Measuring stress reactivity in the home: Preliminary findings from a version of the Trier Social Stress Test (TSST-H) appropriate for field-based research

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Abstract

Stress induction paradigms are essential tools for studies investigating psychobiological mechanisms linking stress reactivity with mental and physical health outcomes, especially among youth growing up in high-stress contexts such as poverty. However, standardized stress paradigms aimed at measuring stress reactivity are limited to laboratory settings and have mostly been conducted in small samples of convenience. The aim of the current study is to present a version of the Trier Social Stress Test (TSST) adapted for administration in participants' homes appropriate for administration in large-scale, population-based samples. We address issues related to the feasibility of administration and present preliminary evidence of the validity of the home-based TSST (TSST-H) in a subsample ($n = 100$) of adolescents (12-13 years) participating in the Family Life Project ($N = 1,292$). Measures of stress physiology included salivary cortisol, alpha amylase, and blood pressure, assessed at baseline, 5 minutes post, 20 minutes post, and 40 minutes post task. Importantly, administration of the TSST-H procedure was successful among 93% of our sample after accounting for participant refusals and significant distractions in the home. We also found preliminary evidence that the TSST-H elicited an autonomic response, reflected by statistically significant increases in salivary alpha amylase and diastolic blood pressure post-task. Our initial assessment indicates that the TSST-H can be effectively implemented in field-based settings with hard to reach populations.

Keywords: TSST, stress paradigm, poverty, adolescence, stress reactivity, psychobiology

Introduction

The Trier Social Stress Test (TSST; Kirschbaum et al., 1993) is a widely used protocol designed to induce social evaluative threat that has been shown to provoke a physiological stress response in adults (Allen, Kennedy, Cryan, Dinan, & Clarke 2014) and children (Yim, Quas, Rush, Granger, & Skoluda, 2015). Prior administration of the TSST has been limited to small convenience samples in laboratory settings. This limits the extent to which prior findings generalize to hard-to-reach populations such as youth in poverty, who, because of social and economic barriers, are less likely to participate in laboratory-based research and are underrepresented in the stress biology literature (Evans, Vermeulen, Barash, Lefkowitz, & Hutt, 2009). Because the effects of poverty on health are thought to be driven, in part, through modulation of multiple physiological stress response systems (McEwen & Gianaros, 2011), measurement of these systems among this population is a major goal of developmental science. To date, no field-based adaptation of the TSST exists. Thus, the goal of this study is to present a model for administering a TSST paradigm in the home setting among adolescents living in predominately low-income and nonurban communities.

Although the benefits to ecological validity from a field-based stress induction procedure such as a home-based TSST are substantial, there are important trade-offs and limitations that must be considered. For example, laboratory-based TSSTs are characterized by a “9-to-5” workday schedule (controlling for circadian rhythms). Additionally, unlike the home environment, which can be prone to unique distractions and challenges (e.g., proximity of caregivers, siblings and overcrowding), the laboratory offers the advantage of consistent administration of the protocol in the same environment for each participant, capitalizing on the unfamiliarity of this setting. Laboratory visits, however, can be logistically difficult for many

families, particularly families in poverty. Furthermore, travelling to the laboratory can itself be stressful and may decrease the likelihood of obtaining a ‘true’ baseline measurement of stress responsive systems (Tolp & Dougherty, 2014). Instead of inviting participants to the lab, some researchers have tackled this empirical challenge by bringing mobile labs (set up in specialized vehicles) to participants’ homes and schools (D’angiulli et al., 2012). A second, less costly alternative is to set up and carry out standardized protocols in children’s homes, which may allow higher rates of participation among resource-strapped families and may also offer a more realistic representation of a child’s stress response (Blair et al., 2008, 2013; Badanes, Watamura, Hankin, 2011). In sum, the potential benefits to the ecological validity of the data collected in a field-based protocol for measuring stress reactivity among population-based samples must be considered in relation to several notable limitations of such a protocol.

The current study addresses the feasibility and preliminary validity of a home-based TSST procedure (TSST-H) and its capacity to induce physiological arousal across multiple biological systems (through repeated measures of salivary cortisol, alpha amylase, and blood pressure) in a small subsample of adolescents ($n = 100$; Mean age = 12.75 years old) participating in a larger study ($N = 1,292$). The TSST-H combines and adapts Yim et al. 2010’s modified child TSST procedure and Cheetham and Turner-Cobb’s (2016) peer sham panel. In this analysis we primarily aim to establish the rate at which administration of the TSST-H protocol was successful, defined as the rate at which the TSST-H was fully completed without incident. Secondarily, we provide a preliminary analysis of physiological data to determine whether successful implementation is accompanied by physiological reactivity. In short, we expected to demonstrate the feasibility of administering the TSST-H and hypothesized that

participants would manifest patterns of initial stress reactivity to the TSST-H protocol as well as subsequent down-regulation in the 40 minutes post-task administration.

Method

Participants

The Family Life Project (FLP) was designed to study families in two of the four major geographical regions of the United States with high poverty rates (Dill, 1999). Three counties in eastern North Carolina (NC) and three counties in central Pennsylvania (PA) were selected to be indicative of the Rural South and Appalachia, respectively. The FLP adopted a developmental epidemiological design in which sampling procedures were employed to recruit a representative sample of 1,292 children whose families resided in one of the six counties at the time of the child's birth. Families were oversampled for low-income in both states and African American families were oversampled in NC (African American families were not oversampled in PA because African Americans made up <5% of the population of the target communities). For a comprehensive description of the sampling plan and recruitment procedures, see Vernon-Feagans, Cox, and The Family Life Project Key Investigators (2013).

In this manuscript, we analyzed data from the first subset ($n = 100$) of adolescents (Mean age = 12.75, SD = 0.10) seen at the most recent wave of data collection. Of the youth in this subsample, 54% are female and 50% reside in PA. Approximately 60% of the youth are Caucasian and 40% are African American.

Procedure

All procedures for the Family Life Project were approved by the Institutional Review Boards of (masked for peer review; #FY2017-1185), (masked for peer review; #16-1189), and (masked for peer review; #16-1189). Primary caregivers provided written consent and

adolescents provided written assent. The majority of home visits took place in the late afternoons and evenings in order to accommodate families' work and school schedules.

As a component of the larger study's 2-3 hour assessment protocol, youth participated in the TSST-H designed to elicit physiological reactivity in the home. Given the diversity of participants' home environments, every step was taken to ensure the highest possible level of standardization of protocol administration. Experimenters were trained to evaluate each home upon entry and find a location to conduct the visit in a room that was open, but limited to distractions. This tended to be the kitchen/dining area and therefore the majority of TSST-H administrations took place there. Experimenters conducted the entire home visit in the same order each time while adhering to a strict use of time-stamping specific portions of the task, and were required to read all instructions for the TSST-H verbatim. Experimenters also maintained a neutral expression throughout the duration of the task. Additionally, in order to ensure that participants received the same affective response to the task, experimenters presented a specified pre-recorded sham panel (described in more detail below). Unique distractions of the home environment (e.g., family members watching child, loud noises, brief interruptions) were recorded in post-visit incident reports. Project staff implemented monthly home visit observations to ensure protocol fidelity across both data collection sites.

Upon entering the home, an experimenter asked the primary caregiver if they could work with the child in the kitchen/eating area while the second experimenter worked with the primary caregiver in the living room, which was typically a separate room at least 15 feet away and out of sight from the child. For rooms that did not have table/counter space, experimenters used a folding table so that the sham panel was always presented on a table approximately three feet away from the participant. During the first 10-15 minutes of the visit the experimenter unpacked

study materials and talked to the participant to make them feel more comfortable before collecting baseline measurements. Participants were then instructed to put on a heart monitor for the analysis of respiratory sinus arrhythmia (RSA). Heart rate was recorded continuous throughout the TSST-H procedure. Because of a large amount of missing heart rate data in this first subsample of 100 cases (51% due to a technical malfunction and shipping delays on the new device), we do not report on RSA findings in the current manuscript nor do we discuss its measurement further.

Experimenters entered a time stamp at the beginning of four time points of interest (baseline, speech, math, and post-math) that were generated automatically in five minute epochs by the data entry software, Blaise (Westat, Rockville, MD). Saliva and blood pressure measurements were taken alongside heart rate according to a fixed schedule outlined below. Approximately 15 minutes after the researcher had been in the home, participants engaged in a 5-minute baseline condition during which heart rate was collected. Participants were provided with a book, *National Geographic Kids Why: Over 1,111 Answers to Everything* (Boyer, 2015). This book was chosen due to its neutral yet engaging nature, which included pictures and text about interesting scientific concepts. In piloting, participants reported that reading this book was a relaxing activity. Immediately following the collection of baseline heart rate, the first blood pressure and saliva sample were taken (time = 0). Participants then responded to a series of questions concerning general health and current medications.

Saliva, blood pressure, and a five-minute post heart rate measurement (again, while reading the National Geographic book) were taken immediately following the TSST-H (time = 1). Following this, participants were debriefed during which they were told about the deception. Saliva and blood pressure were subsequently taken again at 20 (time = 2) and 40 min post task

(time = 3) while participants completed a series of other tasks in the home visit. All saliva samples were also time stamped in Blaise at the time of collection, which were used to control for time of day and to model duration of time between samples.

Measures

Stress paradigm: home-based TSST (TSST-H). Based on Yim et al. 2010's modified TSST and the sham panel protocol in Cheetham and Turner-Cobb (2016), the TSST-H involves a three-minute preparation period, followed by a five-minute speech task and a five-minute math task in front of a sham panel failing to elicit positive feedback. Experimenters administering the protocol were trained to maintain a neutral expression throughout the procedure and to stop the TSST-H if the participant became distressed (i.e. crying).

The sham panel (comprised of older teens) was displayed via video to each participant during the speech task. While the sham panel in the TSST-H appeared to be live, it was actually comprised of a pre-recorded video (10 minutes in duration). To increase the believability of the experimenter's "live videoconferencing" claim, the first 30 seconds of the video includes a pre-recorded loading screen from New York University's Blue Jeans conferencing system. In this pre-recorded video, two adolescents (ages 14-16) were shown sitting at a table dressed in white laboratory coats while feigning signs of disinterest and boredom (i.e., yawning, playing with mobile a phone, and taking notes occasionally). Participants were matched with specific sham panels based on race and gender in order to reduce confounds related to social identity and group membership (Frisch et al., 2015). Each video contained two adolescents of the same gender but at least one of the adolescent panelists was the same race as the participant (e.g., African American girl participants were shown a video with an African American girl and a Caucasian

girl). Videos were presented approximately three feet away from the participant via laptop that contained a built-in webcam.

The speech portion of the task required participants to give a five-minute speech as if they were introducing themselves to new classmates at school. To ensure standardization of administration, experimenters read instructions verbatim telling participants that the goal of the speech was to convince the class that they would be a good student while mentioning at least one good thing and one bad thing about themselves. They were also told that their speeches would be recorded via a video camera placed in the room (separate from the laptop webcam) for experts to analyze later. Before beginning their speech, participants were given three minutes to prepare by taking notes using a pen and paper but were told they were not allowed to use their notes during their speech. While the participant prepared, the experimenter pulled up the participant-matched sham panel video file and then pretended to greet the panel. This was done with the laptop facing away from the participant. When the three minutes were up, indicating the end of the preparation phase, the experimenter instructed the participant to put his/her notes down and to stand up (approximately three feet away) facing the experimenter and the laptop. The experimenter then turned the laptop around to display the sham panel and asked the participant to begin their speech. During the speech, if the child paused for longer than 20 seconds, the experimenter used a standard set of questions in 30-second intervals to encourage the participant to continue for the five minutes. If the participant spoke for four minutes without pausing, the experimenter interrupted the participant and asked the same set of question prompts.

The five-minute math challenge (serial subtraction) began immediately following the speech. Based on reports of severe stress and in some cases extreme distress among pilot participants, the sham panel was not presented during the math task. Participants were asked to

count down from the number 1,027 in multiples of five. If the participant made an error, they were asked to start from the beginning. If the participant made three or more errors within the first minute, the experimenter continued with an easier level (e.g., participant is instructed to subtract 3's from 200). If the participant made no errors in the first minute, they were given a harder level (subtracting 6's from 1,000).

Following completion of the math task, saliva and BP measurements were collected followed by a post-task five-minute heart rate measure. Participants were then debriefed and asked a brief questionnaire assessing levels of subjective stress for the speech and math tasks and whether or not they believed the panel was actually calling in "live" or not. Saliva and BP were then collected again 20- and 40- min post.

Post-visit incident report. At the end of the home visit, experimenters filled out electronic incident reports indicating codes reflecting special circumstances that may affect data quality. Experimenters were also able to write comments to further describe unique characteristics of the home environment that interfered with TSST-H administration. In addition to narrative comments, experimenters coded reasons for missing data, including: 1 = primary caregiver refused, 2 = secondary caregiver refused, 3 = both caregivers refused, 4 = equipment malfunction, 5 = equipment/supplies missing, 6 = other (insert reason/unique distraction), 7 = child refused, 8 = visit done over the phone, 9 = child became too distressed. Codes and additional experimenter comments were used to determine whether or not to include the data in analyses.

Salivary alpha amylase. Saliva samples were collected via passive drool. After collection, samples were immediately placed on ice, then stored frozen (-20°C) until shipped on dry-ice. Samples were then stored frozen at -80 °C until assayed. Following Granger et al.

(2007), saliva samples were assayed for salivary alpha-amylase (10% in duplicate) using a commercially available assay kit for the kinetic measurement of sAA activity (Salimetrics, Carlsbad, CA). The assay utilizes a chromogenic substrate, 2-chloro-p-nitrophenol linked to maltotriose. The enzymatic action of sAA on this substrate yields 2-chloro-p-nitrophenol, which can be spectrophotometrically measured at 405 nm using a standard laboratory plate reader. The amount of sAA activity present in the sample is directly proportional to the increase over a 2 min period in absorbance at 405 nm. Coefficient of variation is less than 10 % for both intra- and inter-assay. Raw sAA levels were subjected to square root transformation to correct positive skew and outliers +/- 3 standard deviations from the mean were removed.

Salivary cortisol. Saliva samples were assayed for cortisol in duplicate using ELISA technology using a highly sensitive enzyme immunoassay (Salimetrics, Carlsbad, CA). The test uses 25 µL of saliva per determination, has a lower limit of sensitivity of 0.007 µg/dL, standard curve range from 0.012 µg/dL to 3.0 µg/dL, an average intra-assay coefficient of variation of less than 10 percent and an average inter-assay coefficient of variation less than 15 percent. Raw cortisol levels were subjected to natural log transformation to correct positive skew and outliers +/- 3 standard deviations from the mean were removed.

Blood pressure. Systolic and diastolic blood pressure (SBP and DBP, respectively) were collected using the Omron 10-series device (Omron Healthcare, Vernon Hills, IL). Each measurement was collected using a fitted arm cuff with participants in a seated position.

Missing data

Seven cases were removed due to participant refusal and improper administration of the TSST-H (see post-visit incident reports and preliminary feasibility in Results section). Of the remaining 93 cases, 85 cases had valid blood pressure data (defined as having values within the

CDC reference values for the 5th and 95th percentiles) at all time points. 92 cases had valid cortisol data. Of those, 10 individual cortisol samples (2.7%) were determined to be outliers (± 3 SDs) and were set to missing. For sAA, 87 had valid cases at baseline and 40 min post, 90 at post-math, and 89 at 20 min post. No outliers (± 3 SDs) were detected for sAA. Thus, the analysis sample included 90 cases with valid sAA data, 92 cases with valid cortisol data, 85 cases with complete SBP data, and 85 cases with complete DBP data.

Statistical analysis

For the analysis of cortisol, sAA, and BP, we generated multilevel models using Mplus 8 software (Muthén & Muthén, 1998-2012). Each model included robust standard errors to predict the intercept and slope of the four physiological measures across the TSST-H. Model-building strategies included Satorra-Bentler scaled chi-square difference tests (Satorra & Bentler, 2001) to compare the fit of nested models. The data for this analysis were unbalanced and not time-structured (Singer & Willett, 2003). Time was centered at the first time point so that intercepts represented levels of cortisol, sAA, or mean BP at baseline (time = 0).

Based on results from Satorra-Bentler scaled chi-square difference tests, we included fixed linear and quadratic mean trends in order to investigate the hypothesis that there would be average reactivity and down-regulation of cortisol, sAA, and BP to the stress task. We included random intercepts and random linear slopes to model individual differences in baseline levels and reactivity. In building each model, we simultaneously entered all predictors (participant age, gender, state of residence, race, and time of day) and also included linear trends for each predictor except time of day as well as quadratic trends for each predictor except time of day. We subsequently removed non-significant quadratic effects followed by non-significant linear effects for the final models.

Results

Post-visit incident reports and preliminary feasibility

Out of the first 100 participants, 97 completed the full TSST-H protocol. Three youth refused to participate in the TSST-H. Of the 97 complete administrations, four were determined to have been improperly administered. Of these, two participants had family members sitting at the same table as the child while the experimenter was administering the TSST-H, one had a large number of friends and family watching the child, and one administration failed because the experimenter reported that the child was too confused to complete the task without significant help from the experimenter. One participant was reported to experience significant distress (i.e. almost crying), but the experimenter was able to complete the entirety of the task and therefore this case was kept in the analyses. In sum, administration of the TSST-H procedure was successful among 93% of the sample after accounting for participant refusals and significant distractions in the home.

Alpha amylase responses

Table 1 displays the two-level mixed model predicting salivary alpha amylase across the TSST-H and figure 1 displays the average sAA response among youth in the sample. On average, youth mounted a stress response that was characterized by sAA increase from baseline to post-math and with a moderate decrease in sAA at the 20 and 40 minute post time points (linear slope $B = 2.39$, $SE = 0.59$, $p < 0.001$; quadratic slope $B = -1.41$, $SE = 0.46$, $p < 0.01$). Consistent with prior literature (Nater al., 2007), time of day of saliva collection was positively associated with sAA indicating that youth seen at later times in the day had higher initial levels of sAA. No other covariates were associated with intercept or linear or quadratic slope effects on sAA across the TSST-H.

Cortisol responses

Table 2 displays the two-level mixed model predicting salivary cortisol across the TSST-H and figure 2 displays the average cortisol response among youth in the sample. In this subsample, salivary cortisol declined, on average, across the TSST-H (linear slope $B = -0.31$, $SE = 0.15$, $p < 0.05$). In contrast to the response pattern of sAA, the modal response pattern of cortisol was not characterized by reactivity to the TSST-H. However, approximately 19% participants exhibited a cortisol increase of 10% or greater 20 minutes post-task. Female gender was associated with the intercept at trend-level significance ($B = 0.23$, $SE = 0.12$, $p = 0.07$), indicating preliminarily that females had higher cortisol levels at baseline than males. Consistent with this, females exhibited a steeper negative slope than males in cortisol across the TSST-H ($B = -0.22$, $SE = 0.105$, $p < 0.05$). Time of day of saliva collection was negatively associated with cortisol indicating that youth seen at later times in the day had lower initial levels of cortisol. No other covariates were associated with intercept or linear or quadratic slope effects on cortisol across the TSST-H.

Systolic and diastolic blood pressure responses

Separate two-level mixed models predicting systolic BP (SBP) and diastolic BP (DBP) suggested no linear or quadratic change in BP across all four time points (SBP: linear slope $B = 0.53$, $SE = 3.34$, $p = 0.88$; quadratic slope $B = -.75$, $SE = 2.79$, $p = 0.80$; DBP: linear slope $B = 0.64$, $SE = 3.36$, $p = 0.85$; quadratic slope $B = 0.00$, $SE = 2.48$, $p = 1.00$). On average, participants reacted from post 20 min to 40 min post TSST-H suggesting that other aspects (e.g., other neurocognitive tasks administered at approximately 40 min post) of the data collection protocol may have activated BP at that time. Rerunning mixed models of SBP and DBP including only the first three time points provided indicated linear and quadratic effects, some of

which were statistically significant at the $p \leq .05$ level, and some of which attained trend levels of significance ($p \leq .10$) (SBP: linear slope $B = 7.78$, $SE = 4.98$, $p = .12$; quadratic slope $B = -10.71$, $SE = 5.41$, $p = .05$; DBP: linear slope $B = 10.58$, $SE = 5.07$, $p = .04$; quadratic slope $B = -9.72$, $SE = 5.26$, $p = 0.07$).

Tables 4 and 5 display the two-level mixed models predicting SBP and DBP, respectively. Figures 4 and 5 displays the average SBP and DBP response among youth in the sample. For SBP, gender was negatively associated with SBP indicating that females had significantly lower levels of SBP. Race was positively associated with SBP such that African American youth exhibited significantly higher levels of SBP. No other covariates were associated with intercept or linear or quadratic slope effects on SBP and DBP across the TSST-H.

Discussion

The goal of the present study was to present a preliminary examination of the feasibility and validity of a home-based version of the TSST for 12-13 year-old youth living in predominately low-income and nonurban communities. Importantly, administration of the TSST-H procedure was successful among 93% of our sample. Administration was unsuccessful in only 7% of cases (due to participant refusal and administration errors and/or significant distractions in the home environment). The results from this study suggest that the TSST-H can be feasibly administered in the home and that physiological data can be collected with high rates of completeness. These preliminary findings support the application of the TSST-H for use with at-risk youth in the home environment.

To accomplish our primary goal of developing a version of the TSST appropriate for administration in the home, we combined aspects of two recent TSST adaptations that have been

successful at inducing a stress response among youth aged 7-15 years old. The first, the TSST-Modified (TSST-M; Yim, Quas, Cahill, & Hayakawa, 2010; Yim, Quas, Rush, Granger, & Skoluda, 2015), closely follows the adult version of the TSST. In this version, children are asked to give a speech as if they are introducing themselves to a new class, which is immediately followed by serial subtraction task. This is all done with an adult panel providing neutral feedback. The use of the adult panel, however, has been argued to limit the validity of the social evaluative threat component of the procedure for adolescents (Cheetham & Turner-Cobb, 2016), due to the importance of peer relations at this age (Flanagan, Erath, & Bierman, 2008). To address this concern, the Bath Experimental Stress Test for Children (BEST-C; Cheetham & Turner-Cobb 2016) used a pre-recorded child sham panel delivered via a sham live video projected on to a large screen. The current study combined these approaches, adopting the TSST-M procedure with a slightly adapted version of the BEST-C sham live video (i.e. TSST-H panel were deemed “teen researchers” and were presented on a laptop matched by participant gender and race) for use in the home.

Preliminary analysis on the physiological data collected alongside the task indicates that the TSST-H evoked physiological arousal across a range of neurobiological systems. Overall, the TSST-H elicited a stress response in the sympathetic branch of the autonomic nervous system, reflected by linear increase followed by decrease (significant linear and quadratic change) in salivary alpha amylase, linear increase in diastolic blood pressure, and significant quadratic change in systolic blood pressure. Interestingly, participants in this subsample exhibited a linear decrease in cortisol rather than increase from baseline. Despite this, approximately 19% of participants showed a cortisol increase of 10% or greater 20 minutes post-task. While modest cortisol increases in response to previous laboratory adaptations of the TSST appropriate for

children have been documented (e.g., Cheetham & Turner-Cobb, 2016; Gordis et al., 2006; Yim, Quas, Cahill, & Hayakawa, 2010), others have failed to yield evidence of reactivity in youth under the age of 13 years old (Dorn et al., 2003; Martel et al., 1999) with one study reporting decreases in cortisol among 11 year olds but not 13 year olds (Gunnar, Wewerka, Frenn, Long, & Griggs, 2009). The absence of a cortisol increase within this preliminary sample may be due to the familiarity of the home environment, anticipatory anxiety triggered when children were first introduced to the task that lessened once the TSST-H protocol was underway, or may indicate a blunted response to stress. Comprehensive analysis of data from administration of the TSST-H with the full FLP sample ($N = 1,292$) will be necessary before any definitive conclusions about the potential of the protocol to elicit a physiological response across the multiple systems being examined. However, for the purposes of this analysis, the findings reported here suggest promising evidence of the preliminary validity of the TSST-H.

While our analysis indicates that the TSST-H can be successfully implemented in the home with adolescent participants, we acknowledge important limitations and future directions. First, it is important to note that participants were asked whether or not they believed the sham panel was live, but this was included in the debrief questionnaire later in data collection and is thus not included in this analysis. Second, every step was taken to maintain a high level of standardization across administrations; however, there are many possible distractions and unique characteristics of the home environment that are out of the experimenters' control. Although this protocol accounts for many of these distractions via experimenter codes and comments on the incident reports, the unpredictability and variation in participants' homes may indirectly affect stress physiology and participant engagement with the task. Previous studies with the FLP have characterized some participants' homes as chaotic and oftentimes overcrowded which may play a

role in their stress response in the home environment (Vernon Feagans, Garrett-Peters, Willoughby, Mills-Koonce, & The Family Life Project Key Investigators, 2012; Raver, Blair, Garrett-Peters, & The Family Life Project Key Investigators, 2015). Having noted this, it is worth underscoring the aspects of the task that were standardized. This includes the location at which the task was administered (kitchen or dining area), order of the home visit protocol, proximity of caregiver, pre-recorded sham panel, and delivery of instructions (all read verbatim). Future analyses with the full FLP sample can help to identify aspects of the home environment that may be associated with physiological responses to this protocol. In addition, prior studies with youth this age have shown significant variability in children's stress responses when accounting for chronic stress and adversity (Cheetham & Turner-Cobb, 2016; Quas et al. 2014). Ongoing analyses with the full FLP sample will examine patterns of stress reactivity in relation to concurrent as well as prior poverty-related adversity.

Although challenging and perhaps limited in several respects, we believe that the advantages of acquiring ecologically valid data on stress reactivity among a population at risk for stress-related disease outweighs potential disadvantages associated with in-home data collection. Specifically, this preliminary look at the TSST-H with 12-13 year old children indicates that the field-based protocol can be feasibly implemented and induces a response across multiple physiological systems. As such, the TSST-H likely has important implications for better understanding associations among chronic stress, the stress response, and the development of stress-related disease in populations at high risk.

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Lay summary: A widely used laboratory stress task, the Trier Social Stress Test (TSST), was adapted for use in the home among a large sample of adolescents (ages 12-13) from primarily low-income families in the United States. Preliminary analysis on the first 100 participants revealed that successful implementation of the home version of the TSST (TSST-H) was accompanied by physiological reactivity. Despite limitations with in-home data collection, the TSST-H has implications for better understanding associations among chronic stress, the stress response, and the development of stress-related disease in populations at high risk.

Table 1. Two-level Model Predicting Salivary Alpha Amylase Across TSST-H

Predictors	Estimate	SE	Estimate/SE	<i>p</i>
Intercept	8.17	0.35	21.78	< 0.001
Time	2.39	0.59	4.04	< 0.001
Time X Time	-1.41	0.46	-3.06	0.003
Age	-2.92	4.06	-0.72	0.47
Female	0.11	0.79	0.14	0.89
State	1.89	1.25	1.51	0.13
Black	0.27	0.79	0.34	0.73
Time of day	0.43	0.13	3.41	0.001

Table 2. Two-level Model Predicting Salivary Cortisol Across TSST-H

Predictors	Estimate	SE	Estimate/SE	<i>p</i>
Intercept	-2.23	0.07	-33.57	< 0.001
Time	-0.31	0.15	-2.02	0.04
Time X Time	-0.12	0.10	-1.10	0.27
Age	0.23	0.82	0.29	0.78
Female	0.23	0.13	1.81	0.07
Female X Time	-0.27	0.11	-2.06	0.04
State	0.02	0.24	0.09	0.93
Black	-0.07	0.15	-0.44	0.66
Time of day	-0.09	0.02	-4.52	< 0.001

Table 3. Two-level Model Predicting Systolic BP Across TSST-H

Predictors	Estimate	SE	Estimate/SE	p
Intercept	102.24	1.19	85.89	<0.001
Time	7.78	4.98	1.56	0.12
Time X Time	-10.71	5.41	-1.98	0.05
Age	19.2	13.81	1.39	0.16
Female	-8.29	2.13	-3.99	<0.001
State	1.41	3.74	0.38	0.71
Black	5.88	2.72	2.16	0.03
Time of day	-0.058	0.38	-1.53	0.13

Table 4. Two-level Model Predicting Diastolic BP Across TSST-H

Predictors	Estimate	SE	Estimate/SE	p
Intercept	71.5	1.14	62.63	<0.001
Time	10.58	5.07	2.09	0.04
Time X Time	-9.72	5.26	-1.85	0.07
Age	8.46	13.48	0.63	0.53
Female	0.22	2.14	0.1	0.92
State	-0.85	3.46	-0.24	0.81
Black	4.21	2.69	1.58	0.12
Time of day	-0.08	0.358	-0.22	0.82

Figure 1. Alpha amylase (sAA) response across the TSST-H.

Figure 2. Cortisol response across the TSST-H.

Figure 3. Systolic blood pressure response across the TSST-H.

Figure 4. Diastolic blood pressure response across the TSST-H.