



Experimental manipulation of the Trier Social Stress Test-Modified (TSST-M) to vary arousal across development



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Summary Reliable laboratory protocols manipulating the intensity of biobehavioral arousal for children are uncommon, and those available have minimal converging evidence of their efficacy in manipulating arousal across multiple biological systems. This report presents two studies of the efficacy of the modified Trier Social Stress Test (TSST-M). In Study 1, sixty-three 7–15-year olds, and 19 young adults (18–25 yrs) completed the TSST-M. Comparable reactivity across age groups was observed for salivary cortisol, salivary alpha-amylase (sAA), pre-ejection period (PEP) and respiratory sinus arrhythmia (RSA), whereas self-reported stress was higher in adults compared to children. In Study 2, eighty-four 7–8-year olds and eighty-six 12–15-year olds were randomly assigned to a standard or low-stress TSST-M condition. Cortisol and self-reported stress responses were higher in the standard compared to the low-stress condition. In contrast, sAA and PEP were higher in the low-stress condition and RSA responses were comparable between the two TSST-M conditions. In addition, age group differences emerged in Study 2, though never in conjunction with the TSST-M manipulation. To test, refine, and advance theory about the implications of stress for child development, laboratory tasks that manipulate and enable assessment of biobehavioral arousal in children are needed.

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1. Introduction

Reliable laboratory stressor paradigms are essential tools for studies investigating neurobiological mechanisms linking stress reactivity with health outcomes (Chrousos and Gold, 1992). The Trier Social Stress Test (TSST; Kirschbaum et al., 1993) has become a gold standard, and variations thereof have evolved to systematically manipulate the degree of arousal (e.g., Dickerson and Kemeny, 2004; Het et al., 2009; Taylor et al., 2010; Wiemers et al., 2013). Research has not focused to the same extent on developing similar tasks for children. During childhood social forces establish and calibrate the set-points and thresholds of biobehavioral stress responses (Alkon et al., 2006), and individual differences in physiological reactivity have important implications for health and functioning (Miller et al., 2011; Shonkoff et al., 2009). In this study, we tested the utility of a laboratory stressor to induce arousal across multiple biological systems in children and adults, and evaluated whether arousal could be manipulated while maintaining the procedure's objective features.

A commonly used laboratory stressor for children is the TSST-C (Buske-Kirschbaum et al., 1997), which typically but not always (e.g., Dorn et al., 2003; Gunnar et al., 2009a; Martel et al., 1999) elicits significant cortisol reactivity. Variation in TSST-C reactivity could result from a less salient element of social-evaluative threat, an important determinant of hypothalamus–pituitary–adrenal (HPA) axis reactivity in adults (Dickerson and Kemeny, 2004). In the TSST-C children finish an exciting story whereas adults in the TSST deliver a mock job interview, which requires self-reflection and is more centrally related to self-identity. Thus, age differences in studies of stress reactivity could be the result of developmental changes in stress systems or of idiosyncratic and uncontrolled features of the different procedures. This also concerns studies of developmental transitions, including the pubertal transition during which considerations of being evaluated socially gain importance. To address this concern, we previously introduced a laboratory stressor based on the TSST which is identical for children and adults and includes a self-evaluative element for both (Quas et al., 2011; Yim et al., 2010b). This procedure needs further replication, across a wider age range and across multiple biological systems.

To draw causal links between stress reactivity and specific outcomes (e.g., emotion regulation, memory), it is imperative to have protocols that differ in their stressfulness but are otherwise comparable. In adults, TSST-like procedures that do not elicit substantive biobehavioral responses exist (Dickerson et al., 2008; Het et al., 2009; Taylor et al., 2010; Wiemers et al., 2013). In developmental studies, however, children often complete categorically different activities in low stress conditions, such as talking about a favorite book or playing a math-based game rather than a TSST-like procedure (Quesada et al., 2012). Differences in interest, effort, attention, or personal involvement between the two types of experiences may affect stress levels but also the specific outcomes of interest.

In the present studies, we tested the utility of the TSST-M at inducing arousal across multiple biological systems in 7–25-year olds (Study 1) and compared stress responses in

children and adolescents who completed the standard or a low stress version of the TSST-M (Study 2). We hypothesized that cortisol, autonomic (sAA, PEP, RSA) and self-reported stress responses to the standard TSST-M would be comparable across ages, and that responses would be attenuated in the low stress condition.

2. General methods

2.1. Participants

Recruitment for both studies was conducted concurrently by a marketing firm specializing in the solicitation of diverse community samples. Employees of the marketing firm contacted individuals, established eligibility, provided information about the study and scheduled the first study day. During the informed consent procedure a member of the research team confirmed eligibility, participants' interest in the study and answered questions. Individuals with chronic mental or physical health problems, who took medication (including oral contraceptives) known to affect HPA axis or autonomic reactivity, smoked or reported anxiety of public speaking or math were excluded.

2.2. Procedure

All procedures were approved by the Institutional Review Board of the University of California, Irvine. Sessions were scheduled between 1300h and 1600h to minimize the effects of circadian variations in cortisol and salivary α -amylase (sAA).

Parents and adults provided written consent and children written assent. After a 10-min rest, electrocardiograph leads were placed on the participants' right clavicle, right lower abdomen, left rib, left lower abdomen (ground), suprasternal notch, xiphoid process, hairline, and lumbar vertebra. A 3-min adjustment period ensued, during which participants sat and relaxed. This was followed by a 3-min pre-task baseline assessment during which participants stood and engaged in a casual conversation with a female research assistant, matching the body position (standing) and behavior (speaking) during the TSST-M, to control for the effects of psychomotor activity on physiological reactivity (Bush et al., 2011). A saliva sample (–2 min) was collected, and participants were escorted to a separate room to complete the TSST-M, which is described in detail in the specific methods sections.

After the TSST-M, a second saliva sample was collected (+1 min), and participants completed a 3-min post-task autonomic assessment (again standing and speaking). Participants then returned to the waiting room where saliva samples were collected at +10, 20, 30, 45, 60 and 75 min. During this time, participants completed questionnaires about their reaction to the TSST-M, demographics, recent behaviors (e.g., sleep and food) and general health (e.g., medications; in children, puberty onset). Parents completed questionnaires for topics about which children may not know (e.g., household income). At the end of the session, participants were thanked, debriefed and paid a modest monetary incentive.

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