Online Appendix B: Complete experimental results for all studies and conditions

As noted in the main paper and in detailed in Online Appendix A (which contains all of our experimental materials), we ran several additional conditions in several studies, including manipulating magnitude (large vs small) and type of uncertainty (outcomes vs amounts). Participants in several studies also answered risky choice questions (with no temporal component), and we have some process measures and individual differences (in Study 5S). Furthermore, we ran three additional studies that are not reported in the main manuscript. The results for all of these studies and conditions are reported in the materials below.

Study 1: Immediate certainty vs future uncertainty, with small vs large outcomes and uncertain outcomes vs amounts

Study Overview

This is a full reporting of the Study 1 that is reported in the main manuscript. The materials can be found in Online Appendix A. The full study includes several additional conditions, including a large magnitude condition (all outcomes 100 times larger) and an uncertain amounts condition (all uncertainty conditions use a range of outcomes, such as a choice between $100 now or a random amount between $50 and $150 in one month). Thus, the full design is sign (gain vs loss, within) x magnitude (small vs large, within) x future uncertainty (future outcomes are certain vs uncertain, within) vs uncertainty type (uncertain outcomes vs uncertain amounts, between) x order of presentation of scenarios (between).

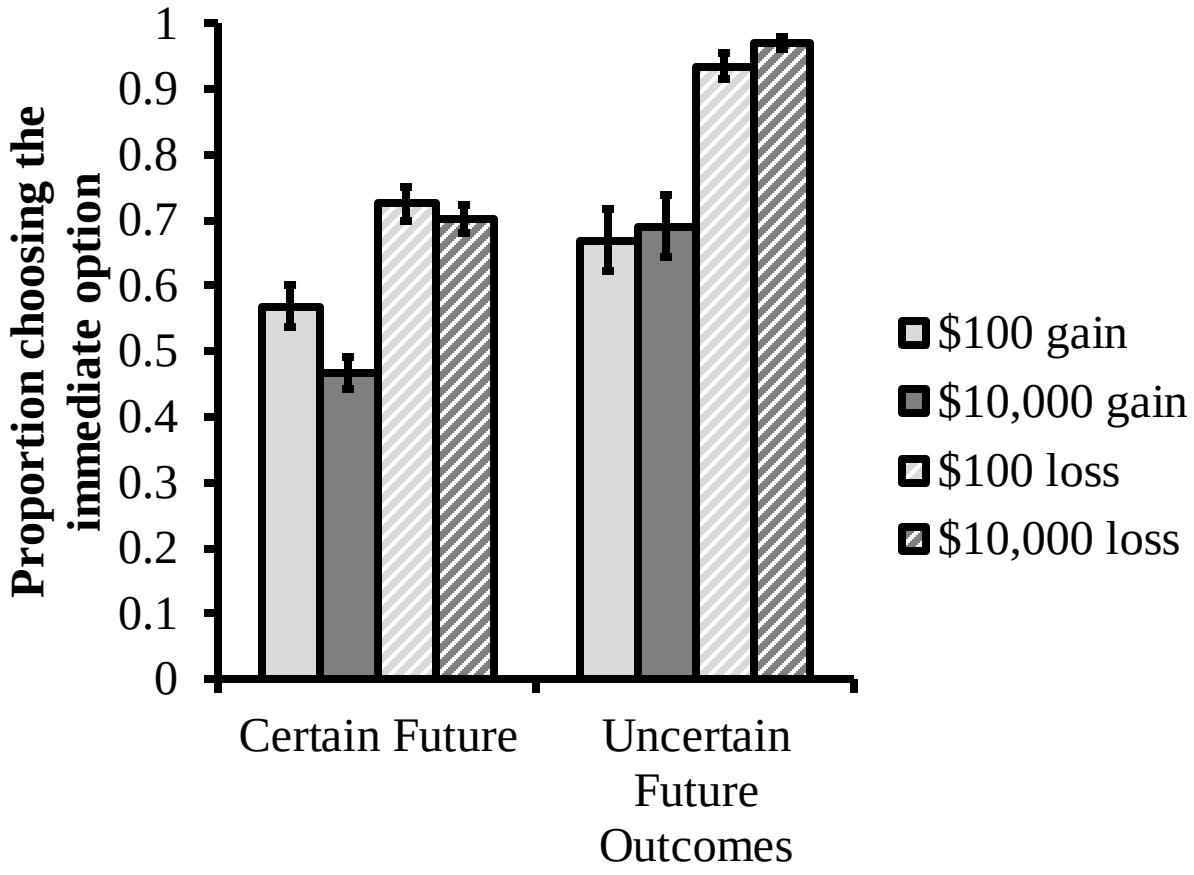
Results with uncertain outcomes

As seen in Figure 1A, the presence (or absence) of future uncertainty had a strong impact on participants intertemporal choices. We ran an omnibus, repeated-measures GLM with future uncertainty (present vs absent), sign (gain vs loss), and magnitude (large vs small) predicting the proportion of

choices for the immediate option. As predicted, a strong main effect of uncertainty, $F(1,69)=70.9$, $p<.001$, $\eta^2=.51$, indicated that participants chose the immediate option more often when the future was uncertain. A main effects of sign, $F(1,149)=56.2$, $p<.001$, $\eta^2=.45$, indicated that participants chose the immediate options more often when considering losses. However, the main effect of magnitude was not significant, $F(1, 69)=1.4$, $p=.25$, $\eta^2=.02$. An interaction of uncertainty and magnitude, $F(1, 69)=12.7$, $p<.001$, $\eta^2=.16$, indicated that the magnitude effect was wiped out when future outcomes were uncertain. The interaction of sign and magnitude, $F(1, 69)=1.9$, $p=.17$, $\eta^2=.03$, was not significant, and neither was the interaction of uncertainty and sign, $F(1, 69)=2.5$, $p=.12$, $\eta^2=.04$, nor the three-way interaction, $F(1, 69)=1.3$, $p=.36$, $\eta^2=.02$.

Figure 1A

Proportion choosing the immediate option when the future is certain vs probabilistic, in Study 1. Error bars indicate +/- one standard error.



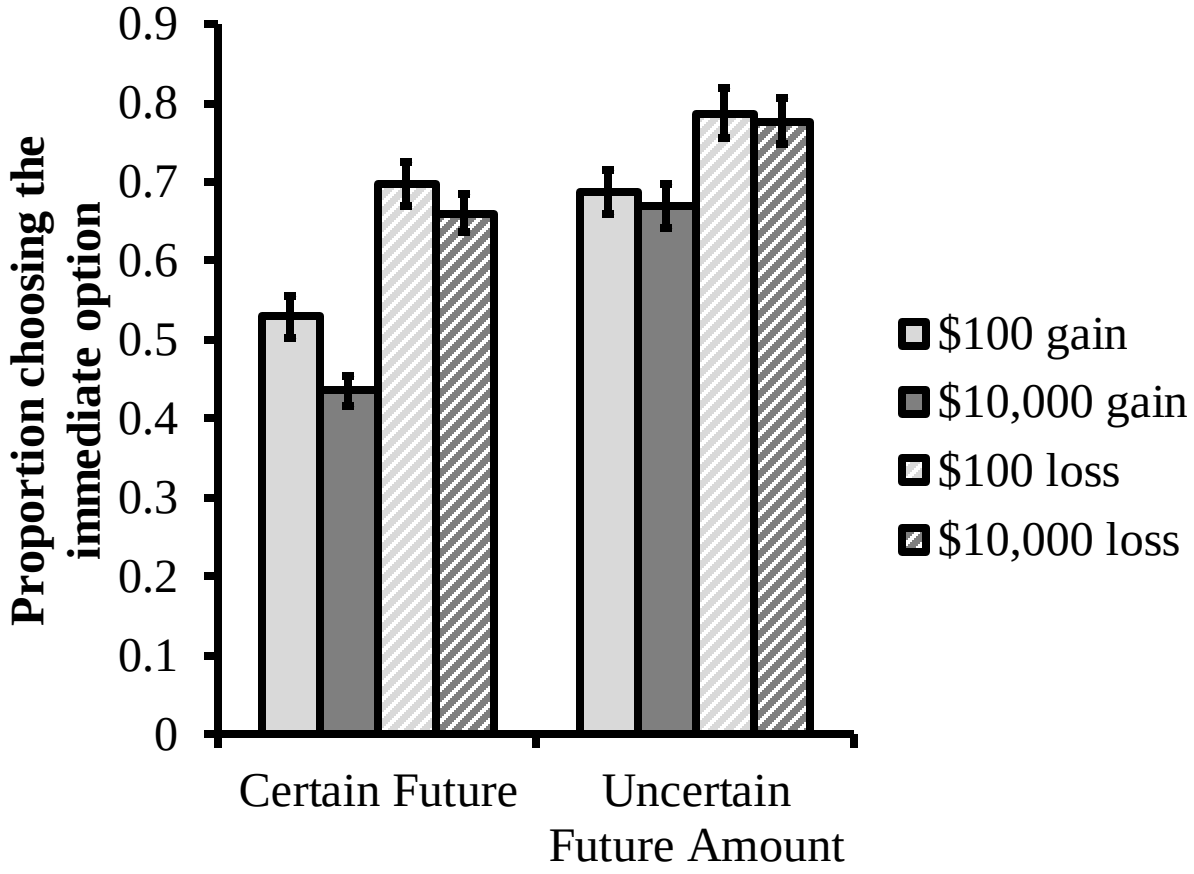
Results with uncertain amounts

As seen in Figure 1B, the presence (or absence) of future uncertainty had a strong impact on participants intertemporal choices. We ran an omnibus, repeated-measures GLM with future uncertainty (present vs absent), sign (gain vs loss), and magnitude (large vs small) predicting the proportion of choices for the immediate option. As predicted, a strong main effect of uncertainty, $F(1,79)=64.3$, $p<.001$, $\eta^2=.45$, indicated that participants chose the immediate option more often when the future was uncertain. Main effects of sign, $F(1, 79)=30.4$, $p<.001$, $\eta^2=.28$, and magnitude, $F(1, 79)=6.9$, $p<.05$, $\eta^2=.08$,

indicated that participants chose the immediate options more often when considering losses and when considering smalle stakes. An interaction of uncertainty and magnitude, $F(1, 79)=11.3$, $p<.01$, $\eta^2=.13$, indicated that the magnitude effect was wiped out when future outcomes were uncertain. An interaction of uncertainty and sign, $F(1, 79)=7.5$, $p=.01$, $\eta^2=.09$,indicated that the effect of uncertainty was larger for gains than for losses. Neither the interaction of sign and magnitude, $F(1, 79)=2.4$, $p=.13$, $\eta^2=.03$, nor the three-way interaction, $F(1, 79)=2.4$, $p=.13$, $\eta^2=.03$, were significant.

Figure 1B

Proportion choosing the immediate option when the future is certain vs variable, in Study 1. Error bars indicate +/- one standard error.



Study 2: Immediate vs future X certainty vs uncertainty (2x2), with small vs large outcomes, uncertain outcomes vs uncertain amounts, and MBAs vs non-MBAs, plus risk preference for all-immediate outcomes

Study Overview

This is a full reporting of the Study 2 that is reported in the main manuscript. The materials can be found in Online Appendix A. The full study includes several additional conditions, including a large magnitude condition (all outcomes 100 times larger) and an uncertain amounts condition (all uncertainty conditions use a range of outcomes, such as a choice between $100 now or a random amount between $50 and $150 in one month), an immediate uncertainty condition (e.g., 50% chance of $200 now or $100 for sure in the future), a both uncertainty condition (50% chance of $200 now or 50% chance of $200 in the future), a risky choice condition (with no intertemporal component), and two different subject populations (MBAs vs non-MBAs). Thus, the full design is sign (gain vs loss, within) x magnitude (small vs large, within) x uncertainty timing (future uncertain, present uncertain, or both uncertain) x uncertainty type (uncertain outcomes vs uncertain amounts, between) x order of presentation of scenarios (between), plus simple risky choice and intertemporal choice questions. It includes a comparison of risk preferences when all outcomes are immediate, vs when there are intertemporal outcome, demonstrating that these two factors interact.

Results with uncertain outcomes

Time preference for certain vs uncertain outcomes

As summarized in Figure 3A, participants generally avoided uncertainty when making intertemporal choices. The results of a 3(uncertainty now, later, or both) x 2(sign) x 2(magnitude) x 2(MBA or not) mixed GLM are shown in Table 1A, demonstrating that uncertainty was the strongest predictor (ie, largest effect size) for whether someone would choose the immediate or future option. When the future outcome was uncertain, people tended to choose the immediate option, when the

immediate option was uncertain, people tended to choose the future option, and when both were uncertain, people's choices were unaffected. This same pattern is seen for both MBAs and nonMBAs. The one notable exception to the pattern is that for small gains, uncertainty did not affect the time preferences of MBAs, $F(2,85)=0.4$, $p=.65$, $\eta 2=.01$.

Time preferences for MBAs vs nonMBAs

As summarized in Figure 3A, participants generally preferred the immediate option when there was no uncertainty, and the time preferences of MBAs and non-MBAs were quite similar. A 2(sign) x2(magnitude)x2(MBA or not) mixed GLM revealed a main effect of sign (participants chose immediate losses more often than immediate gains), $F(1, 469)=36.7$, $p<.001$, $\eta^2=.07$, a main effect of magnitude (participants chose immediate small outcomes more often than immediate large outcomes), $F(1,469)=98.3$, $p<.001$, $\eta^2=.17$, a sign by magnitude interaction, $F(1, 469)=33.5$, $p<.001$, $\eta^2=.07$ (the effect of magnitude was larger for gains than for losses), and a marginally significant main effect of MBA status, $F(1, 469)=3.2$, $p=.08$, $\eta^2=.01$, indicating that MBAs were less likely to choose immediate gains and losses. There were no other significant interactions (all $p>.5$).

Risk preferences for MBAs vs nonMBAs

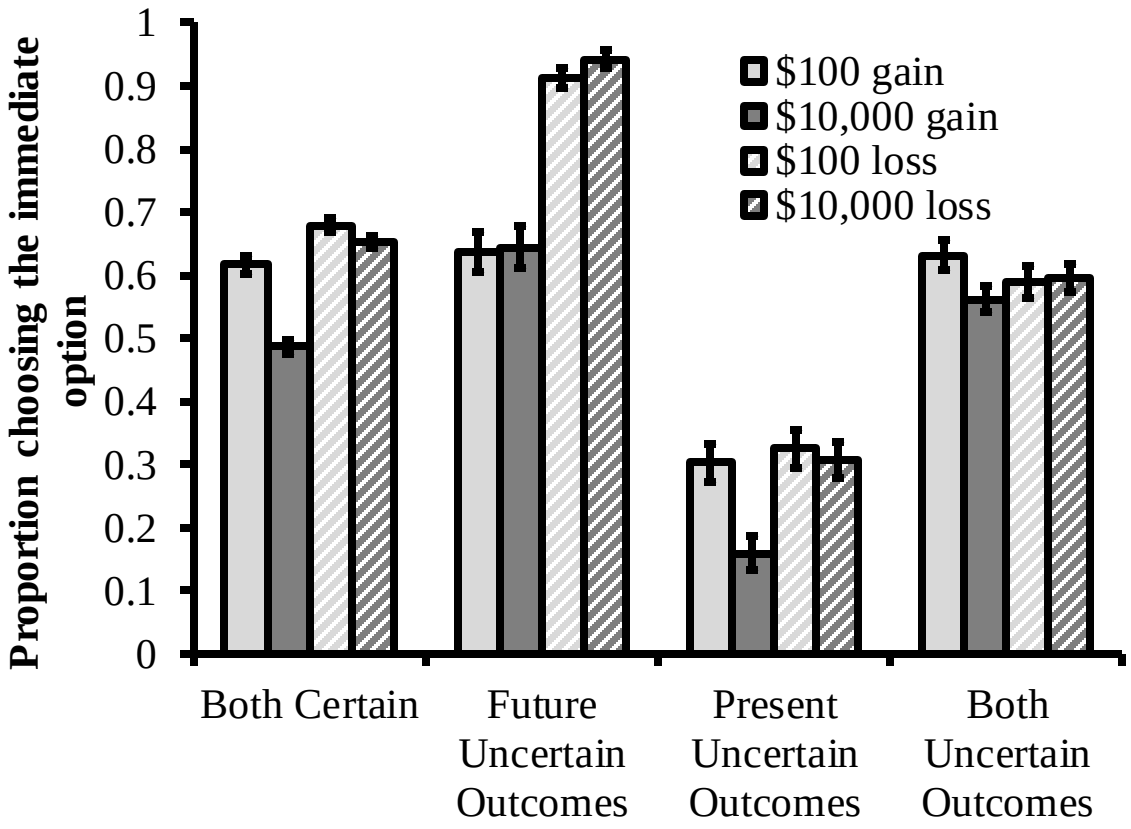
As seen in Table 2A, participants were generally risk averse, preferring the certain outcomes, and were much more risk averse for gains than for losses. A 2(sign) x2(magnitude)x2(MBA or not) mixed GLM revealed a main effect of sign (participants chose uncertain losses more often than uncertain gains), $F(1,469)=77.7$, $p<.001$, $\eta^2=.14$, a main effect of magnitude (participants chose certain outcomes more often when the magnitudes were large), $F(1, 469)=42.2$, $p<.001$, $\eta^2=.08$, and a small but statistically significant main effect of MBA status, $F(1, 469)=5.2$, $p=.02$, $\eta^2=.01$, indicating that MBAs chose uncertain options more often than non-MBAs did. There was also a significant 3-way interaction of sign, magnitude, and MBA status, $F(1, 469)=4.0$, $p=.05$, $\eta^2=.01$, indicating that with MBAs, the magnitude effect was larger for gains, while for non-MBAs, the magnitude effect was larger for losses. There were no other significant interactions (all $p>.1$).

Prospect Theory for immediate vs intertemporal outcomes

For each participant, we calculated a Prospect Theory Effect (PTE) score, which was the proportion of risky choices for losses minus the proportion of risky choices for gains (collapsing across magnitudes). We found that the difference between gains and losses was stronger when all outcomes were immediate (mean PTE score = .20, *SD* = .40), than when choosing between certain immediate outcomes and uncertain future outcomes (mean = -.27, *SD* = .41) or when choosing between uncertain immediate outcomes and certain future outcomes (mean = .06, *SD* = .36). In all three cases the PTE score was significant different from zero, $p = .04$ or lower. A 2 (intertemporal choice vs not) x 2 (uncertainty timing: now vs future) x 2 (MBA vs not) mixed GLM confirmed a main effect of intertemporal choice, $F(1,321) = 73.5$, $p < .001$, $\eta^2 = .19$, indicating that the PTE was weaker when making intertemporal choices. A main effect of uncertainty timing, $F(1, 465) = 9.7$, $p < .001$, $\eta^2 = .04$, indicated that the PTE was weaker when considering future uncertainty than when considering immediate uncertainty. These were qualified by an intertemporal choice by uncertainty timing interaction, $F(1, 465) = 7.7$, $p < .001$, $\eta^2 = .03$, indicating that the effect of intertemporal choice on the PTE was greater when considering future uncertainty than when considering immediate uncertainty. MBA status had no main effect, $F(1, 465) = 0.7$, $p = .414$, $\eta^2 = .00$, and no two or three-way interactions, all $p > .19$. Follow-up pairwise contrasts confirmed that the PTE was weaker when considering future uncertainty than when all outcomes were immediate, $t(174) = 11.4$, $p < .001$, $d = 0.86$, and that the PTE was also weaker when choosing between immediate uncertainty and future certainty than when all outcomes were immediate, $t(149) = 3.3$, $p = .001$, $d = .27$ In summary, we confirmed that the difference in risk preferences between gains and losses (i.e., Prospect Theory) is weaker when making intertemporal choices.

Figure 3A

Proportion choosing the immediate option when immediate and/or future outcomes are probabilistic, in Study 2. The top panel shows data from the general population, and the bottom panel shows data from participants currently enrolled in an MBA program. Error bars indicate +/- one standard error.


Proportion choosing the immediate option
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
$100 gain
$10,000 gain
$100 loss
$10,000 loss
Both Certain
Future Uncertain Outcomes
Present Uncertain Outcomes
Both Uncertain Outcomes

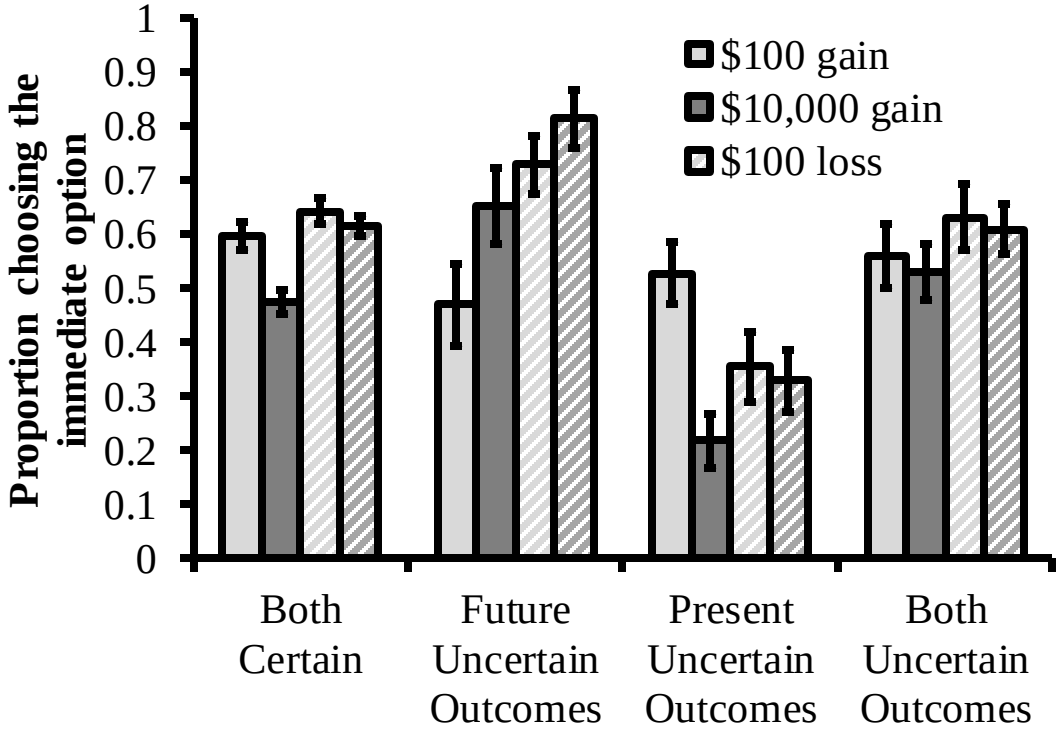

Proportion choosing the immediate option
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
$100 gain
$10,000 gain
$100 loss
Both Certain
Future Uncertain Outcomes
Present Uncertain Outcomes
Both Uncertain Outcomes

Table 1A

Repeated measure GLM results from Study 2, showing the ability of uncertain outcome timing (now, later, or both), sign (gain or loss), magnitude (large or small) and MBA status (current MBA or not) to predict time preferences.

effect	df model	df error	F	p-value	partial η^2
uncertainty	2	465	126.0	<.001	.35
sign	1	465	21.3	<.001	.04
magnitude	1	465	4.6	.03	.01
MBA status	1	465	0.1	.47	.00
uncertainty X sign	2	465	11.3	<.001	.05
uncertainty X magnitude	2	465	26.6	<.001	.10
uncertainty X MBA	2	465	7.5	<.01	.03
sign X magnitude	1	465	8.6	<.01	.02
sign X MBA	1	465	0.7	.40	.00
magnitude X MBA	1	465	0.2	.63	.00
uncertainty X sign X magnitude	2	465	9.8	<.001	.04
uncertainty X sign X MBA	2	465	1.6	.20	.01
uncertainty X magnitude X MBA	2	465	6.8	<.01	.03
sign X magnitude X MBA	1	465	0.1	.81	.00
uncertainty X sign X magnitude X MBA	2	465	3.4	.04	.01

Table 2A

Proportion choosing the certain option in the probabilistic choice scenarios, in Study 2. Standard errors are in parentheses.

scenario	non-MBAs	MBAs
small gain	.81 (.02)	.73 (.05)
large gain	.94 (.01)	.93 (.03)
small loss	.62 (.02)	.57 (.05)
large loss	.76 (.02)	.64 (.05)

Results with uncertain amounts

Time preference for certain vs uncertain outcomes

As summarized in Figure 3B, participants generally avoided uncertainty when making intertemporal choices. The results of a 3(uncertainty now, later, or both) x 2(sign) x 2(magnitude) x 2(MBA or not) mixed GLM are shown in Table 1B, demonstrating that uncertainty was the strongest predictor (ie, largest effect size) for whether someone would choose the immediate or future option. When the future outcome was uncertain, people tended to choose the immediate option, when the immediate option was uncertain, people tended to choose the future option, and when both were uncertain, people's choices were unaffected. This same pattern is seen for both MBAs and nonMBAs.

Time preferences for MBAs vs nonMBAs

As summarized in Figure 3B, participants generally preferred the immediate option when there was no uncertainty, and the time preferences of MBAs and non-MBAs were quite similar. A 2(sign) x2(magnitude)x2(MBA or not) mixed GLM revealed a main effect of sign (participants chose immediate losses more often than immediate gains), $F(1,469)=43.0$, $p<.001$, $\eta 2=.08$, a main effect of magnitude (participants chose immediate small outcomes more often than immediate large outcomes), $F(1, 469)=105.2$, $p<.001$, $\eta 2=.18$, a sign by magnitude interaction, $F(1, 469)=25.3$, $p<.001$, $\eta^2=.05$. There was no main effect of MBA status, $F(1, 469)=1.3$, $p=.25$, $\eta 2=.00$, and no other significant interactions (all $p>.1$).

Risk preferences for MBAs vs nonMBAs

As seen in Table 2B, participants were generally risk averse, preferring the certain outcomes, and were much more risk averse for gains than for losses. A 2(sign) x2(magnitude)x2(MBA or not) mixed GLM revealed a main effect of sign (participants chose uncertain losses more often than uncertain gains), $F(1,469)=60.6$, $p<.001$, $\eta^2=.11$, no main effect of magnitude, $F(1, 469)=1.4$, $p=.23$, $\eta^2=.00$, a sign by magnitude interaction, $F(1, 469)=5.3$, $p=.02$, $\eta^2=.01$. There was no main effect of MBA status, $F(1, 469)=1.3$, $p=.25$, $\eta^2=.00$, and no other significant interactions (all $p>.1$).

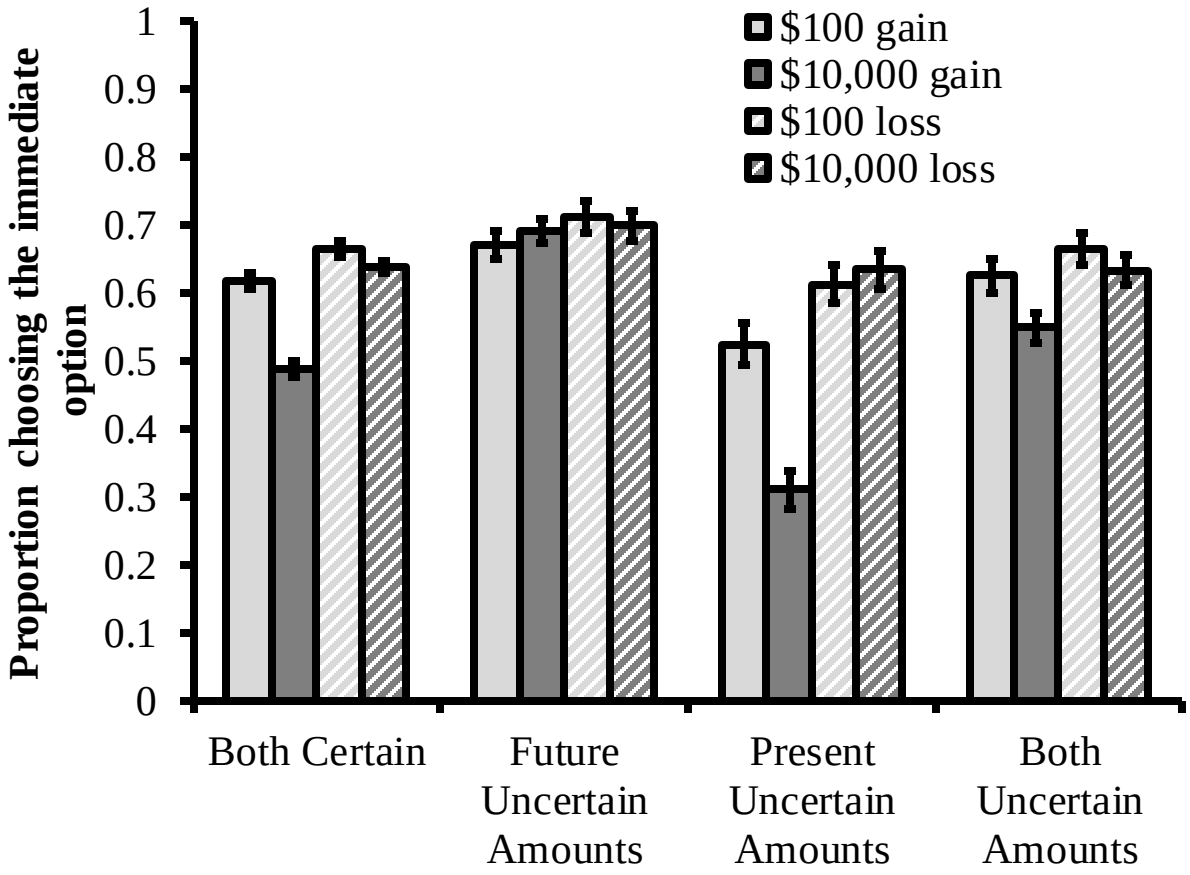
Prospect Theory for immediate vs intertemporal outcomes

For each participant, we calculated a Prospect Theory Effect (PTE) score, which was the proportion of risky choices for losses minus the proportion of risky choices for gains (collapsing across magnitudes). We found that the difference between gains and losses was stronger when all outcomes were immediate (mean PTE score = .23, $SD = .49$, $t(471) = 10.2$, $p < .001$), than when choosing between certain immediate outcomes and uncertain future outcomes (mean = -.00, $SD = .36$, $t(168) = -0.2$, $p = .83$) or when choosing between uncertain immediate outcomes and certain future outcomes (mean = .20, $SD = .36$, $t(143) = 6.6$, $p < .001$). A 2 (intertemporal choice vs not) x 2 (uncertainty timing: now vs future) x 2 (MBA vs not) mixed GLM confirmed a main effect of intertemporal choice, $F(1,309) = 14.7$, $p < .001$, $\eta^2 = .05$, indicating that the PTE was weaker when making intertemporal choices. A main effect of uncertainty timing, $F(1, 321) = 16.8$, $p < .001$, $\eta^2 = .05$, indicated that the PTE was weaker when considering future uncertainty than when considering immediate uncertainty. The intertemporal choice by uncertainty timing interaction was not significant, $F(1, 309) = 0.5$, $p = .50$, $\eta^2 = .00$, indicating that the effect of intertemporal choice on the PTE was the same when considering future uncertainty and when considering immediate uncertainty. MBA status had no main effect, $F(1, 309) = 0.2$, $p = .69$, $\eta^2 = .00$, and no two or three-way interactions, all $p > .13$. Follow-up pairwise contrasts confirmed that the PTE was weaker when considering future uncertainty than when all outcomes were immediate, $t(168) = 5.3$, $p < .001$, $d = 0.41$, and that the PTE was marginally weaker when choosing between immediate uncertainty and future certainty than when all outcomes were immediate, $t(143) = 1.8$, $p = .08$, $d = .15$ In summary,

we confirmed that the difference in risk preferences between gains and losses (i.e., Prospect Theory) is weaker when making intertemporal choices.

Figure 3B

Proportion choosing the immediate option when immediate and/or future outcomes are variable, in Study 2. The top panel shows data from the general population, and the bottom panel shows data from participants currently enrolled in an MBA program. Error bars indicate +/- one standard error.



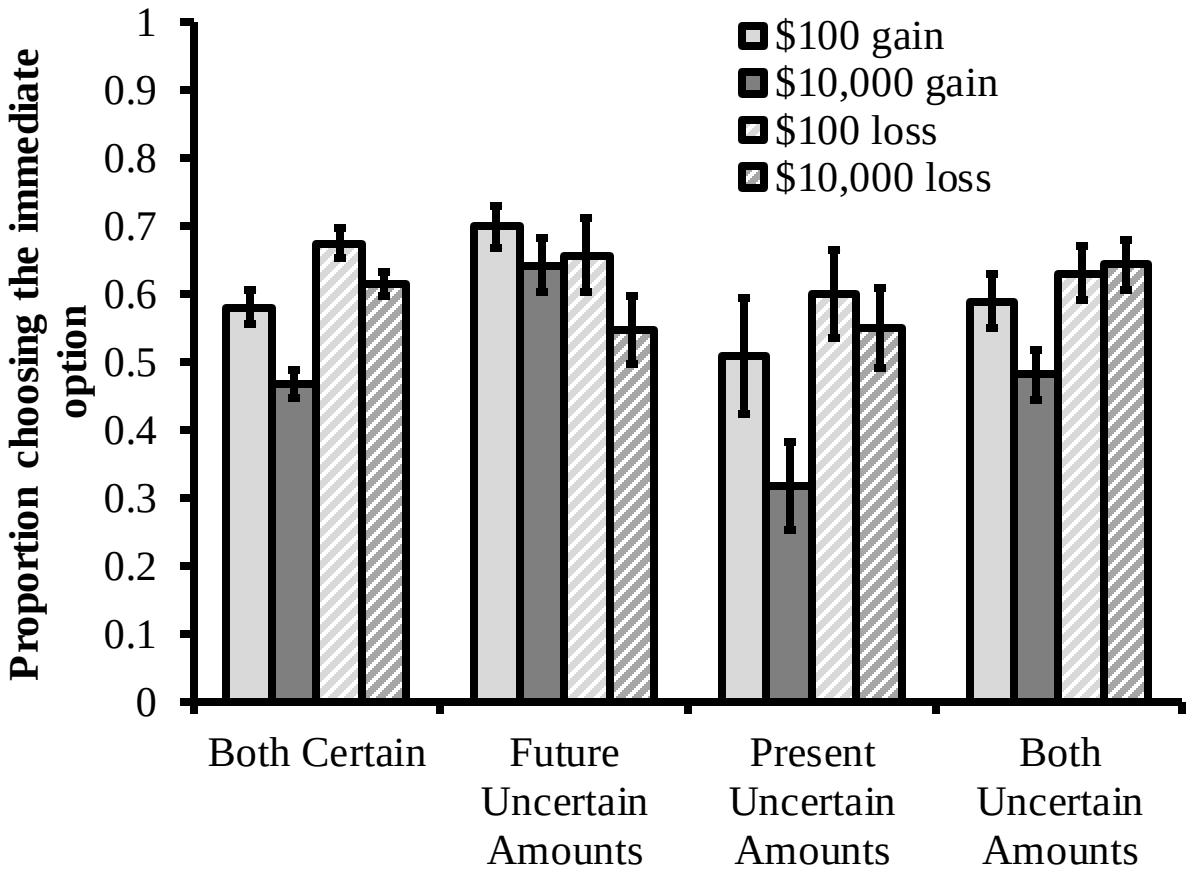


Table 1B

Repeated measure GLM results from Study 2, showing the ability of uncertain amount timing (now, later, or both), sign (gain or loss), magnitude (large or small) and MBA status (current MBA or not) to predict time preferences.

effect	df model	df error	F	p-value	partial η^2
uncertainty	2	465	16.6	<.001	.07
sign	1	465	17.8	<.001	.04
magnitude	1	465	33.8	<.001	.07
MBA status	1	465	3.2	.08	.01
uncertainty X sign	2	465	9.1	<.001	.04
uncertainty X magnitude	2	465	33.8	<.001	.07
uncertainty X MBA	2	465	0.2	.82	.00
sign X magnitude	1	465	12.8	<.001	.03
sign X MBA	1	465	0.7	.40	.00
magnitude X MBA	1	465	2.4	.12	.01

uncertainty X sign X magnitude	2	465	9.2	<.001	.04
uncertainty X sign X MBA	2	465	1.2	.30	.01
uncertainty X magnitude X MBA	2	465	1.7	.18	.01
sign X magnitude X MBA	1	465	0.1	.77	.00
uncertainty X sign X magnitude X MBA	2	465	1.3	.28	.01

Table 2B

Proportion choosing the certain option in the variable choice scenarios, in Study 2. Standard errors are in parentheses.

scenario	non-MBAs	MBAs
small gain	.74 (.02)	.68 (.05)
large gain	.81 (.02)	.76 (.04)
small loss	.55 (.03)	.53 (.05)
large loss	.54 (.03)	.50 (.05)

Study 2S: Immediate uncertainty vs future certainty, with small vs large outcomes and uncertain outcomes vs uncertain amounts

Study Overview

This study was not reported in the main manuscript. It is quite similar to the version of Study 2 that is reported in the main manuscript, but with a much smaller sample size. It examines the case of immediate uncertainty vs future certainty.

Results with uncertain outcomes

Intertemporal choices (with and without immediate uncertainty)

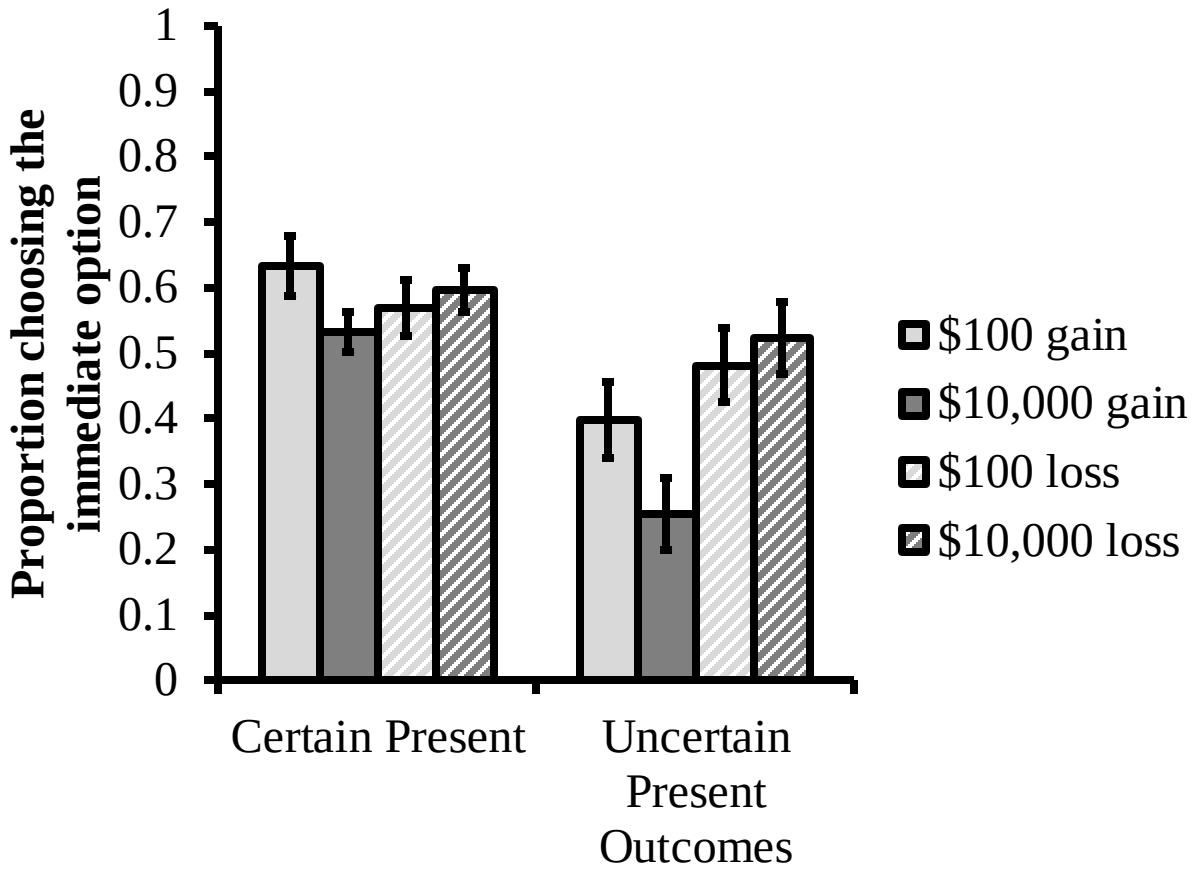
As seen in Figure 2A, when balancing immediate uncertainty versus future certainty, participants avoided the uncertainty (parallel to the results of Study 1). This led to preference for larger, later gains and larger, later losses. An omnibus GLM showed a main effect of uncertainty, $F(1,35)=16.0$, $p<.001$, $\eta^2=.31$, indicating that participants chose the immediate option less often when the present was uncertain. Main effect of sign, $F(1, 35)=4.9$, $p<.05$, $\eta^2=.13$, and a trend for magnitude, $F(1, 35)=2.9$, $p=.10$, $\eta^2=.08$, indicated that participants chose the immediate option more often when considering losses and when considering small outcomes. An uncertainty by sign interaction, $F(1, 35)=8.1$, $p<.01$, $\eta^2=.19$, indicated that the effect of uncertainty was stronger for gains than for losses. A sign by magnitude interaction, $F(1, 35)=12.6$, $p<.01$, $\eta^2=.26$, indicated that the magnitude effect was stronger for gains than for losses. The interactions of uncertainty and magnitude, $F(1, 35)=0.1$, $p=.78$, $\eta^2=.00$, and the three-way interaction, $F(1, 35)=0.4$, $p=.53$, $\eta^2=.01$, were not significant.

Risk preferences for immediate outcomes

When participants only considered immediate outcomes, the pattern of results was more typical of Prospect Theory. When considering certain vs uncertain gains, participants chose the certain option 69% of the time, whereas when considering certain losses, participants chose the certain option 49% of the time. Thus, participants were risk averse for gains, roughly risk neutral for losses, and were much more risk averse for gains than for losses, $F(1, 35)=25.7$, $p<.001$, $\eta^2=.42$. Participants were not more risk averse for large outcomes than small outcomes, $F(1, 35)=2.6$, $p=.12$, $\eta^2=.07$. The interaction of magnitude and sign was also not significant, $F(1, 35)=0.1$, $p=.79$, $\eta^2=.00$.

Figure 2A

Proportion choosing the immediate option when immediate outcomes are certain versus probabilistic, in Study 2S. Error bars indicate +/- one standard error.



Results with uncertain amounts

Intertemporal choices (with and without immediate uncertainty)

As seen in Figure 2B, when balancing immediate uncertainty versus future certainty, participants avoided the uncertainty (parallel to the results of Study 1). This led to preference for larger, later gains and larger, later losses. An omnibus GLM showed a main effect of uncertainty, $F(1,39)=13.3$, $p<.01$, $\eta^2=.25$, indicating that participants chose the immediate option less often when the present was uncertain. Main effect of sign, $F(1, 39)=13.5$, $p<.01$, $\eta^2=.26$, and magnitude, $F(1, 39)=21.3$, $p<.001$, $\eta^2=.35$, indicated that participants chose the immediate option more often when considering losses and when considering small outcomes. An uncertainty by sign interaction, $F(1, 39)=9.7$, $p<.01$, $\eta^2=.20$, indicated that the effect of uncertainty was stronger for gains than for losses. A sign by magnitude interaction, $F(1,$

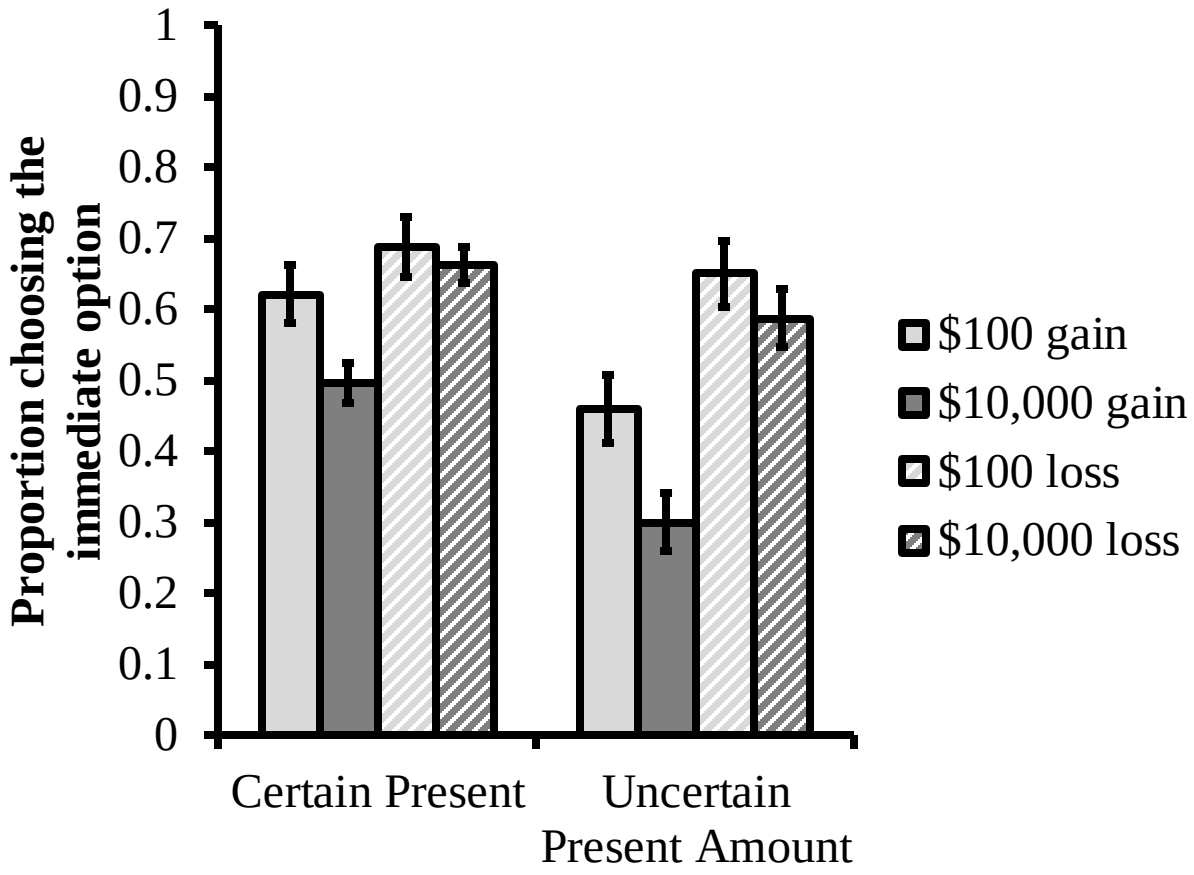
39)=5.5, p=.02, η^2=.12, indicated that the magnitude effect was stronger for gains than for losses, replicating Study 1. The interactions of uncertainty and magnitude, F(1, 39)=1.4, p=.24, η^2=.04, and the three-way interaction, F(1, 39)=0.0, p=.95, η^2=.00, were not significant.

Risk preferences for immediate outcomes

When participants only considered immediate outcomes, the pattern of results was more typical of Prospect Theory. When considering certain vs uncertain gains, participants chose the certain option 81% of the time, whereas when considering certain losses, participants chose the certain option 57% of the time. Thus, participants were risk averse for gains, roughly risk neutral for losses, and were much more risk averse for gains than for losses, F(1,39)=23.6, p<.001, η^2=.38. Participants were also more risk averse for large outcomes than small outcomes, F(1, 39)=21.7, p<.001, η^2=.36. The interaction of magnitude and sign was not significant, F(1, 39)=2.3, p=.14, η^2=.06.

Figure 2B

Proportion choosing the immediate option when immediate outcomes are certain versus variable, in Study 2S. Error bars indicate +/- one standard error.



Study 3: Time preferences when all outcomes are certain vs all outcomes are uncertain

Study Overview

This is a full reporting of the Study 3 that is reported in the main manuscript. The materials can be found in Online Appendix A. The full study includes several additional conditions, including a large magnitude condition (all outcomes 100 times larger) and an uncertain amounts condition (all uncertainty conditions use a range of outcomes, such as a choice between a random amount between $50 to $150 now or a random amount between $50 and $150 in one month). Thus, the full design is sign (gain vs loss, within) x

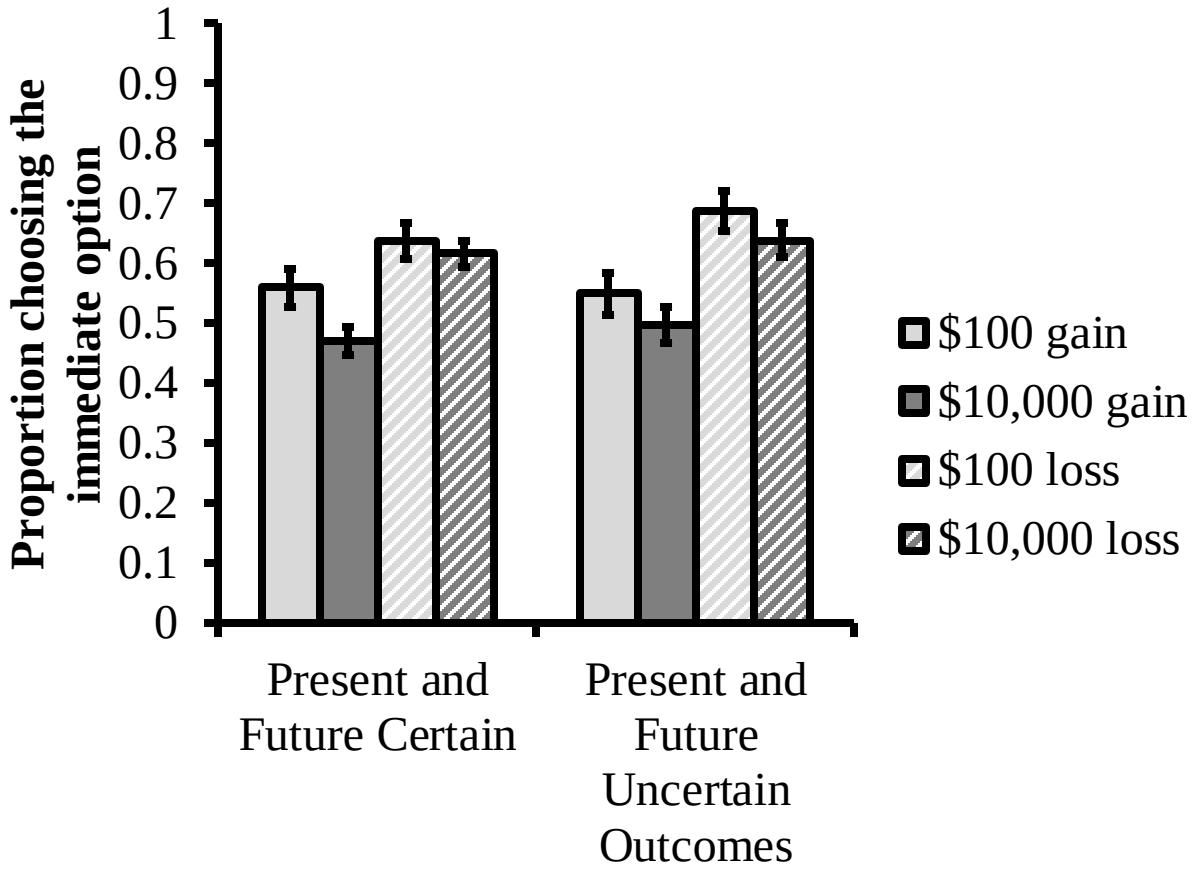
magnitude (small vs large, within) x future uncertainty (both outcomes are certain vs uncertain, within) vs uncertainty type (uncertain outcomes vs uncertain amounts, between) x order of presentation of scenarios (between).

Results with uncertain outcomes

When both immediate and future outcomes were *uncertain*, choices were similar to those in the certainty condition, as seen in Figure 4A. Differences between the certainty and uncertainty conditions were small and not significant; an omnibus GLM found no main effect of uncertainty (versus certainty), $F(1,52)=2.1$, $p=.15$, $\eta^2=.04$, no interaction of uncertainty and sign, $F(1, 52)=1.0$, $p=.32$, $\eta^2=.02$, no interaction of uncertainty and magnitude, $F(1, 52)=0.0$, $p=.89$, $\eta^2=.00$, and no three-way interaction, $F(1, 52)=1.3$, $p=.25$, $\eta^2=.03$. The main effects of sign, $F(1, 52)=10.4$, $p<.01$, $\eta^2=.17$, and magnitude, $F(1, 52)=17.0$, $p<.001$, $\eta^2=.25$, were significant, but not their interaction, $F(1, 52)=1.3$, $p=.25$, $\eta^2=.03$.

Figure 4A

Proportion choosing the immediate option when immediate and future outcomes are certain versus probabilistic, in Study 3. Error bars indicate +/- one standard error.



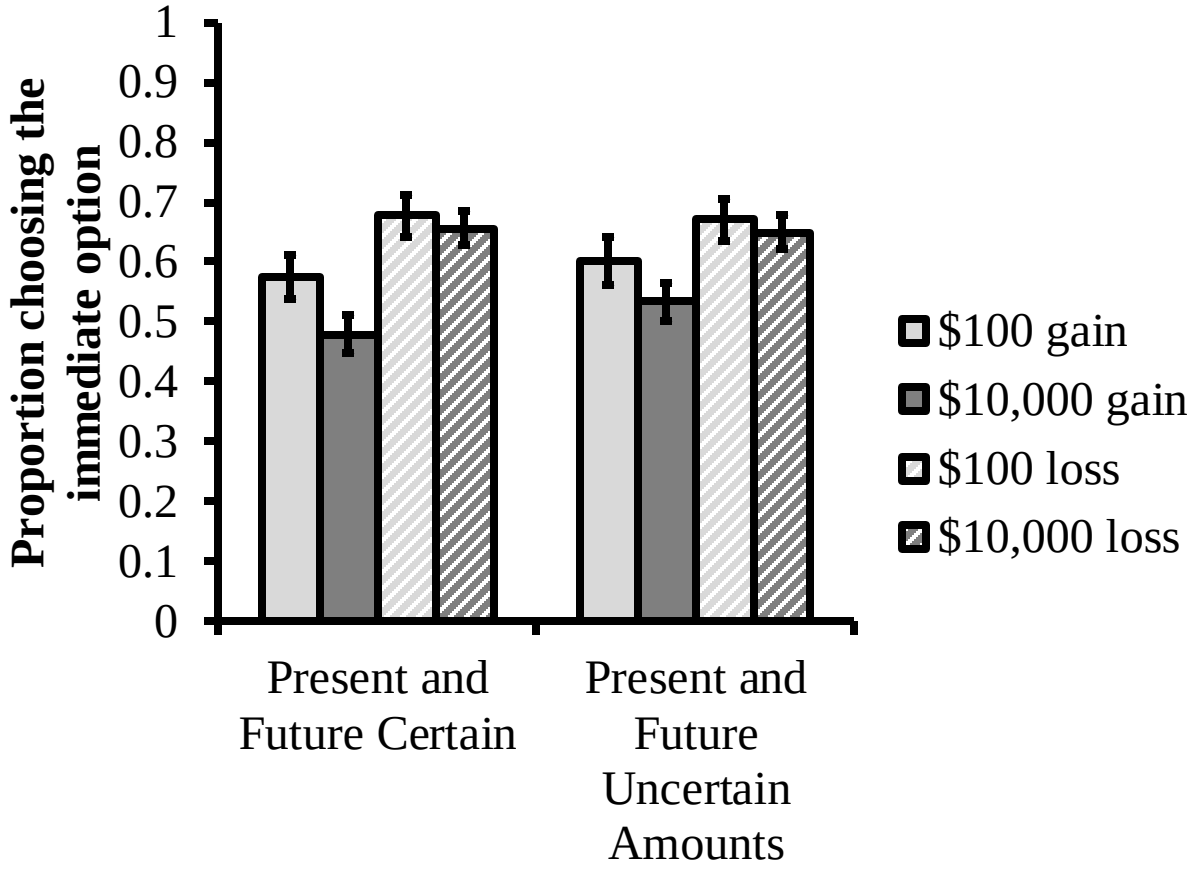
Results with uncertain amounts

When both immediate and future outcomes were *uncertain*, choices were similar to those in the certainty condition, as seen in Figure 4B. Differences between the certainty and uncertainty conditions were small and not significant; an omnibus GLM found no main effect of uncertainty (versus certainty), $F(1,48)=1.3$, $p=.26$, $\eta^2=.03$, no interaction of uncertainty and sign, $F(1, 48)=2.2$, $p=.15$, $\eta^2=.04$, no interaction of uncertainty and magnitude, $F(1, 48)=0.2$, $p=.64$, $\eta^2=.01$, and no three-way interaction, $F(1,$

48)=0.4, p=.53, η^2=.01. The main effects of sign, F(1, 48)=9.8, p<.01, η^2=.17, magnitude, F(1, 48)=7.8, p<.01, η^2=.14, and a trend for their interaction, F(1, 48)=2.9, p=.10, η^2=.06, were significant.

Figure 4B

Proportion choosing the immediate option when immediate and future outcomes are certain versus variable, in Study 3. Error bars indicate +/- one standard error.



Study 4S: Intertemporal Choice Controlling for Risk Preferences

Study Overview

Study 4S is not reported in the main manuscript. Study 4S examines time preference for certain vs uncertain outcomes *while controlling for immediate risk preferences.* Participants first stated their indifference point between a sure outcome and a risky outcome (with both outcomes

immediate) in a matching task. We then added delay to either outcome, and forced participants to choose between the two options. We predicted that participants would choose the certain option more than 50% of the time while making these intertemporal choices, demonstrating risk aversion in intertemporal contexts.

Method

A sample of 186 participants was recruited from Amazon Mechanical Turk in the same manner as Studies 1-3. Participants were randomly assigned to the gains condition or the losses condition. Each participant answered three questions total (other than demographics): one indifference point (with all outcomes in the present) and two intertemporal choices. For the indifference point question, all participants read the following:

> Please imagine you had to choose between a sure thing or a risky thing. Please fill in the amount below that would make you indifferent between the two options.
>
> | | | |
> |---|---|---|
> | Receive [Lose] $_____ today for sure | OR | 50% chance to receive [lose] $2000 today and 50% chance to receive [lose] $0 today |
>
> (Your answer must be greater than 0 and less than 2000.)

Participants were only allowed to proceed if their answer was greater than $0 and less than $2000.[1] Their answer was recorded by the computer and automatically entered into questions two and three, individually tailored for each participant. The second question was:

> Which would you choose?

[1] We originally piloted a different version of this study where participants indicated their indifference between $1,000 today or a 50% chance of $X today. Some answers did not appear to be reasonable indifference points, with some below $1,000 and some extremely high (up to $1,000,000). Therefore, we ran the Study 4S version of record, where participants chose between $X or a 50% chance of $2000, and it is clear that X should be greater than 0 and less than 2000 (and we forced participants to answer in this range). Furthermore, comparing the level of risk aversion for gains vs losses requires reverse scoring one measure, which is only possible with a bounded range such as we used in the final version of Study 4S.

Receive [Lose] $X today for sure	OR	50% chance to receive [lose] $2000 in one month and 50% chance to receive [lose] $0 in one month

The $X was filled in with the indifference point that the participant had previously specified for the immediate outcomes. The third question (in counterbalanced order with question two) was:

Which would you choose?

Receive [Lose] $X in one month for sure	OR	50% chance to receive [lose] $2000 today and 50% chance to receive [lose] $0 today

Results

Results with uncertain outcomes

Risk preference for immediate outcomes

Participants' indifference points for immediate outcomes indicated greater risk seeking for losses than for gains, broadly consistent with the Prospect Theory. Participants in the gain condition (n = 96) were indifferent on average between receiving $910 today or a 50% chance of receiving $2,000 today, demonstrating mild risk aversion. This was not statistically different from $1,000, $t(95) = -1.5$, $p = .13$, however, indicating risk neutrality. Participants in the loss condition (n=90) were indifferent on average between losing $434 today or a 50% chance of losing $2,000 today. This was significantly lower than $1,000, $t(89) = -9.9$, $p < .001$, indicating risk seeking. To statistically compare the level of risk seeking for gains vs losses, we reverse scored the indifference points for losses (i.e., $2000-$X), so that higher values would indicate more risk seeking for both gains and losses. Consistent with Prospect Theory, risk seeking was stronger for losses than for gains, $t(184) = 8.0$, $p < .001$, $d = 1.2$.

Time preferences for certain vs risky outcomes

There was a marginally significant main effect of scenario order (intertemporal choice with immediate uncertainty first vs intertemporal choice with future uncertainty first) on choices, $F(1,182) = 3.4$, $p = .07$, $\eta^2 = .02$, such that when the scenario with immediate uncertainty was presented before the scenario with future uncertainty, participants chose the certain option marginally more often (in both scenarios). Interactions were not significant, ps = .59 or greater. In the following analyses, we collapse across order.

When making intertemporal choices, participants generally preferred the certain outcome, as predicted, replicating the results of Studies 1-3. Participants in the gain condition chose the immediate certain $X (over the risky future $2,000) 89% of the time (i.e., 85 out of 96 participants), which was significantly greater than 50%, t (95) = 11.8, $p < .001$, demonstrating risk aversion, as predicted. They also chose the future certain $X (over the risky immediate $2,000) 69% of the time, again demonstrating risk aversion, t (95) = 3.9, $p < .001$. Participants in the loss condition chose the immediate certain $X (over the risky future $2,000) 61% of the time, t (89) = 2.2, $p = .03$, and chose the future certain $X (over the risky immediate $2,000) 68% of the time, t (89) = 3.6, $p = .001$, thus again demonstrating risk aversion, as predicted.

While participants generally showed risk aversion when making intertemporal choices, this tendency was especially pronounced when choosing between an immediate, certain gain and a risky, future gain. This was confirmed with a 2 (sign: gain vs loss) x 2 (uncertainty timing: immediate vs future) mixed GLM using proportion of certain choices as the DV. A main effect of sign, $F(1,184) = 6.0$, $p = .02$, $\eta^2 = .03$, indicated greater risk aversion for gains than for losses (broadly consistent with Prospect Theory). A main effect of uncertainty timing, $F(1,184) = 5.1$, $p = .03$, $\eta^2 = .03$, indicated greater risk aversion for future (vs present) uncertainty. These main effects are qualified by an interaction, $F(1,184) = 20.8$, $p < .001$, $\eta^2 = .10$, indicating that the

effects of sign and timing were especially pronounced in the uncertain future gain condition. In other words: participants like immediate, certain gains much better than future, uncertain gains.

Discussion

When participants considered only immediate outcomes, they showed a pattern of results directionally consistent with Prospect Theory (showing risk seeking for losses, and mild risk aversion for gains). Yet, when making *intertemporal* choices about the exact same outcomes, participants showed significant risk aversion for both gains and losses, replicating the results of Studies 1-3.

Results with uncertain amounts

Study 4 only investigated probabilistic uncertainty (there was no uncertain amounts condition).

Study 5S: Replication of "uncertainty aversion" effects in intertemporal choice (compared to risky choice), plus mediation by relative complexity

Study Overview

This study was not reported in the main manuscript. The full materials can be found in Online Appendix A. It replicates earlier findings on immediate uncertainty and future uncertainty in one study. It also replicates previous findings on risk preferences (with no intertemporal component), and on the way that risk preferences change between all-immediate contexts and intertemporal contexts. Furthermore, it includes process measures, where participants indicated how complex they found each choice option to be. We find that these complexity ratings mediate the impact of uncertainty on intertemporal choices.

Results with uncertain outcomes

Choices

Participants' risk preferences largely replicated earlier studies. When considering gains, participants chose the certain option 95% of the time (SE=3.0%), whereas when considering losses, participants chose the certain option 55% of the time (SE=6.7%), a significant difference, $t(55)=5.6$, $p<.001$, $d=.74$.

As seen in Figure 5A, uncertainty had a strong influence on intertemporal choices. Our main goal in this study was to understand when and *why* participants shift their preferences when making simple intertemporal choices vs when making intertemporal choices under uncertainty. Therefore, to more easily quantify the effect of uncertainty on intertemporal choices, we computed change scores for each participant, by taking the proportion of immediate choices made in the intertemporal choice scenarios and subtracting it from the proportion of immediate choices in the scenarios with intertemporal choice plus uncertainty (such that greater choice shift scores indicate a stronger preference for the immediate outcome in the uncertain scenario than the certain scenario). A GLM using uncertainty timing (immediate vs future uncertainty) and sign (gain vs loss) to predict choice shift revealed a main effect of uncertainty timing, $F(1,54)=72.5$, $p<.001$, $\eta^2=.57$, indicating that when uncertainty was in the future, participants shifted towards now, whereas when uncertainty was now, participants shifted towards the future, as predicted. There was no main effect of time on choice shift (ie, choices for gains and losses shifted equally), $F(1,54)=2.5$, $p=.12$, $\eta^2=.04$, and no interaction, $F(1,54)=0.8$, $p=.37$, $\eta^2=.02$, indicating that the difference in choice shift between immediate and future uncertainty was the same for gains and losses.

Prospect Theory for immediate vs intertemporal outcomes

Following the same analysis procedure as in Study 2, we compared risk preferences for losses and gains when all outcomes were immediate vs when making intertemporal choices. We found that the difference between gains and losses was stronger when all outcomes were immediate (mean PTE score = .39, $SD = .53$, $t(55) = 5.6$, $p < .001$), than when choosing between certain immediate outcomes and uncertain future outcomes (mean = .02, $SD = .52$, $t(30) = 0.3$, $p = .85$) or when choosing between uncertain immediate outcomes and certain future outcomes (mean = -.01, $SD = .33$, $t(24) = -0.1$, $p = .93$). A 2 (intertemporal choice vs not) x 2 (uncertainty timing: now vs future) mixed GLM confirmed a main

effect of intertemporal choice, $F(1,54) = 29.0$, $p < .001$, $\eta^2 = .35$, indicating that the PTE was weaker when making intertemporal choices. The main effect of uncertainty timing was marginally significant, $F(1, 54) = 3.0$, $p = .09$, $\eta^2 = .05$, indicating that the PTE was slightly stronger when considering future uncertainty. An intertemporal choice by uncertainty timing interaction, $F(1, 54) = 5.6$, $p = .02$, $\eta^2 = .10$, indicated that the effect of time on risk preferences was stronger for future uncertainty than for immediate uncertainty. Follow-up pairwise contrasts confirmed that the PTE was weaker when considering future uncertainty than when all outcomes were immediate, $t(30) = 5.5$, $p < .001$, $d = 0.97$, and that PTE was also weaker when choosing between immediate uncertainty and future certainty than when all outcomes were immediate, $t(24) = 2.2$, $p = .04$, $d = 0.44$ In summary, we confirmed that the difference in risk preferences between gains and losses (i.e., Prospect Theory) is weaker when making intertemporal choices.

Mediators

We hypothesize that when the choice set is relatively simple (involving only time, or only risk), participants choose according to standard models of time and risk. However, when the choice set becomes more complex, involving both time and risk, participants avoid the complexity and choose the simpler choice options. The previous results show that when uncertainty is added to intertemporal choices, participants' preferences shift away from the uncertain options. To test our theory, we therefore examined the ability of complexity to explain the effect of uncertainty on choice shift. In other words, does the addition of intertemporal uncertainty also increase the relative complexity of the uncertain options (as subjectively rated by participants)? And does the change in complexity, in turn, predict the shift intertemporal choices (above and beyond the direct effect of uncertainty)? To examine this, we calculated a measure of relative complexity, by subtracting the complexity of the immediate option from the complexity of the delayed option, and a measure of complexity shift, by subtracting the relative complexity under uncertainty from the relative complexity in the simple intertemporal choice scenarios. We tested this measure of complexity shift as a mediator. As summarized in Figure 6A, we ran a series of mixed models using uncertainty timing (immediate vs future; between subjects) and complexity shift to predict choice shift. We also included sign (gains vs losses; within subjects) as a fixed effect, and a

random effect of subject. Thus, there were two observations per participant, one for gains and one for losses. The key components of the mediation model were all significant: uncertainty timing predicted complexity shift, and complexity shift predicted choice shift even while controlling for the effect of uncertainty timing. Using a recommended bootstrapping test of mediation (Shrout & Bolger, 2002) with 10,000 replications, the mediation model was marginally significant at p=.08 (two-tailed). In summary, when uncertainty was added to intertemporal choice options, this increased the complexity of the task of choosing, and consequently decreased the likelihood that participants would choose these more complex options. However, it should be noted that the mediation was only partial -- as seen in Figure 6A, when controlling for complexity shift, uncertainty timing was still a strong predictor of choice shift.

Interestingly, although relative complexity predicts preferences for uncertain intertemporal gains and losses, $F(1, 110)=53.5$, $p<.001$, it does not predict preferences for simple intertemporal choice scenarios (without uncertainty), $F(1,110)=1.3$, $p=.25$, or for simple risky choice scenarios (without delay), $F(1, 110)=0.2$, $p=.67$. Thus, the role of relative complexity in predicting preferences only seems to come into play when multiple factors are involved in the decision and the decision maker is presumably struggling to evaluate and balance them all.

When considering uncertain gains, participants' estimates of expected value were not significantly different from the mathematical expected value. The average expected value of an immediate 50% chance of gaining $2,000 was $904 ($SE$ = 141.6), and the average expected value of a future 50% chance of gaining $2,200 was $1,155 ($SE$ = 141.8). When considering uncertain outcome *losses*, participants tended to expect the worst, and their estimates of expected value were significantly lower than the actual expected value. For example, the average expected value of an immediate 50% chance of losing $2,000 was -$1,518 (SE = 118.4), and the average expected value of a future 50% chance of losing $2,200 was -$1,595 (SE = 132.4). Next, we examined the ability of participants' expected value predictions to explain time preference change scores. To do this, we first assigned the expected value of certain outcomes to be equal to their actual value, and the expected value of the uncertain outcomes came from participants' estimates. We then computed a measure of relative expected value by subtracting the expected value of

the future option from the expected value of the immediate option, and a measure of expected value shift, by subtracting the relative expected value under uncertainty from the relative expected value in the simple intertemporal choice scenarios. In a mixed model with uncertainty timing, sign, and expected value shift predicting choices, participants' expected value shift scores were not a significant predictor of choice shift, $F(1, 108) = 1.1$, $p = .29$. Furthermore, uncertainty timing does not predict expected value shift, $F(1, 109) = 0.0$, $p = .86$. Therefore, expected value does not mediate the influence of uncertain outcomes on choices.

Moderators

First, we looked at whether Need for Cognition would moderate the effect of uncertainty timing on choice shift. A mixed model with uncertainty time, need for cognition, sign, and the interactions (plus a random effect of participant) did not find any significant effects of need for cognition, all $p>.27$.

Next, we looked at whether numeracy would moderate the effect of uncertainty timing on time preference change scores. A mixed model with uncertainty timing, numeracy, sign, and the interactions found an interaction between uncertainty timing and numeracy, $F(1, 107) = 6.0$, $p = .02$, indicating that participants with lower numeracy showed a stronger effect of uncertainty timing on choice shift. In other words, the "intertemporal uncertainty avoidance" effect is stronger among participants that are lower in numeracy, consistent with the "complexity aversion" theory.

Figure 5A

Proportion choosing the immediate option when immediate or future outcomes are uncertain, in Study 5. Error bars indicate +/- one standard error.

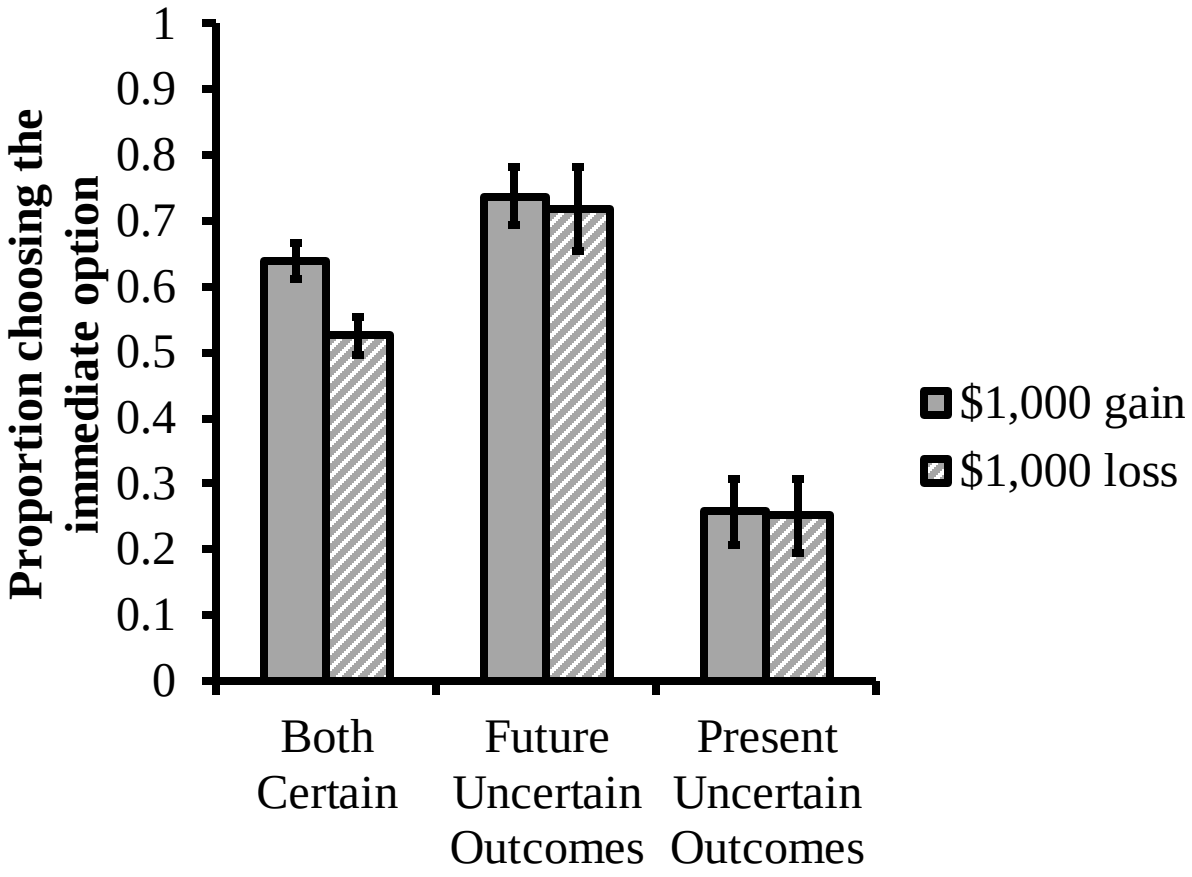
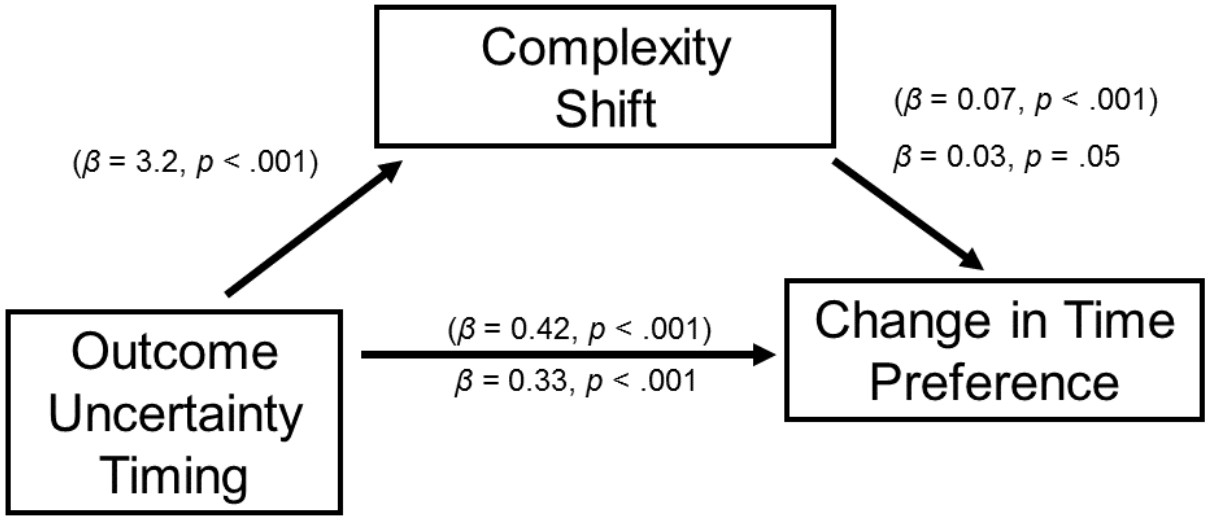


Figure 6A

Mediation diagram showing how outcome uncertainty predicts complexity, in turn explaining the effect of uncertainty on time preference under outcome uncertainty. Beta coefficients are in raw units (ie, not standardized).



Results with uncertain amounts

Choices

Participants' risk preferences largely replicated earlier studies. When considering gains, participants chose the certain option 88% of the time (SE=4.7%), whereas when considering losses, participants chose the certain option 49% of the time (SE=7.2%), a significant difference, $t(48)=4.8$, $p<.001$, $d=.68$.

As seen in Figure 5B, uncertainty had a strong influence on intertemporal choices. To more easily quantify the effect of uncertainty on choice, we computed change scores for each participant by taking the proportion of immediate choices made in the intertemporal choice scenarios and subtracting the proportion of immediate choices in the scenarios with intertemporal choice plus uncertainty (such that greater choice shift scores indicate a stronger preference for the immediate outcome in the uncertain scenario than the certain scenario). A GLM using uncertainty timing (immediate vs future uncertainty)

and sign (gain vs loss) to predict choice shift revealed a main effect of sign, $F(1,47)=13.4$, $p<.01$, $\eta^2=.22$, indicating that choices for gains shifted towards "now" more strongly than losses did, and a main effect of uncertainty timing, $F(1, 47)=13.6$, $p<.01$, $\eta^2=.22$, indicating that when uncertainty was in the future, participants shifted towards now, whereas when uncertainty was now, participants shifted towards the future, and a sign by timing interaction, $F(1, 47)=10.6$, $p<.01$, $\eta^2=.18$, indicating that while both gains and losses shifted equally for future uncertain amounts, gains shifted more than losses for immediate uncertain amounts.

Prospect Theory for immediate vs intertemporal outcomes

Following the same analysis procedure as in Study 2, we compared risk preferences for losses and gains when all outcomes were immediate vs when making intertemporal choices. We found that the difference between gains and losses was stronger when all outcomes were immediate (mean PTE score = .39, $SD = .57$, $t(48) = 4.8$, $p < .001$), than when choosing between certain immediate outcomes and uncertain future outcomes (mean = .06, $SD = .28$, $t(26) = 1.1$, $p = .29$) or when choosing between uncertain immediate outcomes and certain future outcomes (mean = .10, $SD = .23$, $t(21) = 2.2$, $p = .04$). A 2 (intertemporal choice vs not) x 2 (uncertainty timing: now vs future) mixed GLM confirmed a main effect of intertemporal choice, $F(1,47) = 12.2$, $p = .001$, $\eta^2 = .21$, indicating that the PTE was weaker when making intertemporal choices. The main effect of uncertainty timing, $F(1, 47) = 0.2$, $p = .65$, $\eta^2 = .00$, and the intertemporal choice by uncertainty timing interaction, $F(1, 47) = 0.0$, $p = .97$, $\eta^2 = .00$, were both non-significant. Follow-up pairwise contrasts confirmed that the PTE was weaker when considering future uncertainty than when all outcomes were immediate, $t(26) = 2.8$, $p = .01$, $d = 0.53$, and that PTE was also weaker when choosing between immediate uncertainty and future certainty than when all outcomes were immediate, $t(21) = 2.2$, $p = .04$, $d = 0.47$ In summary, we confirmed that the difference in risk preferences between gains and losses (i.e., Prospect Theory) is weaker when making intertemporal choices.

Mediators

First, we examined the ability of complexity to explain the effect of uncertainty on choice shift. In other words, does the addition of intertemporal uncertainty also increase the relative complexity of the uncertain options? And does the change in complexity, in turn, predict the shift intertemporal choices (while controlling for the direct effect of uncertainty)? To examine this, we calculated a measure of relative complexity, by subtracting the complexity of the immediate option from the complexity of the delayed option, and a measure of complexity shift, by subtracting the relative complexity under uncertainty from the relative complexity in the simple intertemporal choice scenarios. We tested this measure of complexity shift as a mediator. As summarized in Figure 6B, we ran a series of mixed models using uncertainty timing (immediate vs future; between subjects) and complexity shift to predict choice shift. We also included sign (gains vs losses; with subjects) as a fixed effect, and a random effect of subject. Thus, there were two observations per participant, one for gains and one for losses. The key components of the mediation model were all significant: uncertainty timing predicted complexity shift, and complexity shift predicted choice shift even while controlling for the effect of uncertainty timing. Using a recommended bootstrapping test of mediation (Shrout & Bolger, 2002) with 10,000 replications, the mediation model was significant at p=.03. In summary, when uncertainty was added to intertemporal choice options, this increased the complexity of the task of choosing, and consequently decreased the likelihood that participants would choose these more complex options. However, it should be noted that the mediation was only partial -- as seen in Figure 6B, when controlling for complexity shift, uncertainty timing was still a strong predictor of choice shift.

Interestingly, although relative complexity predicts preferences for uncertain intertemporal gains and losses, $F(1,96)=21.4$, $p<.001$, it does not predict preferences for simple intertemporal choice scenarios (without uncertainty), $F(1, 96)=0.3$ $p=.62$, or for simple risky choice scenarios (without delay), $F(1, 96)=0.0$, $p=.90$. Thus, the role of relative complexity in predicting preferences only seems to come into play when multiple factors are involved in the decision and the decision maker is presumably struggling to evaluate and balance them all.

For uncertain amounts, participants' estimates of expected value were not significantly different from the mathematical expected value (all $p = .1$ or greater). The average expected value of an immediate gain between \$500 and \$1,500 was \$961 (SE =22.5), and the average expected value of a future gain between \$550 and \$1,650 was \$1025 (SE = 43.4). The average expected value of an immediate loss between \$500 and \$1,500 was \$993 (SE = 15.5), and the average expected value of a future loss between \$550 and \$1,650 was \$1080 (SE = 37.4). Next, we examined the ability of participants' expected value predictions to explain time preference change scores. In a mixed model with uncertainty timing, sign, and expected value shift predicting choices, participants' expected value shift scores were a not significant predictor of choice shift, $F(1, 94) = 0.0$, $p = .87$. Furthermore, uncertainty timing does not predict expected value shift, $F(1, 95) = 0.0$, $p = .83$. Therefore, the effect of amount uncertainty on choice shift is not explained by subjective differences in expected value.

Moderators

First, we looked at whether Need for Cognition would moderate the effect of uncertainty timing on choice shift. A mixed model with uncertainty time, need for cognition, sign, and the interactions (plus a random effect of subject) did not find any significant effects of need for cognition, all $p>.5$.

Next, we looked at whether numeracy would moderate the effect of uncertainty timing on time preference change scores. A mixed model with uncertainty timing, numeracy, sign, and the interactions found no interaction between uncertainty timing and numeracy, $F(1, 93) = 0.5$, $p = .46$.

Figure 5B

Proportion choosing the immediate option when the immediate or future amounts are uncertain, in Study 5. Error bars indicate +/- one standard error.

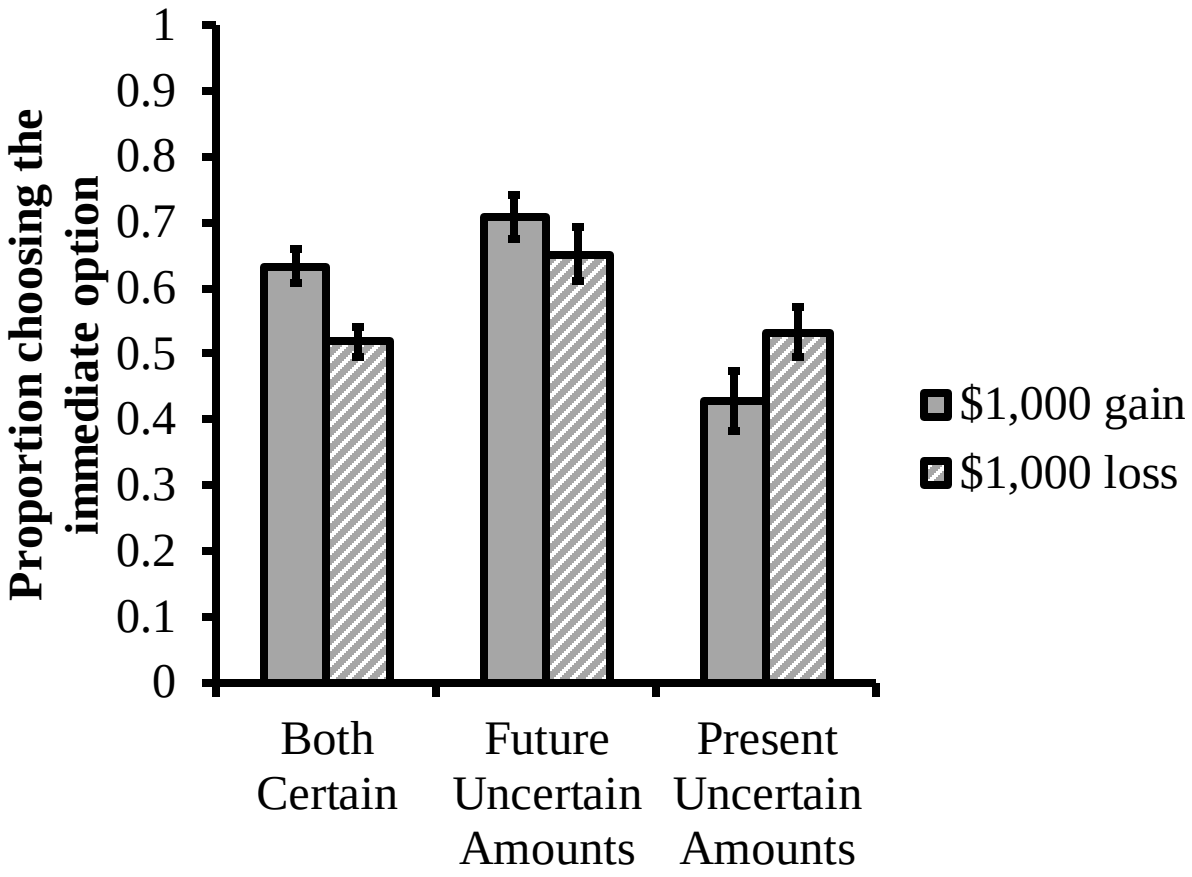


Figure 6B

Mediation diagram showing how amount uncertainty predicts complexity, in turn explaining the effect of uncertainty on time preference under amount uncertainty. Beta coefficients are in raw units (ie, not standardized).