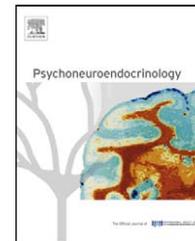




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# The Trier Social Stress Test for Groups (TSST-G): A new research tool for controlled simultaneous social stress exposure in a group format

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**Summary** Psychological stress is an ubiquitous challenge across human cultures affecting mental and physical health. Recent evidence indicates that performance tasks combining elements of socio-evaluative threat and uncontrollability elicit reliable stress responses. The Trier Social Stress Test (TSST) is the most frequently used psychological protocol in stress research; however, to date it has only been available in a single-subject version. In particular, there is an increasing need in several emerging research fields such as stress research or social neurosciences for a standardized research tool to expose relatively large groups of subjects to controlled simultaneous stress. In search of a laboratory stressor that allows simultaneous stress exposure in a group format, we exposed a total of 25 healthy male participants to the Trier Social Stress Test for Groups (TSST-G; public speaking and mental arithmetic tasks in front of a panel of two evaluators in groups of six participants) and a specific control condition. Results showed that the TSST-G induced significant increases in cortisol, heart rate, and psychological stress responses. The TSST-G provides a novel, effective, and economical protocol for experimental paradigms requiring simultaneous stress induction in multiple participants.

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## 1. Introduction

Human beings are fundamentally and pervasively motivated to form and maintain enduring positive interpersonal

interactions (Baumeister and Leary, 1995). Depending on the circumstances, social interactions can be a source of stress, contributing to a wide spectrum of somatic, psychosomatic, and psychiatric disorders with major public health significance, or buffer against stress (Ruberman et al., 1984; House et al., 1988; Kirschbaum et al., 1995; Uchino et al., 1996; Heinrichs et al., 2003).

There is substantial evidence indicating that exposure to psychosocial stress alters hypothalamic-pituitary-adrenal

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(HPA) axis function, which regulates the release of cortisol, an important hormone associated with psychological and physical health functioning (Chrousos, 2009). More specifically, a recent meta-analysis showed that motivated performance tasks combining elements of socio-evaluative threat and uncontrollability elicit robust and reliable psychological and biological stress responses (Dickerson and Kemeny, 2004). Socio-evaluative stress occurs when an aspect of the self could be negatively judged by others (Gruenewald et al., 2004). Uncontrollability refers to the inability of the individual to affect an outcome by a behavioral response (Thompson, 1981).

The Trier Social Stress Test (TSST; Kirschbaum et al., 1993) was developed for the induction of moderate psychosocial stress in a laboratory setting. As this stress paradigm combines uncontrollable and socio-evaluative elements in a highly standardized manner, it reliably leads to psychobiological stress responses (Dickerson and Kemeny, 2004), including 2–3-fold increases in HPA axis and cardiovascular stress responses. Due to large effect sizes and high reliability, the TSST has become a worldwide standard for psychological stress induction under controlled conditions. In brief, the original TSST protocol consists of a 5-min public speaking task (mock job interview) and a subsequent 5-min mental arithmetic task (serial subtraction) performed out loud in front of a panel of two unfamiliar evaluators and a conspicuous video camera. In addition to being used in studies on the deleterious effects of stress, the TSST has also been used as an experimental paradigm to investigate different stress buffering effects (e.g., social support, social attachment, physical contact, exercise, breast-feeding) (Heinrichs et al., 2001, 2003; Ditzen et al., 2007, 2008; Rimmele et al., 2007, 2009; Simeon et al., 2007; Storch et al., 2007; Robles et al., 2009). As the TSST is a single-subject method, the paradigm is unfortunately not applicable to experimental studies that require group testing, such as numerous study designs in social psychology, social neurosciences or behavioral economics. For economical experimental testing of relatively large groups of individuals and to avoid excessive expenses and infrastructures, a controlled simultaneous stress protocol for multiple individuals is required.

To date, there have been no experimental studies that directly address the development of a simultaneous group version of a psychosocial laboratory stressor in a randomized controlled study design. As a consequence, we undertook a controlled trial to develop and evaluate a new tool for standardized social stress exposure in a group format, which we hypothesized would significantly increase cortisol, heart rate, and subjective ratings. In addition, no or little changes of biological and psychological parameters were hypothesized in response to a specifically designed control condition containing all factors of the stress condition except for the psychosocially stressful components (i.e., socio-evaluative threat and uncontrollability).

## 2. Methods

### 2.1. Participants

Twenty-five healthy males with a mean age of 22.08 years ( $SD = 3.08$ ) participated in the study. All participants were recruited via an online database at the University of Zurich. Exclusion criteria were prior participation in a stress

experiment, studying psychology, medication intake, reported medical illness, symptoms of psychopathology, substance abuse or smoking more than 5 cigarettes per day. Five of the original 30 participants did not meet the eligibility criteria and were therefore excluded from statistical analyses: one participant who met criteria for a mental disorder based on the Brief Symptom Inventory (Derogatis and Melisaratos, 1983), one with a BMI of 38.6, and three participants who participated in only one experimental condition so that no repeated measures were available. The study was approved by the institutional review board of the University of Zurich. Before participation, all participants provided written informed consent and were informed of their right to discontinue participation at any time. All participants were naïve to the applied stress procedure; participants within one group were not familiar with each other and no participant was familiar with the investigators. After completion of the experiment, participants were debriefed and were paid 100 Swiss francs for their participation.

### 2.2. Procedure

Participants were asked to have a standard breakfast and lunch at the two days of participation and were instructed to abstain from food 2 h prior to the afternoon session as well as from caffeine, alcohol, exercise, and any medication 24 h before the experiment. Participants were told that they would undergo two different stress tasks and underwent the stress and control conditions, separated by a 1-week interval, in a randomized balanced within-subject design. The 2.5-h sessions took place between 17:15 h and 19:45 h in order to control for diurnal variations of cortisol secretion (Pruessner et al., 1997). As depicted in Fig. 1A, the procedure included a preparation period (50 min), the task (TSST-G or control condition, 30 min), and a resting and debriefing period (60 min). After providing informed consent, participants had to draw a number (from 1 to 6), were instructed not to communicate with each other to provide anonymity, and were then guided to room A. They were then introduced to the experiment, a heart rate device was applied individually and saliva collection was explained within the preparation period of 50 min in room A. During this time, first psychometric and physiological measures were taken (see Assessments). The preparation as well as the resting and debriefing period were identical in the two conditions. Psychosocial stress was induced by the Trier Social Stress Test for Groups (TSST-G), which is based on the single-subject version, referred to as the Trier Social Stress Test (TSST) (Kirschbaum et al., 1993). The TSST is a standardized psychosocial laboratory stressor consisting of a brief preparation period followed by a test period in which the subject is required to deliver a free speech concerning their suitability for employment in a mock job interview and to perform mental arithmetic in front of a panel of two evaluators (Foley and Kirschbaum, 2010).

*TSST-G protocol* – The TSST-G is a standardized motivated performance task protocol that combines high levels of socio-evaluative threat and uncontrollability in a group format. As depicted in Fig. 1A, the task consists of three phases: (i) an introduction, preparation, and anticipation phase of 10 min, (ii) a public speaking task (mock job

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