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### **Presenter Information**

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# Exposure to the Trier Social Stress Test Enhances Central Detail Memory, Reduces False Memory, and Results in Intrusive Memories that Last for Days

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## Introduction

Most studies examining the effects of stress on learning and memory utilize stressors that are extrinsic to the learning task. For instance, investigators may expose participants to a social evaluative stressor, such as the Trier Social Stress Test (TSST), and then examine its impact on participant memory for a list of words, images, or a film<sup>1</sup>. However, this scenario is limited in its translational value, as it does not assess what participants remember about the stress experience itself. Because life frequently requires individuals to recall stressful events (e.g., crimes, traumatic events), it is important to understand what aspects of these events an individual is able to accurately recall. In the present study, we used a modified version of the TSST paradigm, originally developed by Wolf and colleagues<sup>2</sup>, to test participants' memory for a laboratory-controlled stress event. We aimed to replicate previous work with the paradigm<sup>2-5</sup> and extend on it by quantifying false memories and intrusive memories in stressed participants.

## Methods

- 107 undergraduate participants [42 males, 65 females (32 naturally cycling);  $M_{age} = 19.65$  years,  $SD = 2.73$ ]
- Day 1: TSST or fTSST
  - Salivary cortisol: SalivaBio Oral Swabs<sup>6</sup> placed under the tongue for 1.5 minutes, after collected sample were stored at  $-20^{\circ}\text{C}$  until assayed
    - Collected before and after the speech/conversation
  - 22 items within view of participant during speech/conversation
    - Objects manipulated by panel members during speech/conversation deemed "central objects," all other items deemed "peripheral objects"
  - TSST: participants instructed to deliver 10-min speech assuming the role of a job applicant
  - fTSST: participants instructed to have a conversation about their aspirations, hobbies, favorite book/movie, etc.
- Day 2: Memory Assessments
  - Free recall and recognition assessments testing object memory
  - Intrusive memory questionnaire
- Days 4, 6, and 8
  - Online intrusive memory questionnaire administered via Qualtrics

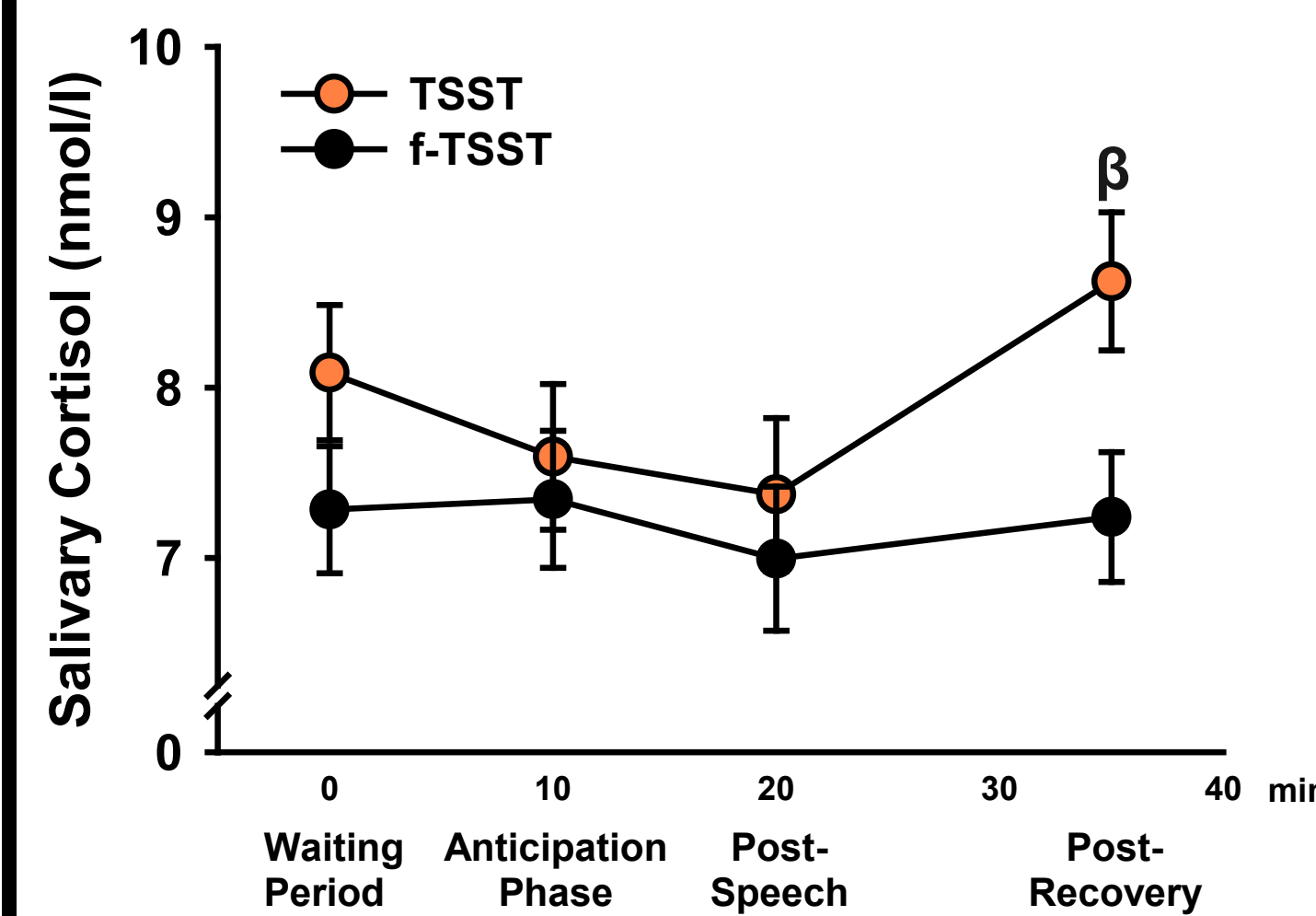


TSST only: panel members wore lab coats; participants were informed the speech would be recorded by a camera located to the left of the table

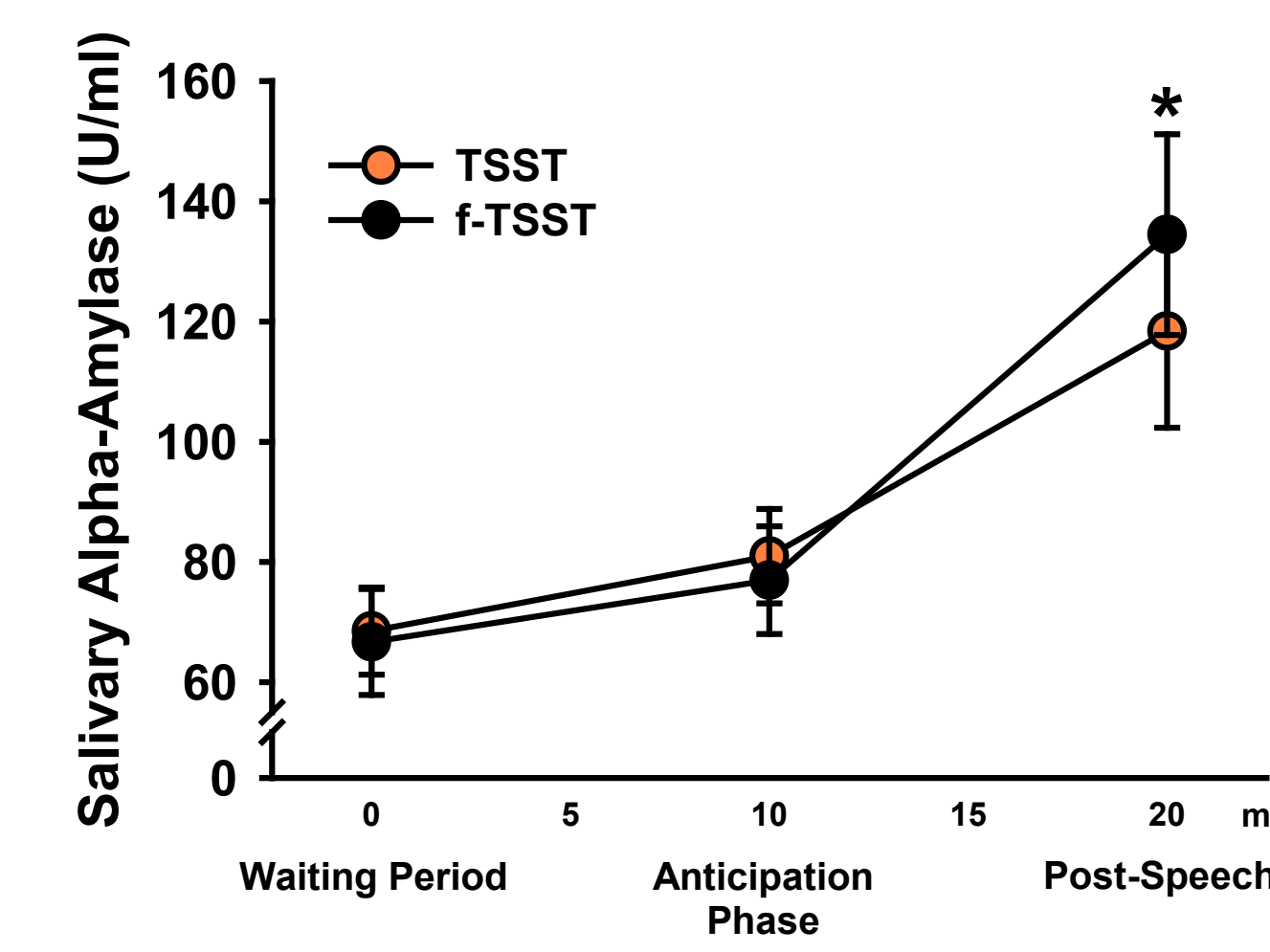


Participants were instructed to stand on the white X to deliver their speech/have a conversation with the panel members

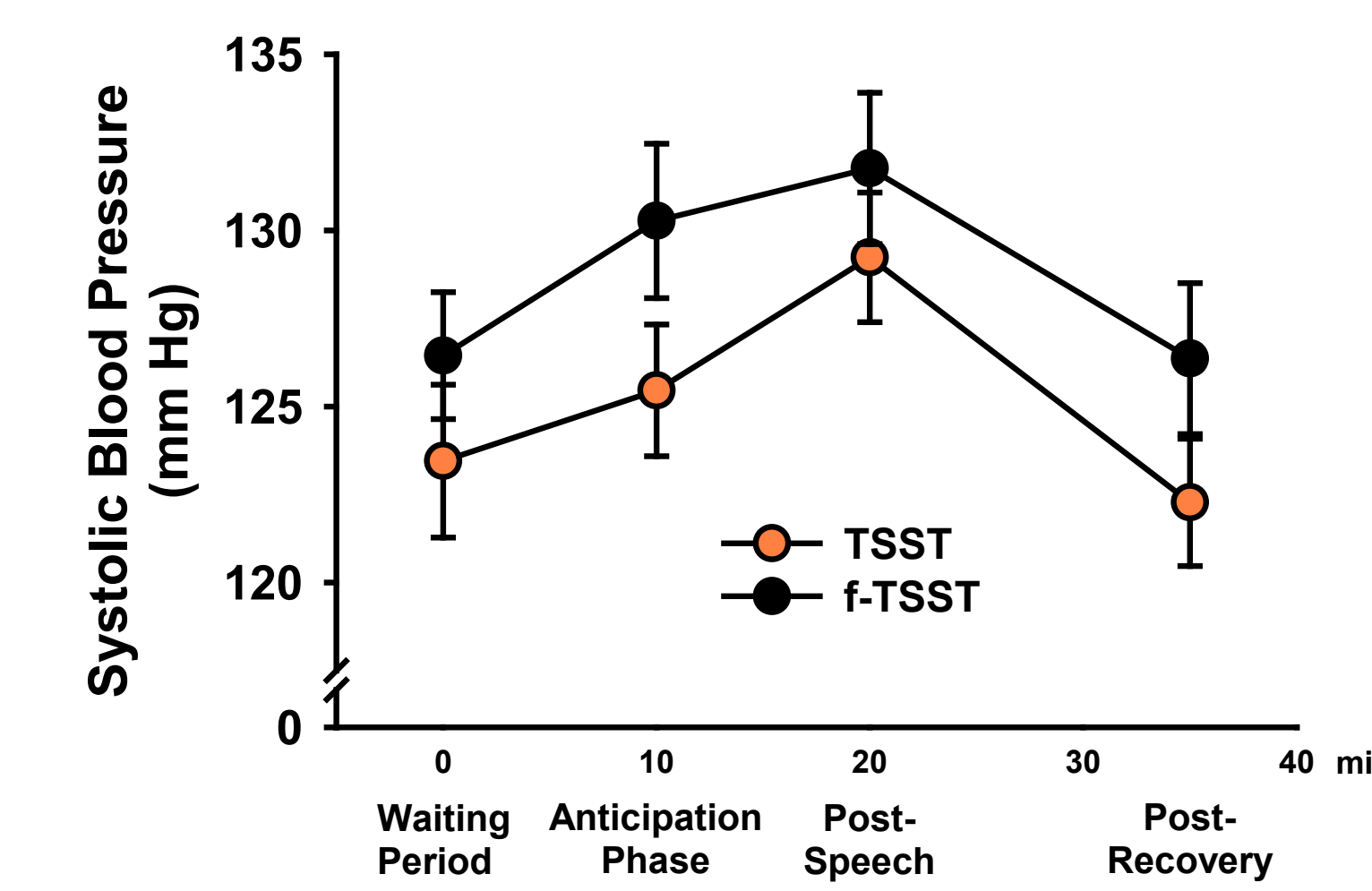
## Results (all data are means $\pm$ SEM)



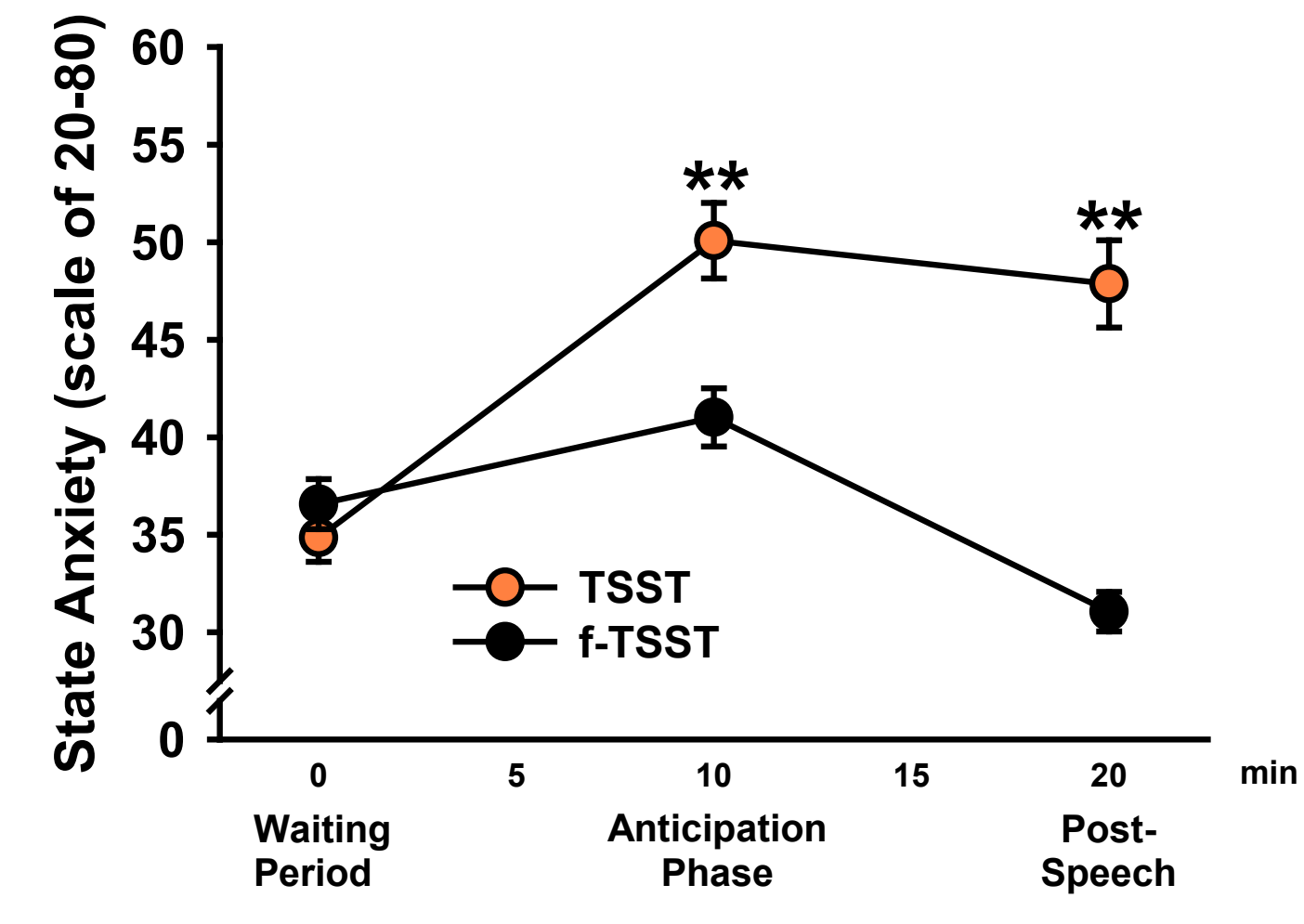
**Figure 1:** The TSST group did not demonstrate a significant increase in salivary cortisol levels following the speech task, but their post-recovery levels were greater than those observed in the f-TSST group. Despite a nonsignificant, Condition x Time Point interaction,  $F(2,75,247.09) = 1.21$ ,  $p > 0.30$ , we performed planned comparisons between the groups at this time point, which indicated that the difference was significant.  $\beta = p < 0.02$  relative to f-TSST.



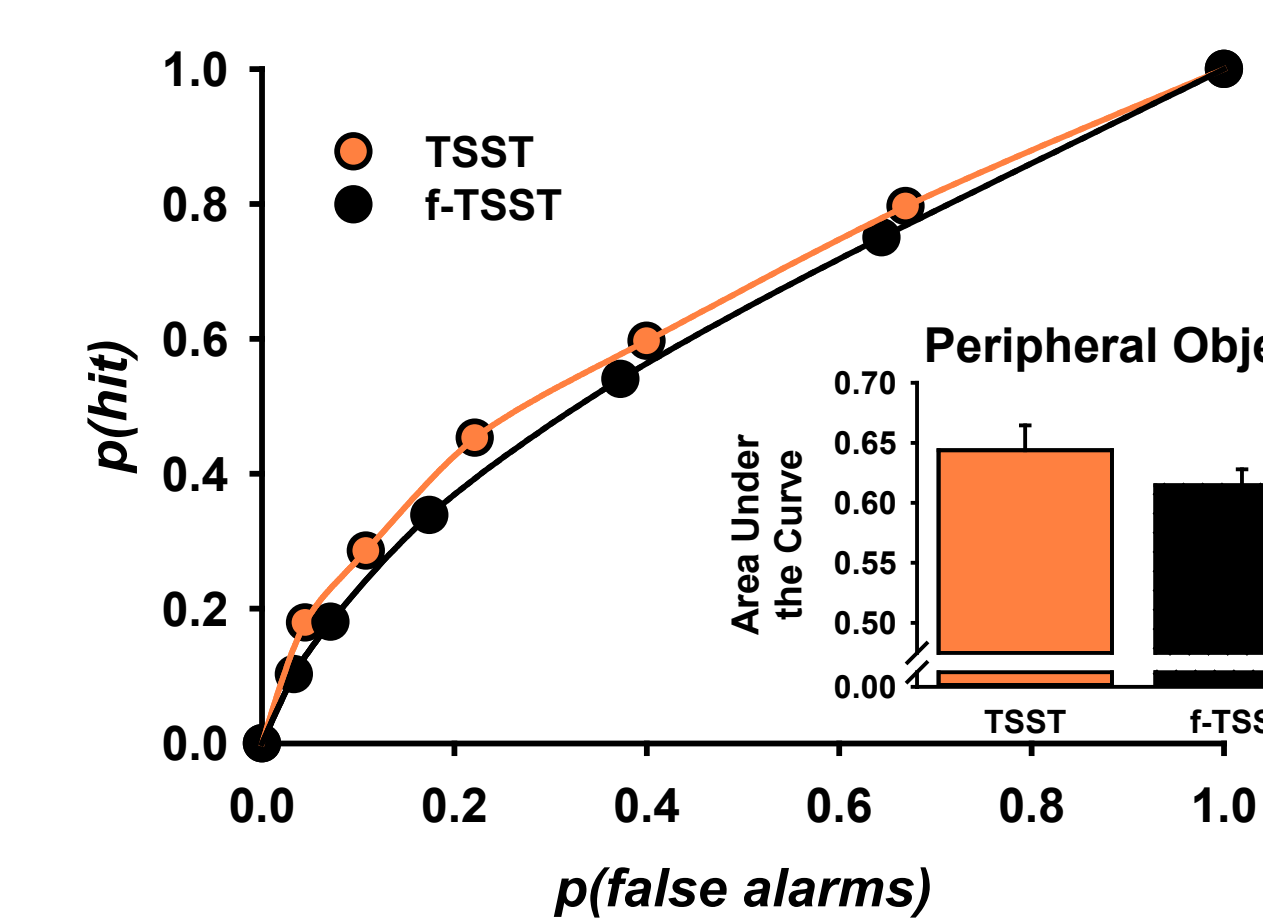
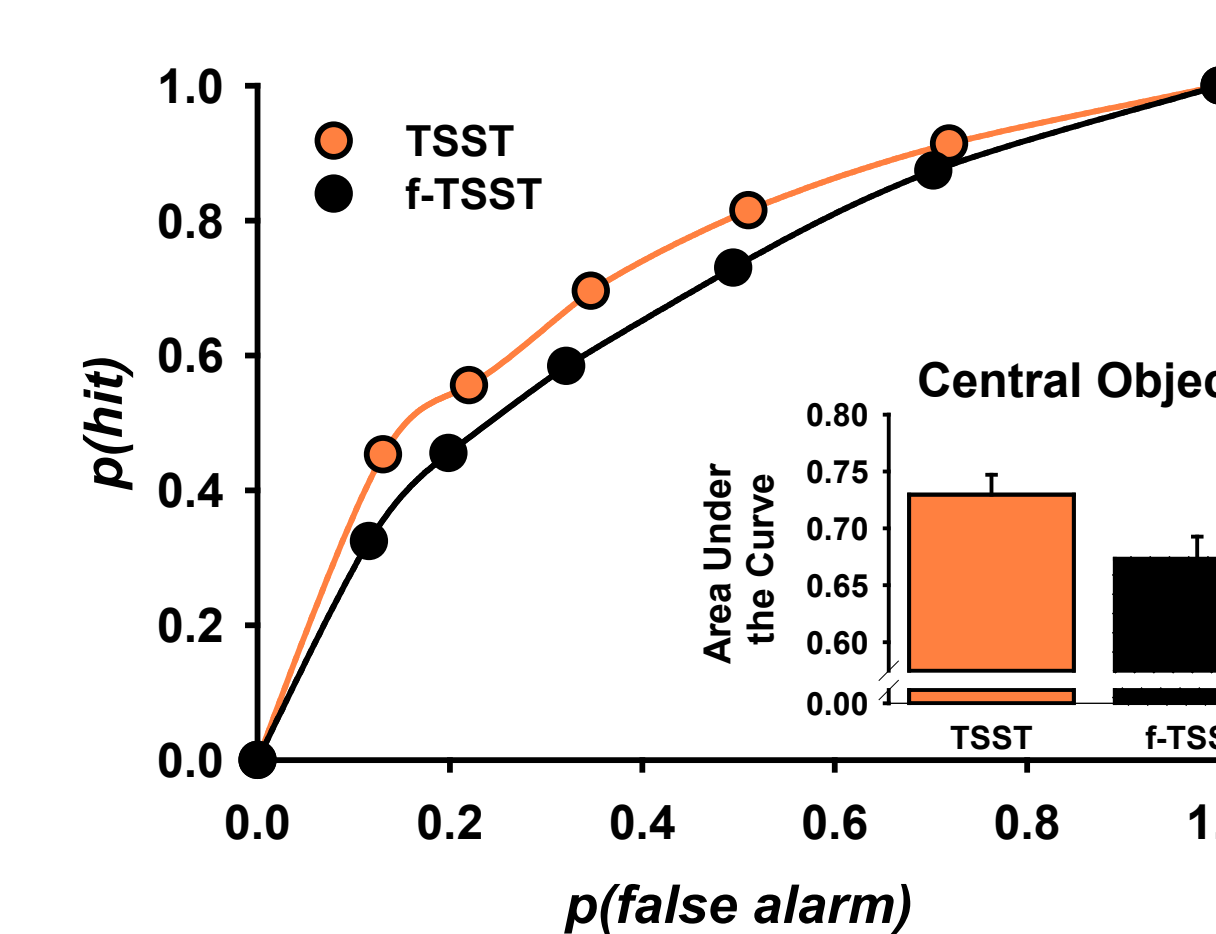
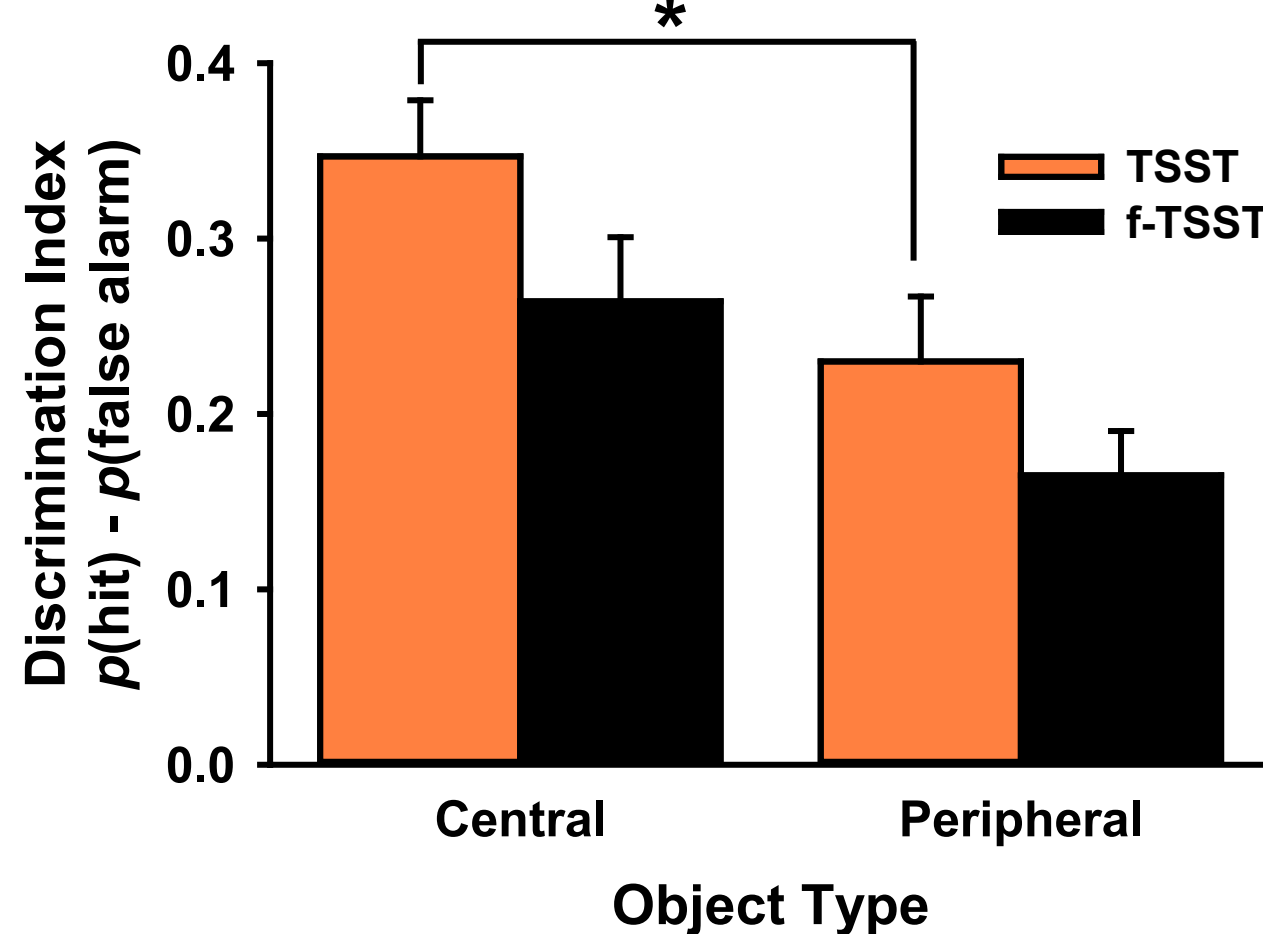
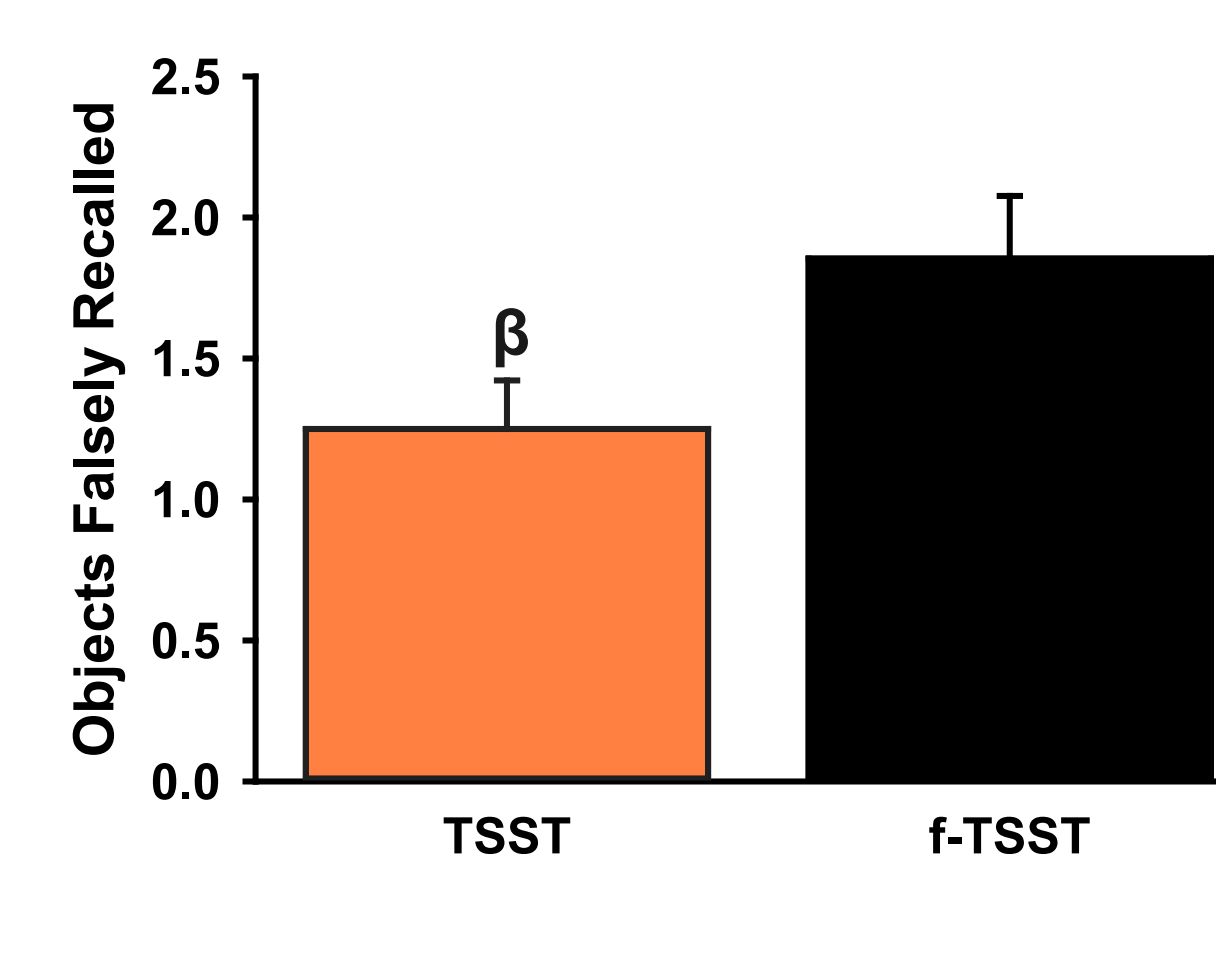
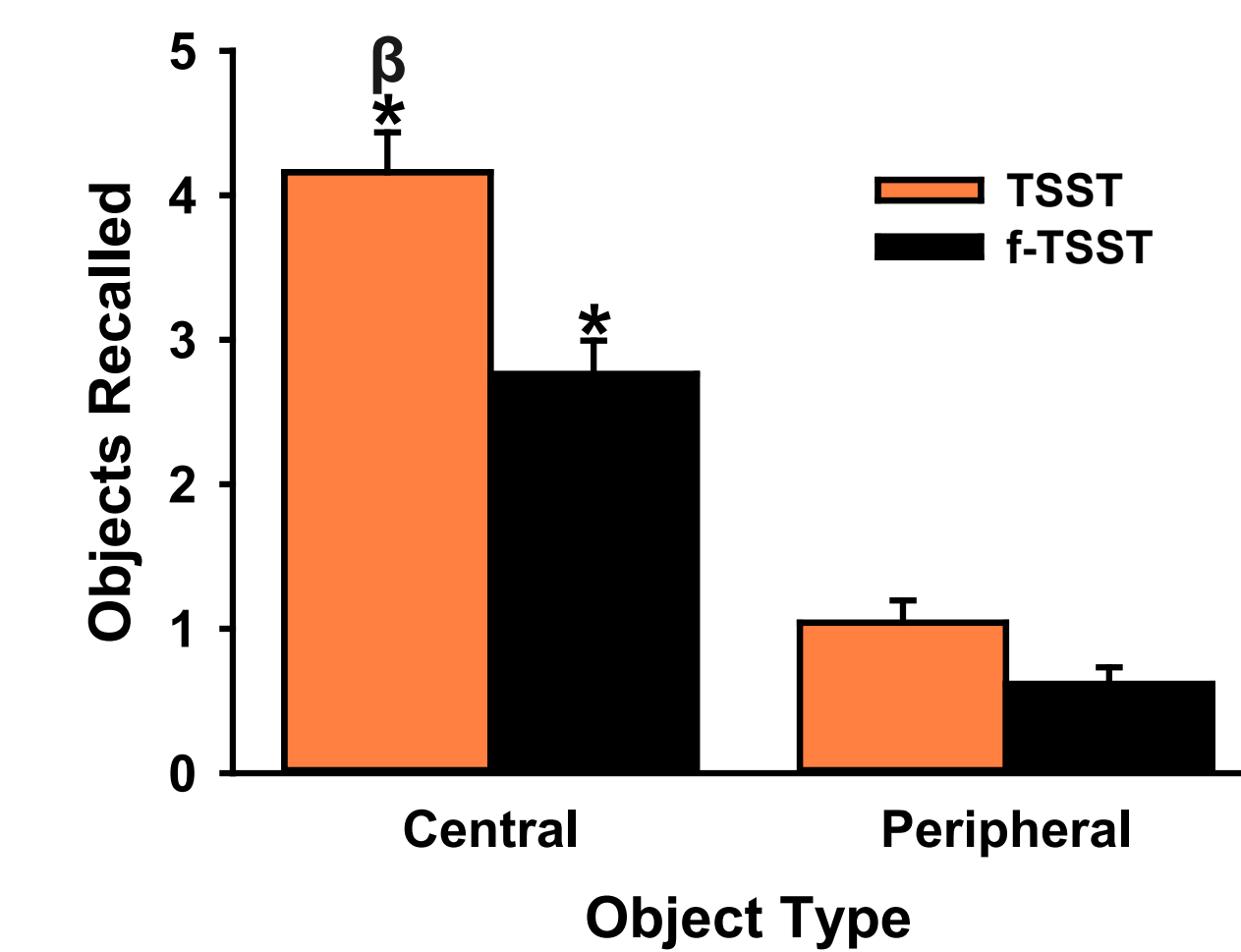
**Figure 2:** All participants, independent of condition, exhibited a significant increase in salivary alpha-amylase levels after the speech or conversation [effect of time point:  $F(2,194) = 15.06$ ,  $p < 0.001$ ]. \* =  $p < 0.05$  relative to waiting period and anticipation phase.



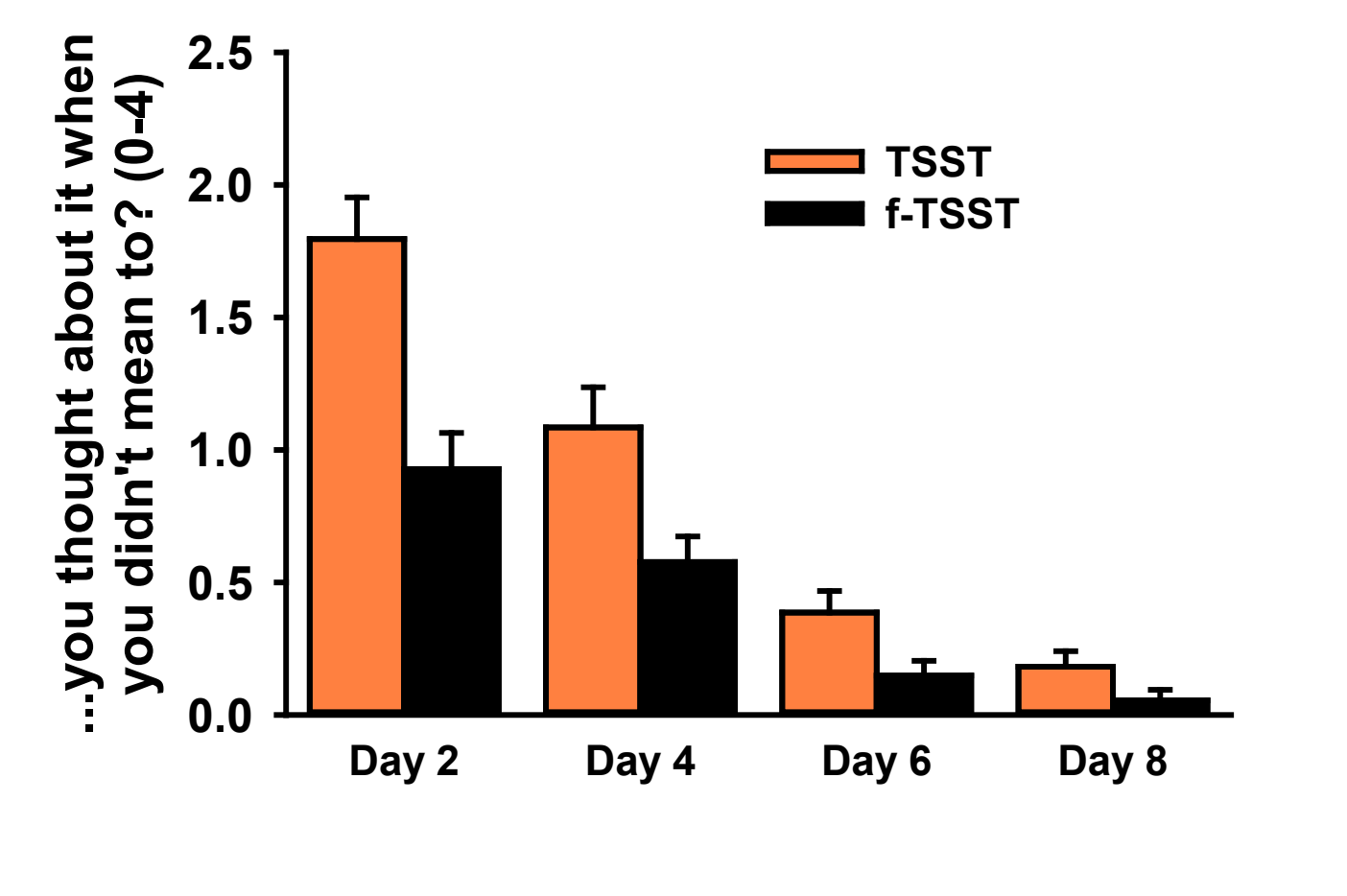
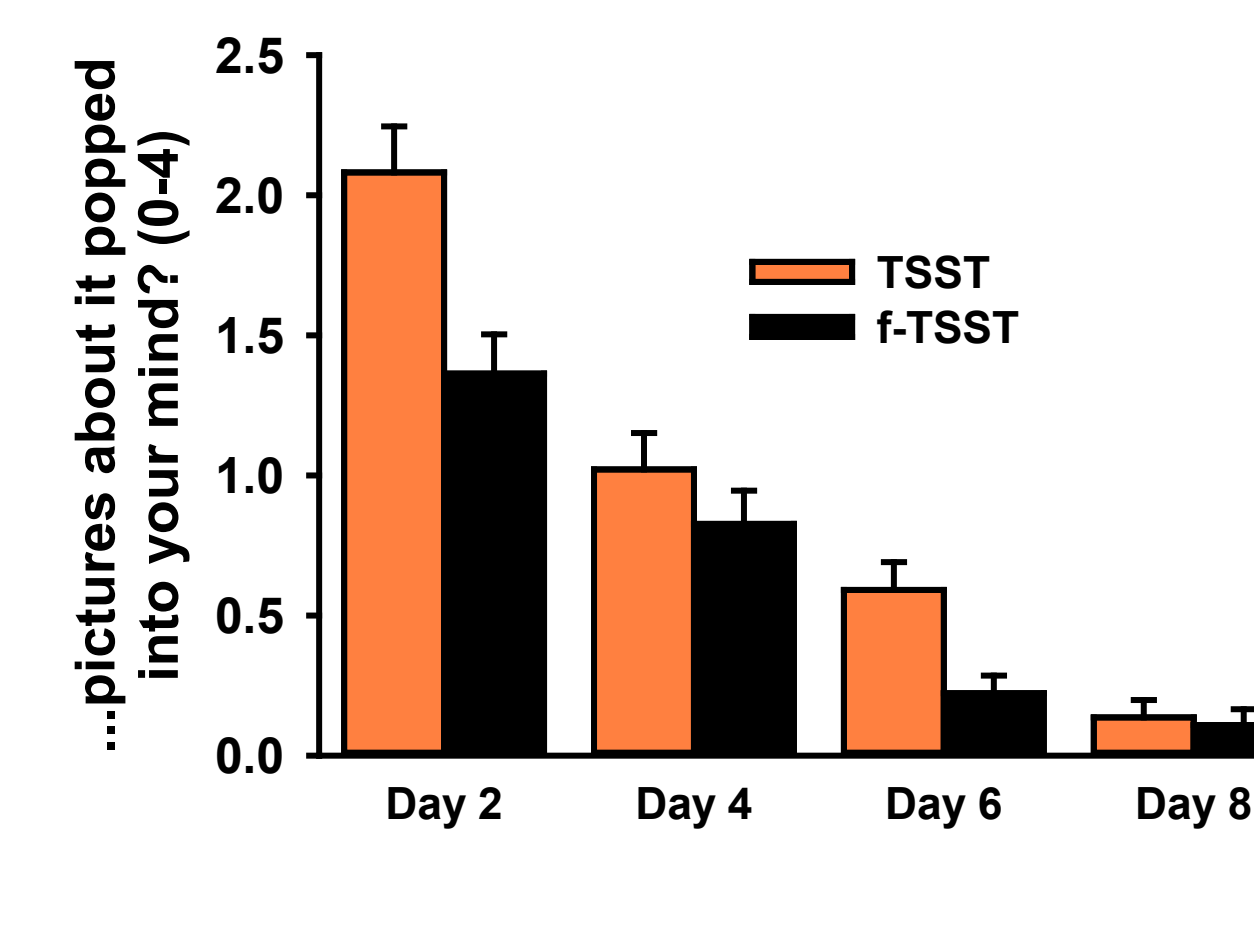
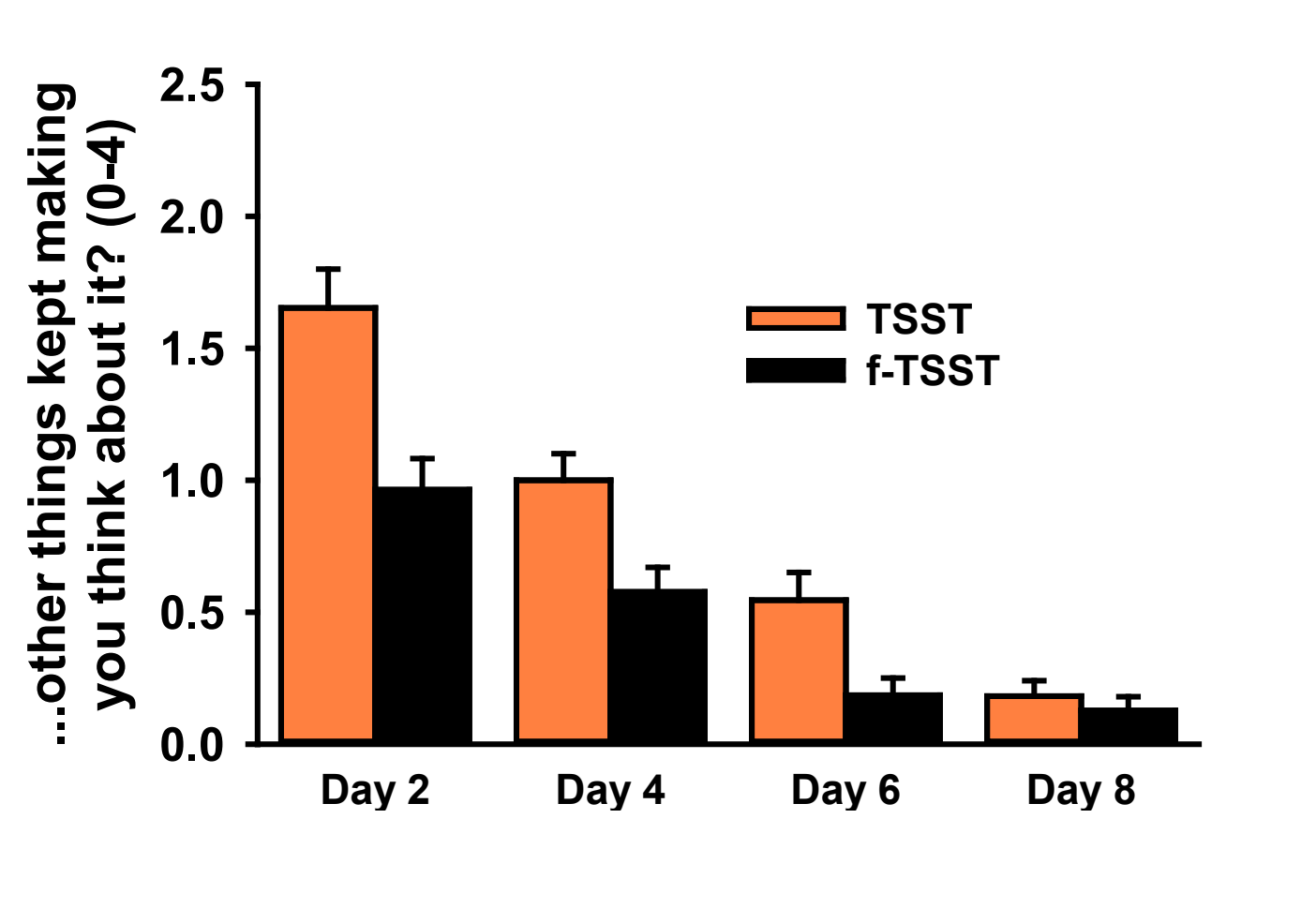
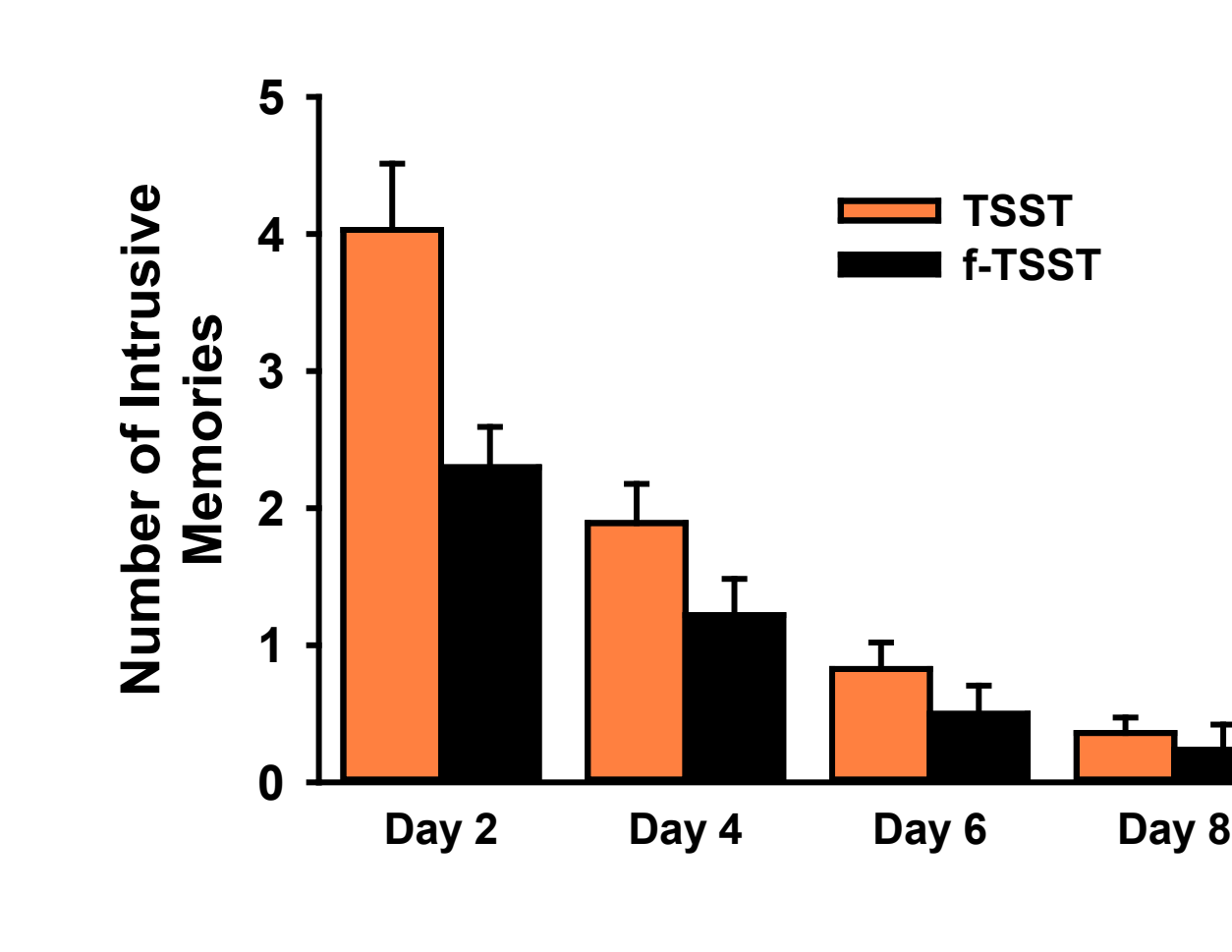
**Figure 3:** The analysis of systolic BP revealed a significant effect of time point,  $F(3,300) = 15.08$ ,  $p < 0.001$ . Participants' systolic BP immediately following the speech/conversation was greater than their systolic BP at the end of the waiting period ( $p < 0.001$ ) and at the end of the anticipation phase ( $p = 0.004$ ). By the post-recovery time point, participants' systolic BP had significantly declined ( $p < 0.001$ ).



**Figure 4:** Both groups exhibited significant increases in state anxiety at the end of the anticipation phase [effect of time point:  $F(1,85,183.60) = 39.24$ ,  $p < 0.001$ ], but this increase was greater in the TSST group [Condition x Time Point interaction:  $F(1,85,183.60) = 34.48$ ,  $p < 0.001$ ]. By the end of the speech or conversation, state anxiety has significantly declined in the f-TSST group, while it remained elevated in the TSST group. \*\* =  $p < 0.001$  relative to waiting period and f-TSST.



**Figure 5:** The TSST and f-TSST groups recalled more central objects than peripheral objects [effect of object type:  $F(1,100) = 183.84$ ,  $p < 0.001$ ]. However, the TSST group recalled more central objects than the f-TSST group [Condition x Object Type interaction:  $F(1,100) = 6.18$ ,  $p = 0.02$ ]. The TSST group exhibited less false recall than the f-TSST group,  $F(1,99) = 4.86$ ,  $p = 0.03$ . Participants exhibited greater recognition accuracy for central objects than for peripheral objects [effect of object type:  $F(1,100) = 10.72$ ,  $p = 0.001$ ]. Participants exposed to the TSST had greater recognition accuracy than participants exposed to the f-TSST [effect of condition:  $F(1,100) = 4.25$ ,  $p = 0.04$ ]. The area under the ROC curves for central objects was greater than the area under the ROC curves for peripheral objects [effect of object type:  $F(1,100) = 18.65$ ,  $p < 0.001$ ]. Independent of object type, the area under the ROC curves from the TSST group was greater than the area under the ROC curves from the f-TSST group [effect of condition:  $F(1,100) = 4.05$ ,  $p < 0.05$ ], although this difference seemed to be driven by greater area under the ROC curve for central objects in the TSST group. \* =  $p < 0.05$  relative to peripheral objects or f-TSST;  $\beta = p < 0.05$  relative to f-TSST.



**Figure 6:** For the analysis of intrusive memory phenomena, a repeated measures MANOVA revealed significant effects of condition [ $F(1,85) = 8.93$ ,  $p = 0.004$ ], question [ $F(1,27,108.03) = 26.14$ ,  $p < 0.001$ ], and day [ $F(1,85,157) = 129.88$ ,  $p < 0.001$ ], as well as significant Condition x Day [ $F(1,85,157) = 10.17$ ,  $p < 0.001$ ] and Question x Day [ $F(2,55,216.75) = 22.12$ ,  $p < 0.001$ ] interactions. The significant effects revealed that the magnitude of intrusive memory phenomena reported by participants decreased each day. On Days 2 ( $p < 0.001$ ) and 4 ( $p = 0.02$ ), participants exposed to the TSST reported greater intrusive memory phenomena than participants exposed to the f-TSST. By Day 6, this difference was no longer significant ( $p = 0.13$ ). The effect observed on Day 4 appeared to be driven by group differences for Q1 ("other things kept making you think about it...") and Q3 ("you thought about it when you didn't mean to...").

## Conclusions

Participants exposed to the TSST recalled more central objects than participants exposed to the f-TSST. These participants also demonstrated greater overall recognition memory (though this effect seemed to be driven by greater recognition of central objects) and less false recall. These findings are consistent with previous studies reporting that stress enhances participant memory for the central details of an experience. We also found that participants exposed to the TSST reported greater intrusive memories up to four days following the speech task. Collectively, our results indicate that the modified TSST paradigm is a useful way to study memory accuracy related to a stressful experience, as well as intrusive memories that ensue.

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