

# Turning up the Heat:

## The Impact of Temperature on Cognitive Processes and the Validity of Self-Report

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### Abstract

The effect of heat on productivity is tested either assessing output such as manual labour in a quasi-experimental context (macro), or causally in the lab (micro) where results are difficult to generalize to real-life situations. High cognitive workers' productivity remains difficult to measure. As a result, this productivity problem is circumvented by looking at self-reported comfort, hypothesizing that lower comfort will result in lower productivity.

We propose decision quality and risk as output measure. We further investigate the self-reported comfort and hinder people experience and identify the predictive value of these reports on performance. We find no effect for heat on decisional quality. We also find, however, that self-report might only offer a partial solution to the productivity problem, as men are consistently inaccurate in self-reported versus actual performance.

### Introduction

#### Earlier Research

- Heat effect on productivity projected to reduce output annually by 12%<sup>1</sup>
- Performance of cognitive functions, affective decision-making, and risk are proposed to suffer from hot temperature conditions<sup>2</sup>
- Gender difference: women perform better on cognitive tasks<sup>3</sup>
- Current research focuses on comfort in absence of a performance proxy<sup>4</sup>

#### Lacking

- Underlying cognitive construct effected by hot indoor temperature
- Relationship between performance and self-reported evaluation of performance

### Objective

- Attempt to approximate productivity with decisional quality
- Applying the framework of rational versus intuitive thinking, we expect performance to decline by decreased rational and increase intuitive responses.
- Asses the accuracy of participants own evaluation of the effect of temperature manipulations on performance

### References

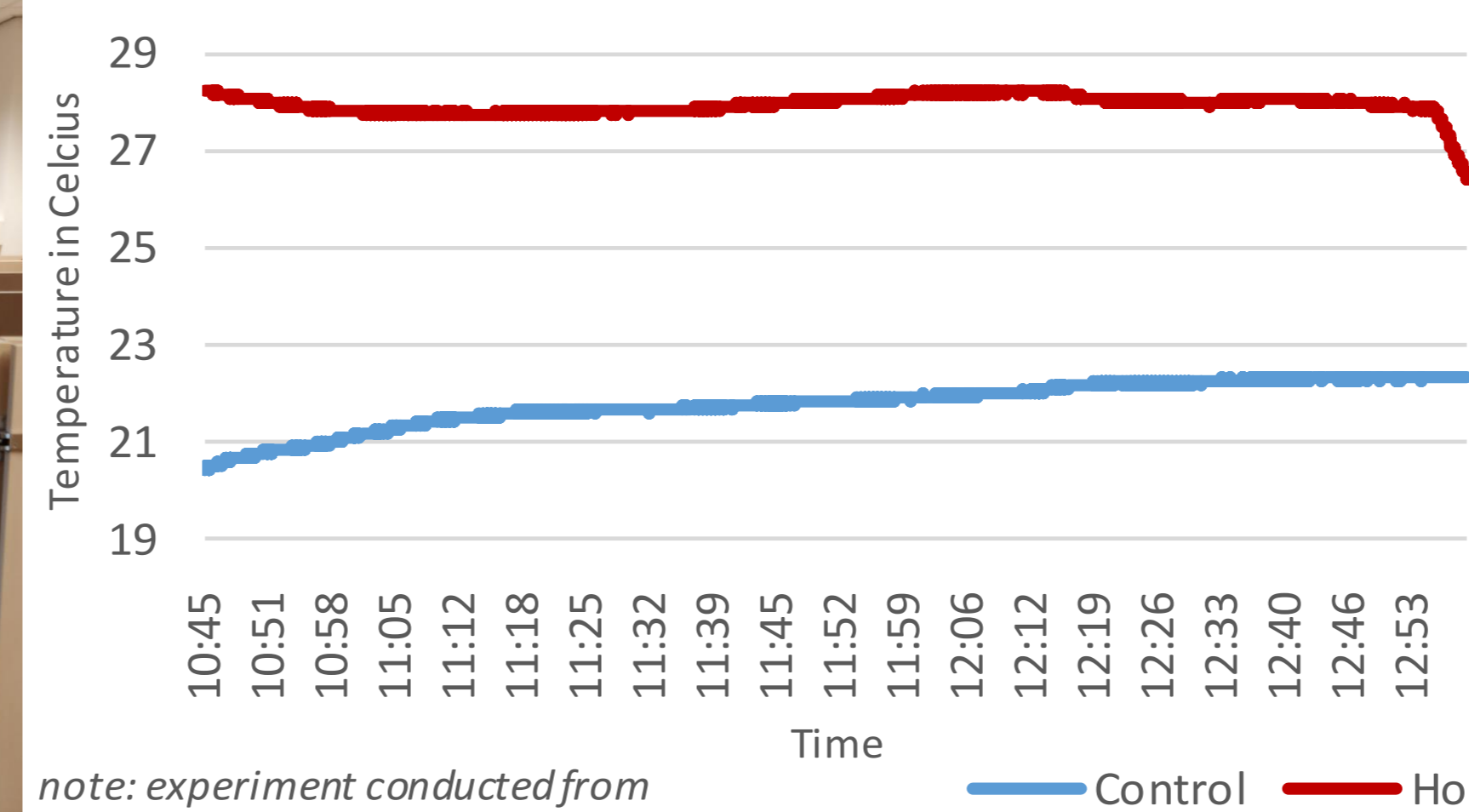
- <sup>1</sup> Zhang, P., Deschenes, O., Meng, K., & Zhang, J. (2018). Temperature effects on productivity and factor reallocation: Evidence from a half million Chinese manufacturing plants. *Journal of Environmental Economics and Management*, 88, 1-17.
- <sup>2</sup> Lan, L., Lian, Z., & Pan, L. (2010). The effects of air temperature on office workers' well-being, workload and productivity-evaluated with subjective ratings. *Applied Ergonomics*, 42(1), 29-36. <https://doi.org/10.1016/j.apergo.2010.04.003>
- <sup>3</sup> Chang, T. Y., & Kajackaite, A. (2019). Battle for the thermostat: Gender and the effect of temperature on cognitive performance. *PLoS one*, 14(5)
- <sup>4</sup> Bluysen, P. M. (2013). *The Healthy Indoor Environment: How to Assess Occupants' Wellbeing in Buildings*. Routledge. <https://doi.org/10.4324/9781315887296>

### Methods

- 257 men and women randomly assigned into a control (22°C/72°F) and manipulation (28°C/ 83°F) condition, including 60 minutes adaption time and standardized shirts.
- Between-subject experimental design
- Measures included Cognitive Reflection Tasks, Heuristics Battery, Risk Lottery Task, General Risk attitude, and self-reported evaluation of temperature and performance



Indoor Temperature Manipulation



### Results

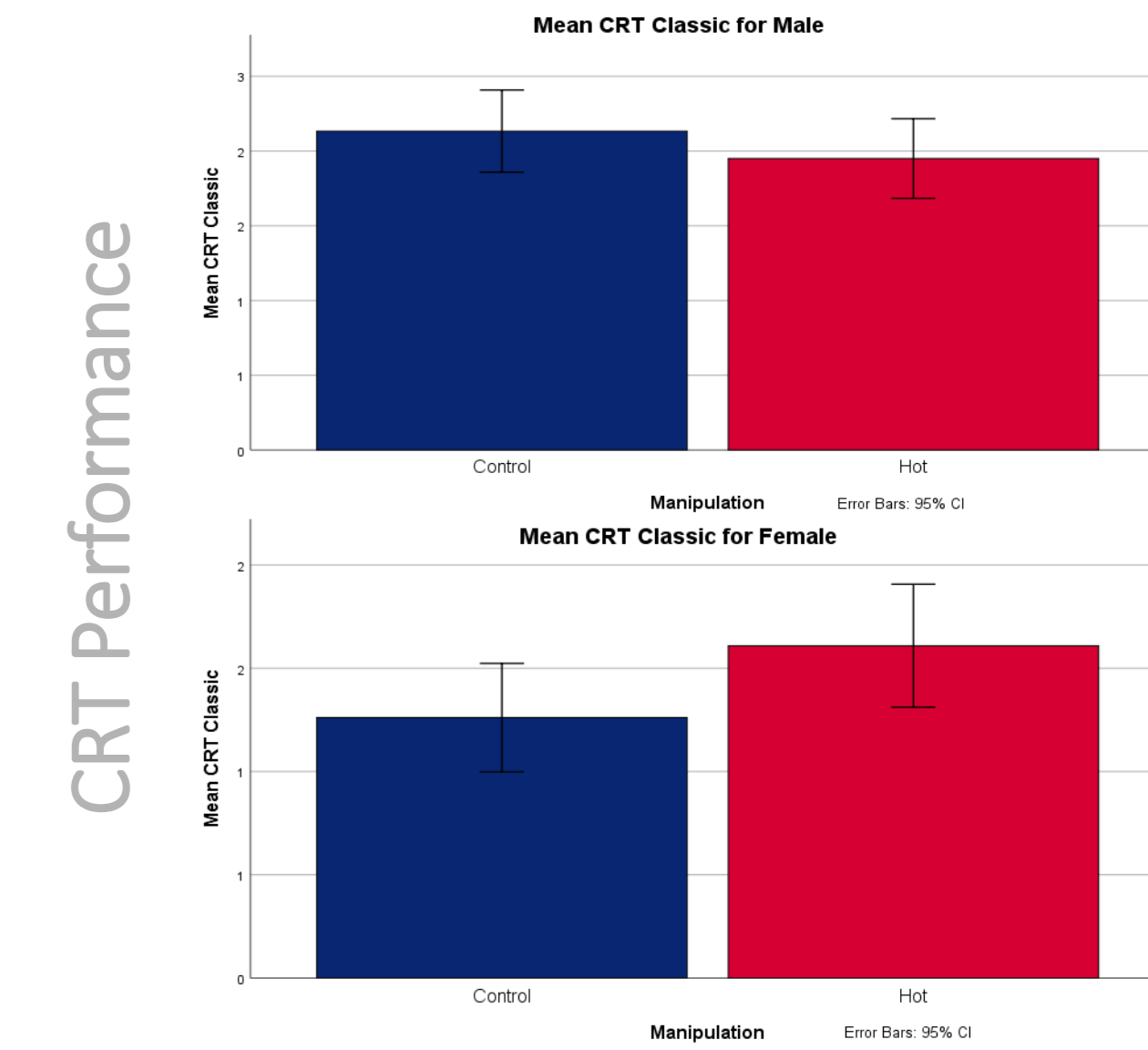
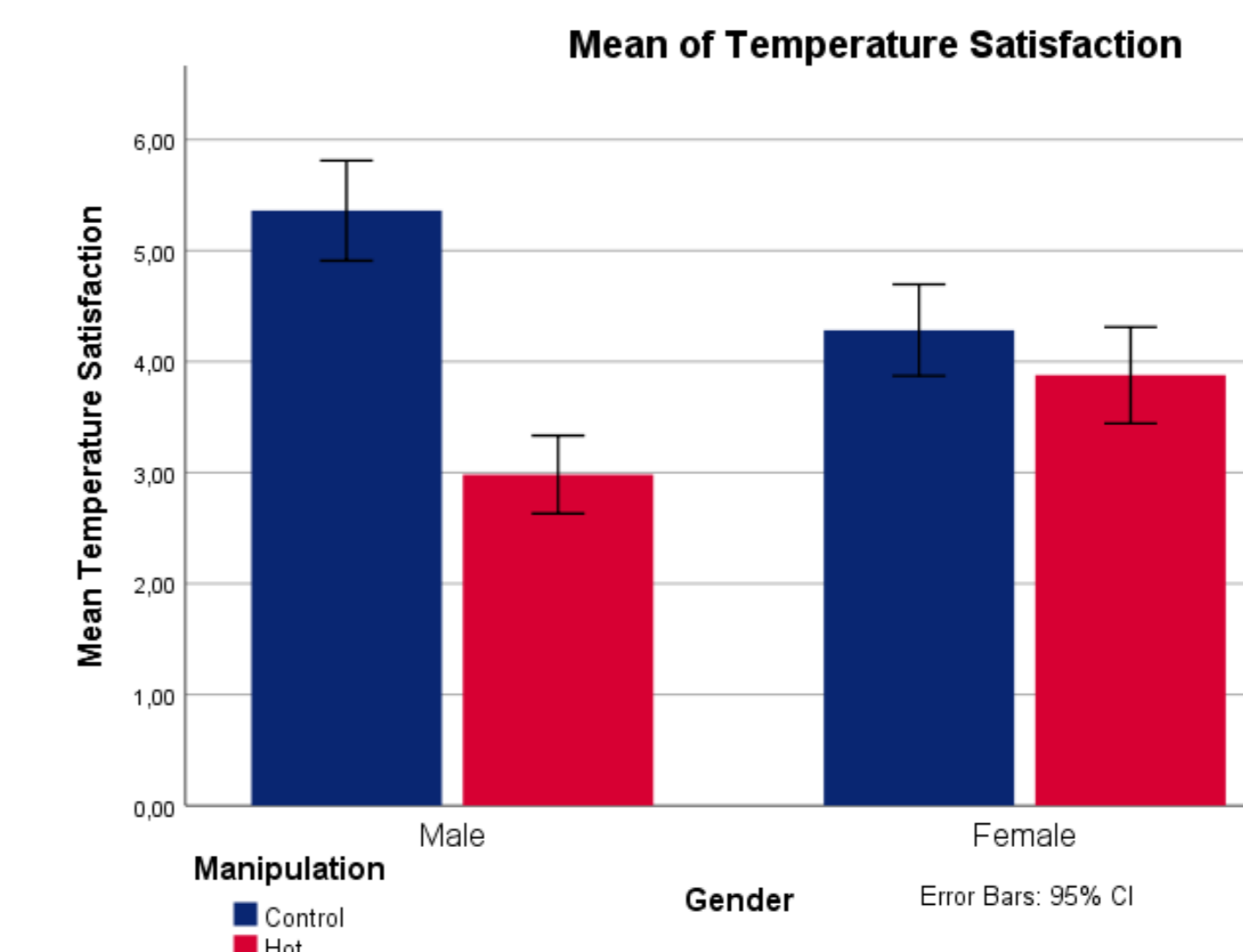
#### Performance on intuition and heuristics tasks

- No significant difference in performance tasks (CRT and heuristics) for both genders.
- *However*, men significantly predict *decrease* in performance ( $Z = -7.42, p < .001$ ) and decreased temperature satisfaction for men. Woman report no significant differences

#### Risk

- Women become more risk taking in behaviour ( $Z = 2.51, p = .01$ ), but remain unchanged in general risk attitude
- *However*, men do not differ in risk behavior, yet significantly report *decreased* self-reported general risk attitude ( $Z = 2.19, p = 0.03$ )

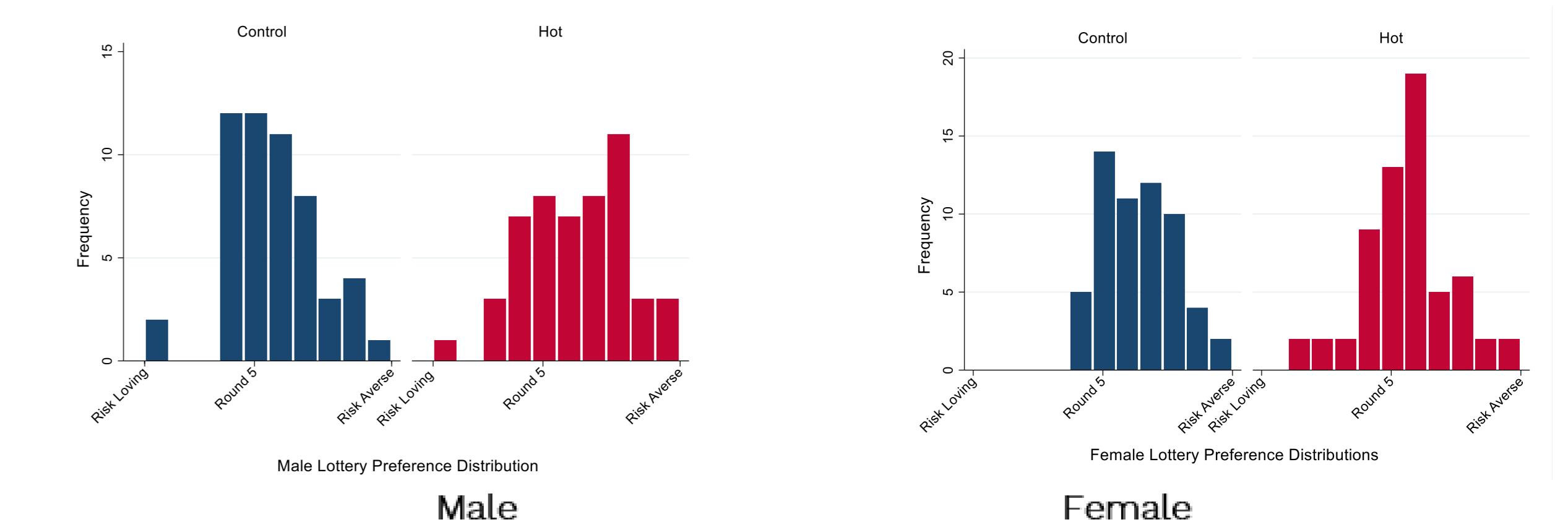
Temperature Satisfaction



### Conclusion

1. Applying the **cognitive framework of Kahneman** remains relevant and promising from the literature for temperature, yet **proofs challenging to asses**.
2. **For men, we find clear discrepancy** between the **experienced hinder** and the **actual results** in both the performance tasks and risk tasks.
3. Our results suggest that the **validity of comfort and self-report** proposed by current literature as a proxy for productivity **might be systematically overestimated** when gender is not taken into consideration

Risk Lottery Task



	Male			Female		
	Control	Hot	Diff.	Control	Hot	Diff.
Risk Preference	M (SD)	M (SD)		M (SD)	M (SD)	
	5.70(1.84)	6.29(2.05)	.60	6.48(1.57)	5.61(1.89)	-.87**
General Risk Attitude	6.08(1.80)	5.4(1.78)	-.68*	5.49(2.00)	5.46(1.74)	-.03

Note: reported are mean (M) and standard deviation (SD).  
\* indicates  $z < .05$ . \*\* indicates  $z < .01$ . GRA tested using non-parametric tests (Mann-Whitney Ranksum)



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