Risk is reward: Exploiting the environment's risk-reward structures in decisions under uncertainty

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1 INTRODUCTION

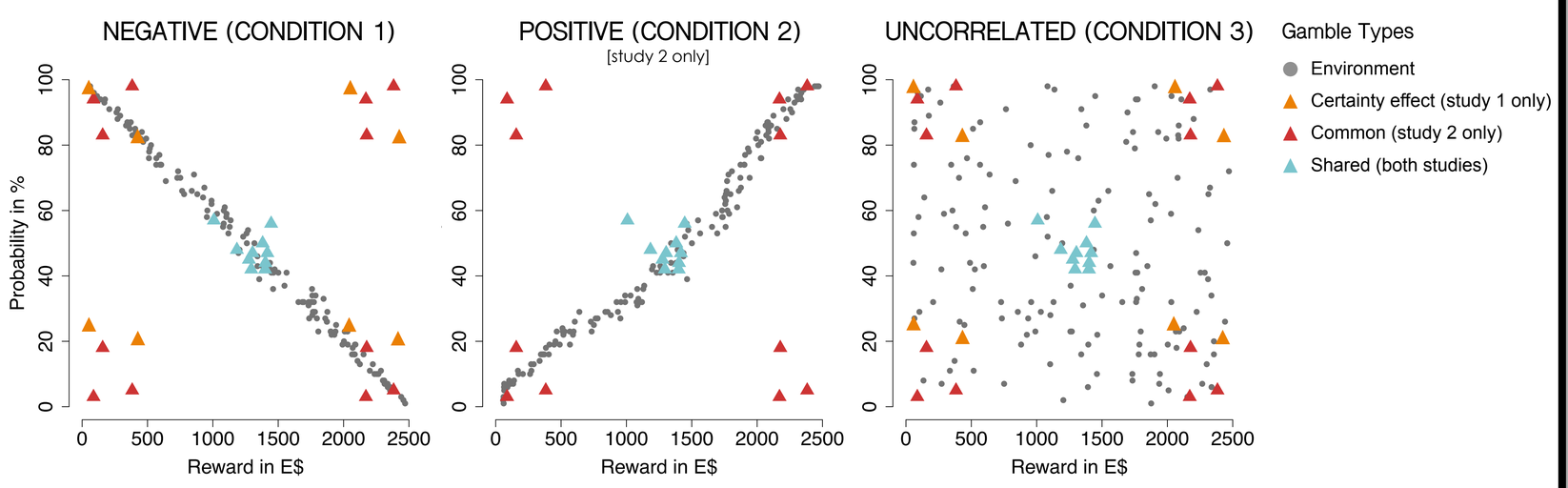
In many domains in the environment, the high rewards that people desire are unlikely to occur[1]. This negative risk-reward relationship seems natural for people to exploit to infer missing probabilities for **uncertain prospects**. At the same time, an adaptive view of cognition implies that people do not blindly apply such a heuristic, but **match** their decision strategies to the **structure of the environment**[2,3,4].

How do people (1) **adapt** to different risk-reward environments and (2) **use** different risk-reward relationships in decisions under uncertainty?

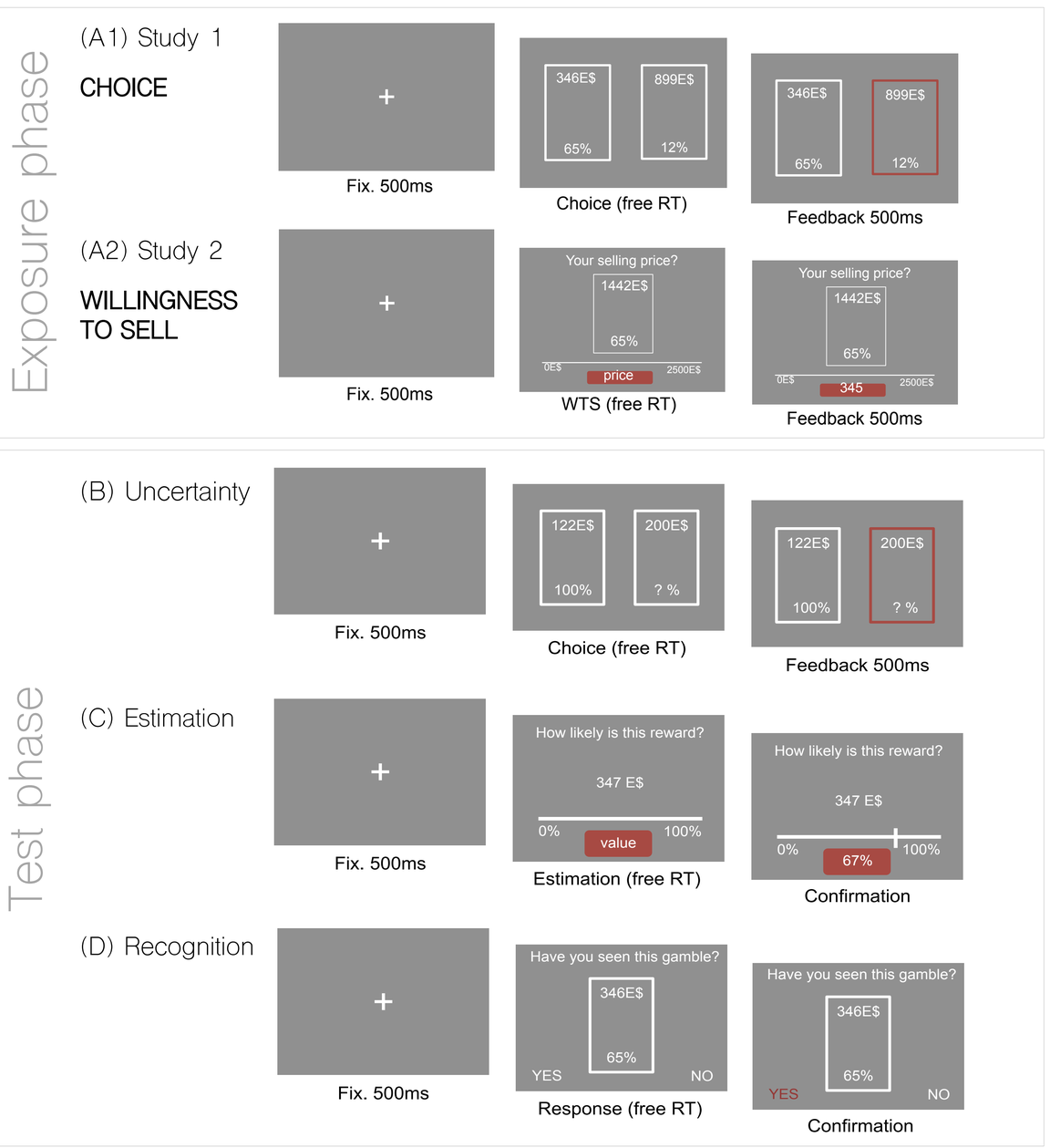
Here, we **exposed** participants to different risk-reward environments through gamble choices (study 1, *N* = 62), or a willingness-to-sell task (study 2, *N* = 90). In a **test phase**, we looked at how the different environments influenced decisions under uncertainty.

2 STIMULI

Participants were exposed to monetary gambles of the form '*p chance of winning x (otherwise 0)*'. The gambles were drawn from a **negatively correlated**, **positively correlated** or **uncorrelated** environment.



3 PROCEDURE



Task procedure. (A) Participants chose between two gambles (A1, study 1) or indicated their willingness to sell for single gambles (A2, study 2). All common gambles were interspersed after 50 environment-only gambles. (B, C, D) Tasks in the test phase were identical across all studies and conditions.

4 RESULTS

(A) BEHAVIOR DURING THE EXPOSURE PHASE (DECISIONS UNDER RISK)

STUDY 1

● ▲ Across both conditions, **expected utility theory** provided the best account of the data. There were no parameter differences between conditions ($M_{utility\_par}$ = .55, M_{choice_rule} = .2).

Modelfits

(BIC scores, lower scores indicate better fit)

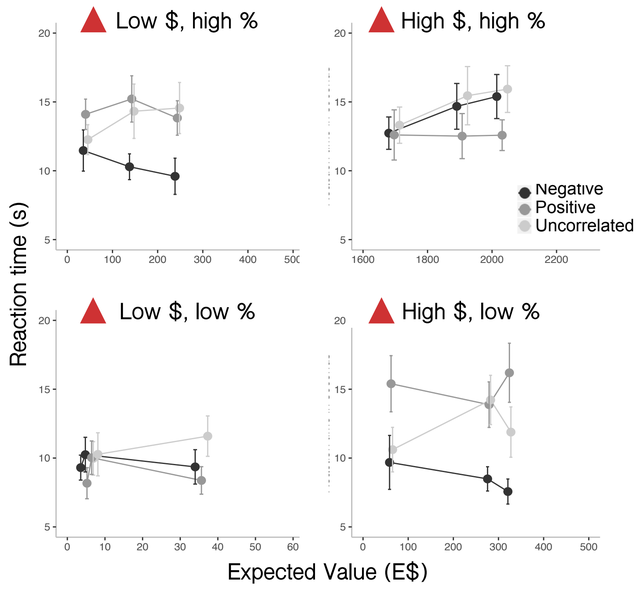
	Negative	Uncorrelated
Baseline	4436.14	4158.89
Expected Value	3369.76	2791.66
Expected Utility	**2700.56**	**1895.42**
Prospect Theory	2803.43	1904.72

▲ Standard **certainty effect** in both conditions. Most participants prefer the certain (100% > 80%), but lower payoff. These preferences switch when payoffs remain the same but probabilities are scaled down (25% < 20%).

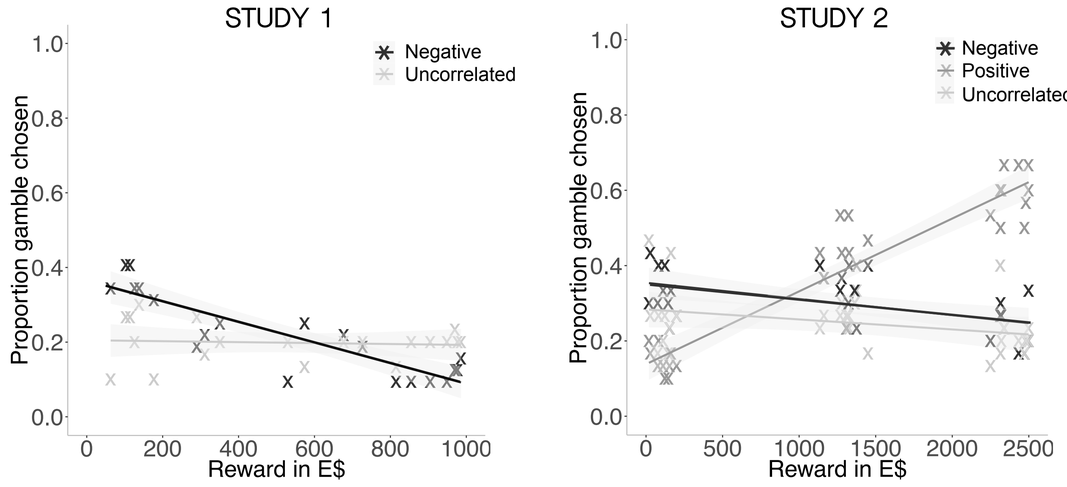
STUDY 2

● ▲ ▲ Across conditions, prices were well-described by **prospect theory.** There were no par. differences between conditions. Consistent with participants stating selling prices the average values suggested risk seeking ($M_{utility\_par}$ = 1.12, $M_{prob\_weight.}$ = 1.16).

▲ **Faster responses** for gambles that fit a condition's risk-reward structure.

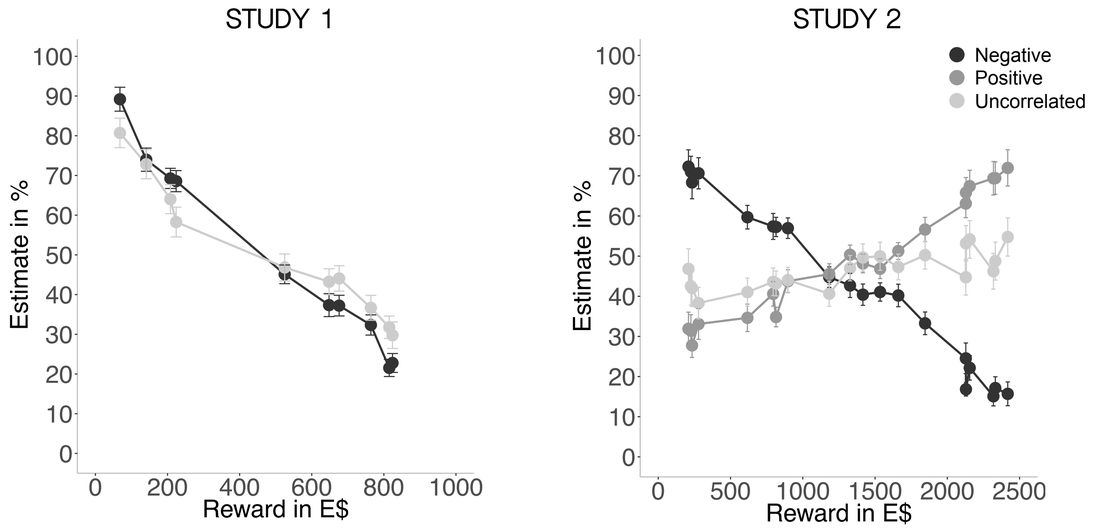


(B) DECISIONS UNDER UNCERTAINTY (MISSING PROBABILITIES)



Sure thing = ½ * gamble.

(C) EXPLICIT PROBABILITY ESTIMATES



(D) MEMORY JUDGMENTS OF RISKY PROSPECTS

▲ ▲ ▲ Both studies: No **recognition or discrimination ability** of specific gambles (% & $ combinations). Participants in the correlated conditions systematically rejected gambles (both targets and lures**) that did not fit the condition's risk-reward structure.**

5 SUMMARY & OUTLOOK

Summary

In the **exposure phase**, participants integrated payoffs and probabilities to maximize subjective utility (A), and processed single gambles faster if these gambles fit a given risk-reward structure (A2). Gambles incoherent with previously experienced risk-reward structures were systematically rejected in a recognition task (D). This suggests that participants encoded risk-reward structures in a rule-based manner, not via exemplars.

In **decisions under uncertainty**, participants who had been exposed to a negative risk-reward relationship were more risk-seeking for low payoffs and risk-averse for high payoffs. This pattern reversed in the positive condition and disappeared in the uncorrelated condition, in which participants were risk-averse throughout (B). This is consistent with participants inferring probabilities from payoffs (C). Overall, these results suggest that people are sensitive to different risk-reward ecologies and exploit the relationship that is present in the particular environment.

Outlook

Attentional mechanisms in different risk-reward environments?

Lifespan implications? (Stronger risk-reward sense as we grow older?)

6 REFERENCES

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[3] Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). The Adaptive Decision Maker. New York, NY: Cambridge University Press.

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