

The effect of acute pain on risky and intertemporal choice

Lina Koppel¹, David Andersson¹, India Morrison¹, Daniel Västfjäll^{1,2} and Gustav Tinghög¹

¹Linköping University, Sweden and ²Decision Research, Eugene, OR

Contact: lina.koppel@liu.se

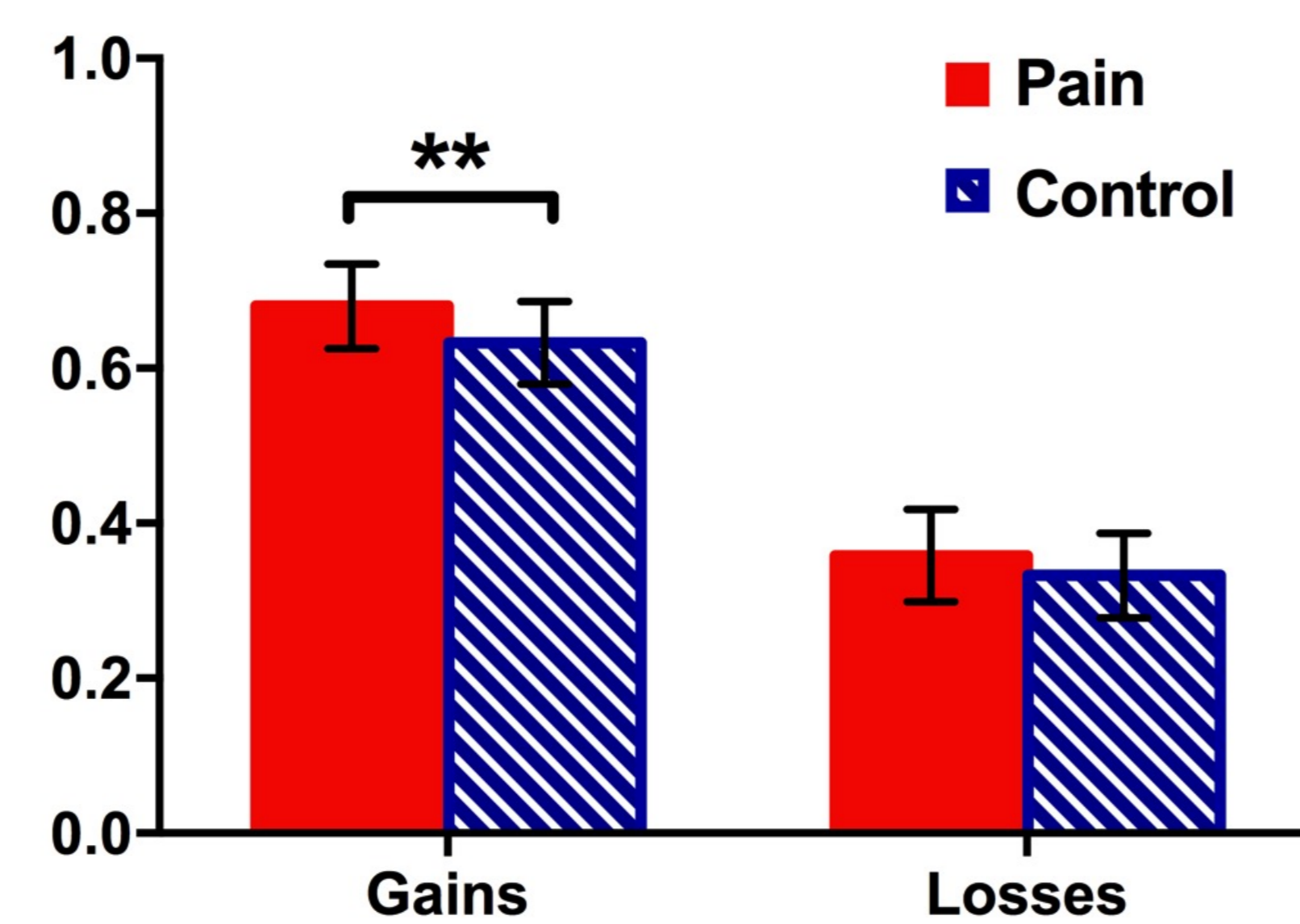
Introduction

Pain is a salient and attention-demanding experience. Therefore, it should result in more intuitive (*system 1*) decisions, including more impatient behavior and greater reliance on automatic biases such as the reflection effect of prospect theory, i.e. less risk-seeking for gains and more risk-seeking for losses.^{1,2}

On the other hand, patients with chronic pain make riskier decisions than control participants, especially when high potential gains are at stake.^{3,4}

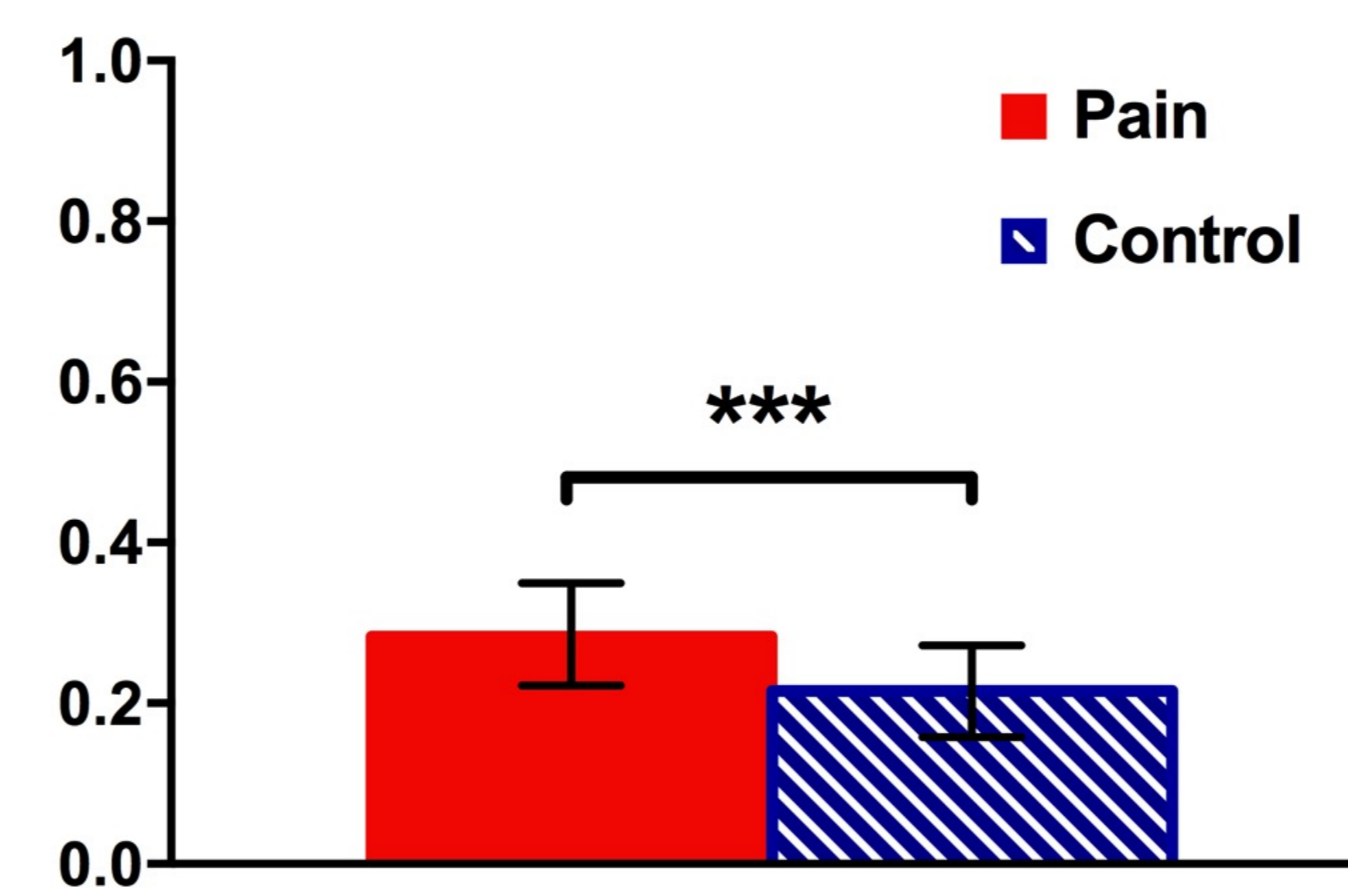
Here we investigate the effect of acute pain on decisions in three standard economic tasks: risky gains, risky losses, and intertemporal choice.

Proportion of risky choices



The proportion of risky choices was greater in the pain condition than in the control condition, but only for gains ($t_{106} = 2.06, p = .042, d = .12$) and not for losses ($t_{106} = 1.00, p > .250, d = .07$).

Proportion of impatient choices



The proportion of impatient choices was greater in the pain condition than in the control condition ($t_{106} = 3.84, p = .0002, d = .16$).

Risk aversion and discounting parameters

Constant relative risk aversion: $u(x) = (x^{1-r}) / (1-r)$

Exponential discounting: $u(x) = \delta^t u_t(x)$

	Risk aversion for gains		Risk aversion for losses		Discount factor (δ)	
	(1)	(2)	(1)	(2)	(1)	(2)
Pain	-.02 (.01)	-.10*** (.03)	-.001 (.01)	.00 (.03)	-.00*** (.00)	-.002 (.002)
Round		-.12*** (.03)		.03 (.03)		-.001 (.002)
Pain × Round		.18*** (.05)		-.05 (.05)		.001 (.00)
Constant	.14*** (.02)	.19*** (.02)	.13*** (.02)	.12*** (.02)	.97*** (.001)	.97*** (.001)

Note. Robust standard errors corrected for clustering on the individual level in parentheses.

* $p < .10$, ** $p < .05$, *** $p < .01$

Method

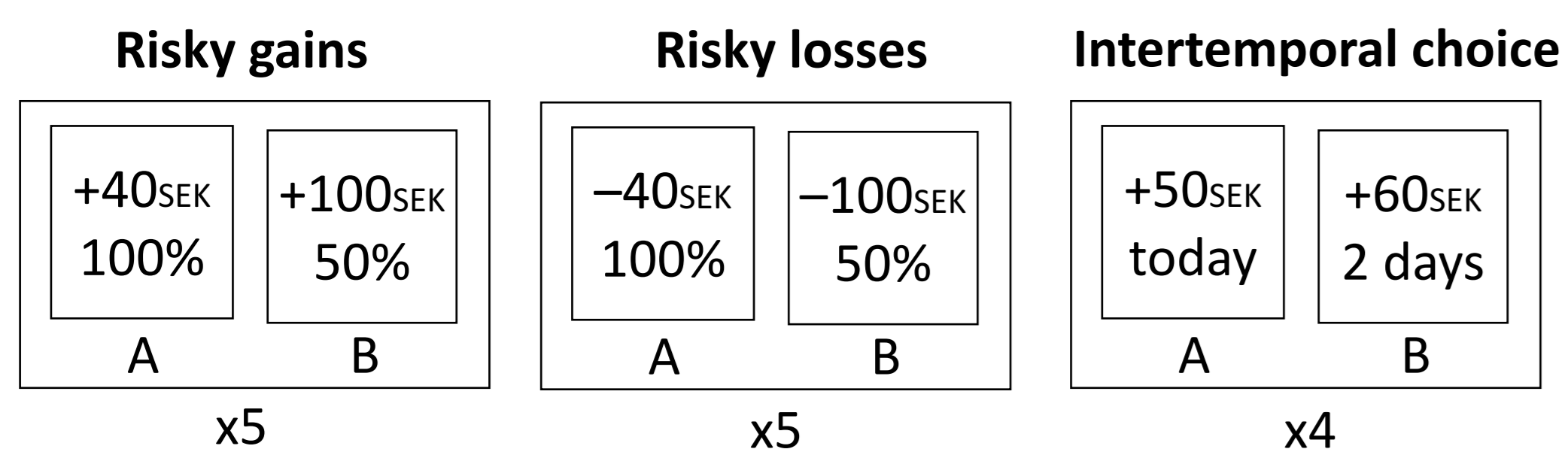
Participants ($N = 109$, 35% women, M age = 23 years) performed three tasks twice: once in the pain condition and the control condition (in counterbalanced order).

Pain condition: Painful heat stimulation was delivered for 60s during each task. The stimulation was calibrated to each participant's subjective pain threshold ($M = 48^\circ\text{C}$).



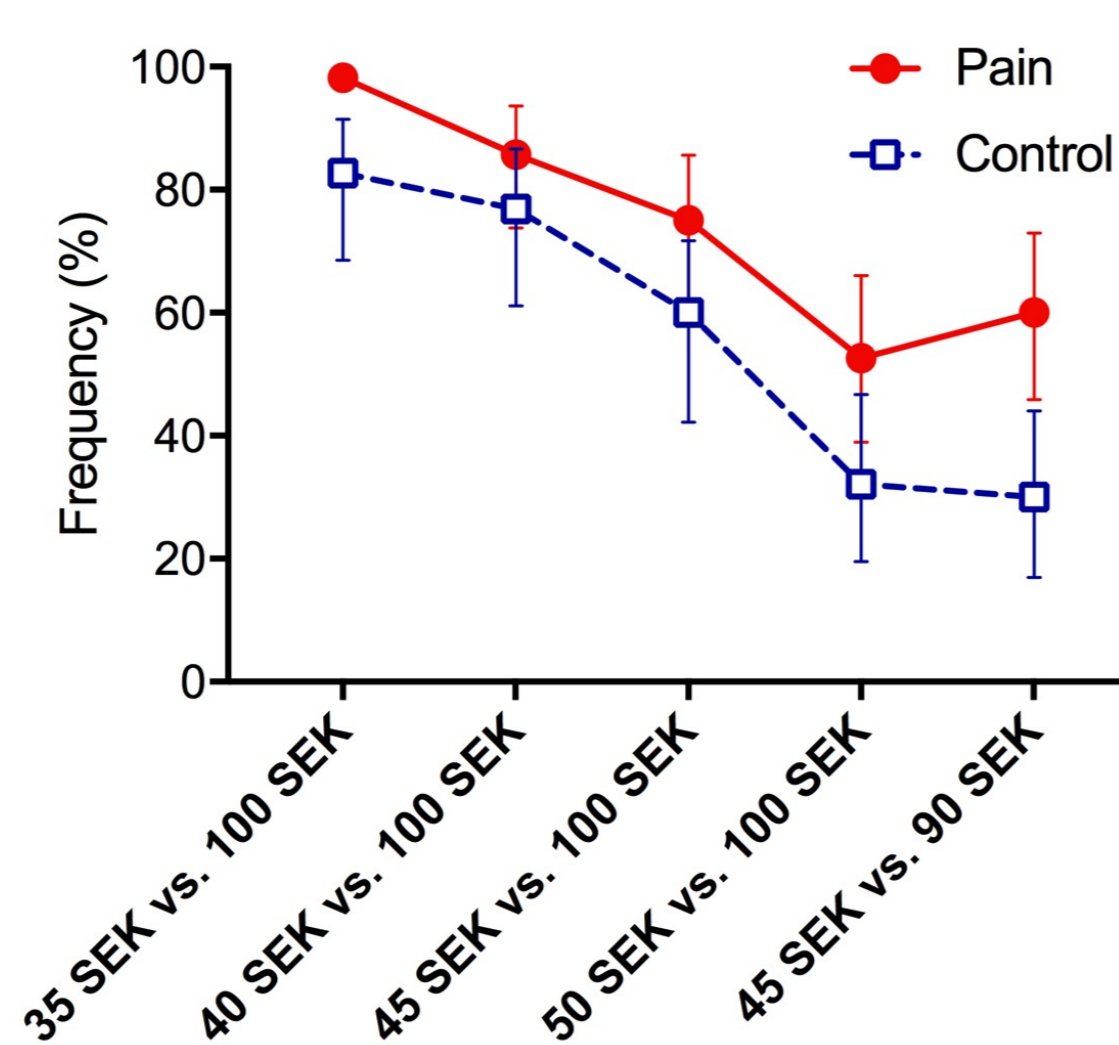
Medoc Q-Sense

Control condition: No pain.



Risky gains

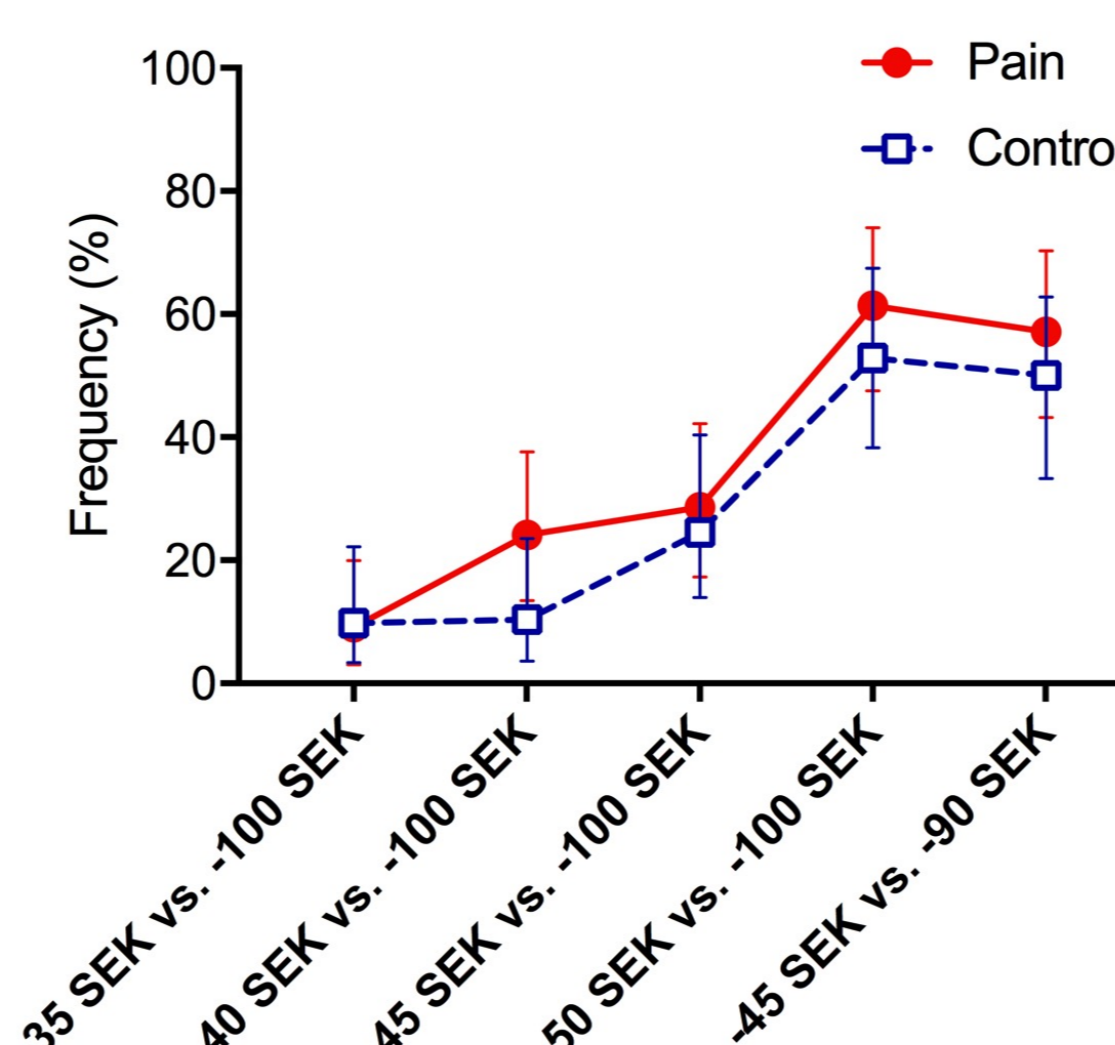
Frequency (%) of risky choices per trial in the first round



The overall proportion of risky choices in the first round was greater in the pain than the control condition ($t_{105} = 3.47, p < .001, d = .69$).

Risky losses

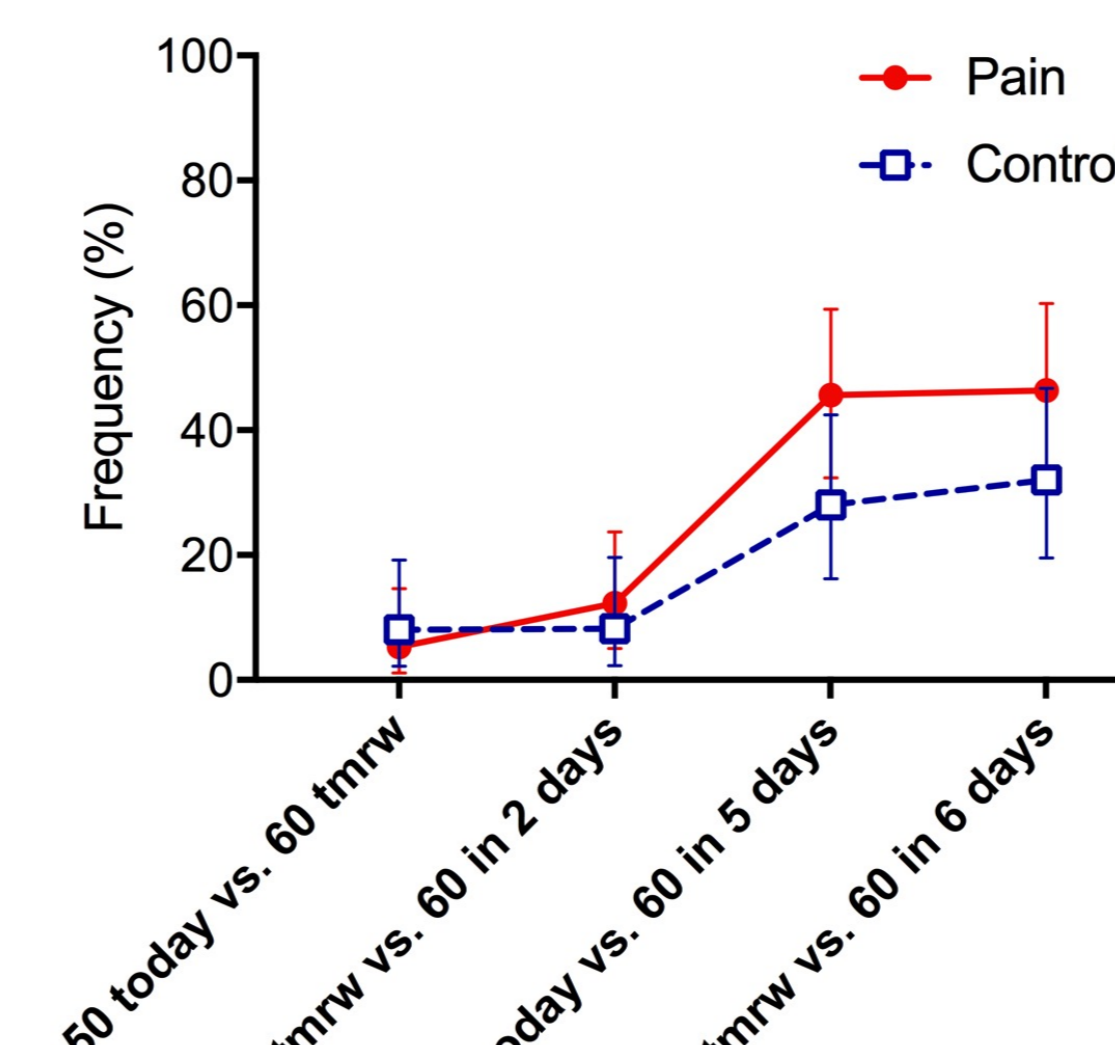
Frequency (%) of risky choices per trial in the first round



No significant difference in overall proportion of risky choices in the first round ($t_{105} = 1.09, p > .250, d = .23$).

Intertemporal choice

Frequency (%) of impatient choices per trial in the first round



No significant difference in overall proportion of impatient choices ($t_{105} = 1.46, p = .147, d = .27$).

Conclusions

Acute pain increased risk-seeking for gains but not for losses, in line with research on chronic pain.^{3,4}

Acute pain led to greater preferences for immediate (smaller) over future (larger) monetary rewards, i.e. made participants more impatient, in line with dual-process theories.^{1,2}

We interpret these results in terms of a motivation to offset the negative, pain-induced state. Receiving money feels rewarding, and the act of winning can reduce the subjective intensity and aversiveness of a painful stimulus.⁵ Thus, increased risk-seeking and impatience could be viewed as an attempt to relieve pain and repair one's mood.

Acknowledgements

We thank Kinga Posadzy for assistance with parameter estimation. This research was funded by the Ragnar Söderberg Foundation and Marianne & Marcus Wallenberg Foundation.

References

- Evans, J. S. B. T. (2003). In two minds: dual-process accounts of reasoning. *Trends in Cognitive Sciences*, 7, 454–459.
- Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and Biases* (pp. 49–81). Cambridge: Cambridge University Press.
- Apkarian, A. V., Sosa, Y., Krauss, B. R., Thomas, P. S., Fredrickson, B. E., Levy, R. E., ... Chialvo, D. R. (2004). Chronic pain patients are impaired on an emotional decision-making task. *Pain*, 108, 129–136.
- Berger, S. E., Baria, A. T., Baliki, M. N., Mansour, A., Herrmann, K. M., Torbey, S., et al. (2014). Risky monetary behavior in chronic back pain is associated with altered modular connectivity of the nucleus accumbens. *BMC research notes*, 7, 739.
- Becker, S., Gandhi, W., Elfassy, N. M., & Schweinhardt, P. (2013). The role of dopamine in the perceptual modulation of nociceptive stimuli by monetary wins or losses. *The European Journal of Neuroscience*, 38, 3080–3088.