Effects of acute stress on probabilistic reversal learning in healthy participants

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Introduction

Stressful situations can alter reward-based learning. In some studies stress leads to increased learning from rewards, in others it does not show an effect [1]. A task addressing reward-based learning is the reversal learning task, which uses probabilistic rewards as feedback and incorporates sudden changes in reward contingencies. Deficits in reversal learning have been described in psychiatric patient populations, such as psychosis or addiction, known to be susceptible to stress. Here, we investigated the effect of acute social stress, using the Trier Social Stress Test (TSST), a well-validated psychosocial stress induction (ST) vs. a control condition (CT) in a within-subject design in healthy control participants.

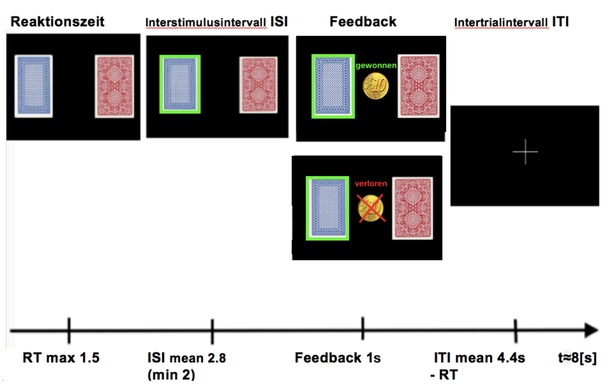
Methods

Sample

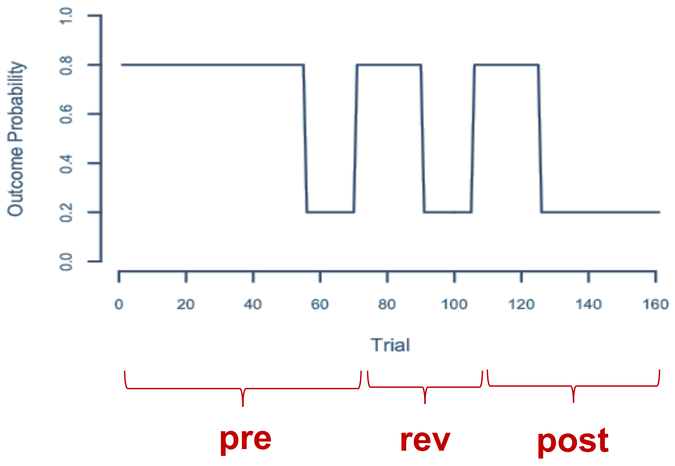
N = 28 healthy subjects (28 male)

Subjects completed the reversal learning task after stress induction (ST) vs. a control condition (CT) in counterbalanced order.

Reversal learning task



Reward contingencies (3 phases)



Analyses

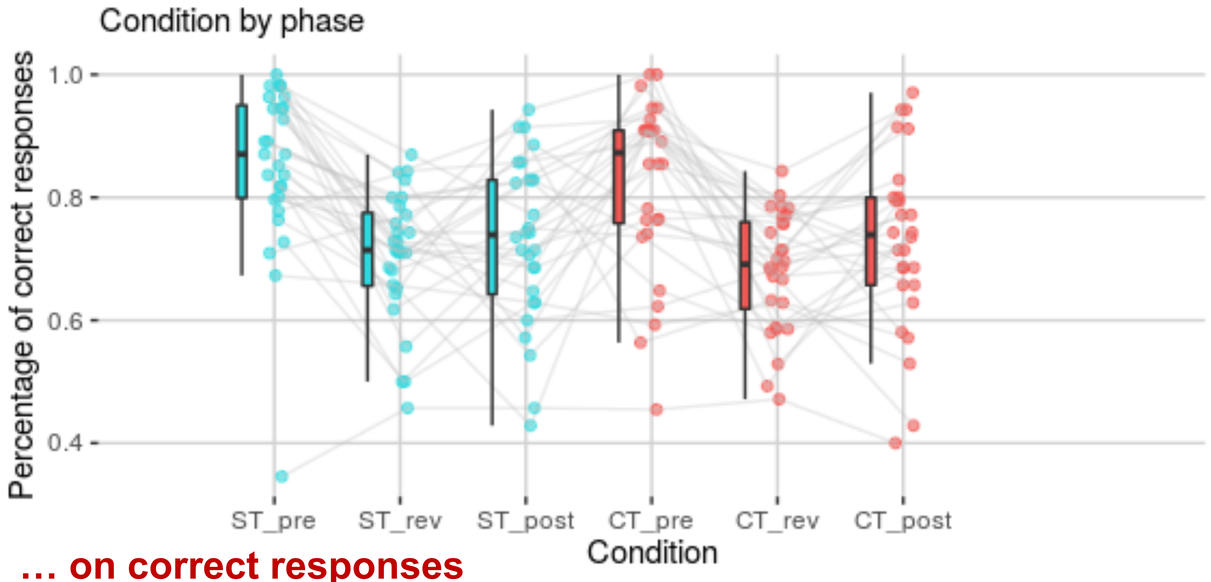
Aggregated outcome variables:
1) correct responses (%)
2) switches afters losses (%)
3) stays after wins (%)

Mixed effects modeling (lme4 package, R): Single trial responses regressed on

Fixed within-subject factors:
- Condition (ST vs. CT)
- Phase (pre, rev, post)
- Random intercept (Subject)

Results

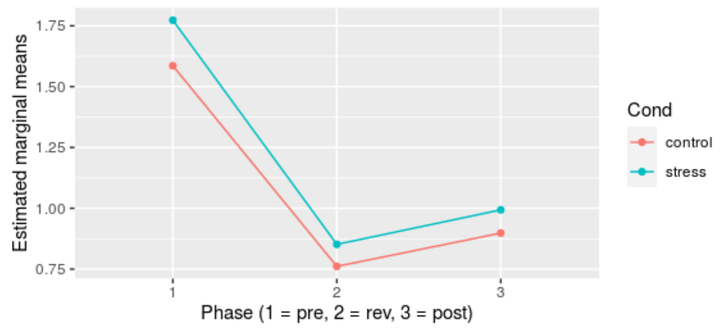
In aggregated outcomes, no main effect of stress…



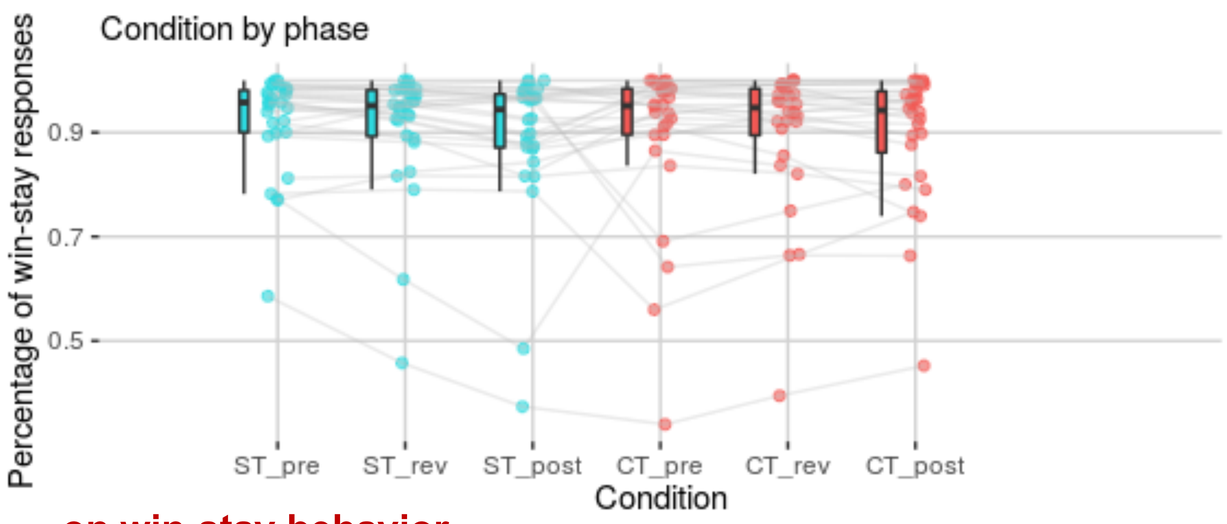
… on correct responses
F(1, 27) = 1.23, p = .278

Stress induction was successful, as shown by cortisol responses, heart rate and subjective stress response [2].

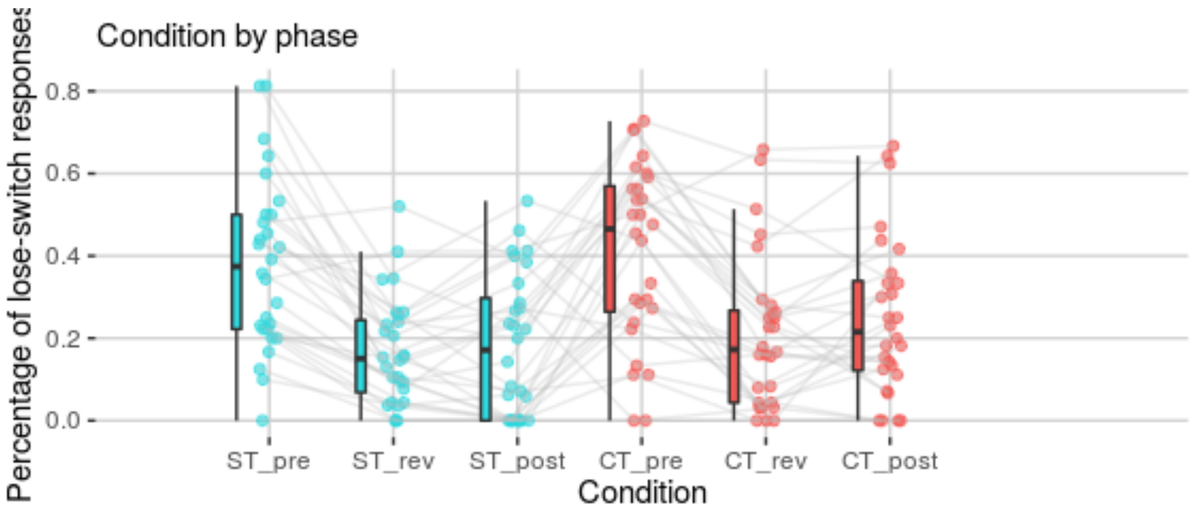
single-trial analyses



multilevel modeling on a single trial basis allowing for a random intercept for subjects revealed a main effect of condition: fixed effect estimate: -0.117 (0.049), p = 0.017



... on win-stay behavior
F(1, 27) = 0.32, p = .579



…on lose-switch-behavior
F(1, 27) = 2.40, p = .133

Conclusion

Behaviorally, reversal learning was robust to stress induction in all three aggregated outcome variables. At closer look on single-trial responses, stress increased correct responses across all phases. Further insight could be derived from computational modeling and analysing fMRI data, which have been collected as well.

Subjecting *n* = 28 healthy males in a within-subject design to acute psychosocial stress increased correct responses slightly and had no impact on win-stay, as well as lose-switch behavior in a probabilistic reversal learning task.

DOWNLOAD POSTER HERE

[1] Starcke K, Brand M. Effects of stress on decisions under uncertainty: A meta-analysis. Psychol Bull. 2016 Sep;142(9):909-933.

[2] Luettgau L, Schlagenhauf F, Sjoerds Z. Acute and past subjective stress influence working memory and related neural substrates. Psychoneuroendocrinology. 2018 Oct;96:25-34.