Drift from rationality caused by affective processes is moderated by numerical skills

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Introduction

- Individuals subjectively transform probabilities and this process can be modeled by an inverse S-shaped probability weighting function (PWF) [1]
- People are less sensitive to changes in the probability scale in the case of affect-rich (i.e., European vacation) relatively to affect-poor outcomes (i.e., tuition payment). [2] (Fig. 1)
- Greater numeracy allows individuals to precisely differentiate emotional reactions to probabilities (i.e., integral affect) leading to less biased (i.e., closer to linearity) probability weighting. [3]
- **Hypothesis: incidental affect (i.e., irrelevant to a decision task), would influence the shape (i.e., curvature) of the PWF, signifying a more distorted probability weighing, but only in the case of less numerate participants**

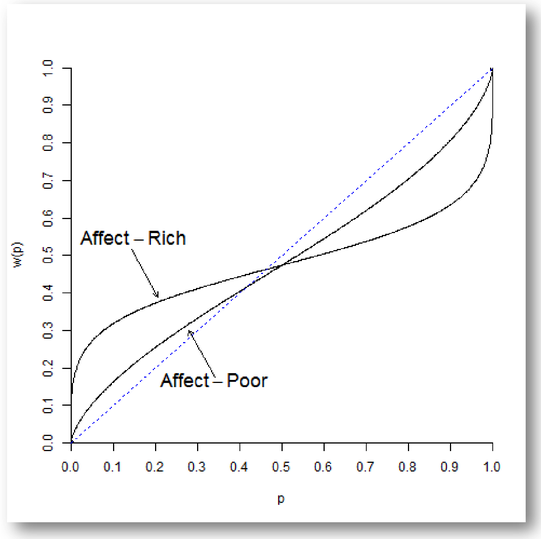


Fig 1. Hypothetical affect-poor and affect-rich weighting functions (and an identity line). [2]

Method

The experiment consisted of two tasks: a *perceptual task* and an *insurance task*. In a 2 x 9 mixed factorial design, affect (neutral vs. negative) was a between-subjects factor in the perceptual task, and probability (1%; 5%; 10%; 25%; 50%; 75%; 90%; 95%; 99%) was presented in the insurance task as a within-subjects factor. Numeracy was measured with a four-item paper version of the Berlin Numeracy Test [4].

Fig.2. All nine insurance decisions were preceded by the perceptual task, which consisted of 10 picture stimuli displayed in the center of the computer screen sequentially for 500 ms each in a randomized order. Participants were instructed to detect and report afterwards a target stimulus while ignoring distractors. Affective distractors were of negative or neutral valence.

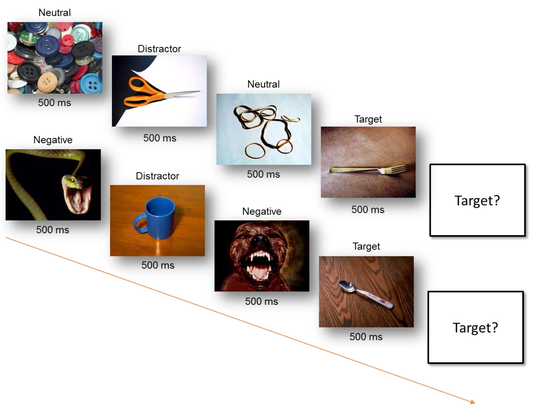


Fig 3. In the insurance task, participants were required to indicate their willingness-to-pay prices (WTP) to insure an envelope containing a 500 PLN voucher that could be lost with a given probability level.

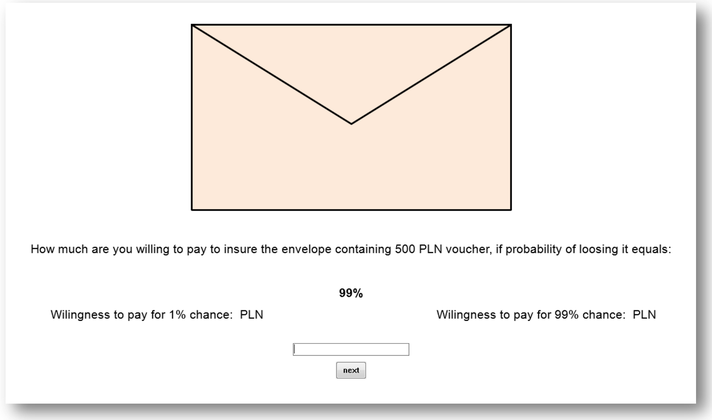
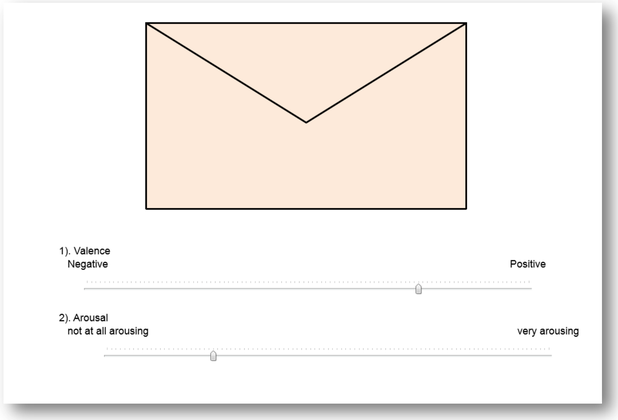


Fig 4. Affective evaluation (AE) task. Participants evaluated emotions elicited by the envelope on valence (0 – negative; 100 – positive) and arousal (0 – not at all arousing; 100 – very arousing) dimensions.



Results

Fig. 5. Separate probability weighting functions (PWF) fitted for the negative and neutral conditions.

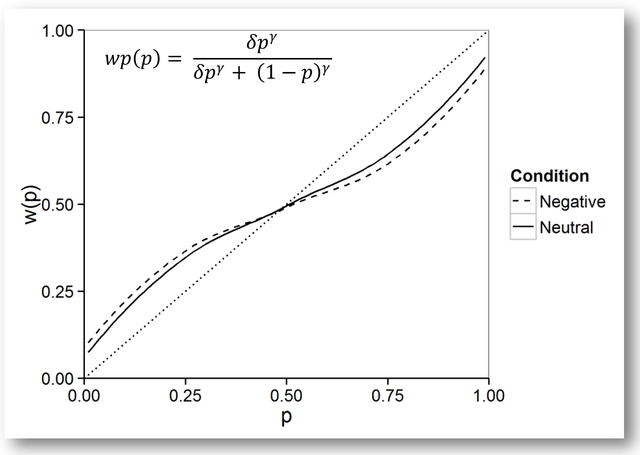
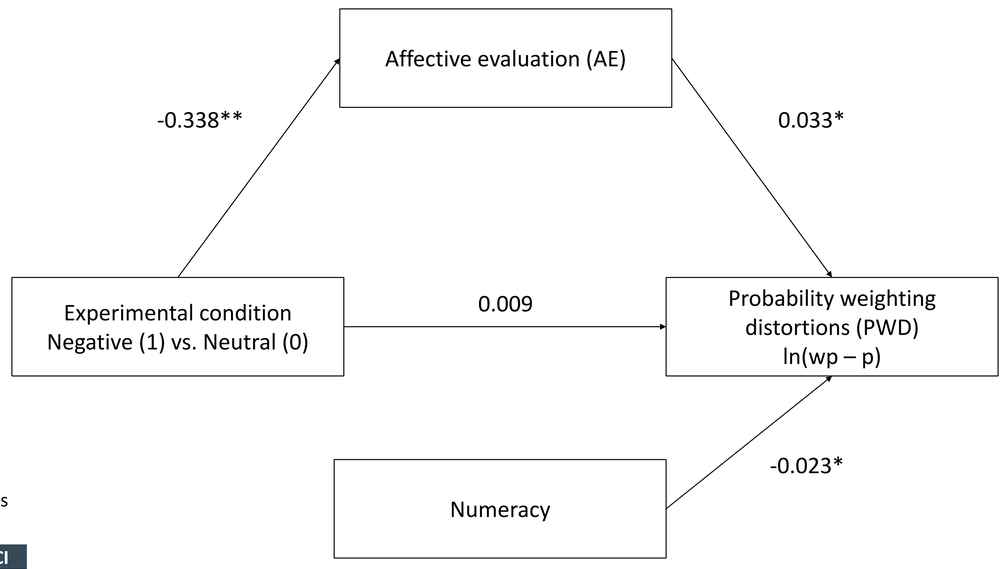


Table 1. Probability weighting function (PWF) parameter estimates fitted to median values with 95% bootstrapped confidence intervals based on 10,000 re-samples

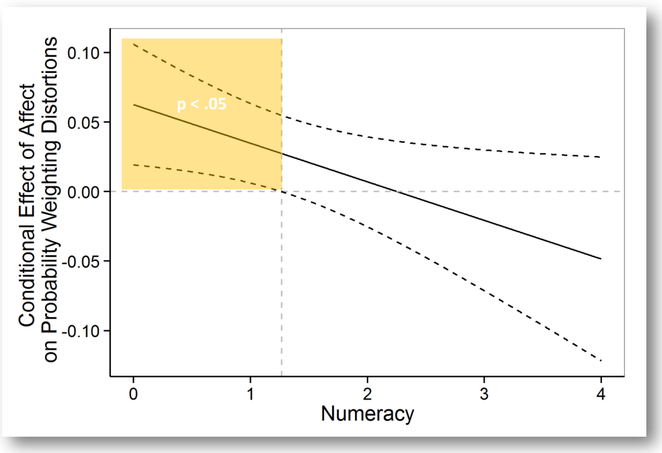
	Negative	2.5% CI	97.5% CI	Neutral	2.5% CI	97.5% CI
γ - discriminability	**0.517**	**0.506**	**0.528**	**0.601**	**0.581**	**0.621**
δ - attractiveness	0.967	0.946	0.986	0.983	0.945	1.012

Fig 6. Moderated mediation model demonstrating the relationship between incidental affect (i.e., experimental manipulation), integral affect (i.e., affective evaluation of an envelope) and probability weighing distortions (PWD). The model is controlled for numeracy.



Indirect effect: Monte Carlo 95% CIs [-0.0262, -0.0001]

Fig 7. Johnson–Neyman regions of significance for the conditional effect of affective evaluation (AE) on probability weighting distortions (PWD).



Note: The solid line plots the conditional effect estimates of AE on PWD at values of numeracy. The dashed lines represent the upper and lower bounds of 95% confidence intervals. For numeracy scores > 1 the relationship between AE and PWD is not significant.

Conclusions

- **Numeracy in risky decision-making goes beyond simple comprehension of numbers.**
- **In addition to performing calculations better [4], drawing more precise affective meaning from numbers [3,5], deliberatively using metacognitive heuristics [6], and better understanding the gist of decisions [7],**
- **highly numerate people may also make <u>better decisions because they effectively disentangle irrelevant affective information</u> during probability weighting**

References

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