashed green) and $\alpha = .3$ (dashed purple). Holding τ constant, as α decreases, appetite for risk taking increases. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

Figure S1.2 illustrates how risk preferences change with different degrees of risk accommodation, α. In addition to the light blue unimodal preference line, the figure includes two crossmodal preference lines. Both set the acuity of translation at $\tau = .8$. The dashed green line is repeated from Figure S1.1 and reflects "full" risk accommodation, $\alpha = 1$, while the dashed purple line reflects quite modest risk accommodation, $\alpha = .3$. Note that a decision maker with $\tau = .8$ and $\alpha = .3$ is effectively indifferent between the crossmodal gamble and an actuarially fair sure thing, $s = 75$, whereas a decision maker with $\tau = .8$ and $\alpha = 1$ is considerably more risk averse. Thus, α controls the level of risk aversion, with comparatively more risk aversion for higher α and comparatively more risk seeking for lower α.

1.2. Studies 1a – 1d

In this section, we show how the TAA model can account for the empirical results in Studies 1a – 1d. For 50-50 gambles, these studies yield all of the following:

> Pattern 1 (Less Crossmodal Sensitivity): Less crossmodal sensitivity to changes in gamble outcomes and the sure thing, s.
>
> Pattern 2 (Slope-Up): Risky crossmodal choice percentages increase as s decreases.
>
> Pattern 3 (Less Crossmodal RA, Unfavorable): Less crossmodal risk aversion for unfavorable gambles.
>
> Pattern 4 (More Crossmodal RA, Favorable): More crossmodal risk aversion for sufficiently favorable gambles.
>
> Pattern 5 (Less Crossmodal RA, Fair): Less crossmodal risk aversion for fair gambles.

We first show that Pattern 1 (Less Crossmodal Sensitivity) holds given $\alpha > 2\tau - 1$, and Pattern 2 (Slope-Up) holds given $\alpha < 2\tau$, in each case provided that there is risk aversion for actuarially fair unimodal gambles and given the standard assumption that f and g are increasing, continuous, and differentiable. Putting things together, we have that Patterns 1 and 2 (Less Crossmodal Sensitivity

& Slope-Up) both obtain when $2\tau - 1 < \alpha < 2\tau$.

Throughout this section, we restrict attention to 50-50 gambles. To begin, we present a simple Lemma which is used in subsequent proofs. It provides an implication of the assumption that there is risk aversion for actuarially fair 50-50 unimodal gambles.

Lemma: Consider a unimodal choice between $[z^*, z_*; 0{,}0]$ and $(s, 0)$. If unimodal preferences are risk averse whenever the gamble is actuarially fair, that is, whenever $s = (z^* + z_*)/2$, then $f'(z) < g'(z)$.

Proof: By assumption, $\Delta_u = f(z^*) + g(z_*) - [f(s) + g(s)] < 0$ for all z^* and z_*. Let $z^* = z + \epsilon$ and $z_* = z - \epsilon$ for some small $\epsilon > 0$, Then $f(z + \epsilon) + g(z - \epsilon) - [f(z) + g(z)] < 0$, or $f(z + \epsilon) - f(z) < g(z) - g(z - \epsilon)$. Dividing by ϵ and taking the limit as $\epsilon \to 0$, we get $f'(z) < g'(z)$. ■

We next provide mathematical conditions that lead to Patterns 1 through 5 within the TAA model.

Claim 1 (Less Crossmodal Sensitivity): There is less sensitivity to variation in gamble outcomes and the sure thing, z^*, z_*, and s, for crossmodal than unimodal choices if $\alpha > 2\tau - 1$.

Proof: Consider a unimodal choice between $[z^*, z_*; 0{,}0]$ and $(s, 0)$, and a crossmodal choice between $[z^*, z_*; 0{,}0]$ and $(0, s)$. The three stylized facts making up Pattern 1 can be written as $\frac{\partial[\Delta_u - \Delta_c]}{\partial z^*} > 0$, $\frac{\partial[\Delta_u - \Delta_c]}{\partial z_*} > 0$, and $\frac{\partial[\Delta_u - \Delta_c]}{\partial s} < 0$. From Equation (S8), we get $\frac{\partial[\Delta_u - \Delta_c]}{\partial z^*} = (1 - \tau)f'(z^*) + (\alpha - \tau)g'(z^*)$. If $f'(z^*) < g'(z^*)$ (by our Lemma) and $f'(z^*)$ is positive (by assumption), then the expression is positive given $\alpha > 2\tau - 1$. We also get $\frac{\partial[\Delta_u - \Delta_c]}{\partial z_*} = (1 - \tau)g'(z_*) + (\alpha - \tau)f'(z_*)$, which is similarly positive given the same bound. From Equation (S8), we get $\frac{\partial[\Delta_u - \Delta_c]}{\partial s} = (2\tau - \alpha - 1)(f'(s) + g'(s))$. Since f and g are increasing functions, this is negative given the same restriction. ■

Note: As we have seen, Figure S1.1 includes two illustrations of lesser crossmodal sensitivity to variation in the sure thing, s. The dashed green line, which has $\tau = .8$ and $\alpha = 1$, and the solid green line, which has $\tau = .6$ and $\alpha = 1$, both satisfy $\alpha > 2\tau - 1$ and, concomitantly, both have a shallower slope than the light blue, unimodal line. In contrast, the dashed purple line in Figure S1.2 has $\tau = .8$ and $\alpha = .3$, which violates $\alpha > 2\tau - 1$. Accordingly, it reflects preferences with *more* crossmodal than unimodal sensitivity; its slope is steeper than that of the light blue, unimodal line.

Claim 2 (Slope-Up): The percentage of subjects who choose the gamble increases as s decreases for both unimodal and crossmodal choices if $\alpha < 2\tau$.

Proof: $\frac{\partial[\Delta_u]}{\partial s} = -[f'(s) + g'(s)]$, which is always negative since $f'(s) > 0$ and $g'(s) > 0$. $\frac{\partial[\Delta_c]}{\partial s} = -\tau\big(f'(s) + g'(s)\big) + (\alpha - \tau)\big(f'(s) + g'(s)\big)$. Since $f'(s) > 0$ and $g'(s) > 0$, the expression is negative if $\alpha < 2\tau$. ■

Note: All of the crossmodal lines in Figures S1.1 and S1.2 satisfy $\alpha < 2\tau$. Thus, consistent with the gamble becoming relatively more attractive as s decreases, they all slope up. However, the red dashed line in Figure S1.3 depicts crossmodal preferences that reflect $\tau = .2$ and $\alpha = .9$ and thus violate $\alpha < 2\tau$. These preferences are thus "inverted": the gamble becomes more attractive as the sure thing, s, improves! The red dashed line slopes the "wrong" way: down rather than up. The main text discusses such behavior from a psychological perspective. The key idea is that preferences can invert not (solely) because of confusion or error but (also) because translation is extremely rough relative to the prevailing level of risk accommodation.

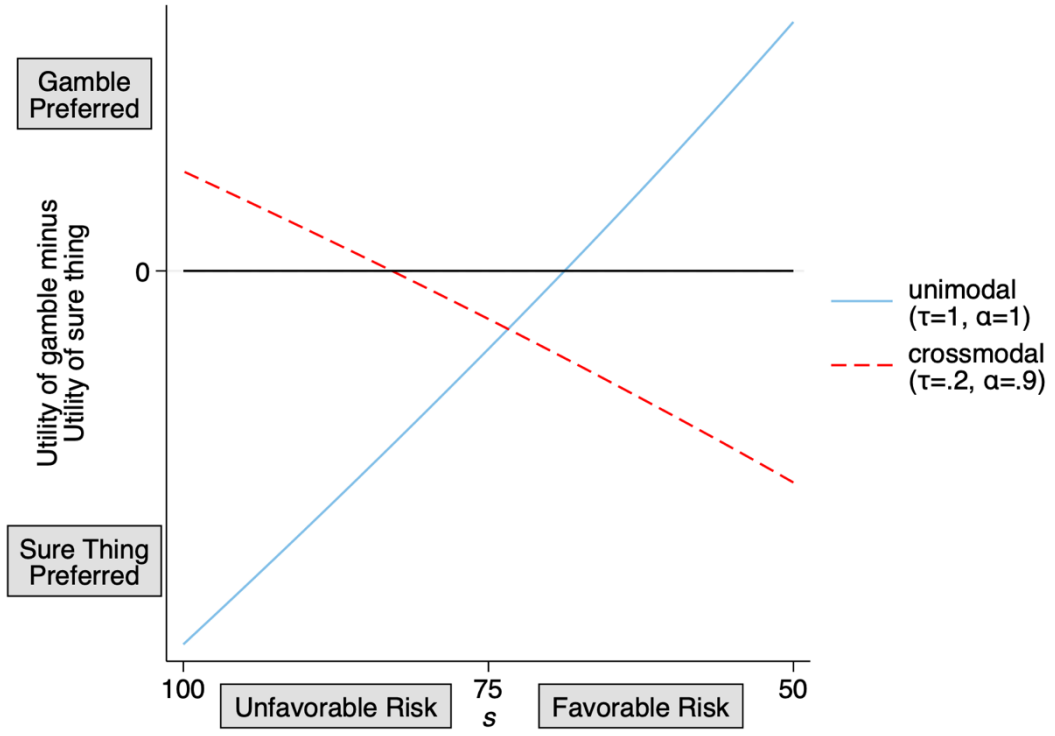


Figure S1.3. The figure illustrates how combination of τ and α can produce crossmodal preferences in which the relative utility of the gamble *decreases* as risk becomes more favorable. It depicts unimodal (Equation (S4)) and crossmodal (Equation (S7)) preferences as a function of the sure thing, s, where s is decreasing from left to right. The unimodal preferences in light blue correspond to $\tau = \alpha = 1$ and have the gamble becoming more attractive as s decreases. The crossmodal preferences in red set τ =.2 and α = .9, which violates the bound $\alpha < 2\tau$ and leads to the gamble becoming *less* attractive as s decreases. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

Figure S1.4 shows how different (τ, α) pairs in the unit square allow for three different kinds of crossmodal preferences. First, if $2\tau - 1 < \alpha < 2\tau$, then Patterns 1 and 2 (Less Crossmodal Sensitivity & Slope-Up) both obtain. In the Figure, the region of the unit square defined by these inequalities is shaded in green. Throughout this region, relative to the prevailing extent of risk accommodation, translation is sufficiently rough so that risk matters less crossmodally, but it is not exceedingly rough, so that preferences are conventional rather than inverted. The dashed and solid green lines from Figures S1.1 and S1.2 are examples of such preferences.

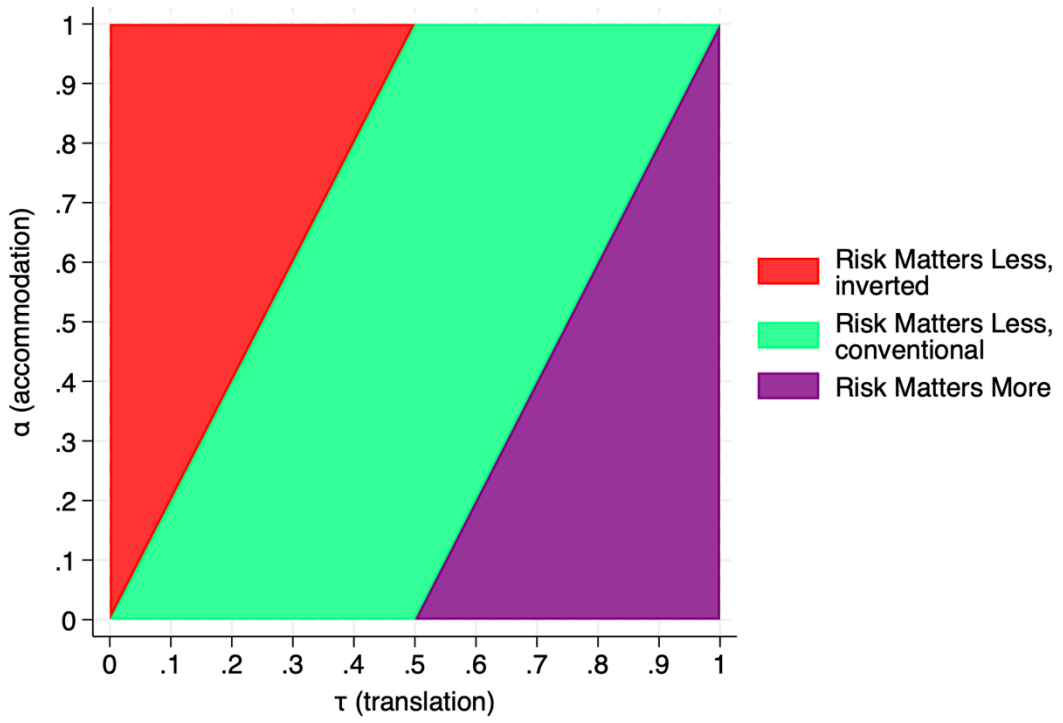


Figure S1.4. The figure illustrates the combinations of τ and α that can produce Pattern 1, lesser crossmodal sensitivity to changes in risk parameters (the sure thing and the gamble outcomes), and Pattern 2, risky crossmodal choice percentages increase as the sure thing decreases. In the green region, $2\tau - 1 < \alpha < 2\tau$, and both Pattern 1 and 2 hold. In the red region, $2\tau - 1 < \alpha$, but $\alpha > 2\tau$ and Pattern 1 holds but not Pattern 2. In the purple region, $\alpha < 2\tau - 1$ and neither Pattern 1 nor Pattern 2 hold. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

Second, when $\alpha > 2\tau$, Pattern 1 obtains but Pattern 2 does not (Less Crossmodal Sensitivity but not Slope-Up). The region defined by this inequality is shaded in red. Here, translation is exceedingly rough given the prevailing extent of risk accommodation, so that beyond risk mattering less crossmodally, preferences invert. The red line from Figure S1.3 is an example of such preferences.

Third, when $\alpha < 2\tau - 1$, Pattern 2 obtains but Pattern 1 does not (Slope-Up but not Less Crossmodal Sensitivity). The region defined by this inequality is shaded in purple. Contrary to our data, in this part of the unit square, risk matters *more* crossmodally, in the sense that, relative to unimodal preferences, crossmodal exhibit greater sensitivity to changes in the sure alternative,

s. The dashed purple line in Figure S1.2 is an example of such preferences.

We now consider Pattern 3 and 4 from Studies 1a – 1d. Recall that Pattern 3 is lesser crossmodal aversion to sufficiently unfavorable gambles (Less Crossmodal RA, Unfavorable), while Pattern 4 is more crossmodal aversion to sufficiently extremely favorable gambles (More Crossmodal RA, Favorable). Together, these patterns create a crossover interaction. We show that Pattern 3 obtains given the familiar bound of $\alpha > 2\tau - 1$, while Pattern 4 obtains given a slightly tighter restriction. This implies that a crossover interaction arises in only a subset of the green region of Figure S1.4 (and in the entirety of the red region). In the remaining portion of the green region, there is lesser crossmodal sensitivity along with a main effect by which there is generally less crossmodal risk aversion.

Below, we investigate two cases: $s = z^*$ for actuarially unfavorable gambles and $s = z_*$ for actuarially favorable gambles (as we go on to detail when analyzing the uncertainty and reverse uncertainty effects, the TAA model indeed allows for instances in which a gamble is not chosen over the stochastically dominated $s = z_*$ as well as instances in which a gamble is chosen over stochastically dominating $s = z^*$). By continuity, if $\Delta_c > \Delta_u$ for $s = z^*$, the same inequality holds for $s = z^* - \epsilon$ for some small $\epsilon > 0$. By a parallel argument, if $\Delta_c < \Delta_u$ for $s = z_*$, the same inequality holds for $s = z_* + \epsilon$ for some small $\epsilon > 0$.

Claim 3 (Less Crossmodal RA, Unfavorable): There is less crossmodal than unimodal risk aversion for $s = z^*$ if $f'(z) \leq g'(z)$ and $\alpha > 2\tau - 1$.

Proof: Using Equation (S8), we let $s = z^*$. Therefore, $\Delta_u - \Delta_c < 0$ if $(1-\tau)(f(z^*) + g(z_*) - [f(z^*) + g(z^*)]) + (\tau - \alpha)\big[f(z^*) + g(z^*) - \big(f(z_*) + g(z^*)\big)\big] < 0$. Simplifying, we get $(\tau - 1)\big(g(z^*) - g(z_*)\big) + (\tau - \alpha)[f(z^*) - f(z_*)] < 0$. Defining $\delta_f = f(z^*) - f(z_*)$ and $\delta_g = g(z^*) - g(z_*)$, we get $(\tau - \alpha)\delta_f < (1-\tau)\delta_g$. To show that our restrictions imply this

inequality, note that $\alpha > 2\tau - 1$ is equivalent to $\tau - \alpha < 1 - \tau$ or $(\tau - \alpha)\delta_g < (1 - \tau)\delta_g$. Since $f'(z) < g'(z)$ implies that $\delta_f < \delta_g$, we get the desired result. ■

Claim 4 (More Crossmodal Risk Aversion, Favorable): There is more crossmodal than unimodal risk aversion for $s = z_*$ if $f'(z) < g'(z)$, and $\alpha > \tau + (\tau - 1)\frac{\delta_f}{\delta_g}$.

Proof: Using Equation (S8), $\Delta_u - \Delta_c > 0$ if $(1 - \tau)(f(z^*) + g(z_*) - [f(z_*) + g(z_*)]) + (\tau - \alpha)\big[f(z_*) + g(z_*) - \big(f(z_*) + g(z^*)\big)\big] = (1 - \tau)\big(f(z^*) - f(z_*)\big) + (\alpha - \tau)\big(g(z^*) - g(z_*)\big) > 0$. Again, defining $\delta_f = f(z^*) - f(z_*)$ and $\delta_g = g(z^*) - g(z_*)$, we get $(\tau - \alpha)\delta_g < (1 - \tau)\delta_f$, or $\alpha > \tau + (\tau - 1)\frac{\delta_f}{\delta_g}$. Finally, because $f'(z) < g'(z)$, it must be that $\frac{\delta_f}{\delta_g} < 1$. Thus, $\alpha > \tau + (\tau - 1)\frac{\delta_f}{\delta_g}$ is a tighter restriction than $\alpha > 2\tau - 1$. ■

Note: Because fewer values of α yield Pattern 4 (More Crossmodal RA, Favorable) than Pattern 3 (Less Crossmodal RA, Unfavorable), there is a subset of the green region of Figure S1.4 in which Patterns 1, 2, and 3 hold but Pattern 4 does not. Figure S1.5 shades this subregion in blue rather than green. To be clear, what is blue in Figure S1.5 is the subset of what is green in S1.4 which yields (a) lesser crossmodal sensitivity, (b) and an "upward shift" of generally less crossmodal risk aversion, rather than a crossover interaction. Furthermore, the region that remains green in S1.5 yields lesser crossmodal sensitivity along with a crossover interaction, by which there is lesser crossmodal aversion to unfavorable risk but greater crossmodal aversion to sufficiently favorable risk.

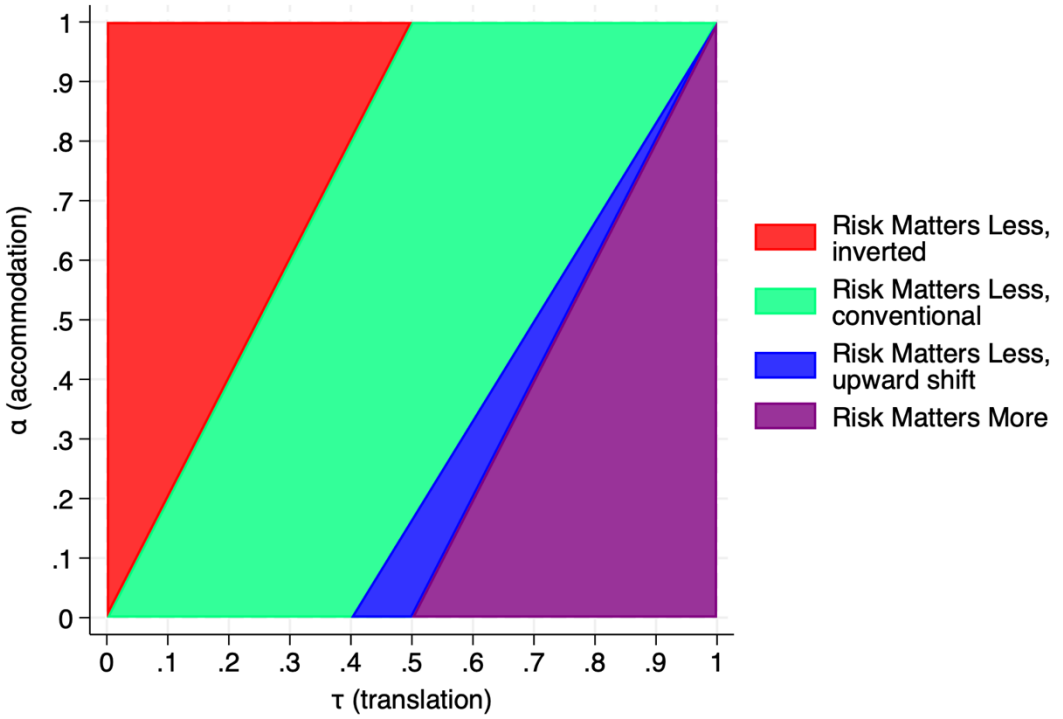


Figure S1.5. The figure illustrates the combinations of τ and α that can produce Pattern 1, lesser crossmodal sensitivity to changes in risk parameters (the sure thing and the gamble outcomes); Pattern 2, risky crossmodal choice percentages increase as the sure thing decreases; Pattern 3, lesser crossmodal sensitivity to unfavorable and fair risk; and Pattern 4, less crossmodal risk aversion for sufficiently favorable risk. In the green and blue regions, $2\tau - 1 < \alpha < 2\tau$. Patterns 1, 2, and 3 hold throughout both of these regions, but Pattern 4 only holds in the green and not in the blue. In the red region, $2\tau - 1 < \alpha$ but $\alpha > 2\tau$; here, Patterns 1, 3, and 4 hold, but Pattern 2 does not. In the purple region, $\alpha < 2\tau - 1$, Pattern 1 does not hold.

What determines the size of the blue region? As risk aversion for actuarially fair unimodal gambles becomes more pronounced, $\frac{\delta_f}{\delta_g}$ becomes smaller, and the blue region grows in size. To provide a concrete example, we again consider the special case of prospect theory, setting $f(z) = \pi(p)v(z)$ and $g(z) = (1 - \pi(p))v(z)$, where $\pi(p)$ is a probability weighting function reflecting subcertainty, with $\pi(.5) = w$ and $v(z) = z^{.7}$. In this special case, the restriction derived for Pattern 4, $\alpha > \tau + (\tau - 1)\frac{\delta_f}{\delta_g}$, becomes $\alpha > \tau + (\tau - 1)\frac{w}{1-w}$. If there is no subcertainty of the probability weighting function, $\pi(.5) = .5$, and the restriction reduces to the familiar bound $\alpha > 2\tau - 1$. In turn, there does not exist a blue region in which there is less crossmodal sensitivity and

a main effect of lesser crossmodal risk aversion. On the other hand, if $w < .5$, then there is a blue region defined by $2\tau - 1 < \alpha < \tau + (\tau - 1)\frac{w}{1-w}$ in which risk matters less and there is an upward shift of risk preferences for crossmodal comparisons. For example, if $w = .4$, then $\tau = .7$ and $\alpha = .45$ is consistent with Patterns 1, 2, and 3 but not Pattern 4. The dashed, dark blue line in Figure S1.6 plots these crossmodal preferences.

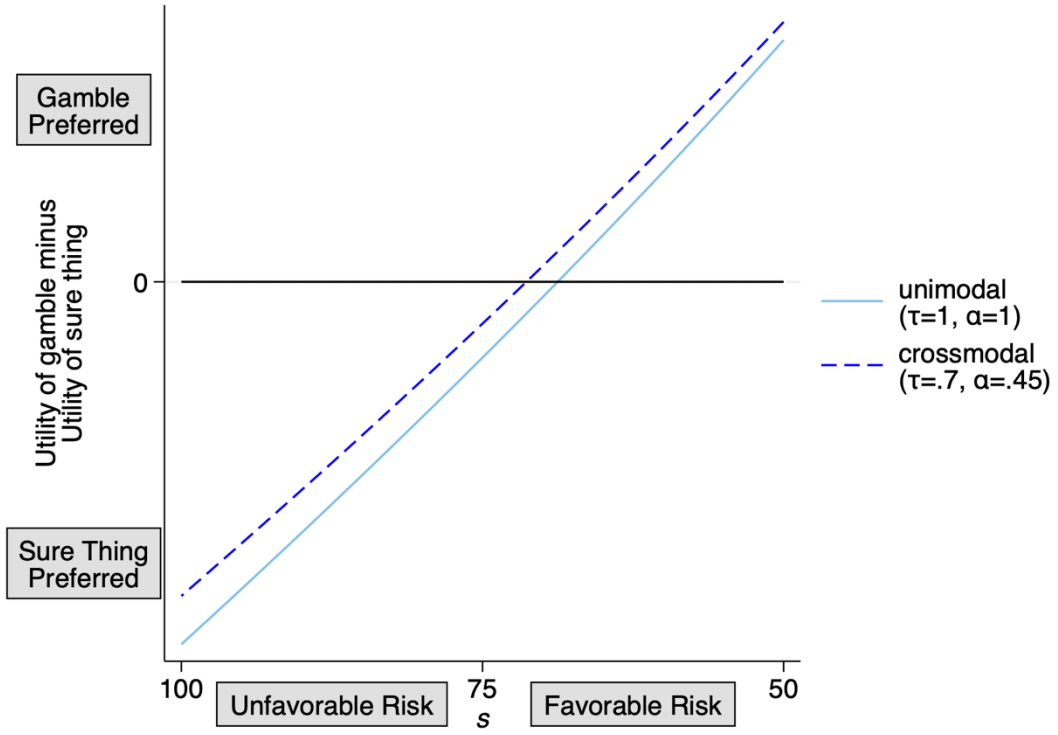


Figure S1.6. The figure illustrates how combination of τ and α can produce a "main effect" or "upward shift" by which crossmodal preferences show less risk aversion than unimodal preferences everywhere and in which risk matters more for crossmodal choices. The plot examines how unimodal (Equation (S4)) and crossmodal (Equation (S7)) preferences change as a function of the sure thing, s. For crossmodal preferences, the dashed blue line illustrates $\tau = .7$ and $\alpha = .45$. Here, crossmodal preferences are everywhere above unimodal preferences. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

To conclude our analysis of findings from Studies 1a – 1d, we consider the observation of lesser crossmodal aversion to fair risk.

Claim 5 (Less Crossmodal RA, fair): There is less crossmodal than unimodal risk aversion for $s = (z^* + z_*)/2$ if f and g are concave and $\max f'(z) < \min g'(z)$ when $z \in [l, h]$, $z^* \leq h$,

$z_* \geq l$, and $\alpha < 1$.

Proof: We have $\Delta_c - \Delta_u = (\tau - 1)\Delta_u + (\alpha - \tau)(f(s) + g(s) - f(z_*) - g(z^*))$, where $\Delta_u = f(z^*) + g(z_*) - f(s) - g(s)$. Since $\max f'(z) < \min g'(z)$, $f'(z) < g'(z)$ for all z, and therefore $\Delta_u < 0$. We denote $D = f(s) + g(s) - f(z_*) - g(z^*)$ and rewrite $\Delta_c - \Delta_u = (\tau - 1)\Delta_u + (\alpha - \tau)D$.

From $\max f'(z) < \min g'(z)$, it follows that $f(s) - f(z_*) < g(z^*) - g(s)$, which in turn implies $D < 0$. In addition, concavity of f and g imply that $f(s) \geq \frac{f(z^*)+f(z_*)}{2}$ and $g(s) \geq \frac{g(z^*)+g(z_*)}{2}$. Combining, we get $f(s) + g(s) \geq \frac{f(z^*)+f(z_*)}{2} + \frac{g(z^*)+g(z_*)}{2}$ or $2\big(f(s) + g(s)\big) \geq f(z^*) + f(z_*) + g(z^*) + g(z_*)$ or $D = f(s) + g(s) - f(z_*) - g(z^*) \geq f(z^*) + g(z_*) - f(s) - g(s) = \Delta_u$. Since D and Δ_u are both negative, we re-write as $|D| \leq |\Delta_u|$. Then, $\Delta_c > \Delta_u$ if and only if $(\tau - 1)\Delta_u + (\alpha - \tau)D > 0$ or $(1 - \tau)|\Delta_u| + (\tau - \alpha)|D| > 0$.

We start with the case in which $\tau > \alpha$, since $\Delta_c - \Delta_u = (1 - \tau)|\Delta_u| + (\tau - \alpha)|D|$ and $1 - \tau \geq 0$, $|\Delta_u| > 0$, $\tau - \alpha > 0$, and $|D| > 0$, $\Delta_c - \Delta_u$ is positive, and therefore $\Delta_c > \Delta_u$.

Next, we consider $\alpha > \tau$. $\Delta_c > \Delta_u$ if and only if $(1 - \tau)|\Delta_u| > (\alpha - \tau)|D|$. Because $|\Delta_u| \geq |D|$, the above holds if $\frac{\alpha-\tau}{1-\tau} < 1$, which follows from $\alpha < 1$. ■

Note: The condition on the derivatives of f and g, $\max f'(z) < \min g'(z)$, is stronger than necessary. For the case, $f(z) = wx^k$ and $g(z) = (1 - w)x^k$, this condition holds for $z^*, z_* \in [100,386]$ if $w = .4$ and $k = .7$. In other words, there is less crossmodal risk aversion for all fair gambles in the interval, [100,386]. However, $\max f'(z) < \min g'(z)$ is a sufficient condition that is used to generate $f(s) - f(z_*) < g(z^*) - g(s)$. If we impose the less stringent condition directly, $f(s) - f(z_*) < g(z^*) - g(s)$, the interval that produces less crossmodal risk aversion for all fair gambles is considerably larger. For example, $g(6000) - g(3050) > f(3050) - f(100)$, implying a range of [100,6000].

1.3. Studies 1e – 1f

In this subsection, we show how the TAA model can account for less crossmodal than unimodal sensitivity to variation in probabilities. Throughout the subsection, we again assume a special case of our formulation, prospect theory with $f(z^*) = \pi(p)v(z^*)$ and $g(z_*) = \big(1 - \pi(p)\big)v(z_*)$, with $\pi'(p) > 0$ and $v'(x) > 0$.

Claim 6 (Less Crossmodal Sensitivity to Probabilities): There is less sensitivity to changes in probabilities for crossmodal than unimodal choices if there is risk aversion for all fair unimodal gambles and $\alpha > 2\tau - 1$. That is, $\frac{\partial[\Delta_u - \Delta_c]}{\partial p} > 0$, where p is the probability of z^*.

Proof: For the formulation described above, $\Delta_u - \Delta_c$ simplifies to $(1-\tau)(\pi(p)v(z^*) + (1-\pi(p))v(z_*)) - (\tau - \alpha)\left(\pi(p)v(z_*) + \big(1-\pi(p)\big)v(z^*)\right) + (2\tau - \alpha - 1)v(s)$. Taking the partial derivative with respect to p, we get $\frac{\partial[\Delta_u - \Delta_c]}{\partial p} > 0$ if $(1-\tau)\pi'(p)\big(v(z^*) - v(z_*)\big) + (\alpha - \tau)\pi'(p)\big(v(z^*) - v(z_*)\big) > 0$, which holds if $\alpha > 2\tau - 1$ since $v'(x) > 0$ and $\pi'(p) > 0$.■

Note: The restriction on τ and α is satisfied in the red and green regions of Figure S1.4 and in the red, green, and blue regions of Figure S1.5.

1.4. Studies S2a and S2b

For Studies S2a and S2b (which are presented later in this Supplementary Material, Part 2), we generalize Equations (S4) and (S7) to include three goods, as well as money. We consider choices between sure things, (s_c, s_h, s_m, s_l), and gambles denoted $[c^*, c_*; h^*, h_*; m^*, m_*; l^*, l_*]$, where h, m and l are mnemonic for the highest-valued, medium-valued, and lowest-valued good. Cash choices pit $(s_c, 0,0,0)$ against $[c^*, c_*; 0,0; 0,0; 0,0]$ and goods choices pit $(0,0,1,0)$ against $[0,0; 1,0; 0,0; 0,1]$, where 1 is an indicator variable to indicate that a particular good is received.

Cash choices are then represented:

$$[c^*, c_*; 0,0; 0,0; 0,0] \succ (s_c, 0,0,0) \Leftrightarrow f_c(c^*) + g_c(c_*) > f_c(s_c) + g_c(s_c). \quad \text{(S9)}$$

Goods choices are represented:

$$[0,0; 1,0; 0,0; 0,1] \succ (0,0,1,0) \Leftrightarrow \tau\big[\big(f_h(1) + f_l(1)\big) - \big(f_m(1) + g_m(1)\big)\big] +$$
$$\alpha\big[\big(f_m(1) - f_l(0)\big) - (g_m(1) - g_h(1))\big] > 0. \quad \text{(S10)}$$

Equations (S9) and (S10) are conceptually identical to Equations (S4) and (S7).

Claim 7 (Less Crossmodal Sensitivity to Goods): There is more sensitivity to changes in money relative to equivalent changes in goods for crossmodal than unimodal choices if $f'_m(z) \leq g'_m(z)$ for all z and $\alpha > 2\tau - 1$.

Proof: Since Studies S2a and S2b involved matching products to money, we take Equation (S10) and substitute the equivalent monetary amounts, defining $(c_h, 0,0,0) \sim (0,1,0,0)$, $(c_m, 0,0,0) \sim (0,0,1,0)$, and $(c_l, 0,0,0) \sim (0,0,0,1)$, and therefore $f_c(c_h) + g_c(c_h) = f_h(1) + g_h(1)$, $f_c(c_m) + g_c(c_m) = f_m(1) + g_m(1)$, and $f_c(c_l) + g_c(c_l) = f_l(1) + g_l(1)$. Therefore, the equivalent unimodal choice is represented by,

$$[c_h, c_l; 0,0; 0,0; 0,0] \succ (c_m, 0,0,0) \Leftrightarrow f(c_h) + g(c_h) > f(c_m) + g(c_m),$$

with the "matched" crossmodal choice represented by

$$[0,0; 1,0; 0,0; 0,1] \succ (0,0,1,0) \Leftrightarrow \tau[(f(c_h) + g(c_h)) - (f(c_m) + g(c_m))] +$$
$$\alpha[(f(c_m) + g(c_m) - (f(c_l) + g(c_h))] > 0.$$

Above, we have omitted the c subscript for simplicity. Simplifying, we get $\Delta_u - \Delta_c = (1-\tau)\big(f(c_h) + g(c_l) - f(c_m) - g(c_m)\big) - (\alpha - \tau)\big(f(c_m) + g(c_m) - f(c_l) - g(c_h)\big)$.

Taking the partial with respect to c_h, we get $\frac{\partial[\Delta_u - \Delta_c]}{\partial c_h} = (1-\tau)f'(c_h) + (\alpha - \tau)g'(c_h)$. If $f'(z) < g'(z)$, then a sufficient condition for $\frac{\partial[\Delta_u - \Delta_c]}{\partial c_h} > 0$ is $2\tau - 1 < \alpha$. $\frac{\partial[\Delta_u - \Delta_c]}{\partial c_l} = (1-\tau)g'(c_l) + (\alpha - \tau)f'(c_l)$. A sufficient condition for $\frac{\partial[\Delta_u - \Delta_c]}{\partial c_l} > 0$ is $1 - \tau + \alpha > 0$, which

clearly holds if $2\tau - 1 < \alpha$. Finally, $\frac{\partial[\Delta_u - \Delta_c]}{\partial c_m} = (\tau - 1 + \tau - \alpha)(f'(c_m) + g'(c_m))$, which is negative if $2\tau - 1 < \alpha$. ■

Note: In the studies, the percentage of subjects who chose the risky gamble decreases for both unimodal and crossmodal choices as *M* (or c_m) improve. We thus also impose $\alpha < 2\tau$.

1.5. The Uncertainty and Reverse Uncertainty Effects

The uncertainty effect refers to instances in which a risky option is valued below its lowest possible outcome; that is, a risky option is valued below a sure thing it stochastically dominates. See the main text for a discussion of demonstrations of this effect and an explanation of the translation-and-accommodation psychology that accounts for it. Here, we characterize the uncertainty effect as a crossmodal but not unimodal preference for sure receipt of a gamble's worst outcome over the gamble itself. That is, the gamble $[z^*, z_*; 0,0]$ is preferred over the stochastically dominated sure thing $(z_*, 0)$, while the sure thing $(0, z_*)$ is preferred over the same gamble. In other words, at $s = z_*$, $\Delta_u > 0$ and $\Delta_c < 0$. We show that the TAA model allows for the uncertainty effect.

Claim 8 (Uncertainty Effect): There is an uncertainty effect, $\Delta_u > 0$ and $\Delta_c < 0$ at $s = z_*$ if $\alpha > \tau\left(1 + \frac{f(z^*) - f(z_*)}{g(z^*) - g(z_*)}\right)$.

Proof: From Equation (S6), $\Delta_u > 0$ implies $f(z^*) + g(z_*) > f(z_*) + g(z_*)$, which holds because f is monotonic. Meanwhile, $\Delta_c < 0$, implies $\tau\big(f(z^*) - f(z_*)\big) + (\alpha - \tau)\big[(f(z_*) + g(z_*)) - \big(f(z_*) + g(z^*)\big)\big] = \tau\big(f(z^*) - f(z_*)\big) - (\alpha - \tau)\big(g(z^*) - g(z_*)\big)$, which is negative if $\alpha > \tau\left(1 + \frac{f(z^*) - f(z_*)}{g(z^*) - g(z_*)}\right) = \tau\left(1 + \frac{\delta_f}{\delta_g}\right)$, where $\delta_f = f(z^*) - f(z_*)$ and $\delta_g = g(z^*) - g(z_*)$, as defined earlier. ■

Note: The uncertainty effect thus requires that α be suitably large relative to τ, or, put the other way, that τ be suitably small relative to α. To be a bit more precise, because $f'(z) < g'(z)$, it follows that $1 + \frac{\delta_f}{\delta_g} < 2$. Thus, the uncertainty effect can arise in a portion of the green region of Figure S1.5, since this region is bounded by $\alpha < 2\tau$, and in the entirety of the red region of that figure, which is defined by $\alpha > 2\tau$. Figure S1.7 updates Figure S1.5, by shading in orange rather than green the region in which there is an uncertainty effect while $\alpha < 2\tau$. Rendering this area in orange highlights that the uncertainty effect can arise with conventionally-directed crossmodal risk preferences, that is preferences by which the gamble becomes more attractive with decreasing s (which require $\alpha < 2\tau$).

What determines the size of the orange region? To answer this question, we once more consider the special case of prospect theory, setting $f(z) = wx^k$ and $g(z) = (1 - w)x^k$, where $w < .5$ and $k < 1$. The restriction $w < .5$ means that the probability weighting function is subcertain and this with a concave power function ensures risk aversion for actuarially fair unimodal gambles. Then, $\alpha > \frac{\tau}{1-w}$ is the region in which $\Delta_c < 0$ for $s = z_*$. If $w = .4$, then $\alpha > \frac{5}{3}\tau$ is needed for an uncertainty effect, which corroborates that the effect can hold with conventionally-directed preferences. It is also easy to see that as $w = \pi(.5)$ decreases, the number of combinations of τ and α that produce the uncertainty effect grows.

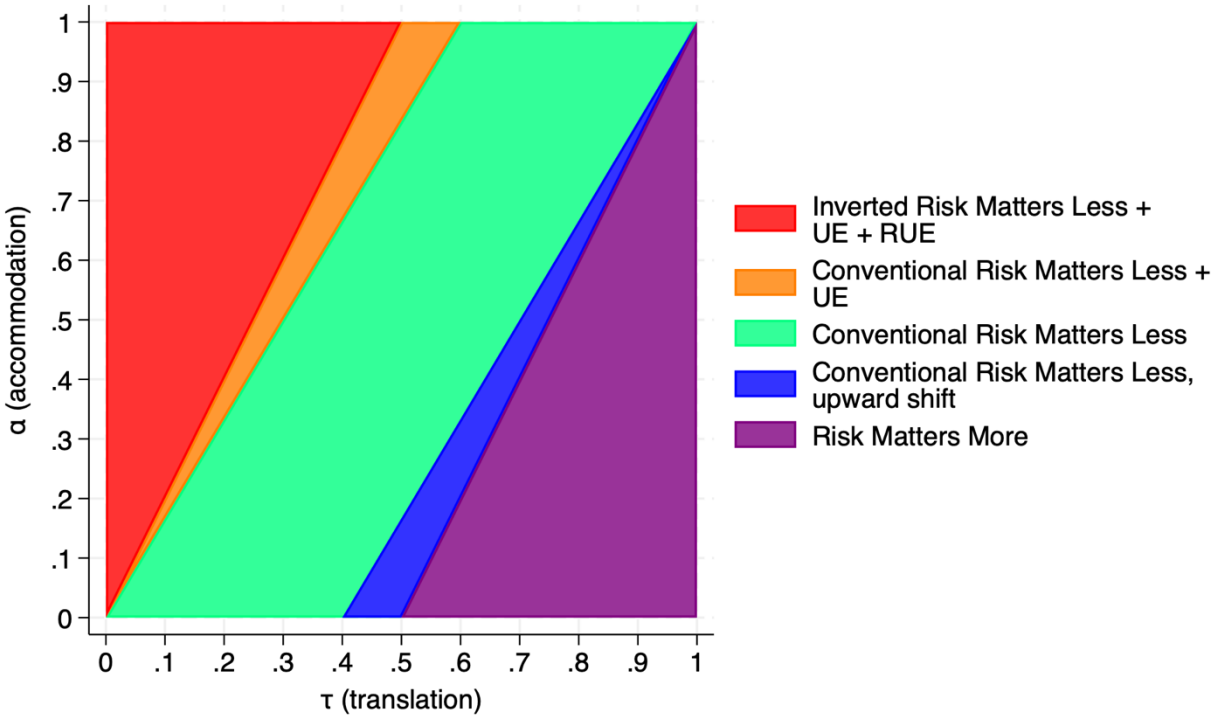


Figure S1.7. The figure indicates which combinations of τ and α can produce various preference patterns. The red region identifies parameters in which crossmodal preferences show an inverted interaction and which admit the possibility of an uncertainty and a reverse uncertainty effect. The orange region identifies parameters in which risk matters less produces a crossover interaction as well as an uncertainty effect. The green region identifies parameters in which risk matters less produces a crossover interaction, but in which there is no possibility for an uncertainty effect or a reverse uncertainty effect. The blue region identifies patterns in which risk matters less but for which there is an upward shift in risk preferences but not a crossover interaction. The purple region identifies parameters in which risk matters *more* for crossmodal preferences. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

The TAA model is also compatible with a "reverse uncertainty effect," by which a risky option is valued above its best possible outcome; that is, a dominated risky option is valued more than a sure thing that stochastically dominates it. Again, see the main text for a discussion of demonstrations of this effect and the translation-and-accommodation psychology that can explain it. Here, we characterize a reverse uncertainty effect as a crossmodal but not unimodal preference for a gamble with outcomes z^* and z_* over the sure thing z^*.

Claim 9 (Reverse Uncertainty Effect): There is a reverse uncertainty effect, $\Delta_u < 0$ and $\Delta_c > 0$ at $s = z^*$ if $\alpha > \tau\left(1 + \frac{g(z^*)-g(z_*)}{f(z^*)-f(z_*)}\right)$.

Proof: From Equation (S6), $\Delta_u < 0$ implies $f(z^*) + g(z_*) < f(z^*) + g(z^*)$, which holds because f is monotonic. Meanwhile, $\Delta_c > 0$, implies $\tau\big(g(z_*) - g(z^*)\big) + (\alpha - \tau)\big[\big(f(z^*) + g(z^*)\big) - \big(f(z_*) + g(z^*)\big)\big] = -\tau\big(g(z^*) - g(z_*)\big) + (\alpha - \tau)\big(f(z^*) - f(z_*)\big)$, which is positive if $\alpha > \tau\left(1 + \frac{g(z^*)-g(z_*)}{f(z^*)-f(z_*)}\right) = \tau\left(1 + \frac{\delta_g}{\delta_f}\right)$, where $\delta_f = f(z^*) - f(z_*)$ and $\delta_g = g(z^*) - g(z_*)$, as defined earlier. ■

Note 1: The condition for Claim 9, the Reverse Uncertainty Effect, $\alpha > \tau\left(1 + \frac{\delta_g}{\delta_f}\right)$, is similar to the condition for Claim 8, the Uncertainty Effect, $\alpha > \tau\left(1 + \frac{\delta_f}{\delta_g}\right)$. Since $f'(z) < g'(z)$, $\alpha > \tau\left(1 + \frac{\delta_g}{\delta_f}\right) > 2$, while $\tau\left(1 + \frac{\delta_f}{\delta_g}\right) < 2$. Thus, the weaker condition $\alpha > 2\tau$, which prevails in the red region of Figure S1.7, produces inverted crossmodal preferences that slope downward. In other words, if there is risk aversion for unimodal fair gambles, then a reverse uncertainty effect can arise only given inverted preferences rather than conventionally-directed preferences. (However, see Figure S1.9 below for an illustration of the case in which there is risk seeking for unimodal fair gambles.)

Note 2: It is straightforward to show that if $\alpha > 2\tau$, then there exists an $s > z^*$ such that $\Delta_c < 0$ as well as an $s < z_*$ such that $\Delta_c > 0$. That is, pairs of α and τ that produce a reverse uncertainty effect also produce an uncertainty effect.

Figure S1.8 provides an example of crossmodal preferences that belong in the orange region of Figure S1.7 and thus produce an uncertainty effect. It also provides an example of crossmodal preference that belong in the red region and produce both an uncertainty and reverse uncertainty effect. Building on previous figures of the same kind, this figure considers a sure thing, s, that

may vary from a high of 110, which exceeds the gamble's superior outcome of 100, to a low of 40, which is less than the gamble's inferior outcome of 50. The figure also adds two new greyed regions. The negative shaded region on the right-hand reflects preferences that favor a sure thing lying between 40 and 50 over the stochastically dominating gamble. In other words, this region demarcates the uncertainty effect. The positive shaded region on the left-hand reflects preferences that favor the gamble over a stochastically dominated sure thing lying between 100 and 110. In other words, this region demarcates the reverse uncertainty effect.

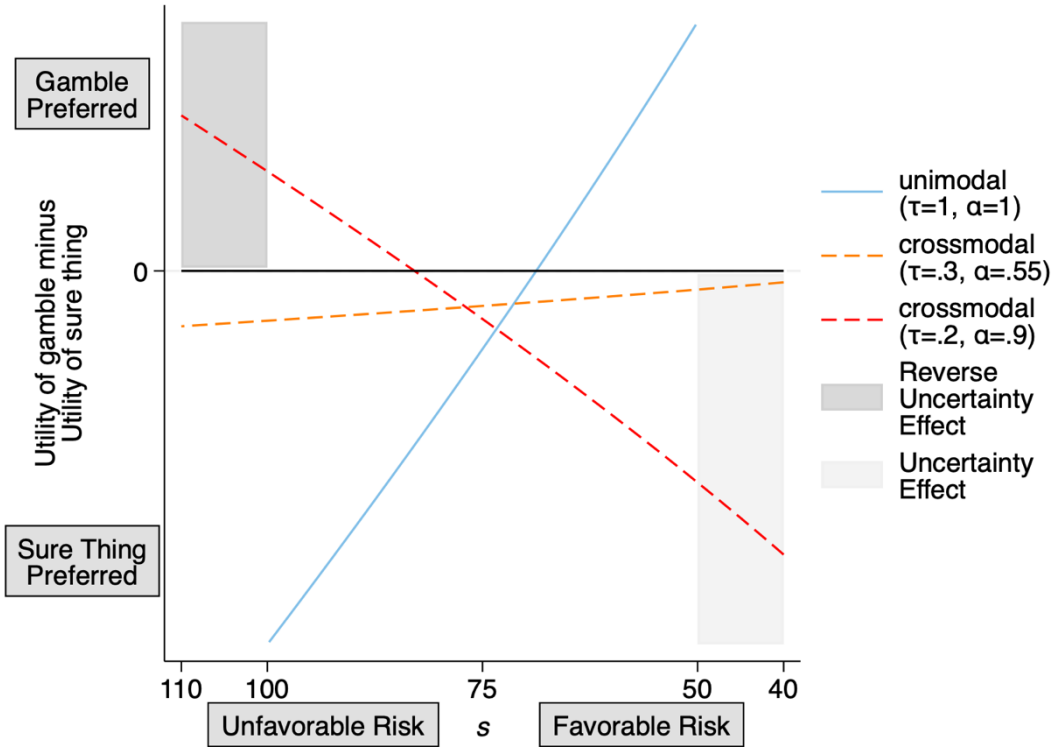


Figure S1.8. The figure illustrates how combination of τ and α can produce an uncertainty effect and a reverse uncertainty effect. The plot examines how unimodal (Equation (S4)) and crossmodal (Equation (S7)) preferences change as a function of the sure thing, s, where s is decreasing from left to right. For crossmodal preferences, the orange line illustrates $\tau = .3$ and $\alpha = .55$. These preferences exhibit risk mattering less crossmodally and a crossover interaction. They also exhibit an uncertainty effect, a crossmodal preference for the sure thing, $s < 50$, over the stochastically dominating gamble. The red line produced by $\tau = .2$ and $\alpha = .9$ has an inverted interaction. In addition, it yields an uncertainty effect, as just defined, as well as a reverse uncertainty effect, a crossmodal preference for the gamble over the stochastically dominating sure thing, $s > 100$. Note: The figure assumes the parametric specification, $f(z) = .4z^{.7}$ and $g(z) = .6z^{.7}$.

As before, unimodal preferences, which correspond to $\tau = \alpha = 1$, are depicted by the light blue line. The dashed orange line reflects crossmodal preferences with $\tau = .3$ and $\alpha = .55$, which satisfies $2\tau - 1 < \alpha < 2\tau$. Accordingly, it is shallower than the light blue unimodal line, indicating lesser crossmodal sensitivity, and it is upward sloping, indicating that preferences are conventionally-directed rather than directionally-inverted. In addition, it intersects the light grey, right-hand region, indicating preferences that allow for an uncertainty effect. It is easy to glean from this line that conventionally-directed preferences that yield an uncertainty effect cannot yield a reverse uncertainty effect.

The dashed red line (which is repeated from Figure S1.3) reflects $\tau = .2$ and $\alpha = .9$. It satisfies $2\tau - 1 < \alpha$ but not $\alpha < 2\tau$. Accordingly, it is shallower than the light blue unimodal line, reflecting lesser crossmodal sensitivity, but it is also downward sloping, reflecting inverted preferences. In addition, it intersects both grey regions, reflecting preferences that allow for both an uncertainty and reverse uncertainty effect.

Referring back to Figure S1.7 helps summarize our analysis. We have distinguished five regions:

- Red: This region allows for lesser crossmodal sensitivity in the form of an interaction, an uncertainty effect, and a reverse uncertainty effect. However, it also produces inverted preferences by which a gamble become relatively more attractive as the sure thing against which it is pit improves.

- Orange: This region is consistent with our observations of lesser crossmodal sensitivity in the form of a crossover interaction and also permits an uncertainty effect. However, it does not permit a reverse uncertainty effect.

- Green: This region is consistent with our observations of lesser crossmodal sensitivity in the form of a crossover interaction. However, it does not permit an uncertainty effect nor a reverse uncertainty effect.

- Blue: This region is consistent our observation of lesser crossmodal sensitivity. However, it does not produce the interaction observed in our studies, by which there is less crossmodal aversion to unfavorable risk but more crossmodal aversion to favorable risk. Contrary to our data, yet consistent with findings from Martin et al. (2016), this

region yields a main effect of upward shift by which crossmodal preferences are always less risk averse than unimodal preferences. In addition, this region does not permit an uncertainty effect nor a reverse uncertainty effect.

- Purple: This region is *inconsistent* with our empirical results: It produces more crossmodal sensitivity to variation in the gamble and sure thing, not less.

Finally, it is worth visualizing how different levels of unimodal risk aversion and even some degree of unimodal risk seeking impact the size of the different regions. Figure S1.7 depicted the various regions, assuming prospect theory with a weighting function such that $w(.5) = .4$.

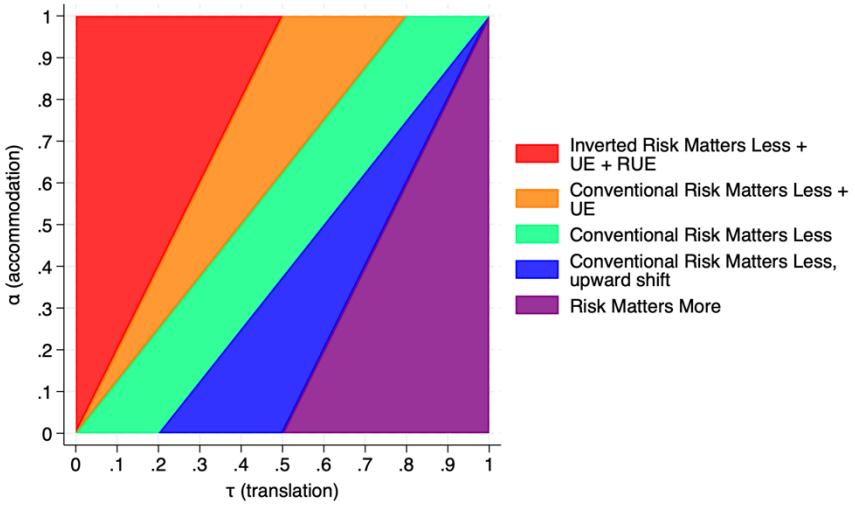
The upper right panel of Figure S1.9 repeats this assumption (and is thus a replica of Figure S1.7). But the three additional panels assume different values of $w(.5)$.

The upper left panel considers $w(.5) = .2$, which induces more pronounced unimodal risk aversion. Relative to the upper right panel, the blue region becomes larger: that is, more combinations of τ and α yield a main effect of greater crossmodal risk seeking rather than a crossover interaction. The orange region also becomes larger: more combinations of τ and α give rise to risk mattering less in the form of a crossover interaction while also allowing for the uncertainty effect.

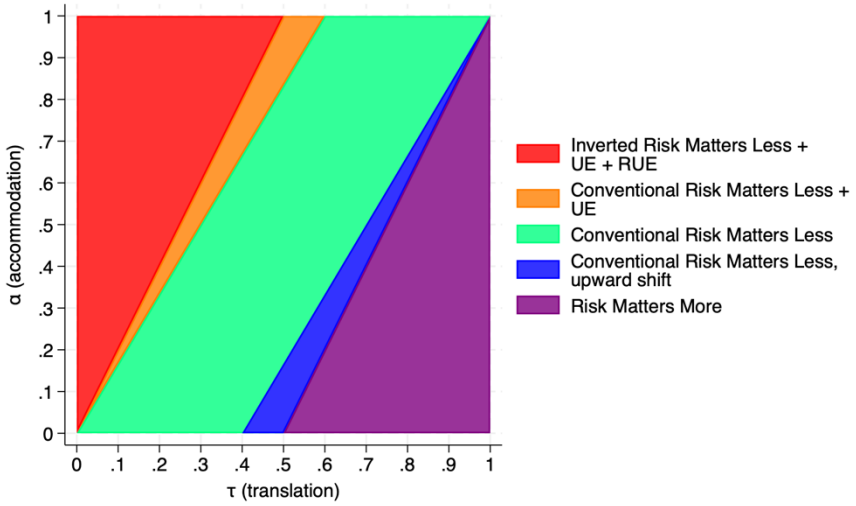
The lower left panel considers $w(.5) = .48$, which is near the risk neutral benchmark of .5. Moving from $w(.5) = .4$ toward risk neutrality shrinks the blue and orange regions.

The lower right panel considers $w(.5) = .6$, which pushes unimodal preferences toward risk seeking. Given such unimodal behavior, crossmodal preferences change substantially. The bright green region in the figure corresponds to risk mattering less, but with the *reverse crossover interaction* from our data: more crossmodal risk aversion for unfavorable and fair risk, less crossmodal aversion for sufficiently favorable risk. We term this pattern, "unconventional" risk mattering less. Furthermore, the blue and orange regions disappear completely. The orange region is replaced by a yellow region in which both the unconventional version of risk mattering less and

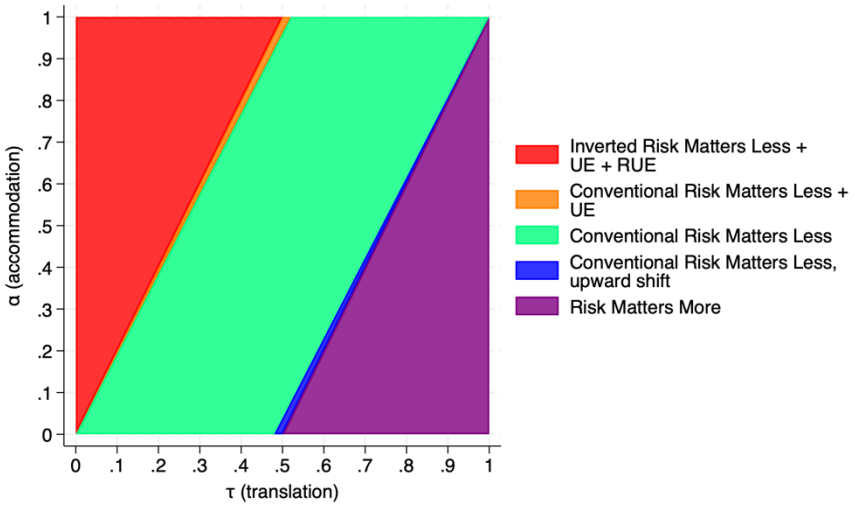
the reverse uncertainty effect prevail. The blue region is replaced by a light blue region in which there is a main effect of greater crossmodal risk aversion.



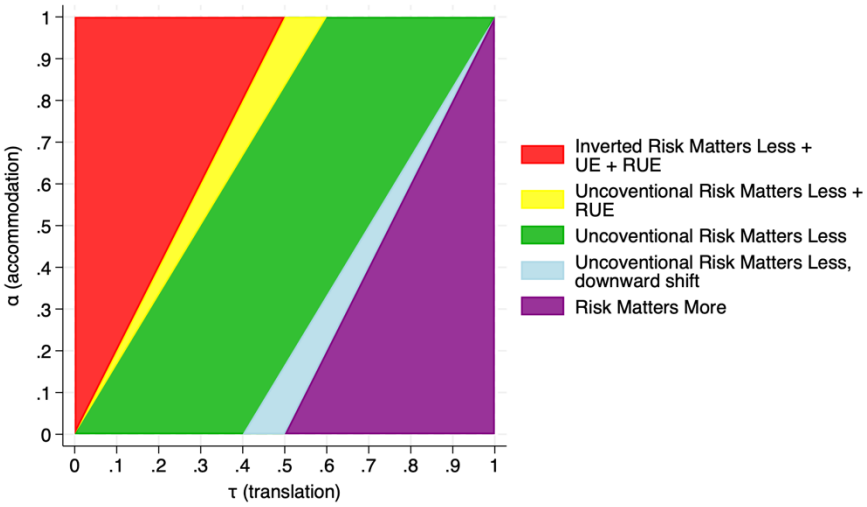
$(a)\ w = .2$



$(b)\ w = .4$



$(c)\ w = .48$



$(d)\ w = .6$

Figure S1.9. How different degrees of unimodal risk aversion and risk seeking influence the combinations τ and α that give rise to various crossmodal patterns. The upper right panes assumes the parametric specification, $f(z) = wz^{.7}$ and $g(z) = (1-w)z^{.7}$, with $w = .4$. Under prospect theory, w is a measure of unimodal risk aversion for actuarially fair gambles. The other panels assume $w = .2$ (more pronounced unimodal risk aversion), $w = .48$ (near unimodal risk neutrality) and $w = .6$, unimodal risk seeking.

Supplemental Material, Part 2: Additional Studies

When Crossmodal Options Only Differ Qualitatively

In the main text, we considered crossmodal decisions whose potential outcomes differ both qualitatively and quantitatively. Here we enlarge our scope to crossmodal decisions whose potential outcomes only differ qualitatively. To extend the translate-and-accommodate model to this setting, we denote a sure thing as $(0, M, 0)$ and a gamble offering outcomes that differ qualitatively from both M and each other as $[(H, 0,0), (0,0, L)]$. H, M, and L can be thought of as indicator variables that capture whether a given product, experience, etc. is part of a gamble or a sure thing. For instance, in a later experiment, we will consider choices between a sure webcam and a binary gamble that can yield either a thermos or a pair of high-quality headphones; these three products are arguably sufficiently distinct that they may be perceived as apples-to-oranges to one another.

Our formulation, as earlier, considers the gamble's advantages and disadvantages compared to the sure thing and represents crossmodal preferences as:

$$[(H, 0,0), (0,0, L)] \succ (0, M, 0) \Leftrightarrow f_H(H) - f_M(M) > g_M(M) - g_L(L). \quad \text{(E1)}$$

Assuming $H \succ M \succ L$, Equation (E1) states that the gamble is preferred over the sure thing if "upside risk," $f_H(H) - f_M(M)$, exceeds "downside risk," $g_M(M) - g_L(L)$. However, as before, we generalize this representation to separate translation and risk accommodation. We do so as follows:

$$\begin{aligned}[(H, 0,0), (0,0, L)] \succ (0, M, 0) \Leftrightarrow\ & \tau\big[\big(f_H(H) + g_H(H)\big) - \big(f_M(M) + g_M(M)\big)\big] \\ & + \tau\big[\big(f_L(L) + g_L(L)\big) - \big(f_M(M) + g_M(M)\big)\big] \\ & - \alpha\big[\big(g_H(H) - g_M(M)\big) + \big(f_L(L) - f_M(M)\big)\big] > 0. \quad \text{(E2)}\end{aligned}$$

In Equation (E2), the first bracketed term, $\big(f_H(H) + g_H(H)\big) - \big(f_M(M) + g_M(M)\big)$, compares sure receipt of H to sure receipt of M, while the second, $\big(f_L(L) + g_L(L)\big) - \big(f_M(M) + g_M(M)\big)$, compares sure receipt of L to sure receipt of M. Together, these terms constitute a riskless translation. However, because H and M are not available with certainty, the final bracketed term corrects for risk. It is a revision from the sure comparisons that places the overall assessment in line with the likelihood of receiving either gamble outcome. By this representation, it is as if, for instance, a person choosing between a sure webcam and a headphones-thermos gamble considers how they feel about each product, and also accommodates for the possibility that they might receive the headphones or the thermos.

In Part 1 of this Supplemental Material, we have detailed a companion unimodal representation. We showed that given $2\tau - 1 < \alpha$, the same restriction on τ and α that appeared in other versions of the model, the representation in Equation (E2) implies the patterns of insensitivity to risk that we have emphasized. That is, crossmodal preferences will show less aversion to actuarially fair and unfavorable risk and more aversion to actuarially favorable risk. Put differently, if between-dimensions translation is rough and risk accommodation is diluted neither too little nor too much, the translate-and-accommodate model again accounts for the interaction by which risk matters less crossmodally.

We next experimentally examine a setting in which crossmodal outcomes differ only qualitatively, while unimodal outcomes again differ only quantitatively.

Study S2a

Examining crossmodal decisions whose outcomes differ only qualitatively and not quantitatively requires a new methodology. The methodology used for Studies 1a – 1f's simple

problems involving common household products cannot be applied because it leveraged quantitative differences. In particular, that methodology achieved a correspondence between crossmodal and unimodal decisions by using the same outcomes in both modalities. It put together qualitatively distinct outcomes, like Tide detergent and Oxo containers, to form crossmodal decisions and kept them separate to form unimodal decisions. However, without quantitative differences, unimodal decisions cannot be formed that way – there can be no decisions involving a single product and no quantitative differences. A different approach is thus required to achieve a correspondence between unimodal and crossmodal decisions.

In the present study, this correspondence is created by having each participant explicitly match the subjective values of the crossmodal and unimodal outcomes they choose among. The study employs a variant of a design previously used by Martin et al. to examine crossmodal choices (2016; see also DeJarnette, 2022) and that had been introduced by Pachur and Galesic (2013). to study affective influences on responses to probability. Participants begin by indicating their willingness-to-pay (WTP) for a single unit of each of a number of different products. Denote three products by H, M, and L, and suppose a particular participant's WTPs for them are $\$_H > \$_M > \$_L$. Like previous researchers (McGraw, Shafir, & Todorov, 2010; Pachur, Hertwig, & 2014; Suter, Pachur & Hertwig, 2016; Pachur, Suter, & Hertwig, 2017, Rottenstreich & Hsee, 2001), we assume each product and its WTP to be of matched subjective value for this participant (we will relax this assumption in Study S2b). We therefore have the participant make a unimodal monetary choice between sure receipt of $\$_M$ and an even chance of receiving either $\$_H$ or $\$_L$ as well as a corresponding crossmodal product choice between sure receipt of M and an even chance at H or L.

Closely related to their facilitating outcome matching, WTPs can be taken as a measure of preference intensity. When WTPs for two products are close, the higher-WTP item may be slightly preferred to the lower-WTP item. When the WTPs are far apart, the higher-WTP item may be markedly preferred. Thus, whereas our initial studies did not measure preference intensity, the present study attempts to do so, allowing us to control for this factor in our analysis.

Indeed, we use WTPs and preference intensity to identify the risk level of a gamble. As $\$_M$ varies from near $\$_H$ to precisely halfway between $\$_H$ and $\$_L$ to near $\$_L$, the risk level of corresponding monetary and product gambles moves from unfavorable to fair to favorable. If $\$_M$ is much closer to $\$_H$ than to $\$_L$, then the equal-likelihood gamble between H and L offers substantially unfavorable risk: The outcome of higher attractiveness, H, is barely better than sure thing M, but the less attractive outcome, L, is a lot worse. Conversely, if $\$_M$ is much closer to $\$_L$ than to $\$_H$, the risk is substantially favorable: relative to the sure thing M, the inferior L is hardly worse but the superior H is a lot better.

It is useful to again contrast the null hypothesis of no systematic unimodal-crossmodal divergence with the hypothesis that risk matters less crossmodally. As before, the null hypothesis is rooted in classic axioms of independence and substitution. Given that available monetary amounts and products are equated at the level of individual participants, the axioms may be interpreted as requiring that these stimuli be evaluated equivalently. That is, at any risk level, the fraction of participants choosing the gamble over the sure thing should be statistically equivalent across money and products. Also as before, our alternative predictions run contrary to the principles captured by independence and substitution. Risk should matter more in monetary choices, which are unimodal, than in product choices, which are crossmodal and should give rise to translation-and-accommodation. We therefore predict an interaction that is conceptually

identical to that of Studies 1a – 1f. At unfavorable and fair risk levels, gambles should be chosen more frequently in product choices than monetary choices. Yet, at sufficiently favorable risk levels, they should be chosen less frequently.

Finally, with affect-driven probability distortion and neglect in mind, we wanted to disentangle the possibility of risk mattering less because products differ qualitatively from the possibility of risk mattering less because the products we used were relatively affect-rich. As detailed later in this Supplemental Material (Part 2, page 38), we thus conducted an addendum study in which a separate group of participants (who did not take part in the main study) initially set WTPs for each product. These participants were then asked to imagine that they received the products, the WTP amounts in cash, 80% of the WTPs, and 50% of the WTPs. They rated how happy they would be to receive each product and cash amount (the same rating task has been used in studies of affect-driven insensitivity to probability; see, e.g., Pachur, Suter, & Hertwig, 2017). Happiness ratings were lower for the products than for the WTPs. They were also lower for the products than for 80% and 50% of the WTPs. Therefore, to the extent that our findings will show risk mattering less in product decisions than monetary decisions, we conclude that this effect may be attributable to the products we use differing qualitatively but not to them being relatively affect-rich.

Method

Participants

We recruited participants at a university lab on the U.S. West Coast. They took part in return for course credit. We pre-registered to run the study through the end of the day on which the 300th participant arrived. We ended up with 340 participants. Given pre-registered exclusions,

we arrived at a final sample of 251 (M_{age} = 20.8, 59.6% female). As we fully explain below, the bulk of exclusions, 66, were participants whose WTP responses did not allow us to construct meaningful sure thing versus gamble choices for them. In addition, 23 participants failed an attention check.

Materials and Procedure

We employed a wholly within-participant design consisting of three tasks. First, participants indicated the maximum amount they would be willing-to-pay (WTP) for four different products: a Logitech webcam, a Thermos, Bose headphones, and an Alera tilt chair. Then, they completed Monetary Choice and Product Choice tasks in a randomized order. As mentioned, we used a participant's WTP responses to construct their monetary and product choices. For any subset of three products for which a participant provided three distinct WTPs, we constructed a corresponding product choice and monetary choice. The middle-priced product or middle WTP served as the sure thing and the remaining products or WTPs served as the gamble outcomes.

Each participant was presented with every monetary and product choice that could be constructed for them. Because a quartet of products can be split into four distinct subsets of three, any participant who provided a different WTP for each product was presented with four monetary and four product choices. In contrast, for any participant who provided only three unique WTPs for the four products, it was only possible to construct a single, undominated monetary choice and two undominated product choices. Such participants were presented with these three choices. Furthermore, it was impossible to construct undominated monetary choices for any participant who provided only one or only two distinct WTPs for the four products. Therefore, such participants were not presented with any choices. 66 participants were excluded because we could not construct choices for them.

We included distractors in each of the three tasks. For the WTP assessment, along with the four target products, participants priced four additional products. These additional products were not included in any subsequent choice. In both monetary and product choice, participants encountered four distractor decisions, involving pre-determined monetary amounts and products other than those for which they had provided WTPs. The distractors are detailed in the Supplemental Material, Part 3, Section 3.4. Within each task, the set of targets and distractors was presented in a randomized order.

After providing WTPs and choices, participants provided demographic information and completed an attention check. Precise wording of instructions, screen shots, and other concrete aspects of the study may also be found in the Supplemental Material, Section 3.4.

Results

As a preliminary, define a gamble attractiveness index (*GAI*) as follows. For any choice, let c_M denote the amount of sure cash available or the WTP of the sure product. Let c_H and c_L be similarly defined for the worst and best outcomes of the gamble. Consider $GAI = \frac{c_H - c_M}{c_H - c_L}$. The higher is this index, the more attractive is the gamble relative to the sure thing. With undominated choices GAI must lie strictly between 0 and 1. For fair gambles, $GAI = .5$. In our data, the mean GAI across all choices was 0.63, and the interquartile range was $[.45, .83]$.

Figure S2.1 plots the percentage of participants who choose the item and cash gambles as a function of *GAI*. Collapsing across all choices, participants selected more product gambles (57.9%) than monetary gambles (53.2%) ($z = 2.01,\ p = .044$, repeated measures logit). In other words, as in our initial studies, we observe behavior consistent with Martin et al.'s main effect.

We also observe the two patterns by which risk matters less crossmodally, lesser recoiling from fair risk and lesser variation across levels of risk. Figure S2.1 shows that for approximately fair risk, product gambles were more popular than monetary gambles ($z = 3.63,\ p < .001$ for $.45 \leq\ GAI \leq .55$, repeated measures logit). Put differently, consistent with risk mattering less crossmodally, there is less crossmodal than unimodal aversion to approximately fair risk. Indeed, crossmodal preferences are essentially risk neutral: given $.45 \leq\ GAI \leq .55$, the percentage of crossmodal choices favoring the gamble is 53.2% ($n = 94$). In contrast, for the same GAI interval, unimodal preferences are markedly risk averse: the percentage of unimodal choices favoring the gamble is only 29.8% ($n = 94$), a figure which is in line with risk aversion rates obtained in the most recent generation of papers examining 50-50 cash choices (Abdellaoui, Baillon, Placido, & Wakker, 2010; Erev, Ert, Plonsky, Cohen, & Cohen, 2017; Noussair, Trautmann, & van de Kuilen, 2014; Peterson, Bourgin, Agrawal, Reichman, & Griffiths, 2021; Rabin & Weizäcker, 2009).

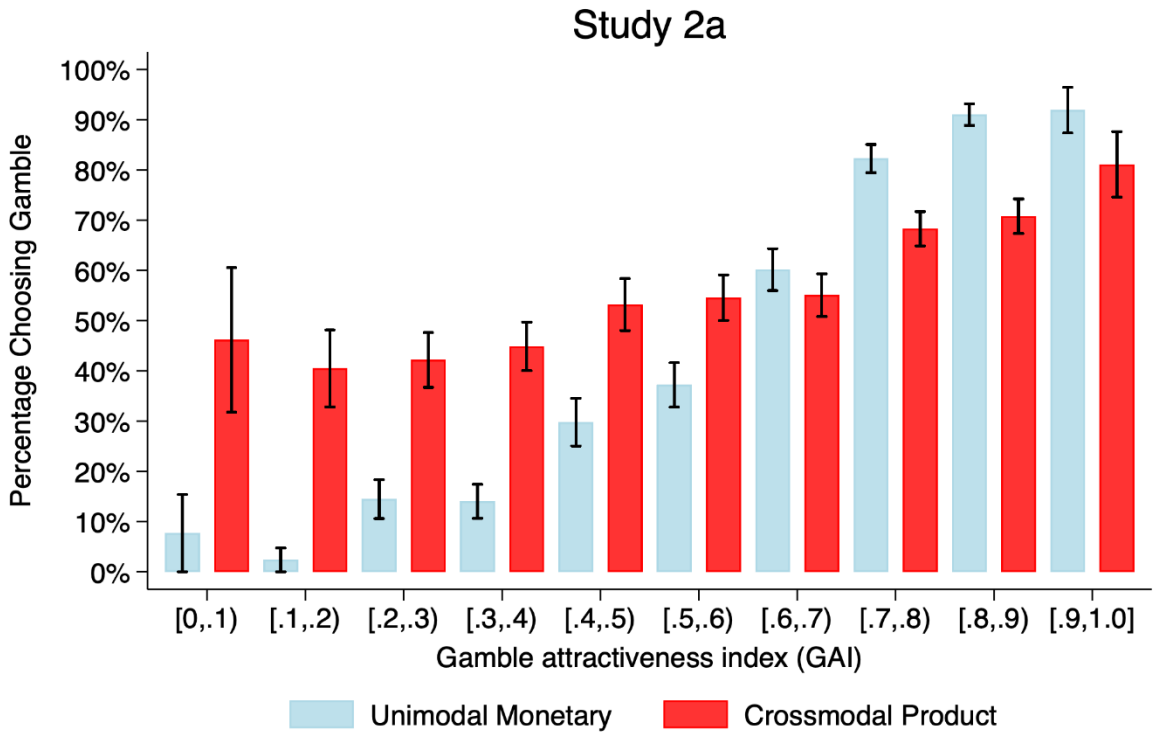


Figure S2.1. Study S2a Results. The percentage of participants choosing the gamble as a function of the gamble attractiveness index (*GAI*). Choices are binned by type, unimodal monetary versus crossmodal product, and *GAI*, [0,.1), [.1,.2), etc. with error bars indicated +/- one standard error.

When $GAI \leq .5$ and hence risk is unfavorable, product gambles (44.2%) are more popular than monetary gambles (15.5%) ($z = 7.36,\ p < .001$, repeated measures logit). Nevertheless, when $GAI > .5$ and hence risk is favorable, monetary gambles (70.6%) are more popular than product gambles (64.2%) ($z = 2.30,\ p = .022$, repeated measures logit).

To further assess statistical significance, we conducted a repeated-measures logistic regression with the selected option (1 for gamble, 0 for sure thing) as the dependent variable. The predictor variables were GAI, a dummy variable indicating whether the choice involved products (1) or cash (0), and the interaction of these two terms. We clustered standard errors at the level of individual participants to account for the repeated measures. There was an unsurprising, significant effect of GAI ($\beta = 7.63,\ z = 13.61,\ p < .001$). In addition, there was a significant

main effect of greater crossmodal gambling ($\beta = -3.73,\ z = 9.20,\ p < .001$). Most importantly, this main effect was qualified by a significant interaction with gamble attractiveness ($\beta = 5.49,\ z = 9.17,\ p < .001$). These results are robust to analyses using probit, OLS, or mixed effects regressions (see Table S2.1).

Study	Analysis	Hypothesis: Interaction in risk seeking between gamble attractiveness and modality ($\chi^2(1)$ or F)
S2a	Logit	84.15
S2a	Probit	86.80
S2a	Linear Probability Model	95.14
S2a	Mixed effects logit random intercept	109.39

Table S2.1. Robustness analysis for aggregate results for Study S2a using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants for logit, probit, and linear probability). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

Discussion

In our initial studies, the potential outcomes of crossmodal decisions differed both qualitatively and quantitively, while unimodal outcomes differed only quantitatively. In Study S2a, crossmodal outcomes differed only qualitatively, while unimodal outcomes still differed only quantitatively. Nevertheless, we again observed the predicted interaction: crossmodal preferences were less averse to fair and unfavorable risk but more averse to favorable risk. That is, crossmodal preferences showed less distaste for fair and unfavorable risk but also less appetite for favorable risk.

These patterns of crossmodal insensitivity are consistent with translation-and-accommodation but not easily accommodated by the alternative accounts of preference intensity,

noisy decision processes, and superior product reference points. Regarding preference intensity, by having participants match unimodal and crossmodal stimuli via WTPs, we explicitly measure this variable and control for it in our analysis. Regarding noise, the elicitation of WTPs is also relevant. There is much evidence that WTPs for products have modest test-retest reliability (Schaafsma et al., 2014; Shiell & Hawe, 2006). That is, they are quite noisy. However, the noisiness of WTPs seems more prone to obscure a unimodal/crossmodal divergence than to induce it. It is likely that many unimodal decisions in our study, whose outcomes are elicited WTPs, instantiate a meaningfully different level of risk than their crossmodal counterpart, whose outcomes are the products for which WTPs are elicited. But there is no evidence that WTPs are biased in a manner that would give rise to our results. The necessary bias would have to be quite intricate. Relative to products a participant deems least and most attractive (which in our design tend to end up as the outcomes of prospects), the bias would have to assign systematically too-high WTPs to some products of middling attractiveness (the product which tend to end up as the sure things in the case of unfavorable or fair risk) and systematically too-low WTPs to other products of middling attractiveness (the products which tend to end up as the sure things in the case of favorable risk). Finally, much as in our earlier studies, the possibility that products are often evaluated from superior reference points, such as the best item in the relevant category, can account for weakened crossmodal risk aversion when GAI is low but not strengthened crossmodal risk aversion when GAI is high.

Addendum to Study S2a – Affect Rating

Given findings on affect-driven probability distortion and neglect, as an addendum to Study S2a, we wanted to disentangle two possible causes for risk mattering less for product choices than

corresponding cash choices: that the products and cash differed qualitatively, per our hypothesis, and that the products were more affect-rich.

We thus had a new group of participants set WTPs for each product, just as Study S2a participants had done. Recall, that with many caveats, we took the products and their WTPs as equivalent in subjective value. We further asked the new participants to imagine that they received the products, cash amounts equal to the WTP amounts they had set, .8 times those amounts, and .5 times those amounts. Participants then rated how happy they would be to receive each product and cash amount. We used a rating task that has previously been used in studies of affect-driven probability distortion and neglect (see, e.g., Pachur, Suter, & Hertwig, 2017).

Happiness ratings were lower for the products than for the cash amounts equal to the products' WTPs. They were also lower for the products than for 80% and 50% the WTPs. Therefore, risk mattering less in product choices than cash choices in Study S2a may be attributable to the products in question differing qualitatively but not to them being relatively affect-rich.

Method

Participants

We recruited participants from a behavioral lab at a public Western U.S. university. They took part in return for course credit and completed the study remotely. We pre-registered to run the study for one week. We ended up with 209 unique participants. In accord with pre-registered exclusions, we cut one participant who failed an attention check and thus arrived at a final sample of 208 (M_{age} = 26.50, 59.13% female).

Materials and Procedure

Like Study S2a, the study was implemented via Qualtrics and contained three tasks. As before, participants assigned WTPs to four different products shown in a random order: Bose

headphones, a Thermos, an Alera tilt chair, and a Logitech webcam. They then completed the affect-rating tasks in a counterbalanced order: either first for all four products (again shown in a random order) and then for all of the cash amounts (ordered randomly) or vice versa.[3] An example product rating question is "Imagine receiving a Thermos Stainless King 16-Ounce Travel Tumbler. How happy would you be?" 1 = Not happy at all, 10 = Very happy). An example cash rating question is "Imagine receiving $20. How happy would you be?" 1 = Not happy at all, 10 = Very happy."

Note that participants could provide ratings for up to 12 cash amounts: their WTP for each of four products, 80% of each of their WTPs, and 50% of each of their WTPs. However, some participants rated fewer cash amounts: if an individual provided the same WTP for two different products then they only rated that cash amount once. Similarly, they only rated 80% and 50% of that amount once.

Near the end of the study, participants provided demographic information and completed an attention check. Instructions and screenshots can be found in Section 3.4.7 of these Supplemental Material.

Results

Consider the results aggregated across all four products. Table S2.2 displays mean ratings and standard deviations. Figure S2.2 displays rating histograms. They show that participants tended to rate themselves as happier from receipt of cash amounts than from receipt of corresponding products. Participants were happier with receiving the WTP they had set for a product ($M = 6.52$) than with receiving that product ($M = 8.40$, $t(206) = 14.24$, $p < .001$, $d =$

[3] Due to an error in our Qualtrics code, participants did not provide ratings for a product if they stated that their WTP for it was $0.

0.990). Moreover, to the extent to which participants were happier to receive cash is robust. They were happier to receive 80% of their stated WTP rather than the corresponding product, ($t(207) = 11.07$ $p < .001$, $d = 0.770$), and even merely 50% of their stated WTP ($t(207) = 7.43$, $p < .001$, $d = 0.516$).

Item	Mean [Median] WTP ($)	Mean Happiness Ratings			
		Product	WTP	80% of WTP	50% of WTP
Bose Headphones	150.19 [130]	8.23 (2.01)	9.11 (1.44)	8.72 (1.77)	8.43 (1.86)
Thermos Travel Tumbler	26.04 [25]	5.27 (2.57)	7.14 (2.44)	6.90 (2.57)	6.50 (2.87)
Alera Chair	101.37 [82.50]	6.40 (2.55)	8.81 (1.680)	8.35 (1.92)	7.97 (2.09)
Logitech Camera	118.80 [70]	6.12 (2.70)	8.64 (1.82)	8.37 (1.99)	7.94 (2.37)
Aggregate		6.51 (2.69)	8.41 (2.03)	8.09 (2.20)	7.66 (2.43)

Table S2.2. Happiness ratings from the affect rating addendum to Study S2a

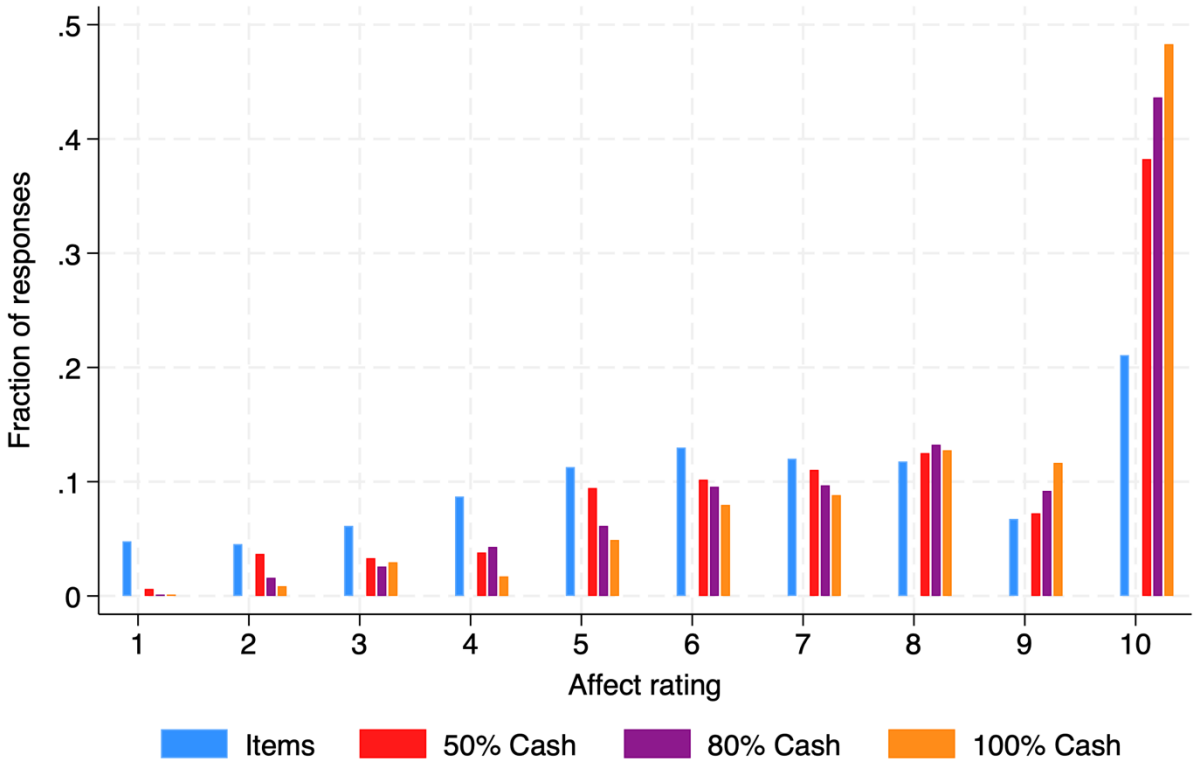


Figure S2.2. Histograms of happiness ratings from the affect rating addendum to Study S2a

This aggregate pattern held for each individual product and corresponding cash amounts. Figure S2.3 presents histograms by product. Furthermore, relative to their WTPs, all four products yielded significantly lower happiness ratings: Bose headphones ($t(205) = 6.19$, $p < .001$), Thermos tumbler ($t(205) = 9.16$, $p < .001$), Alera chair ($t(204) = 12.87$, $p < .001$), and the Logitech camera ($t(198) = 13.45$, $p < .001$). Relative to 80% of their WTPs all four products still yielded significantly lower ratings: headphones, $t(205) = 3.23$, $p = .001$; tumbler, $t(205) = 7.72$, $p < .001$; chair, $t(204) = 10.21$, $p < .001$; camera, $t(198) = 11.76$, $p < .001$). At 50% of their WTPs, the same pattern held directionally for the headphones, $t(206) = 1.25$, $p = .211$. It remained significant for the remaining products: tumbler, $t(205) = 5.36$, $p < .001$; chair, $t(204) = 7.73$, $p < .001$; camera, $t(198) = 8.37$, $p < .001$).

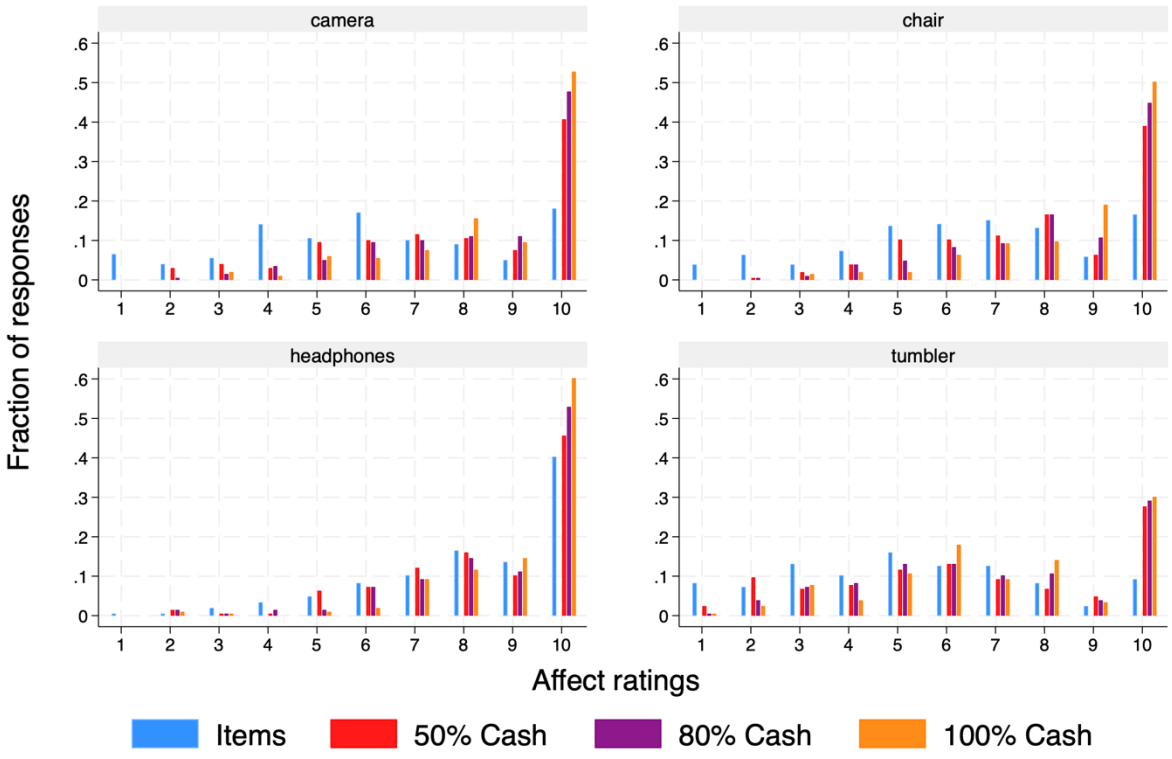


Figure S2.3. Histograms of happiness ratings, by item, from the affect rating addendum to Study S2a

Study S2b: Robust Matching

Study S2a examined crossmodal decisions whose potential outcomes differ only qualitatively. To do so, it formed a correspondence between unimodal and crossmodal outcomes by implementing within-participant matches of products and cash amounts. In particular, we had participants assign WTPs to products. Like previous researchers, we tentatively assumed that receiving a product and a matched cash amount were effectively equally attractive.

We have already noted that noise in how people set these cash amounts undermines the assumption that products and their cash amount are matched in subjective value (though we suggested that the presence of noise may not compromise our analysis and conclusions). It is also possible that there are systematic discrepancies between the subjective values of products and their matched cash amounts. With both noise and systematic discrepancies in mind, Study S2b implements a design that is more robust than that of Study S2a. This design yields statistical tests that are informative even if a product and its matched cash amount are not equally attractive.

The study also returns to crossmodal decisions whose outcomes differ both quantitatively and qualitatively. In particular, it contrasts unimodal monetary sure thing vs. monetary gamble choices with crossmodal product sure thing versus monetary gamble choices. The same monetary gambles appear in both choices. Thus, establishing a match only requires equating the sure things; by contrast, in Study S2a, establishing a match required equating three products with three monetary amounts. The reduction from a three-step to a one-step process presumably improves the resulting match, because there is less that can go awry. But, to reiterate, we are able to implement statistical tests of our predicted interaction that remain valid even if matches are systematically biased and do not equate sure things.

As with Study S2a, we wanted to disentangle the possibility of risk mattering less because products and cash amounts differ qualitatively from the possibility of risk mattering less because the products we considered were more affect-rich than sure money. We thus again conducted an addendum study to collect affect ratings of the products, their matched cash amounts, 80% of each cash amount, and 50% of each cash amount. New participants (who did not take part in the main study) rated how happy they would be to receive each product and cash amount. Happiness ratings were reliably lower for the products than for cash amounts. They were also reliably lower for the products than for 80% of the cash amounts, though not for 50% of the cash amounts. In sum, to the extent that our findings will show risk mattering less crossmodally, this effect cannot be attributed to the products we use being affect-rich. For full details of this addendum study, see the Supplemental Material, Part 2, page 57.

Method

Participants

Via TurkPrime, we recruited 307 US residents on Amazon Mechanical Turk. They were paid $1.25. Based on pre-registered exclusion criteria, we arrived at a final sample of 282 (M_{age} = 42.4, 48.2% female). Six participants were dropped because of incomplete responses, one due to having a repeat IP address, 16 because they completed the study on a phone, two because they failed an attention check.

Materials and Procedure

The study followed a 3 (Risk Level: Fair, Moderately Favorable, Very favorable) × 2 (Type of Decision: Unimodal or Crossmodal) entirely within-subjects design. In a preliminary phase, participants chose between products and sure cash amounts. We used this task to infer the amount

of money a participant deemed just as attractive as a given product – the participant's "cash equivalent" (CE) for that product. After completing the preliminary phase, participants were randomly assigned to encounter either crossmodal choices followed by unimodal choices or the reverse. In the crosmodal condition, they made choices between sure products and two-option, even-chance cash gambles; in the unimodal condition, they made choices between sure cash and two-option, even-chance cash gambles. The sure cash amounts were equal to the participant's CE for the corresponding product, rounded to the nearest dollar.

The preliminary phase proceeded as follows. Participants chose between each product and several cash alternatives. In particular, each product was pitted against a list of ten, increasing, equally-spaced cash amounts (i.e., a "price list"). Table shows the maximum and minimum of every list, as well as the difference between adjacent amounts. Thus, for example, participants selected between a Schwinn recumbent bike and $60, $90, $120, …, and $330. The maximum cash amounts were approximately equal to the products' online price at the time of the study.

We inferred a participant's CE for a product via interpolation. For instance, if someone selected $150 over a Schwinn recumbent bike but selected the bike over $120, we set that individual's CE at $135. However, if a participant chose a given product over every cash amount or chose every cash amount over the product, we termed their CE as "undefined." Critically, then, anybody who was either not particularly interested in a product or extremely interested in it was not assigned a cash equivalent for it. Furthermore, if a participant's choices were inconsistent, in the sense that the individual chose a smaller cash amount over the product but then chose the product over a larger cash amount, we also termed their cash equivalent "undefined."

Product	Minimum and Maximum of the 10 Cash Alternatives	Difference between Adjacent Cash Alternatives
Schwinn Recumbent Bike	$60 to $330	$30
AmazonBasics Office Chair	$8 to $53	$5
6 Quart Crockpot	$22 to $58	$4
Honeywell Tower Fan	$35 to $80	$5
GoWise Air Fryer	$15 to $105	$10
HP Printer Paper, 3 Reams	$5.25 to $9.75	$0.50
Xerox Printer	$65 to $200	$15
Nintendo Switch Lite	$75 to $165	$10
Samsung 65-inch TV	$120 to $750	$70
Black & Decker Dustbuster Vacuum	$15 to $60	$5

Table S2.3. A summary of the stimuli used in the preliminary task of Study S2b.

Each product and its price list appeared on a separate page. The products were presented in a randomized order. The left-right placement of the product and cash amounts was randomly set for each participant but held constant across products.

The crossmodal and unimodal conditions presented participants with choices connected only to those products for which they had a defined cash equivalent. Thus, from the set of products listed in Table , each participant made up to ten sure product-gamble choices and the same number of sure cash-gamble choices.

The gamble that a participant encountered in any given choice was randomly selected from three conditions: fair, moderately favorable, and very favorable. In the fair risk condition, the gamble outcomes were equal to 0.1 and 1.9 times the participant's CE for the relevant product, rounded to the nearest dollar. In the moderately favorable risk conditions, the multiples were 0.5 and 2.2, and in the very favorable condition they were 0.9 and 2.5. Thus, like Studies 1a – 1f, the present study manipulates rather than measures gamble attractiveness. Note that the gamble a participant encountered in a crossmodal choice frequently differed from the gamble a participant encountered in the corresponding unimodal choice (because each was separately randomly assigned a risk level).

As we have mentioned, participants were randomly assigned either to make all of their crossmodal choices and then all of their unimodal choices, or vice versa. Within each of these conditions, the order of the choices was determined randomly. The left-right placement of the options was determined randomly for each choice. Both the crossmodal and unimodal conditions included three distractor choices. Details are found in the Supplemental Material, Part 3, Section 3.5.

The instructions included examples from the preliminary cash equivalent task, crossmodal choice condition, and unimodal choice condition, using products, sure cash amounts and gamble cash outcomes that were not included in the core of the study. Near the end of the study, participants responded to an attention check, filled out a captcha, and provided demographic information. The instructions and additional methodological details can be found in the Supplemental Material, Part 3, Section 3.5.

Results

We first describe the cash equivalents (CEs). 36.9% of all responses did not yield a well-defined CE: 26.9% because the product was never chosen, 4.9% because the monetary amount was never selected, and 5.1% due to inconsistent choices (i.e., choosing a smaller cash amount over the product but the product over a larger cash amount). Thus, a substantial majority ($73\% = .269/.369$) of undefined CEs arose because participants were not particularly interested in the relevant product.

Furthermore, most participants showed meaningful variation in their CEs. For instance, among the final sample of 282 participants, only 18 individuals (6.6%) showed no cross-product variation in the position of their "crossover" (e.g., choosing every product over the smallest five cash amounts but not the largest five). See Figures S2.6, S2.7, and S2.8 for additional analysis of the cash equivalents.

Figure S2.4 shows the percentage of crossmodal and unimodal choices favoring the gamble, across different risk levels. Let $M_{CP,r}$ (respectively, $M_{\$,r}$) denote the fraction of gamble choices at risk level r when the sure thing is a consumer product (respectively, cash). As before, null hypotheses are rooted in principles embodied by independence and substitution axioms. A strong null hypothesis supposes that the preliminary, participant-level matching of product and cash sure things has succeeded: these options' attractiveness is on average equivalent. Then by independence and substitution, these options must remain equally attractive no matter what gamble they are pit against. That is, the difference $M_{CP,r} - M_{\$,r}$ should be zero for all r. A weak null hypothesis acknowledges that the preliminary phase may be imperfect (e.g., O'Donnell & Evers, 2019), so that, on average, product and corresponding cash sure things are not necessarily equally attractive. Nevertheless, independence and substitution imply that these options' relative

attractiveness must remain the same no matter what gamble they are pit against. That is, $M_{CP,r} - M_{\$,r}$ should be constant across r. Put differently, across risk levels, changes in crossmodal and unimodal preferences will be "parallel."[4]

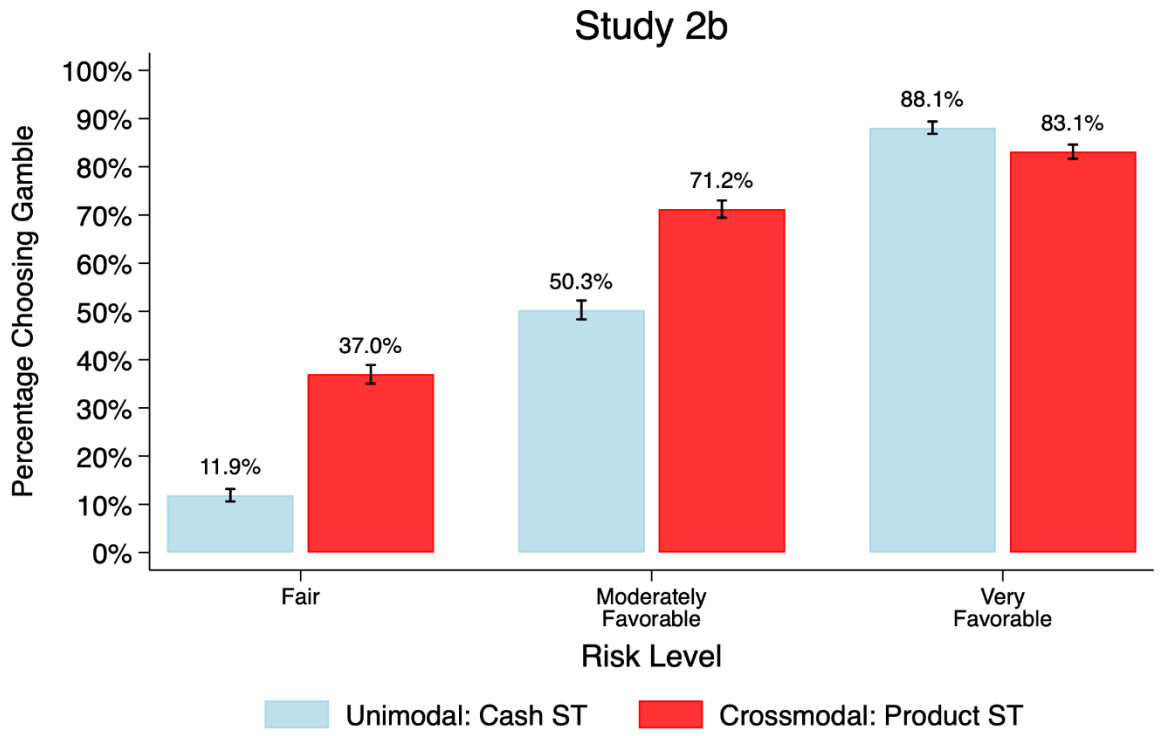


Figure S2.4. The percentage of Study S2b participants choosing the risky gamble, as a function of the type of choice, unimodal (cash sure things vs. cash gamble) or crossmodal (product sure things vs. cash gamble), and risk level. Black bars indicate +/- 1 standard error.

The notion that risk matters less crossmodally yields predictions that diverge from both the strong and weak null hypotheses. By this notion, crossmodal choices will show less recoiling from fair gambles than do unimodal choices. Thus, even if participant-level matching is successful, $M_{CP,r} - M_{\$,r}$ should be positive for fair risk. Also by this notion, crossmodal choices will show less variation: as the gambles offered become increasingly favorable, crossmodal preferences will

[4] However, because choice percentages become more restrictive near 0 and 1, the implementation of our test of "parallelism" uses the log-odds scale (and hence logit regression) rather than choice percentages.

develop less appetite for gambles than will unimodal preferences. Thus, whether or not participant-level matching is successful, $M_{CP,r} - M_{\$,r}$ should decrease with increasingly favorable risk. Put differently, the interaction we have stressed should materialize, so that across risk levels, changes in crossmodal and unimodal choices are not "parallel."

In accord with our analysis, when faced with fair risk, participants were more willing to accept gambles crossmodally ($M_P = .361$) than unimodally ($M_\$ = .112$) ($z = 8.17, p < .0001$, repeated measures logit). However, when faced with very favorable risk, the relationship flipped, participants were less willing to accept gambles crossmodally than unimodally ($M_P = .832 < M_\$ = .882$) ($z = 2.32, p = .021$, repeated measures logit). It is noteworthy that this pattern violates the stochastic independence axiom, $P(x, w) > P(y, w)$ if and only if $P(x, z) > P(y, z)$, which is equivalent to violating simple scalability (Tversky & Russo, 1969).

To test our prediction formally, let $C_{i,j,k}$ represent choice of the gamble (1) or sure thing (0). Here, $i = 1, \ldots, 10$ indexes the 10 products and paired cash equivalents; $j = \{P, \$\}$ indicates whether the sure thing is a product or cash; and $k = \{1,2,3\}$ indexes the risk levels, fair (1), moderately favorable (2), and very favorable (3). To assess our predictions, we create a set of dummy variables, $DUM_{i,j}$, which takes a value of 1 if the choice involves pair i and a sure thing of type j and 0 otherwise. In addition, we create a second set of variables, $RISK_{i,j} = DUM_{i,j} \times k$. We then conduct a logistic regression, predicting $C_{i,j,k}$ with $DUM_{i,j}$ and $RISK_{i,j}$ as predictors (with $\alpha_{i,j}$ and $\beta_{i,j}$ the corresponding regression coefficients), in which the regressions cluster standard errors at the participant level to control for participant effects. The regressions do not include an intercept, because $\alpha_{i,j}$ can be thought of an "intercept" which captures the likelihood (in log odds terms) that the fair risk gamble is chosen over a sure thing of type j in pair i. $\beta_{i,j}$ can be thought of as "slope" that captures how much more attractive the gamble is as it moves from fair risk to

moderately and then very favorable risk. To examine whether there is less aversion to fair risk given product than cash sure things, we test whether $\sum_{i=1}^{10} \alpha_{i,P} = \sum_{i=1}^{10} \alpha_{i,\$}$. Contrary to the strong null hypothesis, the equality is rejected. In other words, as depicted in the left-hand bars of Figure S2.4, under fair risk, there is significantly less aversion to gambling crossmodally than unimodally ($\chi^2 = 95.76, p < .0001$). To examine whether crossmodal choices are less responsive to increasingly favorable risk, we test whether $\sum_{i=1}^{10} \beta_{i,P} = \sum_{i=1}^{10} \beta_{i,\$}$. Contrary to the weak null hypothesis, this equality is also rejected ($\chi^2 = 51.69, p < .0001$). In other words, the interaction we have stressed materializes again: crossmodal preference show less distaste for fair risk but also less appetite for sufficiently favorable risk. That is, crossmodal choices are less averse to fair risk but more averse to sufficiently favorable risk.

The results just summarized hold under different specifications, including probit, linear probability model, and mixed-effect models with random intercepts (see Supplemental Material, Table S2.4). They also replicate when we restrict our sample by eliminating any participant who had *any* crossovers in their price lists, as well as participants who show no variation in their crossover point in the price list.

Figure S2.5 plots the data separately for each product. All ten products reveal both less crossmodal aversion to fair risk and the interaction by which crossmodal preferences are less responsive to changes in risk. 9 of the 10 products show a significant interaction at the standard $p < .05$. As with Studies 1a – 1d, considering individual products allows for an ordinal test that exploits the stochastic independence axiom, $\Pr(P \succ G_w) > \Pr(\$ \succ G_w)$ if and only if $\Pr(P \succ G_z) > \Pr(\$ \succ G_z)$, where G_w and G_z represent gambles from different risk levels. We find that 7 of 10 products yield a violation of this axiom when we compare fair risk to favorable

risk. Each violation will occur with .25 chance, and thus the overall pattern is statistically significant ($z = 2.92, p = .003$). Additional details are found in Table S2.4 and Table S2.5.

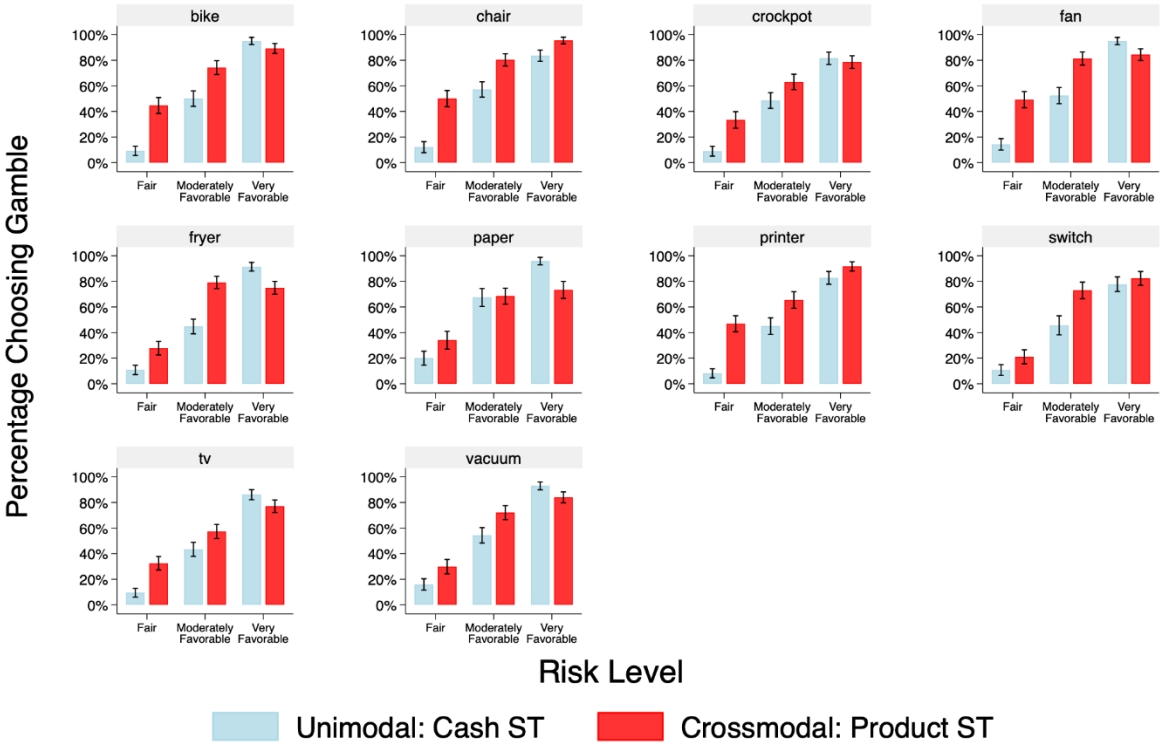


Figure S2.5. The percentage of Study S2b participants choosing the risky gamble for each of the ten items, as a function of the type of choice and risk level. Black bars indicate +/- 1 standard error.

Study	Analysis	Hypothesis: more risk seeking in crossmodal choices for fair risk gambles ($\chi^2(1)$ or F)	Hypothesis: Interaction in risk seeking between gamble attractiveness and modality ($\chi^2(1)$ or F)
S2b	Logit	95.76	51.69
S2b	Probit	103.48	60.28
S2b	Linear Probability Model	121.87	88.48
S2b	Mixed effects logit random intercept	142.49	62.28

Table S2.4. Robustness analysis for aggregate results for Study S2b using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants for logit, probit, and linear probability). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

Study	Product Number	Product	Hypothesis: more risk seeking in crossmodal choices for fair risk gambles ($\chi^2(1)$)	Hypothesis: Interaction in risk seeking between gamble attractiveness and modality ($\chi^2(1)$ or F)
S2b	1	Bike	26.26^{***}	11.90^{***}
S2b	2	Chair	17.27^{***}	.58
S2b	3	Crockpot	9.87^{**}	4.85^{*}
S2b	4	Fan	22.11^{***}	11.97^{***}
S2b	5	Fryer	16.09^{***}	10.53^{**}
S2b	6	Paper	5.60^{*}	10.49^{**}
S2b	7	Printer	18.39^{***}	4.38^{*}
S2b	8	Switch	3.15	0.00
S2b	9	TV	14.04^{***}	11.44^{***}
S2b	10	Vacuum	8.37^{**}	4.57^{*}

Table S2.5. Analyses for Study S2b for 10 different products. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

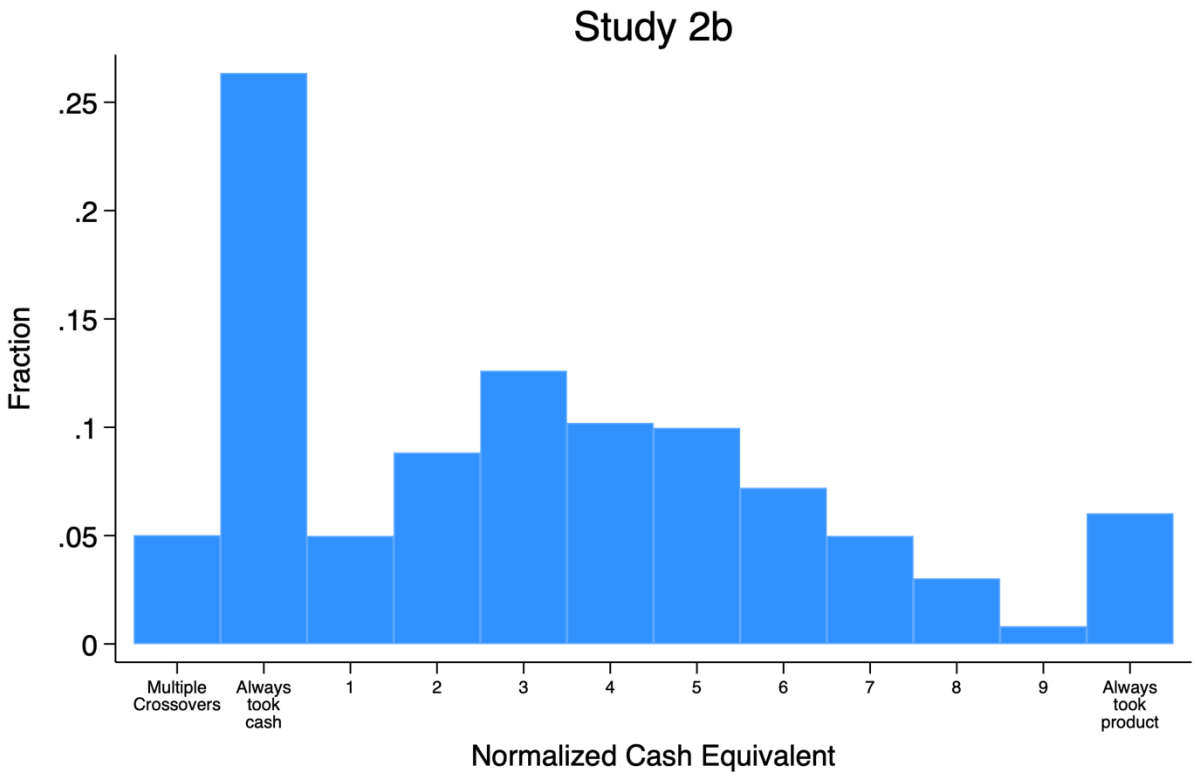


Figure S2.6. Histogram of normalized cash equivalents for Study S2b. Histogram shows fraction of participants, for each item, who had multiple crossovers, always selected the cash in the price list, and always selected the product in the price list. The number refers to the number of cash options that a participant rejected over the prize. For example, "3" indicates that a participant took the product over the lowest three cash amounts in the price list, and the cash for amounts high than that.

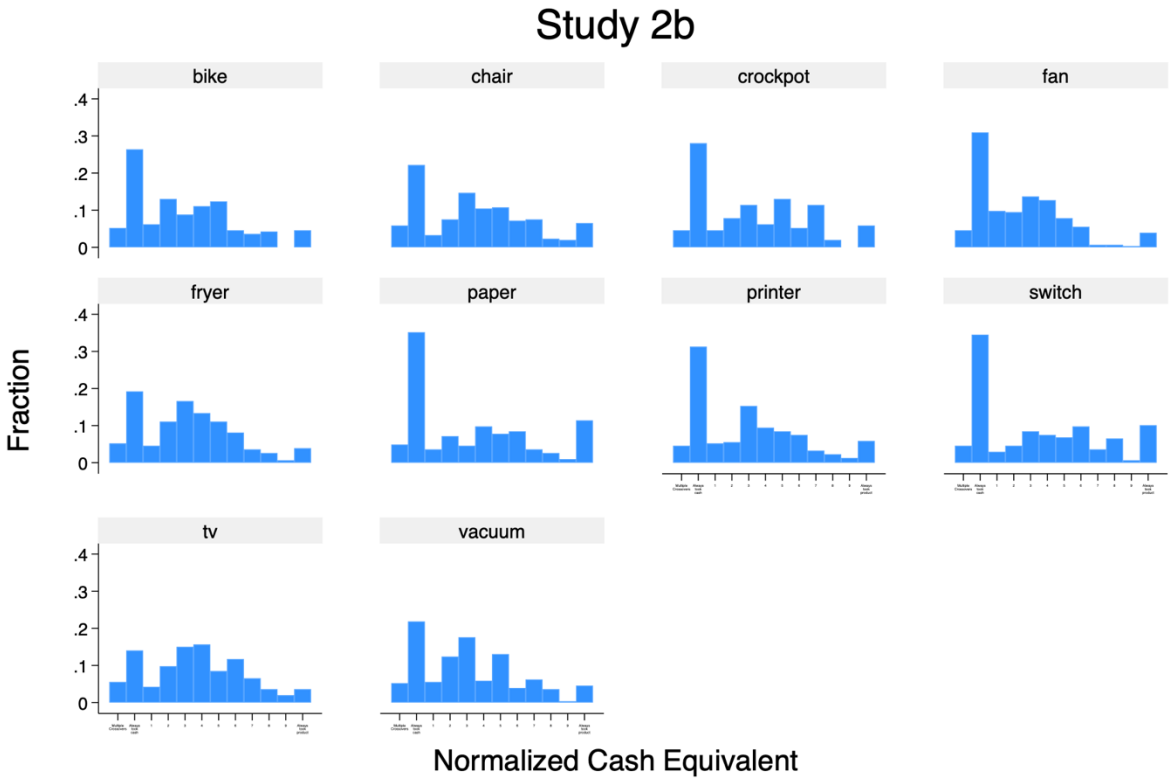


Figure S2.7. Histogram of normalized cash equivalents for Study S2b, broken down by each of the 10 products.

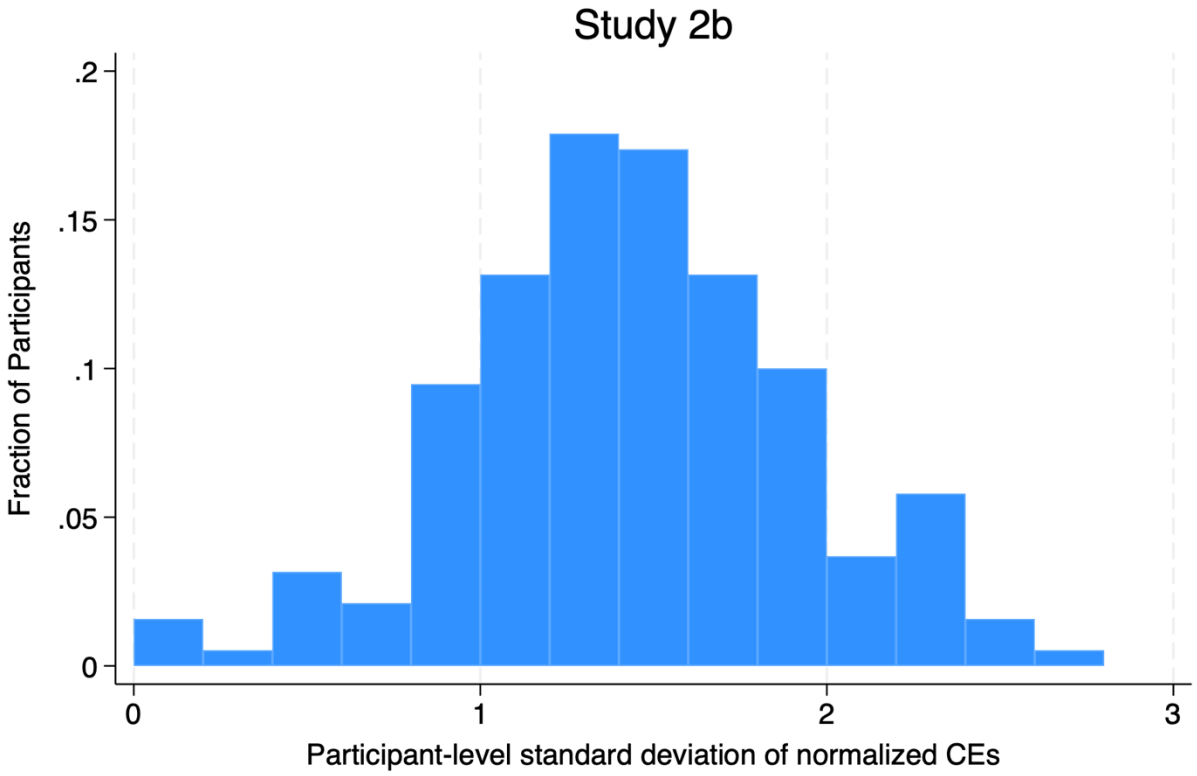


Figure S2.8: Histogram of the standard deviation of normalized cash equivalents in Study S2b. Standard deviations are calculated at the level of participants for the normalized cash equivalents.

Discussion

In accord with our earlier studies, we again find that risk matters less crossmodally. Crossmodal decisions show less recoiling from unfavorable and fair risk. Yet, as risk becomes increasingly favorable, they do not develop as much appetite for it.

As before, our results are consistent with translation-and-accommodation, but not easily explained by alternative explanations concerning preference intensity, noisy decision processes, and superior product reference points. Regarding preference intensity, the preliminary phase of the present study employs a streamlined, one-step process for participant-level matching of product and cash sure things. This process aims to eliminate the possibility that participants prefer either type of sure thing over the other. Yet, however streamlined the process is, it may be imperfect.

The method for equating products and cash equivalents may still be biased, so that participants tend to prefer products over their cash equivalent, or vice versa. Biased matching can thus account for lesser crossmodal aversion to fair risk, that is products outperforming cash equivalent against fair gambles. However, it cannot account for the interaction by which lesser crossmodal risk aversion wanes and eventually flips, so that cash equivalents outperform products against highly favorable gambles.

Likewise, noisy decision processes do not readily mesh with our results. We have suggested that constructing crossmodal preferences may be more complex and therefore noisier than constructing unimodal preferences. One might then expect that the fraction of participants choosing the gamble would tend to be closer to .5 crossmodally than unimodally. Yet, in the moderately favorable condition, the percentage choosing the gamble is 71.2% crossmodally and 50.3% unimodally.

Finally, as we have emphasized, the possibility that products are often evaluated from superior reference points, such as the best item in the relevant category, implies lesser crossmodal aversion to all gambles. However, our data include greater crossmodal aversion to highly favorable gambles.

Addendum to Study S2b – Affect Rating

As we did with Study S2a, we now present an affect-rating addendum to Study S2b. In Study S2b itself, crossmodal choices pit a sure product against a cash gamble, while unimodal choices pit sure cash against the same gamble. The sure product and cash were matched, by having participants make product-sure cash choices from which we inferred a given participant's cash equivalent (CE) for every product. We wanted to corroborate that risk mattered less crossmodally

in that study because the sure products and cash gambles differed qualitatively and not because the sure products were more affect-rich than their sure cash equivalents.

Indeed, happiness ratings were lower for the products than for the CEs. They were also lower for the products than for 80% of the CEs. They were non-significantly greater for products than for 50% of the CEs. Thus, though not quite as robust as in the addendum to Study S2a, the tendency to be happier with cash than with products was again pronounced. Therefore, risk mattering less in product choices than cash choices in Study S2b may be attributable to the products in question differing qualitatively but not to them being relatively affect-rich.

Methodology

Participants

We recruited participants from Prolific in exchange for $1.60. We pre-registered to run 200 participants prior to exclusions. We ended up with 201 unique participants. Given pre-registered exclusions, we arrived at a final sample of 190 (M_{age} = 43.93, 52.63% female). None of the participants failed the attention check, but 11 did not provide coherent valuations for any good.

Materials and Procedure

In a preliminary phase, participants chose between products and various sure cash amounts (exactly as in Study S2b itself). We used this task to infer the amount of money a participant deemed just as attractive as a given product – the participant's "cash equivalent" (CE) for that product. We considered all ten products from Study S2b (see Table S2.6 here).

The remaining elements of our design exactly mirrored the affect rating addendum for Study S2a. After completing the preliminary phase, participants completed product and cash affect ratings. The wording of the rating questions was the same. Participants rated their CE for each product, 80% of that amount, and 50% of that amount.

Instructions and screenshots can be found in section 3.5.7 of these Supplemental Material.

Results

Consider the results aggregated across all ten products. Table S2.6 displays mean ratings and standard deviations. Figure S2.9 displays rating histograms. They show that participants tended to rate receipt of cash as making them happier than receipt of corresponding products. Participants were happier with receiving a product's cash equivalent (CE) than with receiving the product ($t(189) = -6.37$, $p < .001$, $d = 0.462$). They were also happier receiving 80% of the CE than with receiving the product ($t(189 = -3.43$, $p < .001$, $d = 0.249$). However, they were non-significantly happier with the product than with 50% of its CE ($t(189) = 1.40$, $p = .165$, $d = .101$).

Item	Happiness Ratings			
	Product	**CE**	**80% CE**	**50% CE**
Schwinn Recumbent Bike	7.28 (2.38)	9.15 (1.30)	8.85 (1.45)	8.01 (1.79)
AmazonBasics Office Chair	5.14 (2.62)	6.56 (2.70)	6.14 (2.80)	5.61 (2.92)
6 Quart Crockpot	6.66 (2.38)	6.88 (2.44)	6.56 (2.52)	5.94 (2.72)
Honeywell Tower Fan	7.28 (2.27)	7.41 (2.24)	6.99 (2.53)	6.25 (2.75)
GoWise Air Fryer	7.36 (2.08)	7.42 (2.17)	7.09 (2.36)	6.26 (2.64)
HP Printer Paper, 3 Reams	4.64 (2.54)	4.65 (2.82)	4.44 (2.93)	4.22 (2.91)
Xerox Printer	7.15 (2.34)	8.90 (1.47)	8.55 (1.74)	7.77 (2.06)
Nintendo Switch Lite	8.17 (1.81)	9.04 (1.42)	8.46 (1.71)	7.82 (2.12)
Samsung 65-inch TV	9.10 (1.31)	9.76 (0.64)	9.60 (0.88)	9.32 (1.22)
Black & Decker Dustbuster Vacuum	6.78 (2.34)	6.70 (2.59)	6.36 (2.68)	5.77 (2.80)
Aggregate	7.07 (2.51)	7.75 (2.50)	7.41 (2.63)	6.80 (2.80)

Table S2.6. Happiness ratings from the affect rating addendum to Study S2b
Note: Values in parentheses correspond to standard deviations.

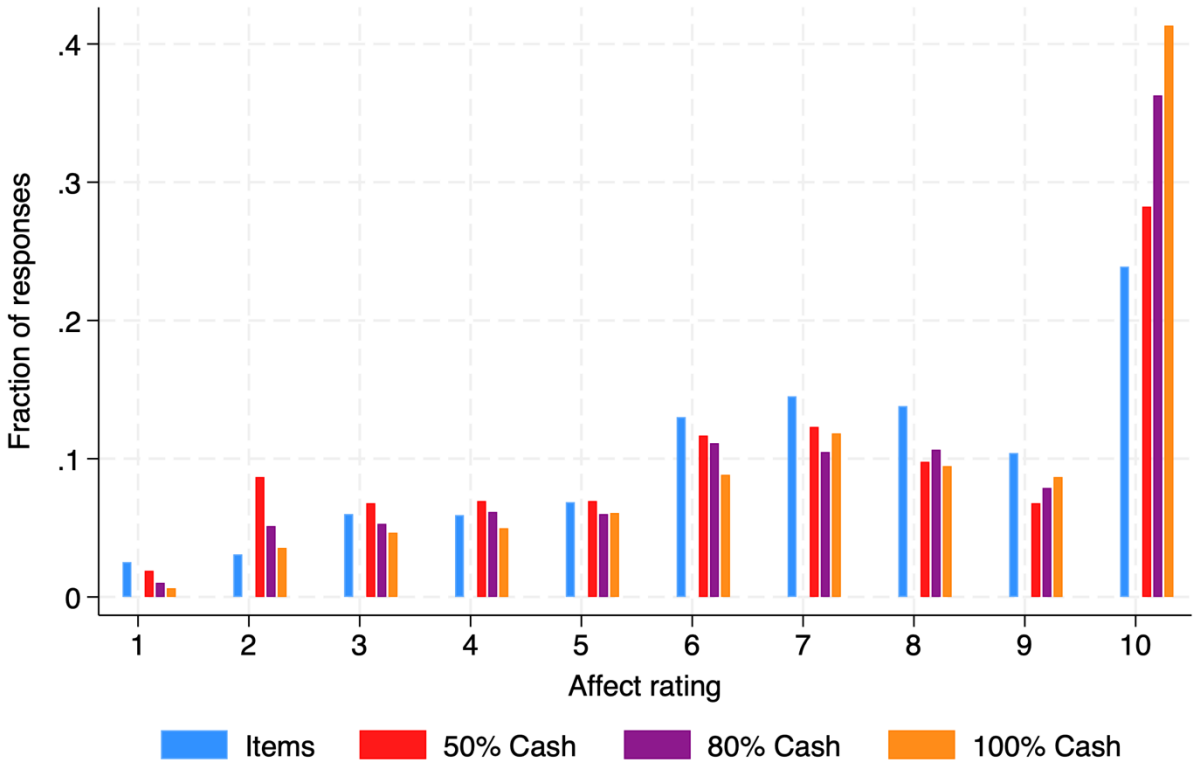


Figure S2.9. Histograms of happiness ratings from the affect rating addendum to Study S2b

This aggregate pattern generally held for each product and corresponding product, though there was some variation. Table S2.7 presents the results of paired *t*-tests for each product and corresponding cash amounts. Figure S2.10 presents histograms by product.

Product	Compared against…		
	CE	80% of CE	50% of CE
Schwinn Recumbent Bike	-9.15***	-7.68***	-3.37**
AmazonBasics Office Chair	-4.94***	-3.44***	-1.65
6 Quart Crockpot	-1.02	0.43	2.94**
Honeywell Tower Fan	-0.66	1.40	4.47***
GoWise Air Fryer	-0.32	1.29	4.88***
HP Printer Paper, 3 Reams	-0.04	0.69	1.43
Xerox Printer	-7.82***	-6.11***	-2.54*
Nintendo Switch Lite	-5.38***	-1.68^	1.73^
Samsung 65-inch TV	-6.52***	-4.49***	-1.94^
Black & Decker Dustbuster Vacuum	0.44	2.19*	4.77***

Table S2.7. Paired *t*-test results from the affect rating addendum to Study S2b.
Note: Positive t-statistics indicate that the happiness rating for the product was higher than the happiness rating for the corresponding cash amount. Negative t-statistics indicate the reverse.
$^{\wedge}\ p < .10,\ ^{*}\ p < .05,\ ^{**}\ p < .01,\ ^{***}\ p < .001$

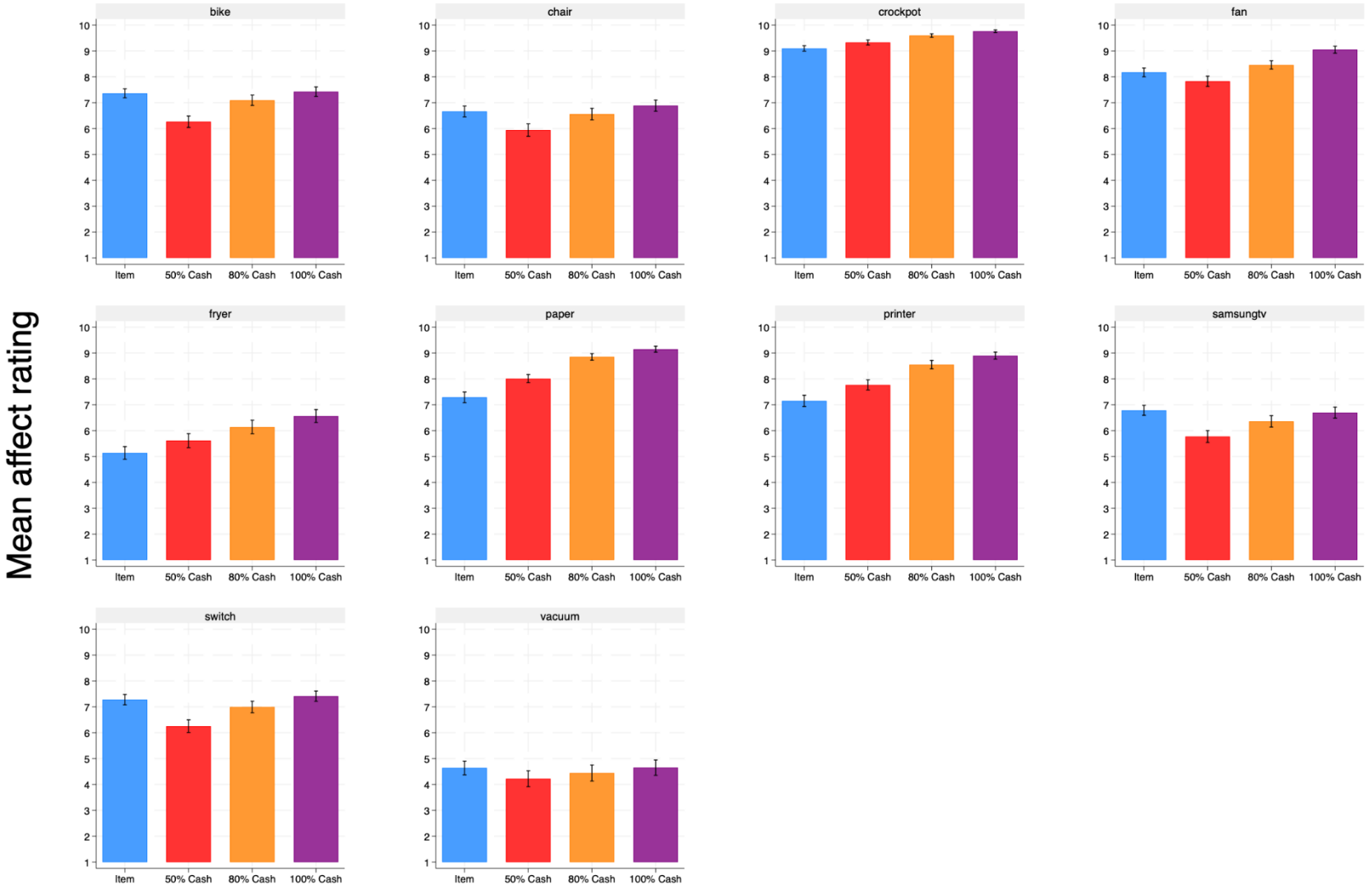


Figure S2.10. Histograms of happiness ratings, by item, from the affect rating addendum to Study S2b

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Supplemental Material, Part 3: Study Materials

3.1. Study 1a Details

3.1.1. Study 1a Instructions

Thank you for participating in this study.

Please take your time and read all instructions carefully. Your thoughtful responses are appreciated.

== Page Break

On each of the following pages, we ask you to make a choice involving consumer items and coin flips.

== Page Break

For example, would you rather receive 2 packs of Godiva chocolate truffles for sure OR flip a coin to determine what you receive? If the coin lands HEADS, you would receive 3 packs of truffles. If it lands TAILS, you would receive 1 pack of truffles.

2 packs of Godiva truffles ○ ○ **HEADS → 3** packs of Godiva truffles
TAILS → 1 pack of Godiva truffles

== Page Break

As another example, would you rather receive 1 Brita Pitcher for sure OR flip a coin? If the coin lands HEADS, you would receive 3 packs of Godiva truffles, but if it lands TAILS, you would receive nothing.

1 Brita Pitcher ○ ○ **HEADS → 4** packs of Godiva truffles
TAILS → Nothing

== Page Break

In the choices that follow, there are no wrong answers. We are interested in your opinions. (choices start on next page)

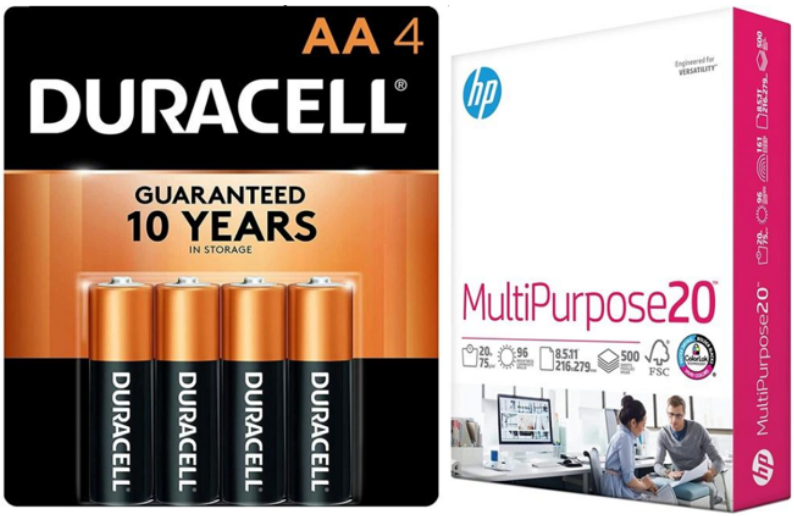
3.1.2. Study 1a Stimuli

Figures S3.1A and S3.1B include screenshot examples of unimodal choices and crossmodal choices in Study 1a.

Figure S3.1A. The unimodal decisions generated by the Tide-Oxo item pair in Study 1a.

Figure S3.1B. The crossmodal decisions generated by the Tide-Oxo item pair in Study 1a.

3.1.3. Study 1a Products Used



Product Pair 1 (Batteries and Ream of Paper)

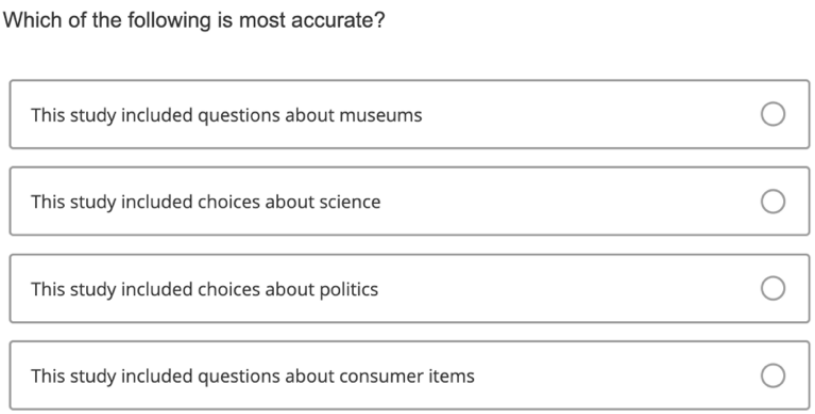
Product Pair 2 (Skinny Pop Popcorn and Paper towels)

Product Pair 3 (Tide vs Oxo Containers)

3.1.4. Study 1a Distractor Choices

Product Number	Choices	Sure Thing	Gamble
1	Batteries	2 packs of batteries	Heads: 4 packs of batteries Tails: 1 pack of batteries
2	Paper	2 reams of paper	Heads: 5 reams of paper Tails: 1 ream of paper
3	Brawny	3 rolls of Brawny	Heads: 5 rolls of Brawny Tails: 2 rolls of Brawny
4	Wipes	4 cannisters of wipes	Heads: 5 cannisters of wipes Tails: 2 cannisters of wipes
5	Skinny Pop	3 bags of Skinny Pop	Heads: 4 bags of Skinny Pop Tails: 1 bag of Skinny Pop
6	Wipes vs Skinny Pop	2 cannisters of wipes	Heads: 4 bags of Skinny Pop Tails: 1 bag of Skinny Pop
7	Pretzel Crisps vs Brawny	2 bags of Pretzel Crisps	Heads: 5 rolls of Brawny Tails: 1 roll of Brawny
8	Tide vs Batteries	3 bottles of Tide	Heads: 5 packs of batteries Tails: 2 packs of batteries
9	Paper vs Oxo Containers	4 reams of paper	Heads: 5 Oxo containers Tails: 2 Oxo containers
10	Batteries vs Pretzel Crisps	3 bags of Pretzel Crisps	Heads: 4 packs of batteries Tails: 1 pack of batteries
11	Brita Pitcher vs Godiva Truffles	1 Brita Pitcher	Heads: 1 pack of Godiva truffles Tails: Nothing
12	Godiva Truffles vs Brita Pitcher	1 pack of Godiva truffles	Heads: 1 Brita Pitcher Tails: Nothing

3.1.5. Attention Checks and Demographics



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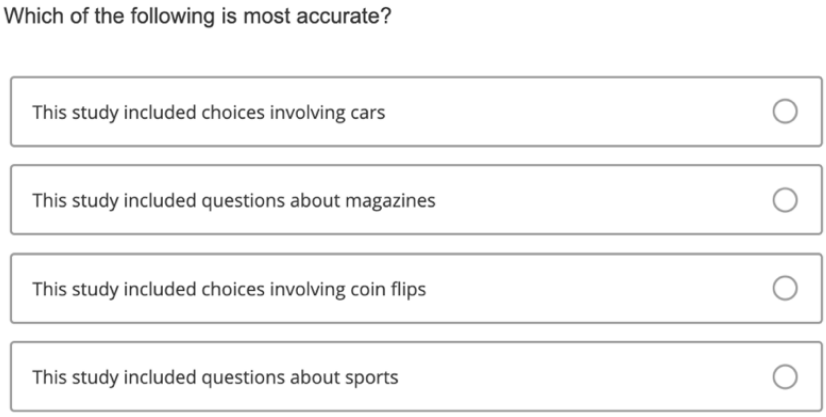

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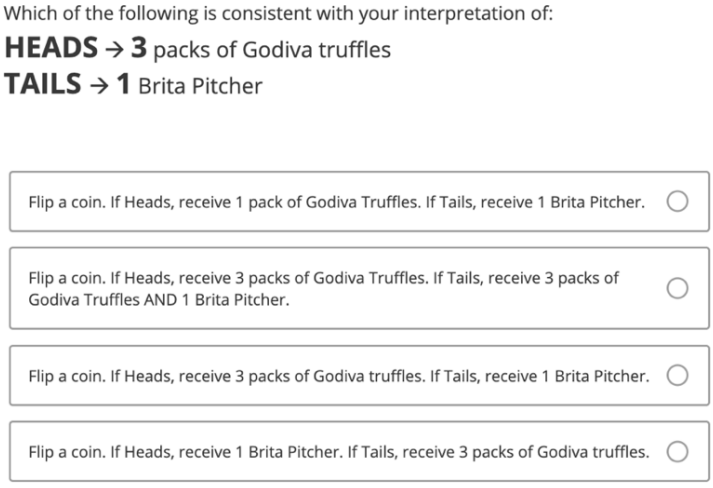

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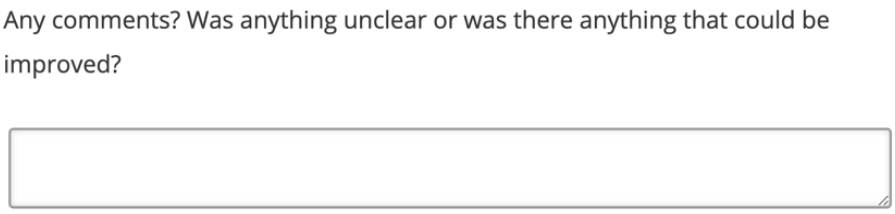

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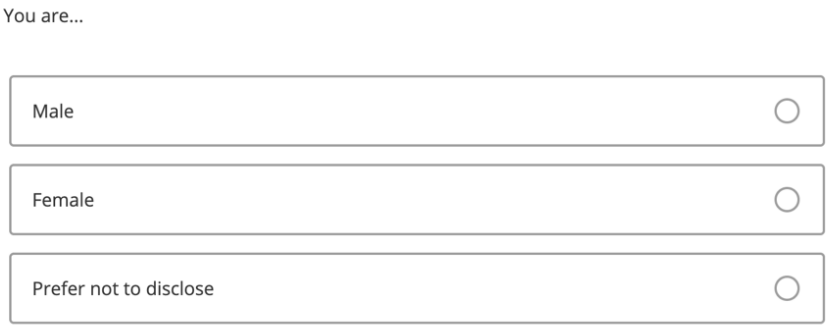
Please answer the following questions about yourself:



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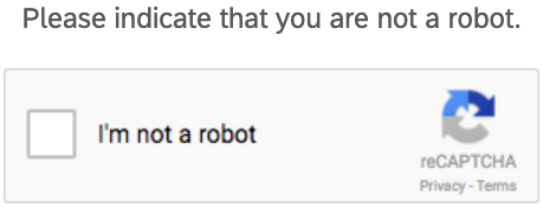


3.2. Studies 1b, 1c, 1d Details

3.2.1. Study 1b Details

3.2.1.1.Study 1b Instructions

Thank you for participating in this study.
Please take your time and read all instructions carefully. Your thoughtful responses are appreciated. == Page Break

On each of the following pages, we ask you to make a choice involving consumer items and coin flips.== Page Break

For example, would you rather receive 2 packs of Godiva chocolate truffles for sure OR flip a coin to determine what you receive? If the coin lands HEADS, you would receive 3 packs of truffles. If it lands TAILS, you would receive 1 pack of truffles.

2 packs of Godiva truffles ○ ○ **HEADS → 3** packs of Godiva truffles
TAILS → 1 pack of Godiva truffles

== Page Break
As another example, would you rather receive 1 Brita Pitcher for sure OR flip a coin? If the coin lands HEADS, you would receive 3 packs of Godiva truffles, but if it lands TAILS, you would receive nothing.

1 Brita Pitcher ○ ○ **HEADS → 4** packs of Godiva truffles
TAILS → Nothing

== Page Break

In the choices that follow, there are no wrong answers. We are interested in your opinions.

3.2.1.2. Study 1b Stimuli

The presentation of choices is identical to images in Figures S3.1A and S3.1B, except with the following product pairs:

Product Pair 1 (Scotch vs Purell)

Product Pair 2(Batteries vs Brawny)

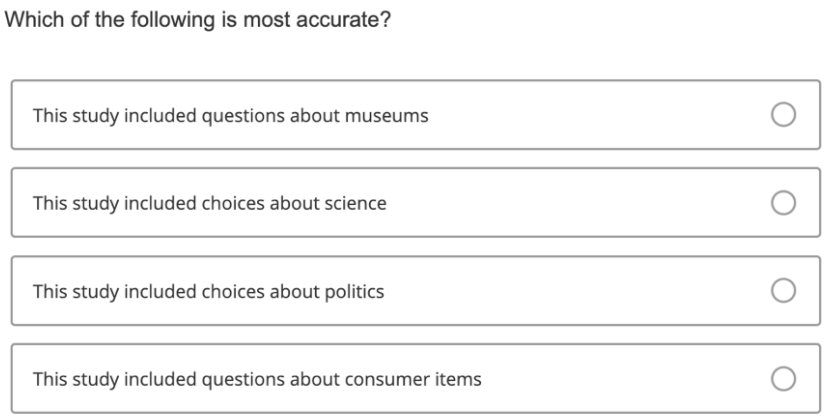
Product Pair 3 (Wipes vs Toothpaste)

Product Pair 4 (Tide vs Oxo Containers)

3.2.1.3. Study 1b Distractor Choices

Product Number	Choices	Sure Thing	Gamble
1	Paper	1 ream of paper	Heads: 3 reams of paper Tails: Nothing
2	Paper	2 reams of paper	Heads: 3 reams of paper Tails: Nothing
3	Paper vs Soap	1 ream of paper	Heads: 3 bottles of soap Tails: Nothing
4	Paper vs Soap	2 reams of paper	Heads: 3 bottles of soap Tails: Nothing
5	Pretzel Crisps vs Skinny Pop	3 bags of Pretzel Crisps	Heads: 4 bags of Skinny Pop Tails: 2 bags of Skinny Pop
6	Skinny Pop vs Pretzel Crisps	2 bags of Skinny Pop	Heads: 3 bags of Pretzel Crisps Tails: 1 bag of Pretzel Crisps
7	Post-Its	3 boxes of Post-Its	Heads: 5 boxes of Post-Its Tails: Nothing
8	Slinky	1 Slinky	Heads: 2 Slinkies Tails: Nothing
9	Cards	2 decks of cards	Heads: 3 decks of cards Tails: 1 deck of cards
10	Kleenex	3 boxes of Kleenex	Heads: 5 boxes of Kleenex Tails: 1 box of Kleenex
11	Soap vs Kleenex	2 bottles of soap	Heads: 3 boxes of Kleenex Tails: 1 box of Kleenex
12	Kleenex vs Soap	2 boxes of Kleenex	Heads: 3 bottles of soap Tails: 1 bottle of soap
13	Brita Pitcher vs Godiva Truffles	1 Brita Pitcher	Heads: 1 pack of Godiva truffles Tails: Nothing
14	Godiva Truffles vs Brita Pitcher	1 pack of Godiva truffles	Heads: 1 Brita Pitcher Tails: Nothing
15	Soap	3 bottles of soap	Heads: 5 bottles of soap Tails: 1 bottle of soap
16	Post-Its	2 boxes of Post-Its	Heads: 3 boxes of Post-Its Tails: 1 box of Post-Its
17	Slinky	2 slinkies	Heads: 3 slinkies Tails: 1 Slinky
18	Cards vs Slinky	2 decks of cards	Heads: 3 slinkies Tails: 1 slinky
19	Slinky vs Cards	2 slinkies	Heads: 3 decks of cards Tails: 1 deck of cards

3.2.1.4. Attention Checks and Demographics



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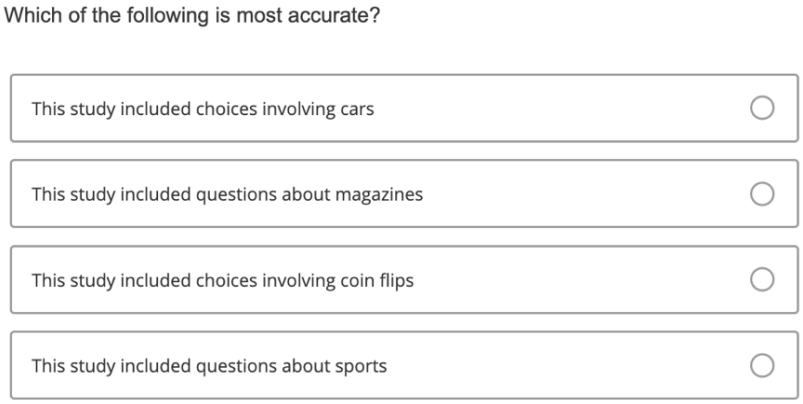

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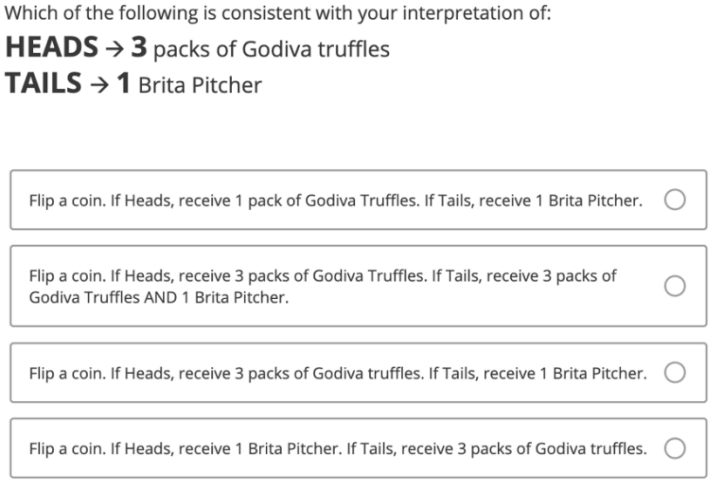

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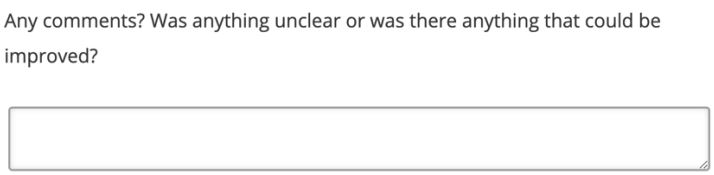

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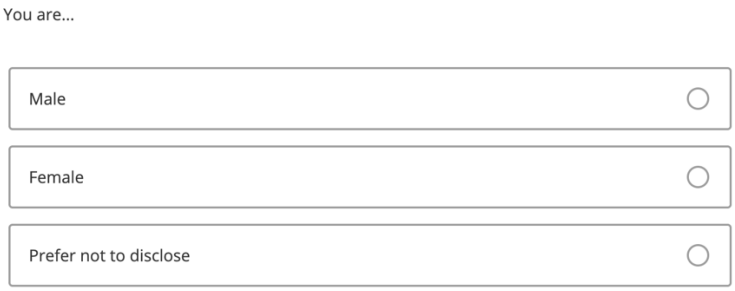
Please answer the following questions about yourself:



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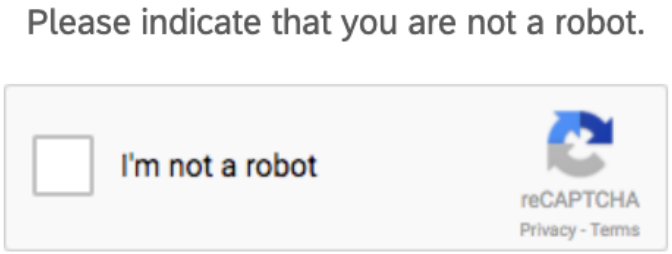


3.2.2. Study 1c Details

3.3.1.1. Study 1c Instructions

Thank you for participating in this study.

Please take your time and read all instructions carefully. Your thoughtful responses are appreciated. == Page Break

On each of the following pages, we ask you to make a choice involving consumer items and coin flips. == Page Break

For example, would you rather receive 2 packs of Godiva chocolate truffles for sure OR flip a coin to determine what you receive? If the coin lands HEADS, you would receive 3 packs of truffles. If it lands TAILS, you would receive 1 pack of truffles.

2 packs of Godiva truffles ○○ **HEADS → 3** packs of Godiva truffles
TAILS → 1 pack of Godiva truffles

== Page Break

As another example, would you rather receive 1 Brita Pitcher for sure OR flip a coin? If the coin lands HEADS, you would receive 3 packs of Godiva truffles, but if it lands TAILS, you would receive nothing.

1 Brita Pitcher ○○ **HEADS → 4** packs of Godiva truffles
TAILS → Nothing

== Page Break

In the choices that follow, there are no wrong answers. We are interested in your opinions. (choices start on next page)

3.3.1.2. Study 1c Stimuli

The presentation of choices is identical to images in Figures S3.1A and S3.1B except with the following product pairs:

Product Pair 1 (Scotch vs Purell)

Product Pair 2(Batteries vs Brawny)

Product Pair 3 (Wipes vs Toothpaste)

Product Pair 4 (Tide vs Oxo Containers)

3.3.1.3.Study 1c Distractor Choices

Product Number	Choices	Sure Thing	Gamble
1	Paper	1 ream of paper	Heads: 3 reams of paper Tails: Nothing
2	Paper	2 reams of paper	Heads: 3 reams of paper Tails: Nothing
3	Paper vs Soap	1 ream of paper	Heads: 3 bottles of soap Tails: Nothing
4	Paper vs Soap	2 reams of paper	Heads: 3 bottles of soap Tails: Nothing
5	Pretzel Crisps vs Skinny Pop	3 bags of Pretzel Crisps	Heads: 4 bags of Skinny Pop Tails: 2 bags of Skinny Pop
6	Skinny Pop vs Pretzel Crisps	2 bags of Skinny Pop	Heads: 3 bags of Pretzel Crisps Tails: 1 bag of Pretzel Crisps
7	Post-Its	1 box of Post-Its	Heads: 3 boxes of Post-Its Tails: Nothing
8	Slinky	1 Slinky	Heads: 2 Slinkies Tails: Nothing
9	Cards	2 decks of cards	Heads: 3 decks of cards Tails: 1 deck of cards
10	Kleenex	3 boxes of Kleenex	Heads: 5 boxes of Kleenex Tails: 1 box of Kleenex
11	Soap vs Kleenex	2 bottles of soap	Heads: 3 boxes of Kleenex Tails: 1 box of Kleenex
12	Kleenex vs Soap	2 boxes of Kleenex	Heads: 3 bottles of soap Tails: 1 bottle of soap
13	Brita Pitcher vs Godiva Truffles	1 Brita Pitcher	Heads: 1 pack of Godiva truffles Tails: Nothing
14	Godiva Truffles vs Brita Pitcher	1 pack of Godiva truffles	Heads: 1 Brita Pitcher Tails: Nothing
15	Soap	2 bottles of soap	Heads: 4 bottles of soap Tails: 1 bottle of soap
16	Kleenex	2 boxes of Kleenex	Heads: 4 boxes of Kleenex Tails: 1 box of Kleenex
17	Post-Its	2 boxes of Post-Its	Heads: 3 boxes of Post-Its Tails: 1 box of Post-Its
18	Slinky	2 slinkies	Heads: 2 Slinkies Tails: 1 Slinky
19	Cards vs Slinky	2 decks of cards	Heads: 3 slinkies Tails: 1 slinky
20	Slinky vs Cards	2 slinkies	Heads: 3 decks of cards Tails: 1 deck of cards

3.3.1.4.Attention Checks and Demographics

Which of the following is most accurate?

- This study included questions about museums
- This study included choices about science
- This study included choices about politics
- This study included questions about consumer items

== Page Break

Which of the following is most accurate?

- This study included choices involving cars
- This study included questions about magazines
- This study included choices involving coin flips
- This study included questions about sports

== Page Break

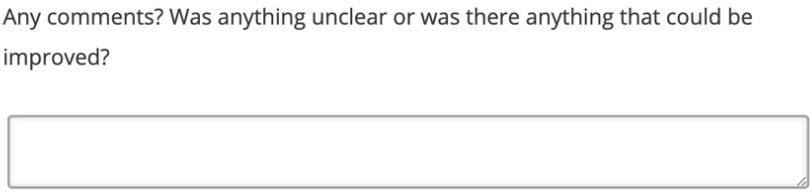
Which of the following is consistent with your interpretation of:

HEADS → 3 packs of Godiva truffles

TAILS → 1 Brita Pitcher

- Flip a coin. If Heads, receive 1 pack of Godiva Truffles. If Tails, receive 1 Brita Pitcher.
- Flip a coin. If Heads, receive 3 packs of Godiva Truffles. If Tails, receive 3 packs of Godiva Truffles AND 1 Brita Pitcher.
- Flip a coin. If Heads, receive 3 packs of Godiva truffles. If Tails, receive 1 Brita Pitcher.
- Flip a coin. If Heads, receive 1 Brita Pitcher. If Tails, receive 3 packs of Godiva truffles.

== Page Break



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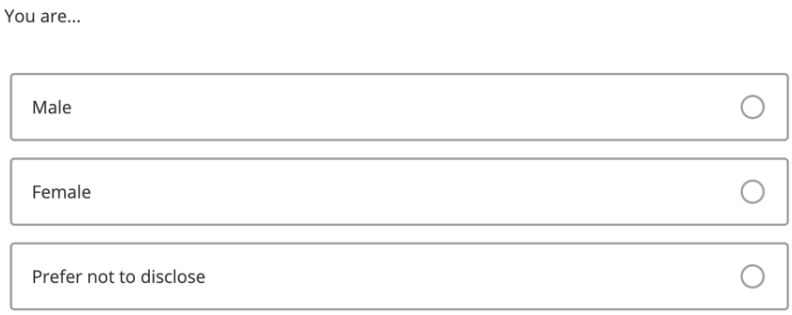
Please answer the following questions about yourself:



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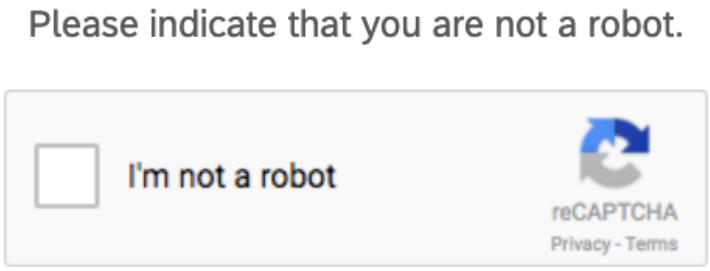


3.3.1. Study 1d Details

3.3.1.1. Study 1d Instructions

Thank you for participating in this study.

Please take your time and read all instructions carefully. Your thoughtful responses are appreciated. == Page Break

On each of the following pages, we ask you to make a choice involving consumer items and coin flips.== Page Break

For example, would you rather receive 2 packs of Godiva chocolate truffles for sure <u>OR</u> flip a coin to determine what you receive? If the coin lands HEADS, you would receive 3 packs of truffles. If it lands TAILS, you would receive 1 pack of truffles.

2 packs of Godiva truffles ○○ **HEADS → 3** packs of Godiva truffles
TAILS → 1 pack of Godiva truffles

== Page Break

As another example, would you rather receive 1 Brita Pitcher for sure OR flip a coin? If the coin lands HEADS, you would receive 3 packs of Godiva truffles, but if it lands TAILS, you would receive nothing.

1 Brita Pitcher ○○ **HEADS → 4** packs of Godiva truffles
TAILS → Nothing

== Page Break

In the choices that follow, there are no wrong answers. We are interested in your opinions.

3.3.1.2. Study 1d Stimuli

The presentation of choices is identical to images in Figures S3.1A and S3.1B except with the following product pairs:

Product Pair 1 (Scotch vs Purell)

Product Pair 2 (Batteries vs Brawny)

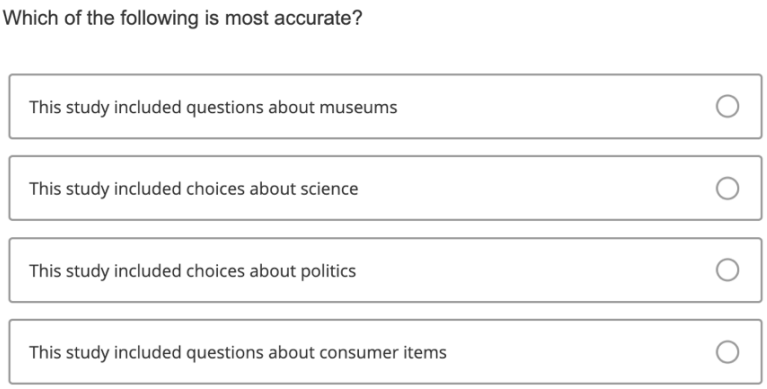
Product Pair 3 (Wipes vs Toothpaste)

Product Pair 4 (Tide vs Oxo Containers)

3.3.1.3. Study 1d Distractor Choices

Product Number	Choices	Sure Thing	Gamble
1	Paper	1 ream of paper	Heads: 4 reams of paper Tails: Nothing
2	Paper	2 reams of paper	Heads: 4 reams of paper Tails: Nothing
3	Paper vs Soap	1 ream of paper	Heads: 4 bottles of soap Tails: Nothing
4	Paper vs Soap	2 reams of paper	Heads: 4 bottles of soap Tails: Nothing
5	Pretzel Crisps vs Skinny Pop	3 bags of Pretzel Crisps	Heads: 4 bags of Skinny Pop Tails: 2 bags of Skinny Pop
6	Skinny Pop vs Pretzel Crisps	2 bags of Skinny Pop	Heads: 3 bags of Pretzel Crisps Tails: 1 bag of Pretzel Crisps
7	Post-Its	1 box of Post-Its	Heads: 4 boxes of Post-Its Tails: Nothing
8	Slinky	1 Slinky	Heads: 2 Slickies Tails: Nothing
9	Cards	2 decks of cards	Heads: 3 decks of cards Tails: 1 deck of cards
10	Kleenex	3 boxes of Kleenex	Heads: 5 boxes of Kleenex Tails: 1 box of Kleenex
11	Soap vs Kleenex	2 bottles of soap	Heads: 3 boxes of Kleenex Tails: 1 box of Kleenex
12	Kleenex vs Soap	2 boxes of Kleenex	Heads: 3 bottles of soap Tails: 1 bottle of soap
13	Brita Pitcher vs Godiva Truffles	1 Brita Pitcher	Heads: 1 pack of Godiva truffles Tails: Nothing
14	Godiva Truffles vs Brita Pitcher	1 pack of Godiva truffles	Heads: 1 Brita Pitcher Tails: Nothing
15	Soap	2 bottles of soap	Heads: 4 bottles of soap Tails: 1 bottle of soap
16	Kleenex	2 boxes of Kleenex	Heads: 4 boxes of Kleenex Tails: 1 box of Kleenex
17	Post-Its	2 boxes of Post-Its	Heads: 3 boxes of Post-Its Tails: 1 box of Post-Its
18	Slinky	2 slinkies	Heads: 3 slinkies Tails: 1 Slinky
19	Cards vs Slinky	2 decks of cards	Heads: 3 slinkies Tails: 1 slinky
20	Slinky vs Cards	2 slinkies	Heads: 3 decks of cards Tails: 1 deck of cards

3.3.1.4. Attention Checks and Demographics



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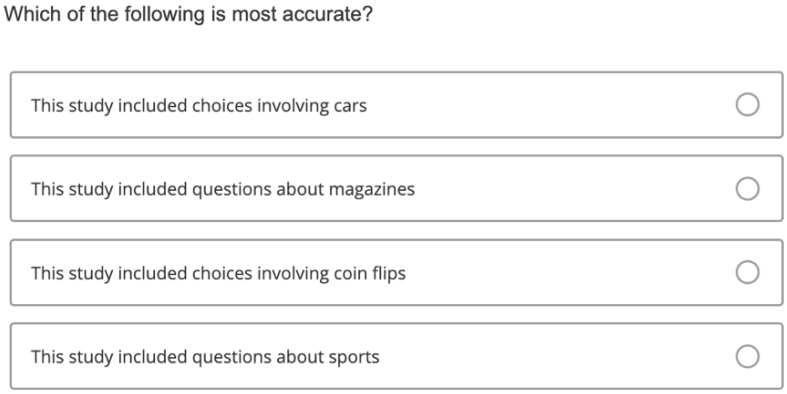

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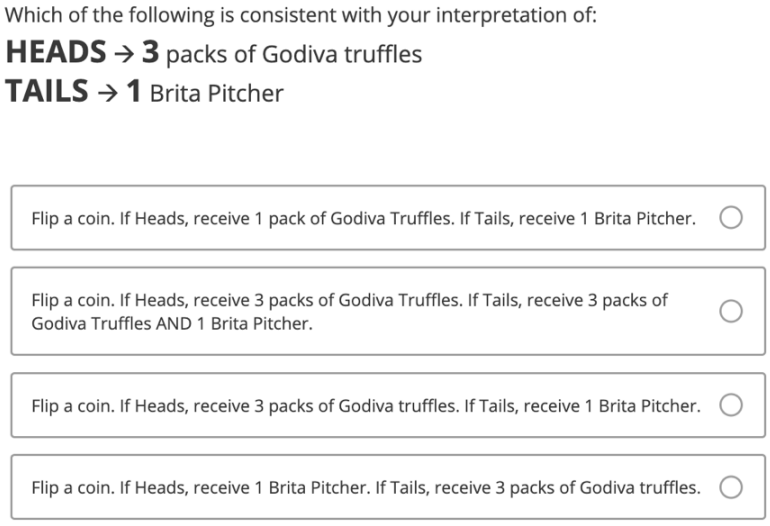

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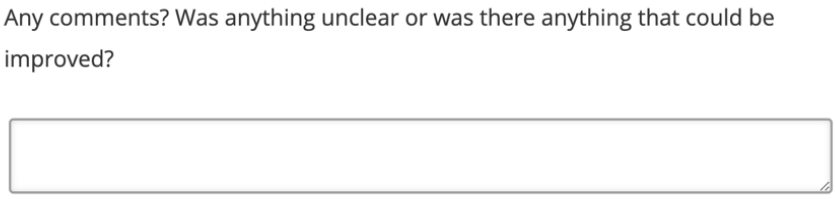

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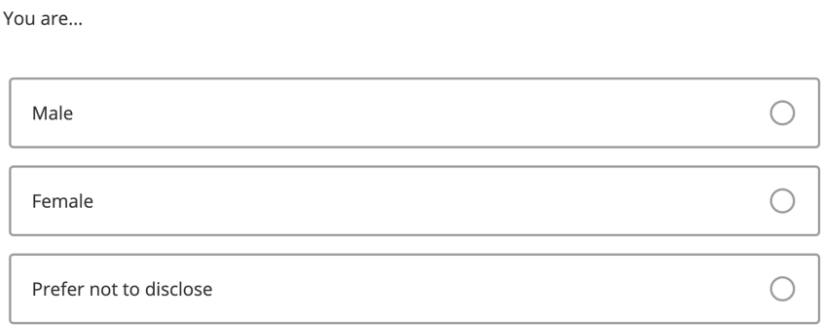
Please answer the following questions about yourself:



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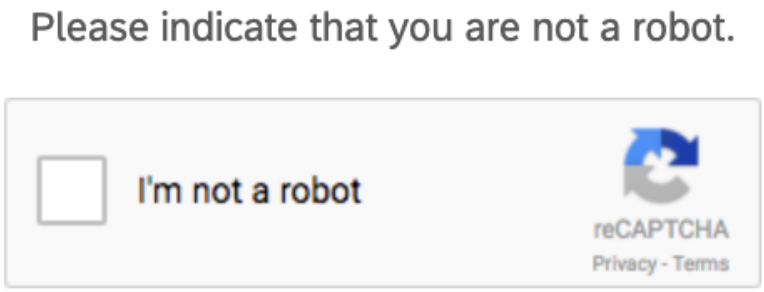


3.3. Study 1e and 1f Details

3.3.1. Study 1e Details

3.3.1.1. Study 1e Instructions

Thank you for participating in this study.

Please take your time and read all instructions carefully. Your thoughtful responses are appreciated. == Page Break

In what follows, we ask you to make choices involving consumer items that are available with different probabilities.== Page Break

For example, suppose you could select the left-hand option and receive 2 packs of Godiva chocolate truffles for sure.

Or, you could select the right-hand option and have a 75% chance to receive 3 packs and a 25% chance to receive only 1 pack.

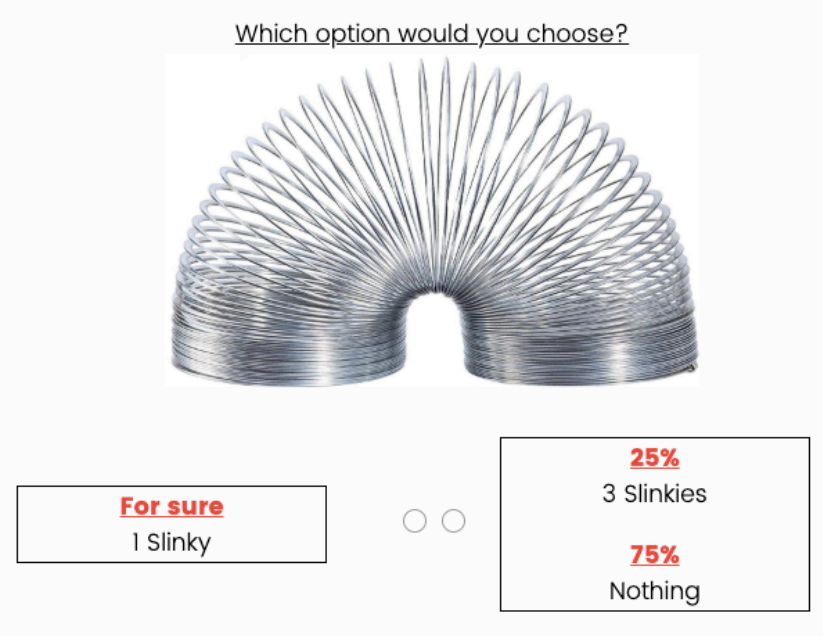
Which option would you choose?

==Page Break

Please note that, as on the previous page, some options will give you a 75% chance of the better outcome and a 25% chance of the worse outcome.

But, other options will offer the reverse: they will give you a 25% chance of the better outcome and a 75% of the worse outcome.

The following screen presents a choice involving this type of option.== Page Break



==Page Break
Please also note that some choices will involve two different consumer items. The following screen includes an example of this kind of choice.==Page Break
Here, the left-hand option gives you a 25% chance to receive 1 Brita Pitcher and a 75% chance to receive nothing.

The right-hand option gives you 1 pack of Godiva truffles for sure.

Which option would you choose?

==Page Break
In the choices that follow, there are no wrong answers. We are interested in your opinions.

3.3.1.2. Study 1e Stimuli

Figures S3.2A and S3.2B include screenshot examples of unimodal choices and crossmodal choices in Study 1e.

Figure S3.2A. The unimodal decisions generated by the Tide-Oxo item pair in Study 1e.

Figure S3.2B. The crossmodal decisions generated by the Tide-Oxo item pair in Study 1e.

3.3.1.3. Study 1e Products Used

Product Pair 1(Batteries vs Brawny)

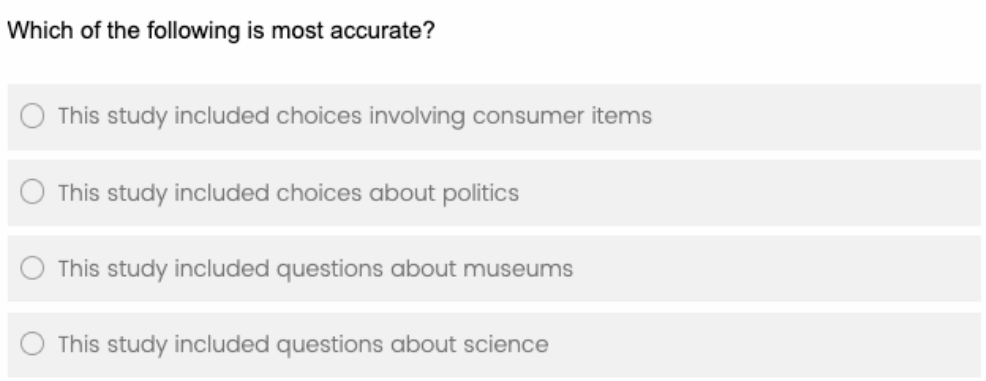
Product Pair 2 (Wipes vs Toothpaste)

Product Pair 3 (Tide vs Oxo Containers)

3.3.1.4. Study 1e Distractor Choices

Product Number	Choices	Sure Thing	Gamble
1	Godiva Truffles	2 packs of Godiva truffles	75%: 4 packs of Godiva truffles 25%: 1 pack of Godiva truffles
2	Brita Pitcher vs. Godiva truffles	2 packs of Godiva truffles	25%: 1 Brita Pitcher 75%: Nothing
3	Pretzel Crisps vs. Skinny Pop	1 bag of Pretzel Crisps	75%: 2 bags of Skinny Pop 25%: 1 bag of Skinny Pop
4	Pretzel Crisps vs. Skinny Pop	2 bags of Pretzel Crisps	25%: 2 bags of Skinny Pop 75%: 1 bag of Skinny Pop
5	Kleenex vs. Deck of Cards	2 boxes of Kleenex	25%: 4 decks of cards 75%: 2 decks of cards
6	Slinky	1 Slinky	25%: 3 Slinkies 75%: Nothing

3.3.1.5. Attention Checks and Demographics



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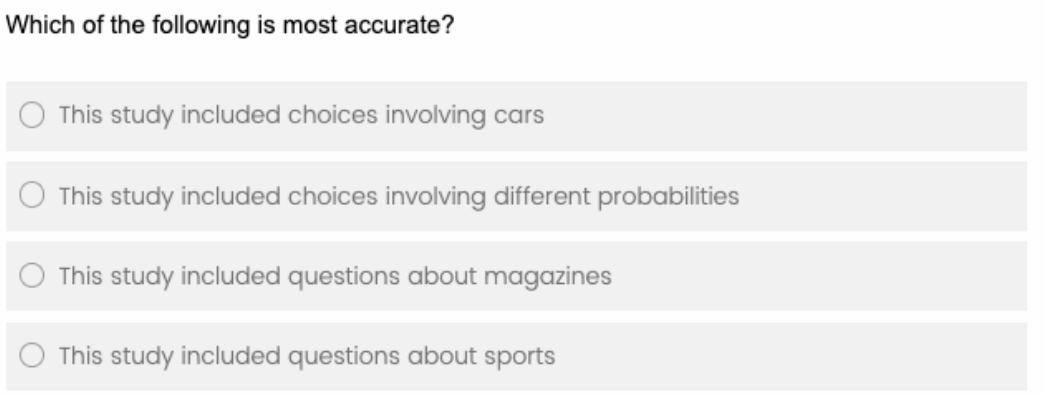

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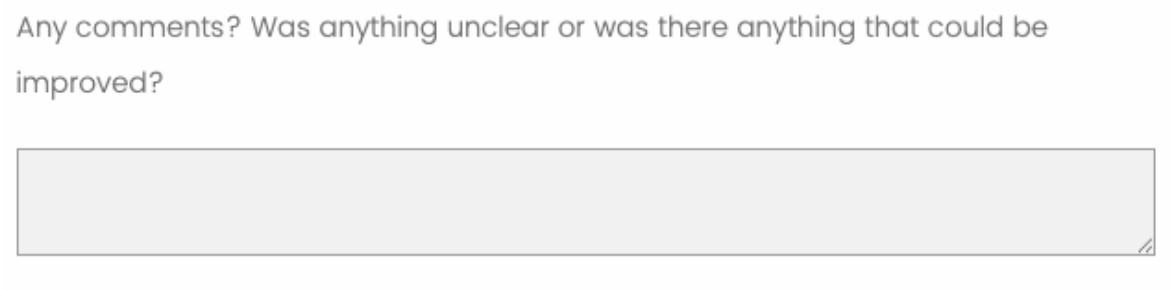
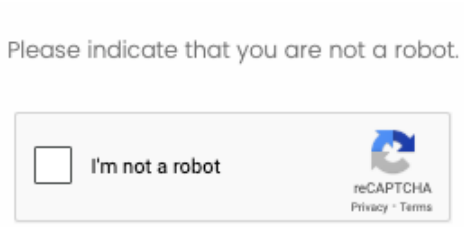


== Page Break

Please answer the following questions about yourself.

== Page Break



3.3.2. Study 1f Details

3.3.2.1. Study 1f Instructions

Thank you for participating in this study.

Please take your time and read all instructions carefully. Your thoughtful responses are appreciated. == Page Break

In what follows, we ask you to make choices involving consumer items that are available with different probabilities.== Page Break

For example, suppose you could select the left-hand option and receive 2 packs of Godiva chocolate truffles for sure.

Or, you could select the right-hand option and have a 90% chance to receive 3 packs and a 10% chance to receive only 1 pack.

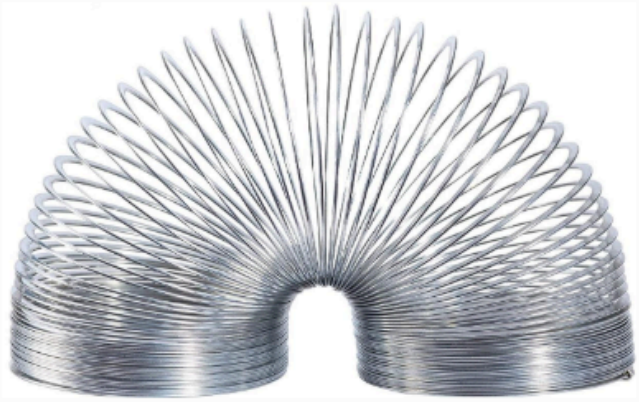
Which option would you choose?

== Page Break
Please note that, as on the previous page, some options will give you a 90% chance of the better outcome and a 10% chance of the worse outcome.

But, other options will offer the reverse: they will give you a 10% chance of the better outcome and a 90% of the worse outcome.

The following screen presents a choice involving this type of option.
==Page Break

Which option would you choose?



For sure 1 Slinky		10% 3 Slinkies 90% Nothing

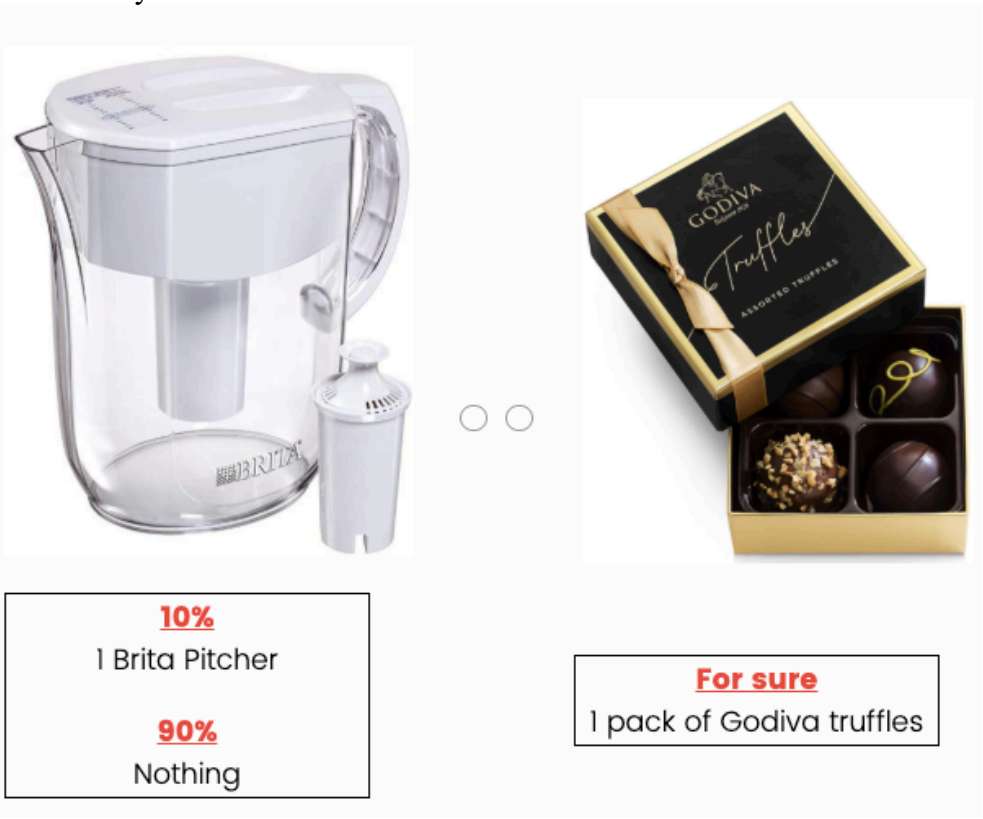
==Page Break

Please also note that some choices will involve two different consumer items. The following screen includes an example of this kind of choice.==Page Break

Here, the left-hand option gives you a 10% chance to receive 1 Brita Pitcher and a 90% chance to receive nothing.

The right-hand option gives you 1 pack of Godiva truffles for sure.

Which option would you choose?



== Page Break
In the choices that follow, there are no wrong answers. We are interested in your opinions.

3.3.2.2. Study 1f Stimuli

The presentation of choices is identical to images in Figures S3.2A and S3.2B, except with the following product pairs and the probabilities 90% and 10%.

Product Pair 1(Batteries vs Brawny)

Product Pair 2 (Wipes vs Toothpaste)

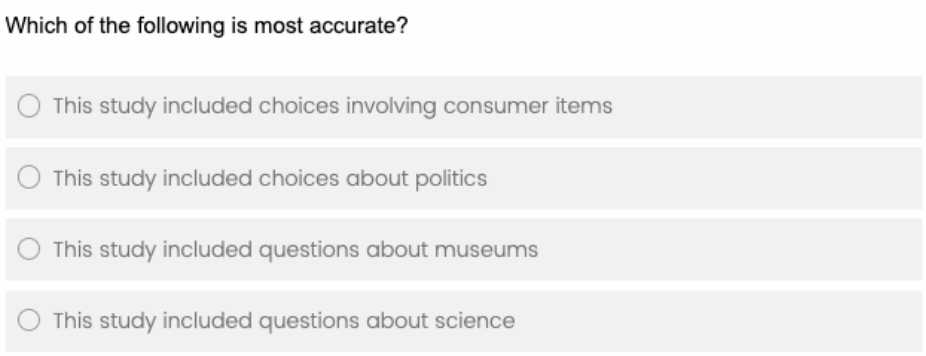
Product Pair 3 (Tide vs Oxo Containers)

3.3.2.3. Study 1f Distractor Choices

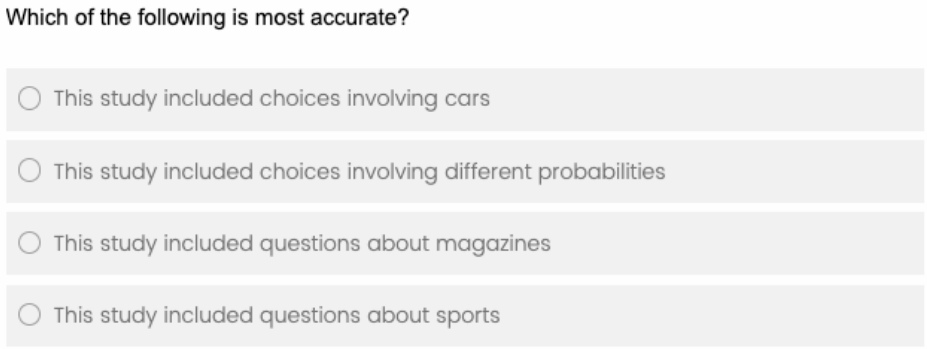
Product Number	Choices	Sure Thing	Gamble
1	Godiva Truffles	2 packs of Godiva truffles	90%: 4 packs of Godiva truffles 10%: 1 pack of Godiva truffles
2	Brita Pitcher vs. Godiva truffles	2 packs of Godiva truffles	10%: 1 Brita Pitcher 90%: Nothing
3	Pretzel Crisps vs. Skinny Pop	1 bag of Pretzel Crisps	90%: 2 bags of Skinny Pop 10%: 1 bag of Skinny Pop
4	Pretzel Crisps vs. Skinny Pop	2 bags of Pretzel Crisps	10%: 2 bags of Skinny Pop 90%: 1 bag of Skinny Pop
5	Kleenex vs. Deck of Cards	2 boxes of Kleenex	10%: 4 decks of cards 90%: 2 decks of cards
6	Slinky	1 Slinky	10%: 3 Slinkies 90%: Nothing

3.3.2.4. Attention Checks and Demographics

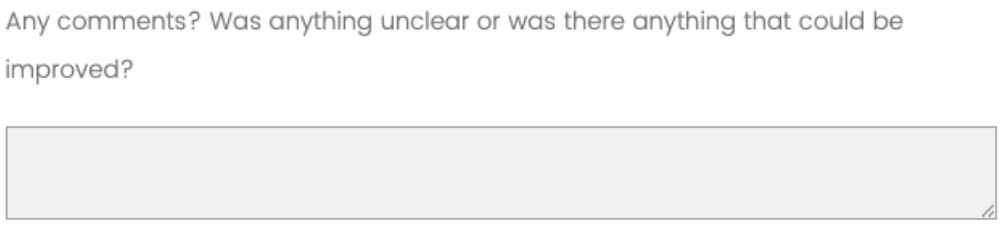
== Page Break



== Page Break



== Page Break



== Page Break

Please answer the following questions about yourself.

3.4. Study S2a

3.4.1. Study S2a Instructions for WTP Assessment for Products

On the next few screens, we ask you to indicate the **maximum amount, in $, you would be willing to pay** for various items. There are no right answers, we are interested in your opinions.

== Page Break

Figure S3.3A is a screenshot example of a WTP Assessment for a distractor item in Study S2a.

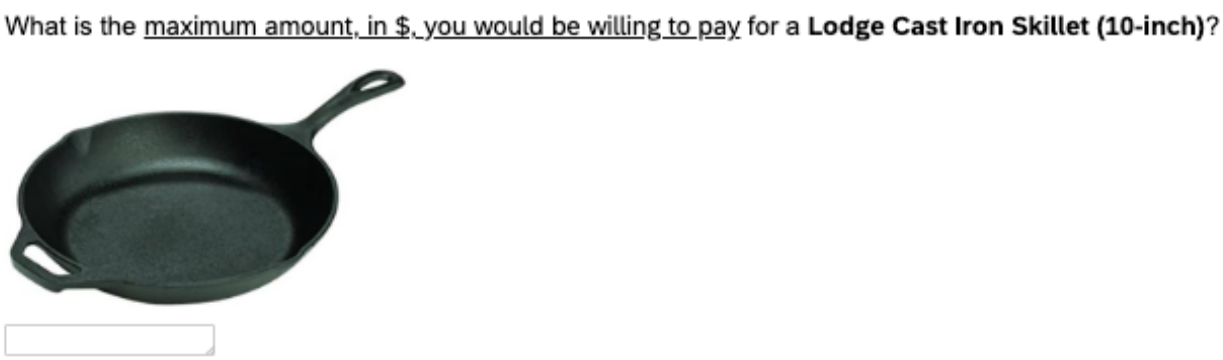


Figure S3.3A. Screenshot from one of the distractor items in Study S2a: WTP Assessment

3.4.2. Study S2a Products Used in WTP Assessment

3.4.2.1. Items

Product 1 (Bose QuietComfort 35 (Series II) Wireless Noise Cancelling Headphones)

Product 2 (Thermos Stainless King 16-Ounce Travel Tumbler)

Product 3 (Alera Mesh Big/Tall Mid-Black Swivel/Tilt Chair)

Product 4 (Logitech Pro 1080p HD Camera)

3.4.2.2. Distractor Items in WTP Assessment

Product 1 (Lodge Cast Iron Skillet (10-inch))

Product 2 (Toshiba Microwave (0.9 cubic feet, 900 watts))

Product 3 (Sony 75-inch TV)

Product 4 (Oculus Quest Virtual Reality Headset (128 GB))

3.4.3. Study S2a Instructions for Product Choices

On each of the following pages, we ask you to choose between an item and a coin flip that could yield you either of two other items.
== Page Break

For example, would you rather (a) receive 3 reams of HP Printer Paper, or (b) flip the coin and receive a Brita Water Pitcher if it lands heads or Mrs. Meyer's Cleaner Spray if it lands tails.

==Page Break

Figures 3B, 3C, and 3D include screenshot examples of crossmodal choices in Study S2a.

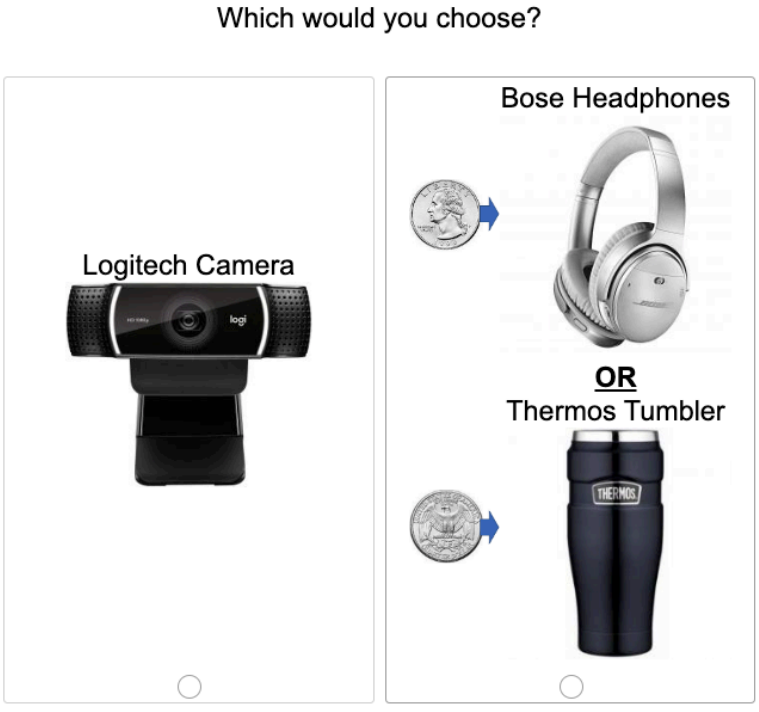


Figure S3.3B. Screen cap from one of the tasks in Study S2a: Product Choice (example 1)

Figure S3.3C. Screen cap from one of the tasks in Study S2a: Product Choice (example 2)

Figure S3.3D. Screen cap from one of the distractor tasks in Study S2a: Product Choice (Item 3 from Distractor Product Choices)

3.4.4. Study S2a Product Choices

3.4.4.1. Product Choices

Choices between sure things and gambles were based on stated valuations of the four products in 3.4.2.1. Participants saw subsets of three products in which the sure thing was the middle-priced product, and the gamble consisted of a higher-priced and lower-priced product.

3.4.4.2. Distractor Product Choices

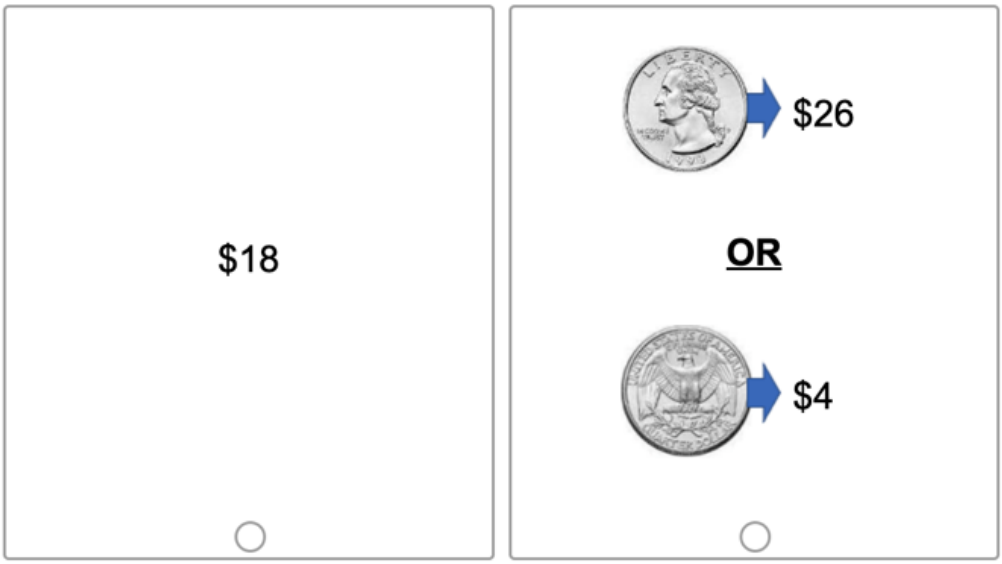
Product Pair Number	Sure Thing	Gamble
1	Honeywell Fan	Heads: Ninja Blender Tails: Swiffer Duster Starter Set
2	Xerox Printer	Heads: Nikon COOLPIX camera Tails: LED Desk Lamp
3	Black + Decker Dustbuster	Heads: Compact fridge Tails: Mr. Coffee
4	Schwinn Bike	Heads: iPad Pro (4th Gen) Tails: Macarons

3.4.5. Study S2a Monetary Choices
3.4.5.1. Study S2a Instructions: Monetary Choice

On each of the following pages, we ask you to choose between a cash amount and a coin flip that could yield you either of two other cash amounts.

== Page Break

For example, would you rather (a) receive $18, or (b) flip the coin and receive $26 if it lands heads or $4 if it lands tails.



== Page Break

Figure S3.3E is a screenshot example of a unimodal choice in Study S2a.

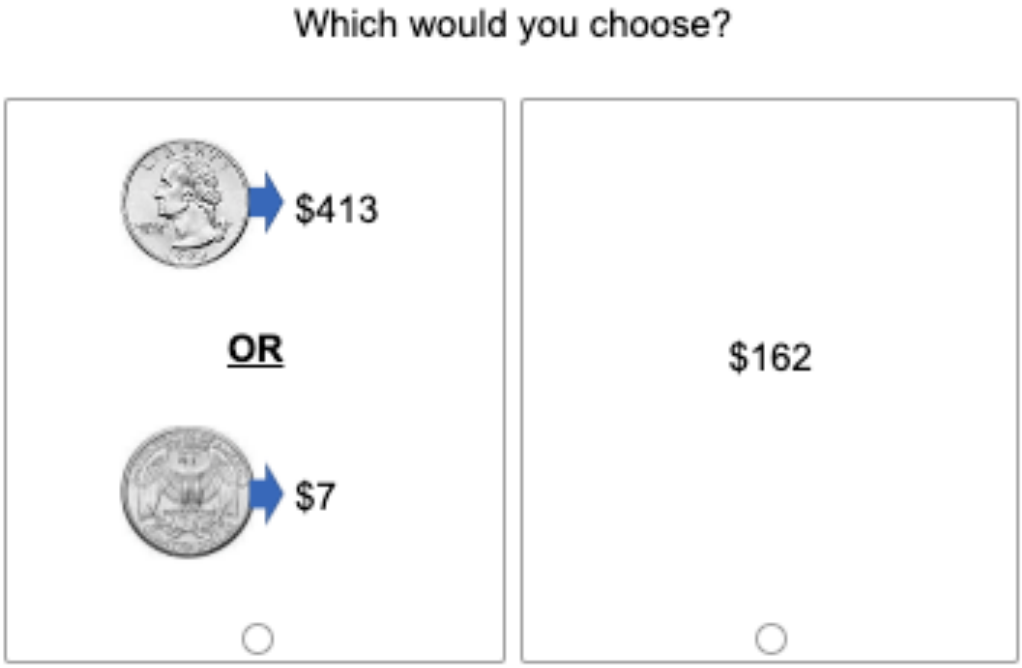


Figure S3.3E. Screen cap from one of the tasks in Study S2a: Monetary Choice (items 4 of the distractor choices)

3.4.5.2. Study S2a Distractor Monetary Choices

Cash Pair Number	Sure Thing	Gamble
1	$38	Heads: $67 Tails: $7
2	$104	Heads: $189 Tails: $11
3	$33	Heads: $64 Tails: $12
4	$162	Heads: $413 Tails: $7

3.4.6. Demographics and Attention Check

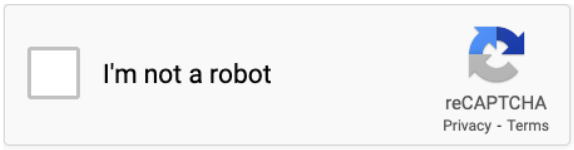
(If participants did not have enough different valuations for the WTP Assessment☺

As it turns out, your initial responses rule out some of the planned follow-up questions, which is okay.

We will have you skip the middle portion of the survey and move ahead to the concluding portion.

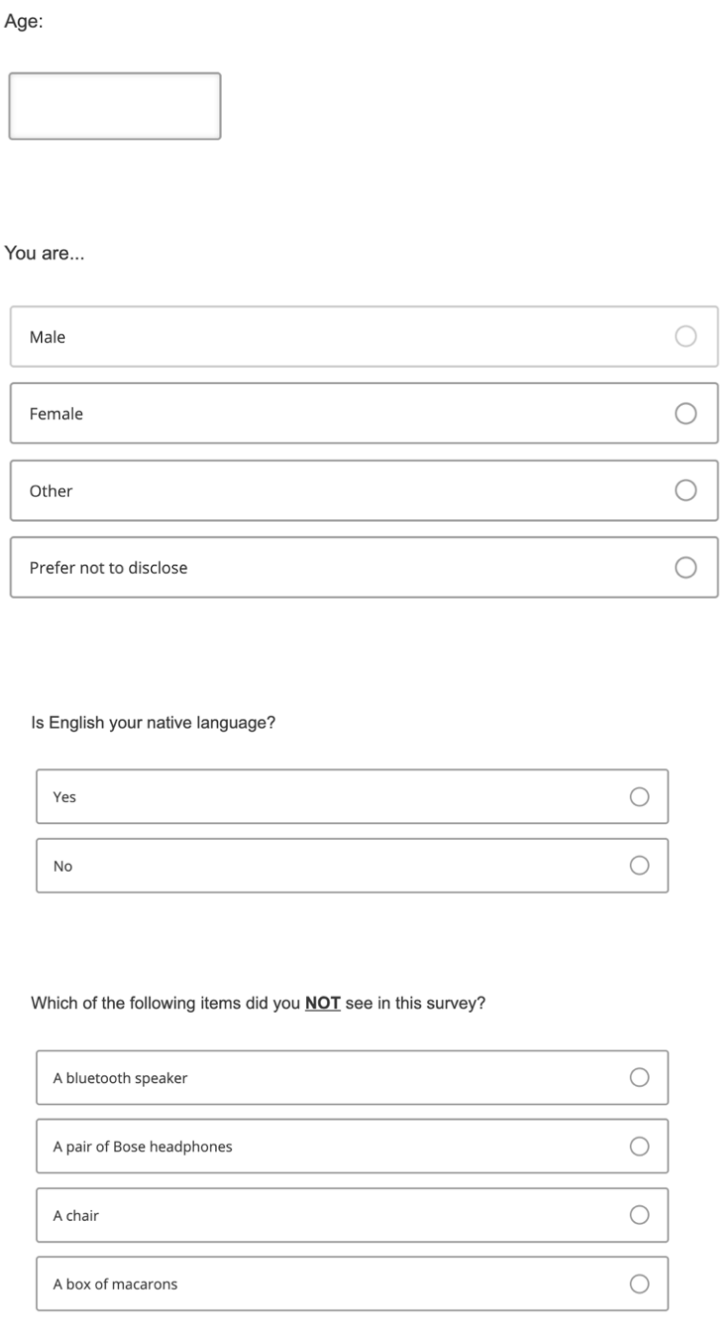
This will not affect your payment.
== Page Break

Please fill out the below.



== Page Break

Please answer the following questions about yourself:



3.4.7. Study S2a Affect Rating Addendum

3.4.7.1. Study S2a Affect Rating Addendum: Instructions for WTP Assessment for Products

On the next few screens, we ask you to indicate the **maximum amount, in $, you would be willing to pay** for various items. There are no right answers, we are interested in your opinions.

== Page Break

Figure S3.3F is a screenshot example of the WTP assessment in Study S2a Affect Rating Addendum.

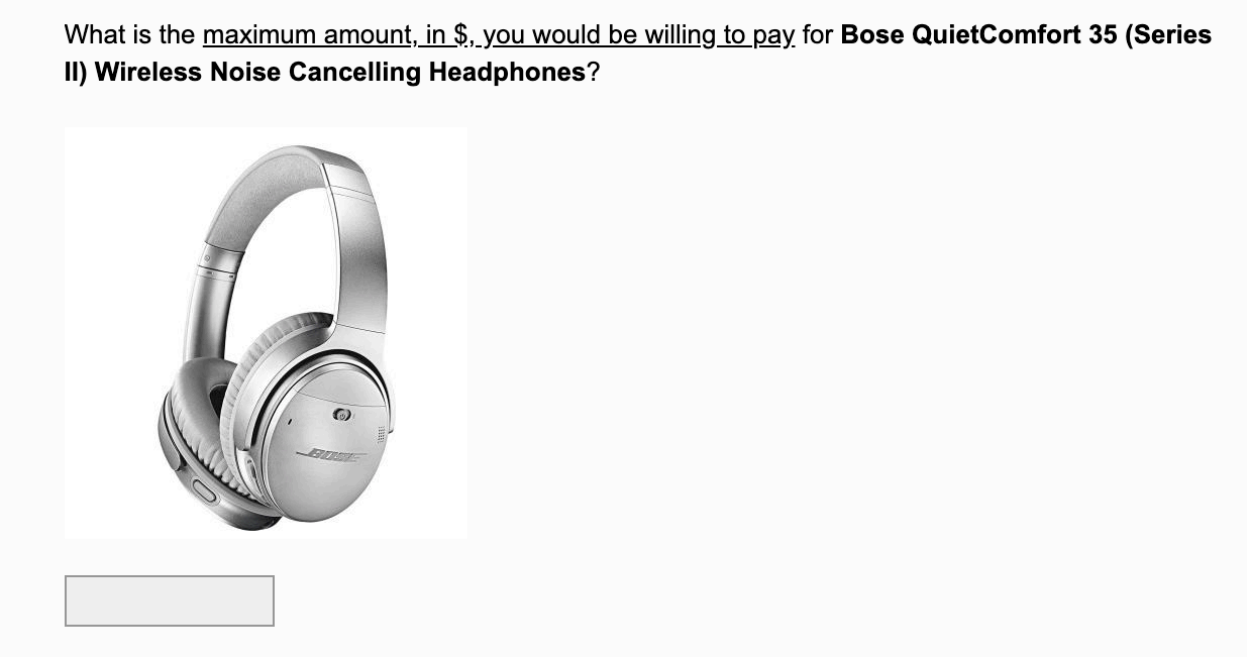


Figure S3.3F. Screenshot from one of the tasks in Study S2a Affect Rating Addendum.

3.4.7.2. Study S2a Affect Rating Addendum: Products Used in WTP Assessment

Product 1 (Bose QuietComfort 35 (Series II) Wireless Noise Cancelling Headphones)

Product 2 (Thermos Stainless King 16-Ounce Travel Tumbler)

Product 3 (Alera Mesh Big/Tall Mid-Black Swivel/Tilt Chair)

Product 4 (Logitech Pro 1080p HD Camera)

3.4.7.3. Study S2a Affect Rating Addendum: Instructions for Cash Affect Rating

On the next few pages, we ask you to imagine that as part of a study, you actually receive some different cash amounts, including those you have just inputted. Please indicate how you would feel about receiving each of them.
== Page Break

Figure S3.3G is a screenshot example of a cash affect rating in Study S2a Affect Rating Addendum.

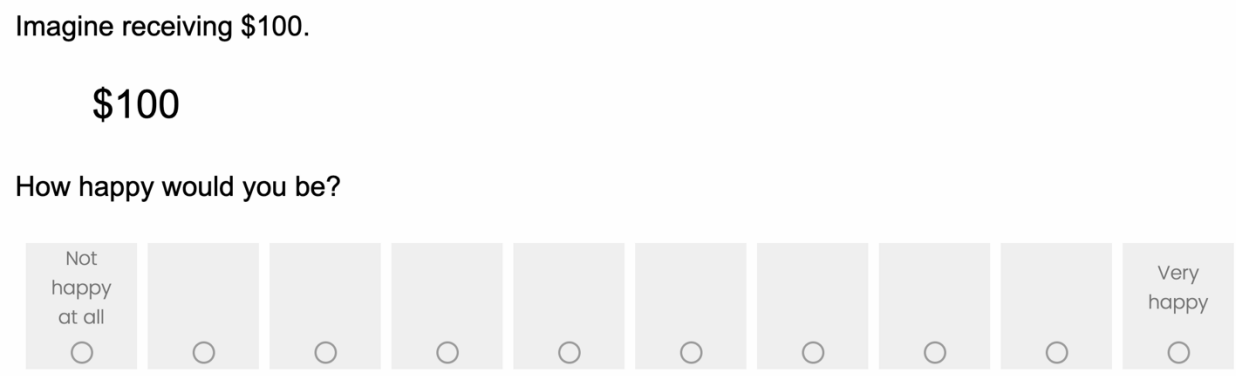


Figure S3.3G. Screencap from cash affect ratings in Study S2a Affect Rating Addendum.

3.4.7.4. Study S2a Affect Rating Addendum: Instructions for Product Affect Rating

On the next few pages, we ask you to imagine that as part of a study, you actually receive some of the consumer items we have mentioned. Please indicate how you would feel about receiving each of them.
== Page Break

Figure S3.3H is a screenshot example of a product affect rating in Study S2a Affect Rating Addendum.

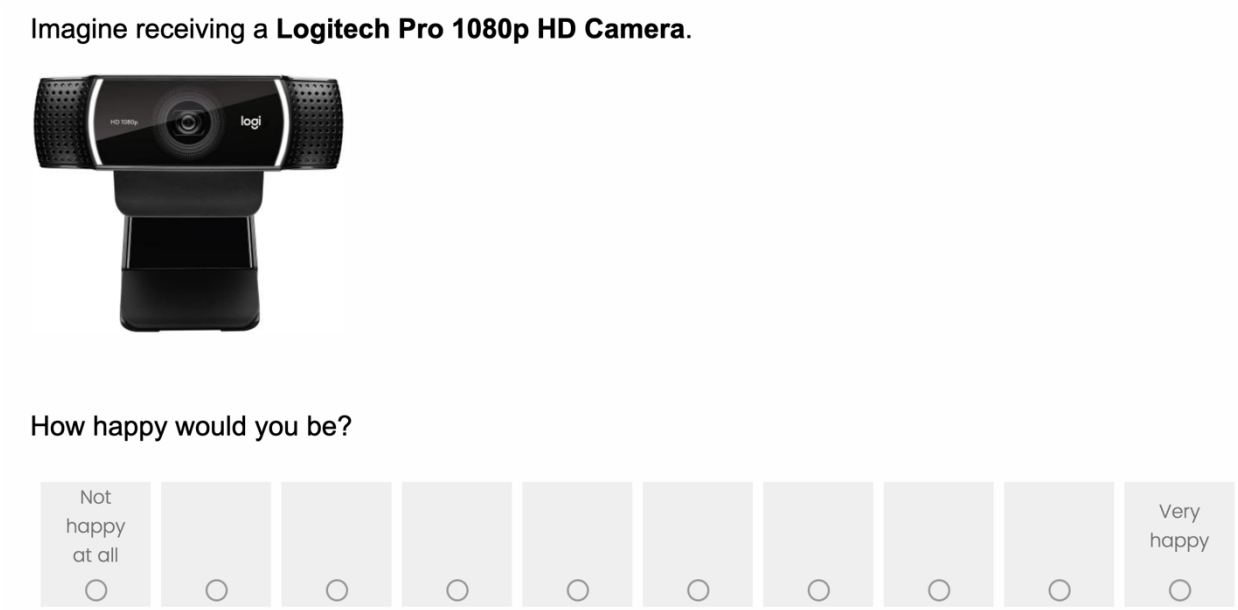
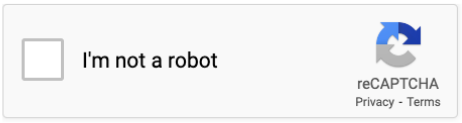


Figure S3.3H. Screencap from product affect rating in Study S2a Affect Rating Addendum.

3.4.7.5. Demographics and Attention Check

Please fill out the below.



== Page Break
Please answer a few questions about yourself.

Age:

You are...

- Male
- Female
- Other
- Prefer not to disclose

Is English your native language?

- Yes
- No

Which of the following items did you **NOT** see in this survey?

- A travel tumbler
- A box of macarons
- A pair of Bose headphones
- A chair

3.5. Study S2b Details

3.5.1. Study S2b Instructions: Certainty Equivalents-Setting Phase

On each of the following pages, we ask you to make a series of choices between a consumer item and various cash amounts.

== Page Break

Condition L (counterbalancing): For example, on each line below, please indicate whether you would choose the listed cash amount or the *Godiva* chocolate truffles.

$10 in cash	○	○	*Godiva* Truffles
$20 in cash	○	○	*Godiva* Truffles

Condition R (counterbalancing): For example, on each line below, please indicate whether you would choose the *Godiva* chocolate truffles or the listed cash amount.

Godiva Truffles	○	○	$10 in cash
Godiva Truffles	○	○	$20 in cash

==Page Break

As you consider the choices that follow, there are no wrong answers. We are interested in your opinions.

==Page Break

3.5.2. Study S2b Stimuli

Figures S3.4A and S3.4B are screenshot example from Study S2b.

Condition 1 (*counterbalancing*; cash alternatives on left):

$22 in cash	○	○	*Crock-Pot*
$26 in cash	○	○	*Crock-Pot*
$30 in cash	○	○	*Crock-Pot*
$34 in cash	○	○	*Crock-Pot*
$38 in cash	○	○	*Crock-Pot*
$42 in cash	○	○	*Crock-Pot*
$46 in cash	○	○	*Crock-Pot*
$50 in cash	○	○	*Crock-Pot*
$54 in cash	○	○	*Crock-Pot*
$58 in cash	○	○	*Crock-Pot*

Figure S3.4A. An illustration of the Certainty Equivalents-Setting Phase in Study S2b in Condition 1.

Condition 2 (*counterbalancing*; cash alternatives on right):

Crock-Pot	○	○	$22 in cash
Crock-Pot	○	○	$26 in cash
Crock-Pot	○	○	$30 in cash
Crock-Pot	○	○	$34 in cash
Crock-Pot	○	○	$38 in cash
Crock-Pot	○	○	$42 in cash
Crock-Pot	○	○	$46 in cash
Crock-Pot	○	○	$50 in cash
Crock-Pot	○	○	$54 in cash
Crock-Pot	○	○	$58 in cash

Figure S3.4B. An illustration of the Certainty Equivalents-Setting Phase in Study S2b in Condition 2 (*counterbalancing; cash alternatives on right*).

3.5.3. List of Products Used in Certainty Equivalents-Setting Phase

Figure S3.4C. An illustration of the Products used in Certainty Equivalents-Setting Phase (*from left to right, top to bottom*: Gowise Air Fryer 6-quart, little or no oil; Schwinn Recumbent Bike; AmazonBasics Office Chair; Honeywell Tower Fan; Nintendo Switch Lite; HP Printer Paper 3 Reams, 1500 Sheets; Xeros Printer Black and White, 31ppm; Samsung 65-inch 4K Smart TV; Black & Decker Dustbuster Vacuum)

3.5.4. Study S2b Instructions: Crossmodal Condition

On each of the following pages, we ask you to make a series of choices between a consumer item and various cash amounts.
== Page Break

Condition A (counterbalancing): For example, please indicate whether you would choose the 24-pack of *Godiva* chocolate truffles or the pictured coin flip, which pays you $4 if the coin lands heads and $29 if the coin lands tails.

Condition B (*counterbalancing*): For example, please indicate whether you would choose the pictured coin flip, which pays you $4 if the coin lands heads and $29 if the coin lands tails, or the 24-pack of *Godiva* chocolate truffles.

== Page Break

3.5.4.1. List of Products Used in Crossmodal Condition

3.5.4.1.1. Products used in this task are mostly identical to the product listing task with additional distractors detailed below.

Figure S3.4D. An illustration of the Products used in Crossmodal Condition (*from left to right, top to bottom*: 6-Quart, Programmable Crockpot; AmazonBasics Office Chair; Gowise Air Fryer 6-quart, little or no oil; Schwinn Recumbent Bike; HP Printer Paper 3 Reams, 1500 Sheets; Black & Decker Dustbuster Vacuum; Honeywell Tower Fan; Samsung 65-inch 4K Smart TV; Xerox Printer Black and White; Nintendo Switch Lite)

3.5.4.1.2. Crossmodal Distractors

Product 1 (256GB iPad Mini)

Product 2 (Lodge 10-inch Cast Iron Skillet)

Product 3 (Meta Quest 2 Headset 128 GB)

3.5.5. Study S2b Instructions: Unimodal Condition

On each of the following pages, we ask you to make a choice between a cash amount and a coin flip that could yield you either of two cash amounts.

== Page Break

Condition X (counterbalancing): For example, please indicate whether you would choose the $15 or the pictured coin flip, which pays you $4 if the coin lands heads and $29 if the coin lands tails.

Condition Y (counterbalancing): For example, please indicate whether you would choose the pictured coin flip, which pays you $4 if the coin lands heads and $29 if the coin lands tails, or the $15.

==Page Break

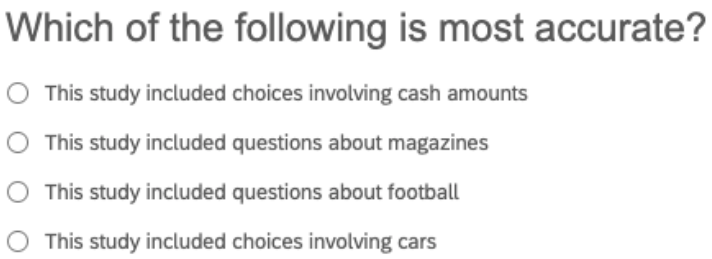
3.5.5.1. Unimodal Distractors

$360 (Cash Equivalent of 256GB iPad Mini)
$21 (Cash Equivalent of Lodge 10-inch Cast Iron Skillet)
$135 (Cash Equivalent of Meta Quest 2 Headset 128 GB)

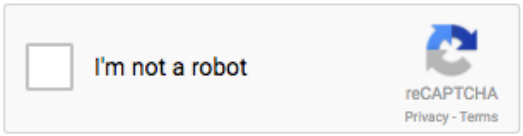
Notes: The values of corresponding gambles in this task are the sure thing, consisting of the cash equivalent (CE) of the distractor items, as well as a preset list of possibilities in which there are six total combinations in the cash vs. gambles block (0.1/1.9 times CE, 0.5/2.2 times CE, and 0.9/2.5 times CE). This is indicated in the survey flow with Profile 2, and below is the list of 3 choice distractors:

	Lodge Skillet (cash equivalent = $21)		iPad (cash equivalent = $360)		Meta Quest 2 Headset (cash equivalent = $135)	
Profile/ Profile2	Lodge skillet low outcome	Lodge skillet high outcome	iPad low outcome	iPad high outcome	VR headset low outcome	VR headset high outcome
1	2	39	180	792	122	338
2	2	39	324	950	68	297
3	11	46	39	684	122	338
4	11	46	324	900	14	256
5	19	53	36	684	68	297
6	19	53	180	792	14	256

3.5.6. Demographics and Attention Checks

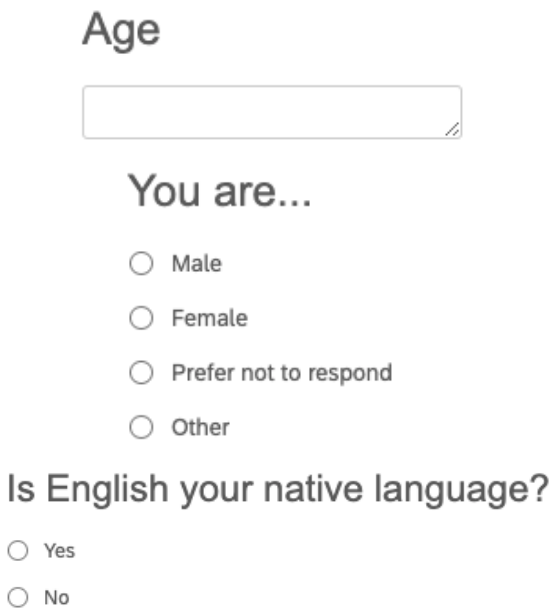


== Page Break



== Page Break

Please answer a few more questions.



3.5.7. Study S2b Affect Rating Addendum Details

3.5.7.1. Study S2b Affect Rating Addendum: Instructions for Certainty Equivalents-Setting Phase

On each of the following pages, we ask you to make a series of choices between a consumer item and various cash amounts.

==Page Break

For example, on each line below, please indicate whether you would choose the *Godiva* chocolate truffles or the listed cash amount.

Godiva Truffles	◯ ◯	$10 in cash
Godiva Truffles	◯ ◯	$20 in cash

==Page Break

As you consider the choices that follow, there are no wrong answers. We are interested in your opinions.

3.5.7.2. Study S2b Affect Rating Addendum Stimuli

Figure S3.4E is a screenshot example in Study S2b Affect Rating Addendum.

Figure S3.4E. An illustration of the Certainty Equivalents-Setting Phase in Study S2b's Affect Rating Addendum (counterbalancing; cash alternatives on the right)

3.5.7.3. List of Products Used in Certainty Equivalents-Setting Phase

Figure S3.4F. An illustration of the Products used in Certainty Equivalents-Setting Phase (*from left to right, top to bottom*: Gowise Air Fryer 6-quart, little or no oil; Schwinn Recumbent Bike; AmazonBasics Office Chair; Honeywell Tower Fan; Nintendo Switch Lite; HP Printer Paper 3 Reams, 1500 Sheets; Xeros Printer Black and White, 31ppm; Samsung 65-inch 4K Smart TV; Black & Decker Dustbuster Vacuum)

3.5.7.4. Study S2b Affect Ratings Addendum: Instructions for Rating Cash

On the next few pages, we ask you to imagine that as part of a study, you actually receive various cash amounts. Please indicate how you would feel about receiving each of them.

==Page Break

Figure S3.4G is a screenshot example of a cash affect rating in Study S2b Affect Rating Addendum.

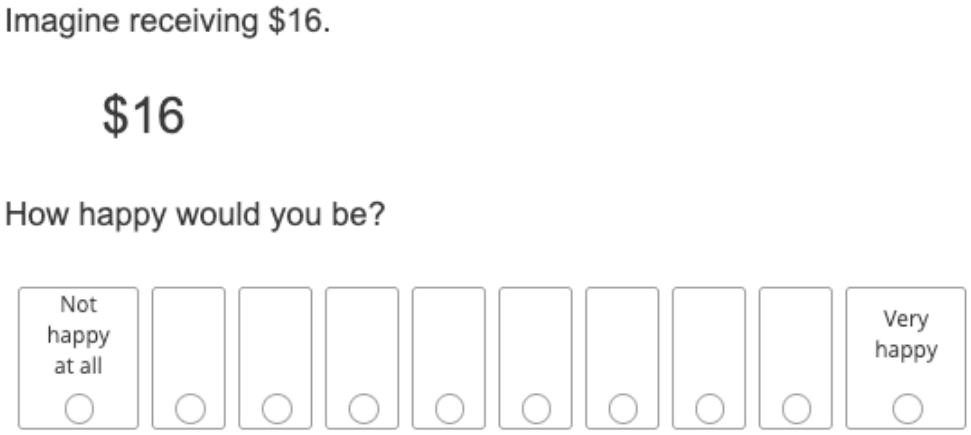


Figure S3.4G. Screencap from Cash affect rating (for a hypothetical $16 cash equivalent) in Study S2b Affect Rating Addendum.

3.5.7.5. Study S2b Affect Ratings Addendum: Instructions for Rating Products

On the next few pages, we ask you to imagine that as part of a study, you actually receive some of the consumer items we have mentioned. Please indicate how you would feel about receiving each of them.
==Page Break

Figure S3.4H is a screenshot example of a product affect rating in Study S2b Affect Rating Addendum.

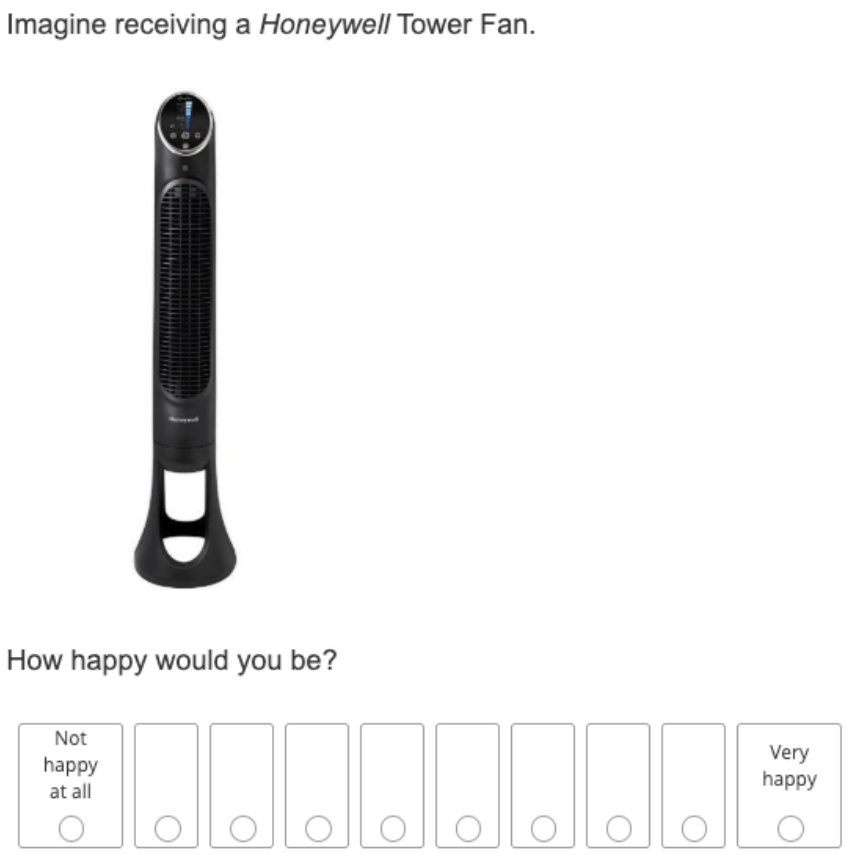
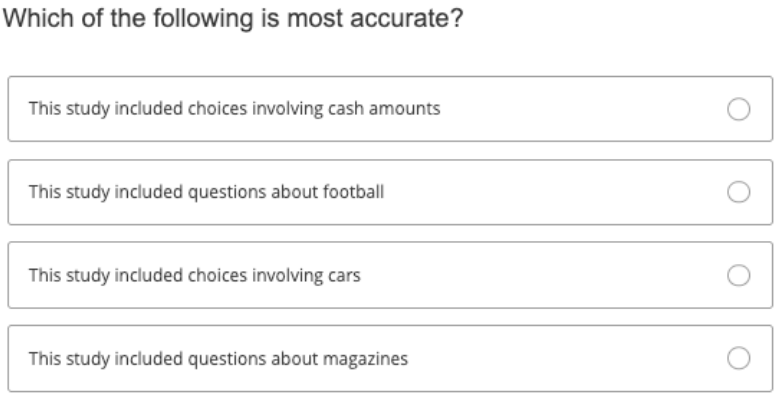
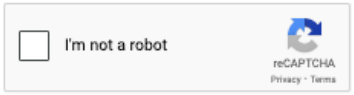


Figure S3.4H. Screencap from Product affect rating in Study S2b Affect Rating Addendum.

3.5.7.6. Demographics and Attention Checks

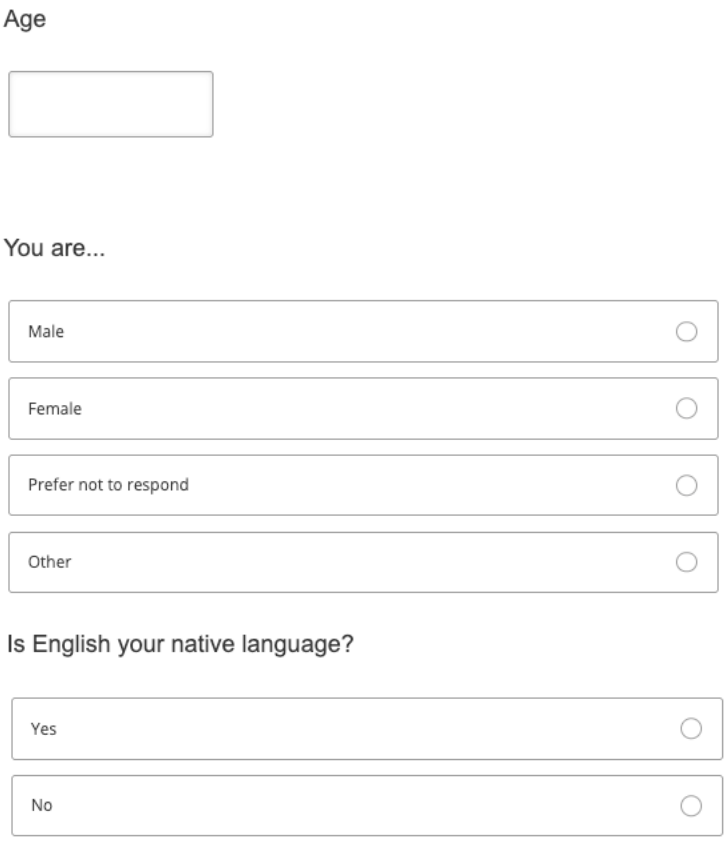


== Page Break



== Page Break

Please answer a few more questions.



3.6. Preregistration Links

Study	AsPredicted#	Link
1a	88630	https://aspredicted.org/kvxj-xjgs.pdf
1b	97396	https://aspredicted.org/7qqt-55r9.pdf
1c	90670	https://aspredicted.org/n4nh-t2n5.pdf
1d	91181	https://aspredicted.org/z6j3-ws8g.pdf
1e	222898	https://aspredicted.org/gp5v-3zvt.pdf
1f	222899	https://aspredicted.org/x7vg-7th2.pdf
S2a	110849	https://aspredicted.org/pcxp-zv4k.pdf
S2a Addendum	240436	https://aspredicted.org/7y9q-pybk.pdf
S2b	146238	https://aspredicted.org/xvd6-s8yc.pdf
S2b Addendum	242371	https://aspredicted.org/7j8t-86sv.pdf

Table S3.1 List of pre-registration links for studies. All pre-registration documents are also located at the OSF (https://osf.io/3728x/?view_only=a79ba611d9a54c06a06d52380c5304e4).

Supplemental Material, Part 4: Additional Analyses

Study	Comparison	β	Odds Ratio
1a	Fair Risk	0.203	1.23
1a	Favorable Risk	0.140	1.15
1b	Fair Risk	0.156	1.17
1b	Favorable Risk	0.265	1.30
1c	Unfavorable Risk	0.764	2.15
1c	Favorable Risk	0.128	1.14
1d	Unfavorable Risk	0.524	1.69
1d	Favorable Risk	0.152	1.16
1e	25/75 Unfavorable Risk	0.194	1.21
1e	75/25 Favorable Risk	0.225	1.25
1f	10/90 Unfavorable Risk	0.112	1.12
1f	90/10 Favorable Risk	0.267	1.31
S2a	Overall Product vs. Monetary Gambles	0.190	1.21
S2a	$GAI \leq .5$	1.465	4.33
S2a	$GAI > .5$	0.292	1.34
S2b	Fair	0.748	2.11
S2b	Moderately Favorable	0.429	1.54
S2b	Very Favorable	0.203	1.23

Table S4.1. Unstandardized binary logistic regression coefficients and corresponding odds ratios.

4.1. Study 1a: Additional Analyses

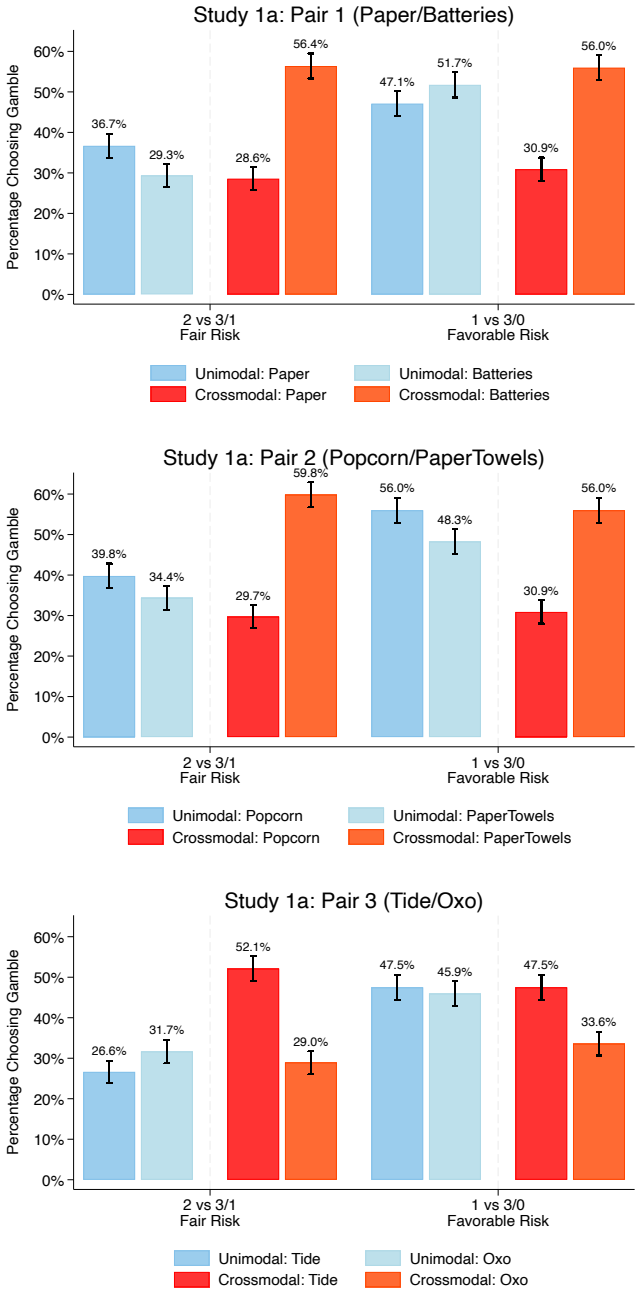


Figure S4.1a. Results from Study 1a, disaggregated for three product pairs. Legend refers to which of two products in the product pair is the sure thing. Bars show the percentage of participants choosing the gamble over the sure thing, broken down by type of decision (unimodal or crossmodal) and risk (fair or favorable). Error bars indicate +/- 1 standard error.

Study	Product Pair	Hypothesis A: more risk seeking in crossmodal choices for unfavorable risk gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for favorable risk gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1a	1	8.37*	4.15*	12.23***
1a	2	5.33*	8.34**	13.47***
1a	3	13.09***	4.22*	16.34***

Table S4.1a.1. Analyses for Study 1a for 3 different product pairs. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Analysis	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$ or F)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$ or F)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$ or F)
1a	Logit	20.78	21.92	66.48
1a	Probit	21.68	21.45	68.06
1a	Linear Probability Model	25.16	19.64	72.88
1a	Mixed effects logit random intercept	30.49	22.16	50.15

Table S4.1a.2. Robustness analysis for aggregate results for Study 1a using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants for logit, probit, and linear probability). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

4.2 Studies 1b-1f: Additional Analyses

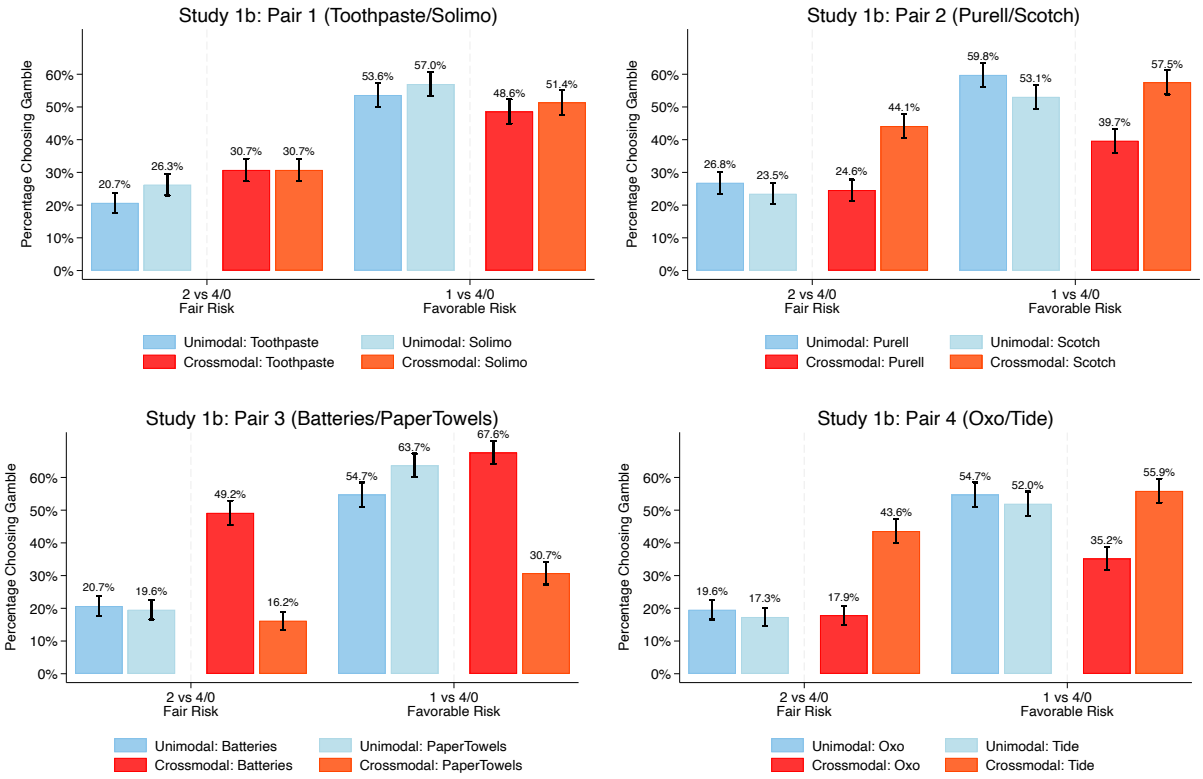


Figure S4.1b. Results from Study 1b, disaggregated for four product pairs. Legend refers to which of two products in the product pair is the sure thing. Bars show the percentage of participants choosing the gamble over the sure thing, broken down by type of decision (unimodal or crossmodal) and risk (fair or favorable). Error bars indicate +/- 1 standard error.

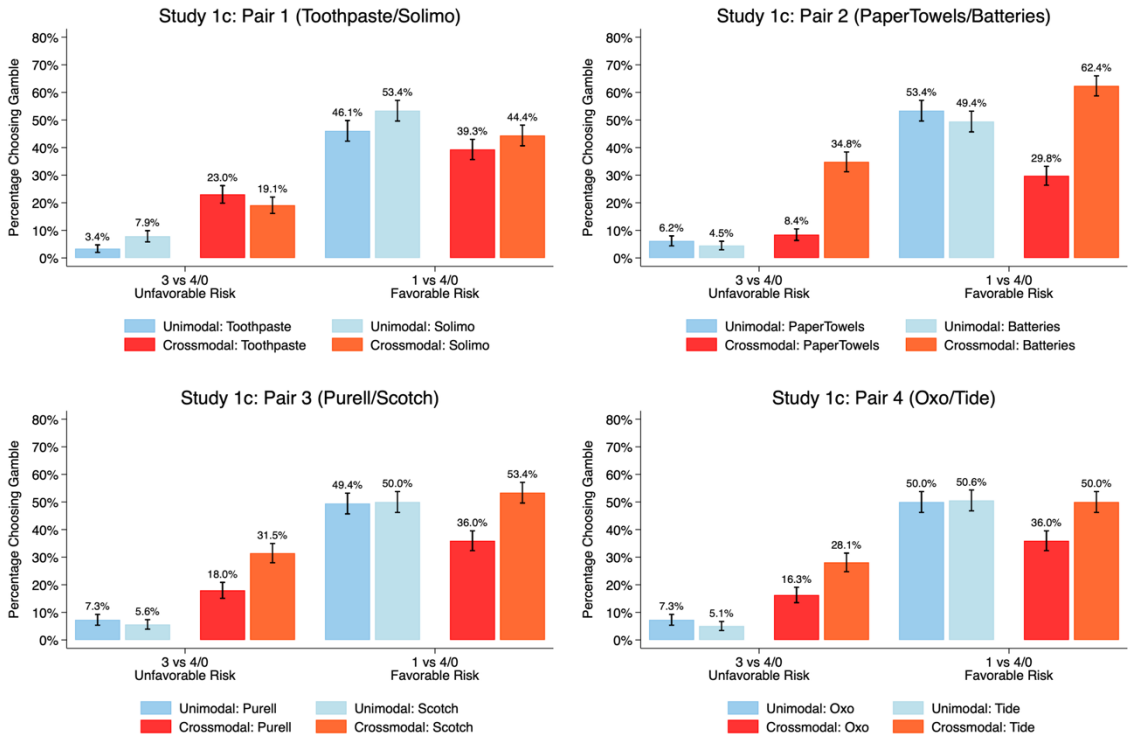


Figure S4.1c. Results from Study 1c, disaggregated for four product pairs. Legend refers to which of two products in the product pair is the sure thing. Bars show the percentage of participants choosing the gamble over the sure thing, broken down by type of decision (unimodal or crossmodal) and risk (unfavorable or favorable). Error bars indicate +/- 1 standard error.

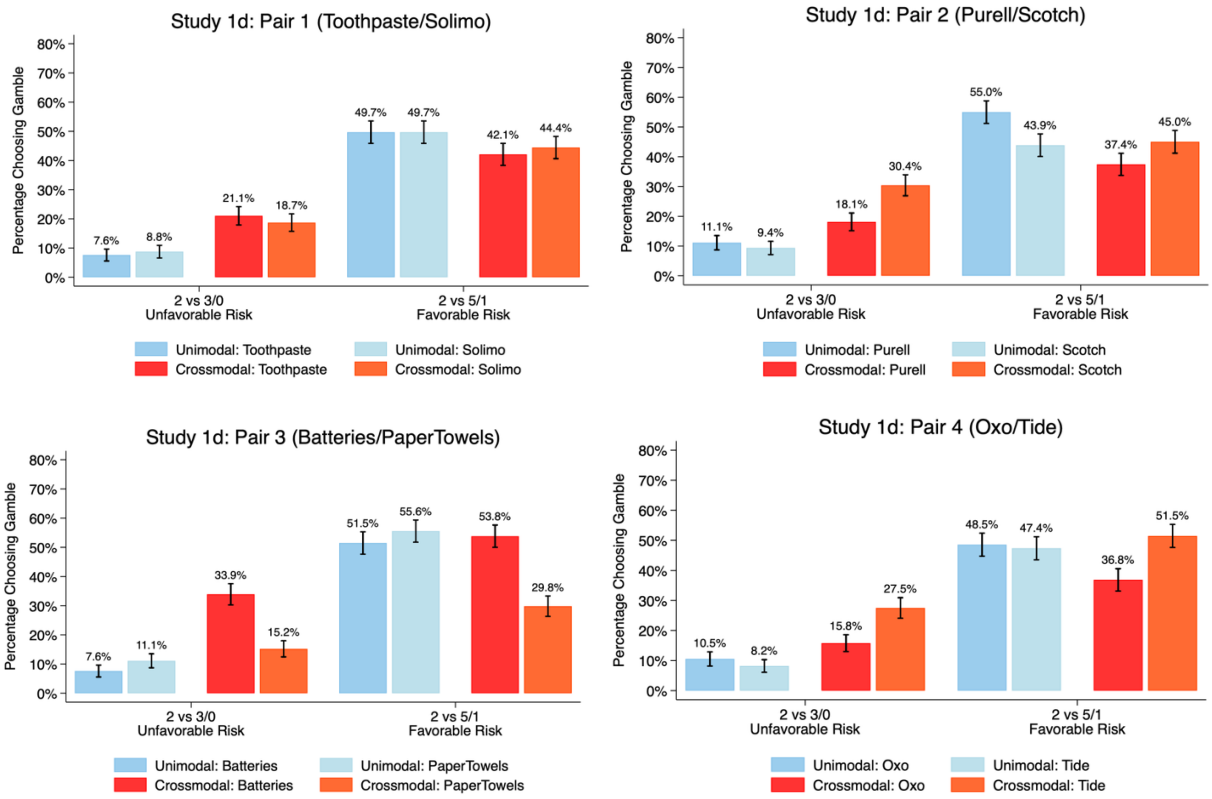


Figure S4.1d. Results from Study 1d, disaggregated for four product pairs. Legend refers to which of two products in the product pair is the sure thing. Bars show the percentage of participants choosing the gamble over the sure thing, broken down by type of decision (unimodal or crossmodal) and risk (unfavorable or favorable). Error bars indicate +/- 1 standard error.

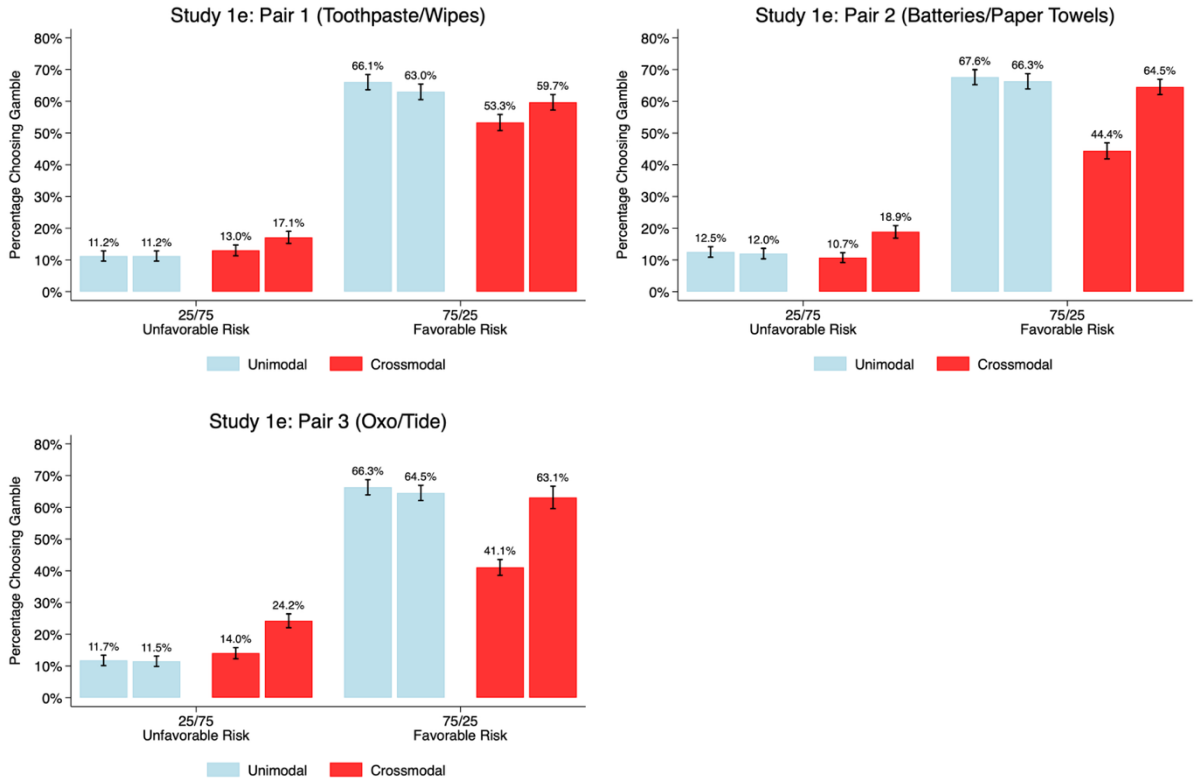


Figure S4.1e. Results from Study 1e, disaggregated for three product pairs. Legend refers to which of two products in the product pair is the sure thing. Bars show the percentage of participants choosing the gamble over the sure thing, broken down by type of decision (unimodal or crossmodal) and risk (unfavorable or favorable). Error bars indicate +/- 1 standard error.

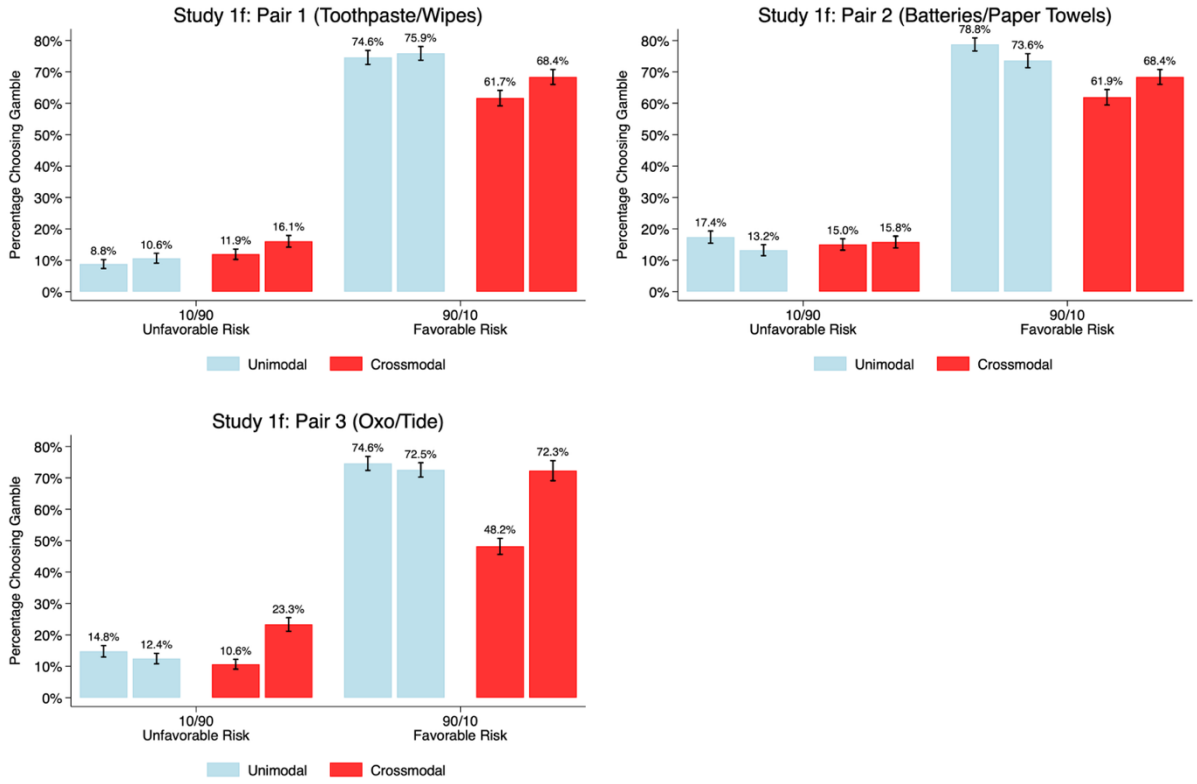


Figure S4.1f. Results from Study 1f, disaggregated for three product pairs. Legend refers to which of two products in the product pair is the sure thing. Bars show the percentage of participants choosing the gamble over the sure thing, broken down by type of decision (unimodal or crossmodal) and risk (unfavorable or favorable). Error bars indicate +/- 1 standard error.

Study	Product Pair	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1b	1	4.90^{*}	2.02	6.76^{**}
1b	2	6.12^{*}	4.38^{*}	10.50^{**}
1b	3	8.80^{**}	7.00^{**}	15.80^{***}
1b	4	10.55**	4.50	11.86^{***}

Table S4.1b.1. Analyses for Study 1b for 4 different product pairs. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Analysis	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$ or F)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$ or F)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$ or F)
1b	Logit	18.43	11.47	32.23
1b	Probit	20.45	18.48	46.36
1b	Linear Probability Model	29.45	18.24	55.74
1b	Mixed effects logit random intercept	41.14	25.99	65.48

Table S4.1b.2. Robustness analysis for aggregate results for Study 1b using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants for logit, probit, and linear probability). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

Study	Product Pair	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1c	1	31.53^{***}	4.43^{*}	35.32^{***}
1c	2	23.49^{***}	2.26	24.77^{***}
1c	3	37.14^{***}	1.92	35.22^{***}
1c	4	31.20^{***}	3.92^{*}	33.89^{***}

Table S4.1c.1. Analyses for Study 1c for 4 different product pairs. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Analysis	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$ or F)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$ or F)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$ or F)
1c	Logit	89.71	14.08	106.50
1c	Probit	113.66	13.87	124.67
1c	Linear Probability Model	178.08	12.99	102.95
1c	Mixed effects logit random intercept	135.40	19.15	149.85

Table S4.1c.2. Robustness analysis for aggregate results for Study 1c using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants for logit, probit, and linear probability). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

Study	Product Pair	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1d	1	18.26^{***}	2.84	20.31^{***}
1d	2	20.80^{***}	4.62^{*}	24.68^{***}
1d	3	22.45^{***}	9.84^{**}	32.29^{***}
1d	4	17.17^{***}	1.05	16.11^{***}

Table S4.1d.1. Analyses for Study 1d for 4 different product pairs. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Analysis	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$ or F)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$ or F)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$ or F)
1d	Logit	53.64	15.30	82.70
1d	Probit	62.14	15.14	92.42
1d	Linear Probability Model	87.03	14.47	86.33
1d	Mixed effects logit random intercept	95.60	22.17	107.88

Table S4.1d.2. Robustness analysis for aggregate results for Study 1d using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

Study	Product Pair	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1e	1	4.80^{*}	10.51^{**}	13.12^{**}
1e	2	1.44	24.28^{***}	14.50^{***}
1e	3	14.48^{***}	21.63^{***}	34.65^{***}

Table S4.1e.1. Analyses for Study 1e for 3 different product pairs. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Analysis	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$ or F)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$ or F)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$ or F)
1e	Logit	18.47	73.85	73.93
1e	Probit	20.11	75.97	84.40
1e	Linear Probability Model	27.32	83.82	118.52
1e	Mixed effects logit random intercept	23.52	89.36	81.30

Table S4.1e.2. Robustness analysis for aggregate results for Study 1e using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. All test statistics are significant at $p < .001$.

Study	Product Pair	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1f	1	6.40^{*}	18.86^{***}	20.82^{***}
1f	2	0.02	22.37^{***}	9.38^{***}
1f	3	1.71	21.55^{***}	16.07^{***}

Table S4.1f.1. Analyses for Study 1f for 3 different product pairs. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Analysis	Hypothesis A: more risk seeking in crossmodal choices for actuarial neutral or unfavorable gambles ($\chi^2(1)$ or F)	Hypothesis B: less risk seeking in crossmodal choices for actuarial favorable gambles ($\chi^2(1)$ or F)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$ or F)
1f	Logit	7.68^{**}	70.74^{***}	66.42^{***}
1f	Probit	8.07^{**}	74.67^{***}	74.39^{***}
1f	Linear Probability Model	9.56^{**}	88.79^{***}	101.94^{***}
1f	Mixed effects logit random intercept	7.79^{**}	91.87^{***}	57.29^{***}

Table S4.1f.2. Robustness analysis for aggregate results for Study 1e using logit, probit, linear probability, or mixed effects logit with random intercept models for hypothesis tests (with standard errors clustered at the level of individual participants). $\chi^2(1)$ are reported for logit, probit, and mixed effects analyses, and a F statistic is reported for the linear probability model. *: $p < .05$; **: $p < .01$; ***: $p < .001$.

Study	Fair/Unfavorable Risk	Favorable Risk	Interaction
1a	1/3	0/3	0/3
1b	3/4	2/4	2/4
1c	4/4	1/4	1/4
1d	4/4	4/4	4/4
Total	12/15	7/15	7/15
Binomial Test	$z = 4.62$, $p < .0001$	$z = 1.64$, $p = .057$	$z = 21.96$, $p < .0001$

Table S4.1g. Results of an ordinal test of independence, $P(x, z) \geq P(y, z)$ if and only if $P(x, w) \geq P(y, w)$ for any x, y, w, z (Tversky and Russo, 1969) for Studies 1a-d. Each product pair in a Study constitutes a separate test for the actuarially neutral/unfavorable condition and the actuarially favorable condition. Of the 24 orderings of choice percentages between the two sure things and the two gambles, 6 (25%) violate independence in the direction predicted by our theory. The table shows the number of predicted violations out of the number of tests. The binomial test compares the ordinal violations of independence to the expected violations under the null hypothesis that 25% of the patterns violated independence by chance. The test is also conducted on the predicted interaction. 36 of 576 (6.25%) orderings constitute independence violations as predicted by our theory. The binomial test for the interaction compares the ordinal violations of independence to the expected violations under the null hypothesis 6.25% of the patterns violated independence by chance.

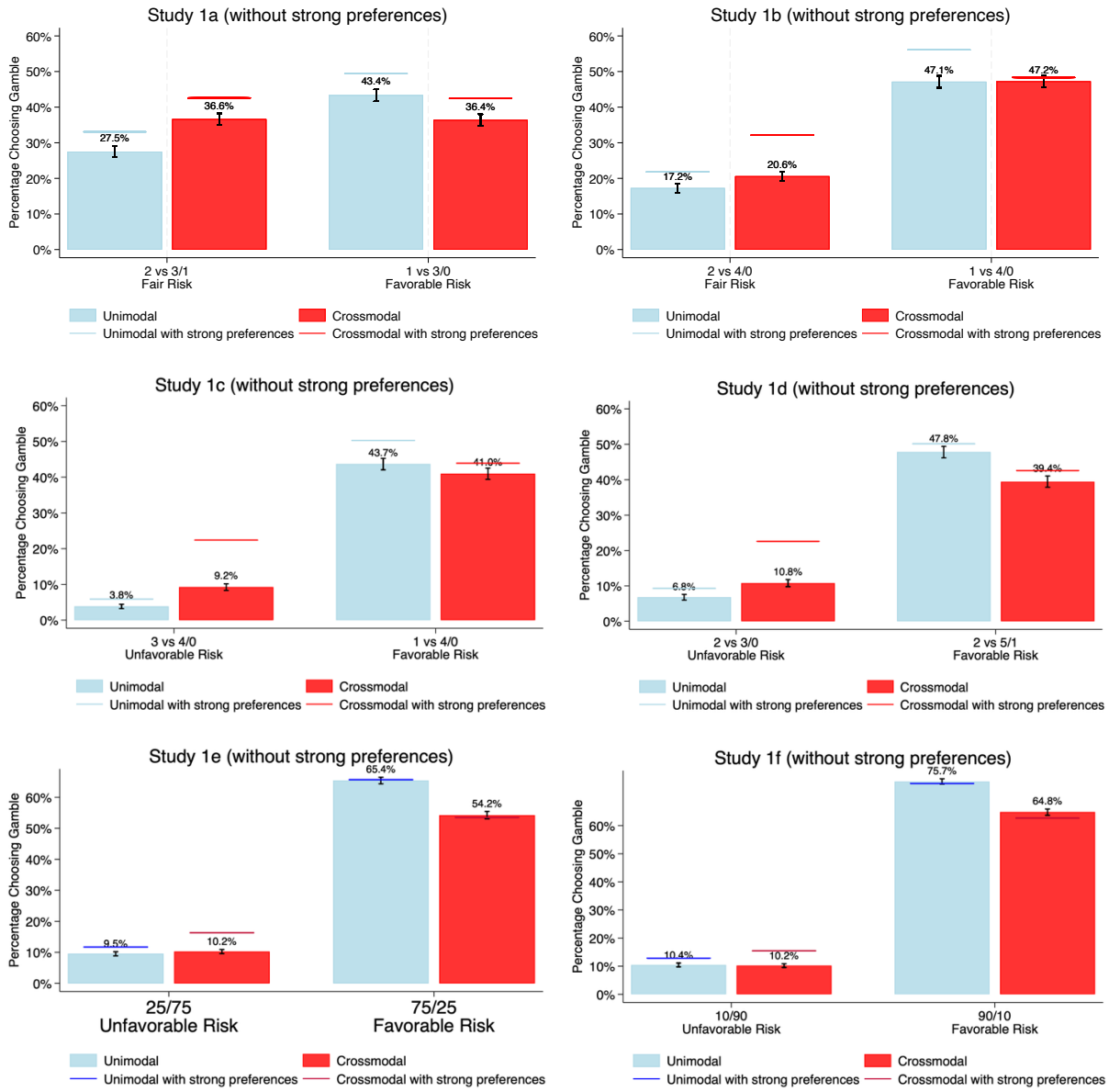


Figure S4.2. Results from Studies 1a – 1f, aggregated over product pairs, excluding strong preferences, i.e., choices of all participants who always chose one product over another product for each of the four crossmodal choices. Bars show the percentage of participants choosing the gamble over the sure thing. Error bars indicate +/- 1 standard error. Horizontal lines indicate risky choice fractions with no exclusions.

Study	Hypothesis A: more risk seeking in crossmodal choices for fair or unfavorable risk gambles ($\chi^2(1)$)	Hypothesis B: less risk seeking in crossmodal choices for favorable risk gambles ($\chi^2(1)$)	Hypothesis C: interaction in risk seeking, crossmodal × risk level ($\chi^2(1)$)
1a	13.03^{***}	15.39^{***}	31.31^{***}
1b	2.52	0.41	1.21
1c	15.23^{***}	1.13	16.90^{***}
1d	11.31^{***}	23.83^{***}	31.29^{***}
1e	0.11	57.83^{***}	19.23^{***}
1f	0.38	52.99^{***}	16.36^{***}

Table S4.1h. Robustness analysis for aggregate results for Studies 1a-1f dropping strong preferences, i.e., choices of all participants who always chose one product over another product for each of the four crossmodal choices. The analysis uses logit regression for hypothesis tests (with standard errors clustered at the level of individual participants). $\chi^2(1)$ are reported. *: $p < .05$; **: $p < .01$; ***: $p < .001$.