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EXPLORATORY STUDY

Behavioral and Biological Indicators of Risk and Well-Being in a Sample of South African Youth

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Abstract

Self report measures have been widely used in research to illustrate high rates of exposure to violence among youth in trauma-saturated regions, such as Cape Town, South Africa. To better understand the risk and resilience factors of youth who have been exposed to, witnessed, or directly experienced violence, the current study used a multi-method assessment in a naturalistic setting that included heart rate variability (an index of regulatory flexibility and cardiovascular health), a computerized risk-taking task, and self report measures. Youth (N = 83) from Cape Town, South Africa, participated in a psychobiological assessment. Findings suggest elevated age-adjusted heart rate variability compared to age related norms, which is indicative of overregulation of behavior and emotion. Additionally, youth, all of whom had witnessed or experienced violence at least once, demonstrated a low risk taking and reward seeking propensity. Low risk taking in the context of elevated heart rate variability may reflect youth's affective and behavioral inhibition, suggestive of stress among children who have an overgeneralized threat response. These results both demonstrate the feasibility of psychophysiological research in community youth settings, and counter the traditional narrative that there is an overarching lack of capacity to regulate and a high propensity to risk in violence-exposed youth.

Keywords Psychophysiology · Child violence exposure · Risk · Resilience · Multi-method · Psychosocial · South Africa

Abundant evidence links early violence exposure and adversity with poor outcomes for children and adolescents. Trauma, poverty, and other forms of adversity are related to a range of negative outcomes, including a negative sense of self (Finzi-Dottan & Karu, 2006); difficulties with attention (Bücker et al., 2012); elevated risk taking propensity (Bornovalova et al., 2008); and ongoing emotion regulation deficits (Marusak et al., 2015) in tandem with elevated physiological stress reactivity (Houtepen et al., 2016; McLaughlin et al., 2014). These developmental adaptations to adversity may occur when children are forced to organize around avoiding threat (Perry et al., 1995). Although initially adaptive, such developments may result in long-term negative outcomes, like disengagement with education (Morrow & Villodas, 2018), negative health outcomes (Dong et al., 2004), psychopathology (Briggs-Gowan et al., 2010), and premature risk of mortality (Felitti et al., 1998) that may further entrench individuals in suboptimal conditions. However, much of this research has been conducted within English speaking, Western cultures, whose context may differ in social, economic, educational, and health dimensions from locations throughout the globe also facing challenges associated with childhood adversity.

One such context is that of Cape Town, South Africa, where collective distress was evident during and continues as a legacy of the policy of apartheid, the institutionalized segregation of People of Color that lasted for four decades. Apartheid left a country-wide stain of economic discrimination, structural violence, and marginalization of the majority of South African people (Wessells, 2008). The political, social, and economic history of apartheid leaves South African children vulnerable to multiple stressors such as inadequate education, family care, and nutrition (Richter & Dawes, 2008). To this day, literature on South African youth demonstrates high rates of community violence exposure that contributes to children's psychological and physical health risks (Cluver et al., 2013; van der Merwe & Dawes, 2000).

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Among children who are exposed to violence, research demonstrates elevated risk taking behavior compared to their non-trauma-exposed peers (Maepa & Ntshalintshali, 2020). High propensity towards risk taking behavior is considered to be a risk factor for adverse psychological and physical health among youth (Norman et al., 2012). Positive self-esteem, by contrast, is documented to mitigate against the negative effects of stress on psychological health (Dumont & Provost, 1999), and as with satisfactory emotion-regulation capacity, is widely considered to be protective against the adverse effects of childhood trauma (Salami, 2010; Troy & Mauss, 2011). Although strong emotion-regulation is considered protective, children who are exposed to maltreatment are often found to exhibit emotional dysregulation (Hébert et al., 2018).

In the present study behavioral, physiological, and self report constructs of risk taking, stress, self-regulation, and self-esteem are used to examine known risk and resiliency factors among children. A danger-free behavioral task, predictive of real world risk taking behavior (Lejuez et al., 2003a, b) was used to measure risk taking propensity. Self-esteem was measured using an implicit behavioral task that assesses positive and negative self-concept. Self report measures were selected to examine participants' perceived stress and well-being as well as sensation seeking, which, if elevated, is associated with risk taking behaviors (Ortin et al., 2012).

Behavioral and self report measures were complemented with a short-term physiological measurement, heart rate variability (HRV). HRV is an index of parasympathetic cardiac influence, which provides an index of resilience and flexible coping in the context of stress (McCraty & Zayas, 2014), derived from the intervals of time between successive heart beats (Hill et al., 2017). Chronic stress is associated with lower HRV (Togo & Takahashi, 2009) and mental health challenges including anxiety (Friedman, 2007), depression (Larsen & Christenfeld, 2009) and posttraumatic stress disorder (Tan et al., 2011). Higher HRV is considered to be a proxy of psychophysiological well-being (Kemp & Quintana, 2013) and associated with emotion regulation (Quintana et al., 2013). However, growing literature shows that individuals from marginalized and systematically discriminated against groups (e.g. African Americans in the United States and women) often have higher HRV (Hill et al., 2015). Higher HRV in oppressed groups may be due to a frequent need to inhibit or suppress anger or other emotions in face of unequal treatment (Butler et al., 2006; Dorr et al., 2007).

Research has consistently evidenced high rates of witnessed and direct exposure to violence among children in Cape Town, South Africa (e.g. Ensink et al., 1997; van der Merwe & Dawes, 2000; Shields et al., 2009). The present study builds off of previous findings, and extends prior self report and interview data by triangulating self report measures, computer-based behavioral tasks, and a non-invasive short-term physiological measurement to better understand the risk and resilience factors among a sample of South African youth.

Study Context

The present paper is part of a multi-method evaluation of a youth surf therapy intervention in Cape Town, South Africa, conducted by Waves for Change as part of its quality assessment. Data presented was collected prior to surf therapy participation. Waves for Change's psychosocial, surf-based, mental health intervention aims to adapt surf instruction to facilitate youths' emotion regulation capabilities, coping strategies, positive life choices, and meaningful relationships. The program targets children aged 10 to 16 years old (i.e. participants), who are chronically exposed to stressful events and have no other access to mental health services. The intervention aims to strengthen self-regulation to promote mental health and reduce risk of psychiatric illness. Relationships are fostered between high-risk youth, caring adults (i.e. surf mentors), who often come from the same at-risk communities themselves, and new peer groups. Mentors, who lead and co-develop programming, support participants to strengthen emotion regulation through mindfulness stress reduction and emotion recognition skills, and pro-social behaviors.

Method

Participants

Data used in this study was collected in 2018 from 83 nine to thirteen year old ($M = 10.69$, $SD = .85$) children who resided in Hangberg ($n = 53$) and Khayelistsha ($n = 30$) townships[1] outside of Cape Town. The majority of participants ($n = 54$) were female. The Hangberg sample was about equally divided between female ($n = 28$) and male participants ($n = 25$), whereas the Khayelitsha sample consisted of mostly female participants ($n = 28$). Teachers and administrators from participants' schools identified children for surf therapy based on Waves for Change's criteria of the child showing

[1] Considered one of the most conspicuous vestiges of apartheid, townships were developed to identify 'non-White' neighborhoods. They were established in the peripheries of cities as part of the segregationist doctrine that aimed to minimize interactions between people of different skin colors (Jürgens et al., 2013). Residents of Hanberg are predominantly 'Coloured' and Afrikaans or English speaking and individuals from Khayelitsha are predominantly Black African and Xhosa speaking. There continues to be high rates of poverty, unemployment, and poor infrastructure, including inadequate education, health, and housing systems in townships (Govender & Killian, 2001).

evidence of poor emotional health or exposure to violence. Observations by school personnel that would indicate a child could be referred to Waves for Change include the child experiencing interpersonal trauma, little or no support structures, exhibiting behavioral aggression and reactivity, and evidence of recent change or deterioration in self-care.

Measures

Behavioral Tasks

Risk taking propensity was assessed using the *Balloon Analogue Risk Task for Youth* (BART-Y; Lejuez et al., 2007). During the BART-Y, participants inflate a computer-generated balloon to earn a prize. With each pump of the balloon, participants gain a point and at any time, prior to the balloon explosion, participants can stop pumping the balloon and transfer the points to a permanent prize meter. If the balloon is pumped and it explodes all of the points earned for that balloon are lost. There is a set number of balloons, and participants are presented with a new balloon after a prize transfer or balloon explosion. The current evaluation set the number of presented balloons at 15, rather than the typical 30 balloons due to time constraints produced by collecting data in a naturalistic environment. Prior research has found nearly identical results using the first 10 balloons compared to 30 balloons (Lejuez et al., 2003a, b). For each non-popped balloon, the number of pumps is recorded and averaged into the typical outcome variable, adjusted average pump count. Adjusted average pump count for the first trial block (10 balloons) and total number of balloon explosions were used as outcome variables, with high values suggestive of greater risk taking.

Self-esteem was measured with a seven-block *Implicit Association Test* (IAT; Greenwald et al., 1998). During the Self-Esteem IAT (Greenwald et al., 2002) participants are asked to categorize attributes associated with pleasant or unpleasant and attributes belonging to the categories of Self or Other. Performance is expected to be faster when highly associated concepts and attributes share the same response key. Given low levels of literacy and comfort using a computer keyboard, certain elements of the task were modified. Positive and negative attribute words were replaced with positive or negative emojis, or simple pictures. The two keys participants were instructed to press were color coded on the keyboard to minimize reaction time, unrelated to the measured construct. IAT summary D score, which includes practice and test trials, was used as the outcome variable, with positive values suggestive of positive associations with the self and negative values suggestive of negative associations with the self. Positive values, equated with positive self esteem, are considered psychologically protective (Dumont & Provost, 1999).

Two other behavioral tasks were piloted in the study, which yielded inconsistent results. The team decided to remove the tasks from the study protocol.

Self Report Measures

Exposure to violence was evaluated using the 25-item *Community Experiences Questionnaire* (CEQ; Schwartz & Proctor, 2000). On a scale from 1 (never) to 4 (lots of times), participants rated statements to indicate how often they had witnessed or directly experienced violence. The CEQ has subscales that assess exposure to violence through witnessing and direct victimization.

The *Perceived Stress Scale for Children* (PSS; White, 2014) was administered to assess participants' self reported stress during the past week on a scale of 0 (never) to 3 (a lot). Items on the scale are summed with the highest possible score being 39. The scale had a low level of consistency determined by Cronbach's alpha of .52. Scores ranged from 5 - 23, with an average score of 12.11 ($SD = 4.66$, $N = 81$). To our knowledge, internal reliability of the PSS-C has yet to be reported in other published manuscripts, limiting our ability to compare the present Cronbach's alpha value with other samples.

The *Brief Sensation Seeking Scale for Children* (BSSS-C; Jensen et al., 2011) was used to measure propensity toward risk taking and sensation seeking behaviors. Two sensation seeking items were eliminated due to lack of relevance and replaced by the items: "I would like to surf big waves even if there are sharks" and "I would like to surf at night." Items on the scale are averaged with the highest possible score being 4. Cronbach's alpha was .58., significantly lower than the internal validity ($a = .82$) found in Jensen et al. (2011) development paper. Participants' scores on the BSSS-C ranged from 1.50 - 4.07 with an average score of 2.82 ($SD = 0.55$, $N = 81$).

Physiological Assessment

Heart rate data were collected with the emWave ear sensor (Heartmath LLC, Boulder, Colorado), which uses plethysmography to obtain heart rate data at 370 samples per second. A two-minute resting baseline measurement was collected for each participant, kept brief to minimize program and participant burden and the likelihood of movement artifact. While the conventional short-term heart rate recording length is five minutes (Task Force of the European Society of Cardiology & The North American Society of Pacing & Electrophysiology 1996), researchers have demonstrated the feasibility of ultra-short-term recording periods from 60 seconds (Salahuddin et al., 2007) to 240 seconds (Baek et al., 2015) for certain HRV variables calculated from an RR interval series, including root mean square

successive difference (RMSSD, in milliseconds). Reliability of short term HRV recordings has also been documented in child populations (Seppälä et al., 2014). Two main spectral components are produced from short-term recordings: low frequency (LF, 0.04-0.15 Hz), and high frequency (HF, 0.15-0.4 Hz) bands. The HF band is supported in interpretation of the parasympathetic nervous system activity (Akselrod et al., 1981; Pomeranz et al., 1985) while the LF band reflects an interaction between the parasympathetic and sympathetic nervous systems (Houle & Billman, 1999). In the current study, participants were instructed to sit quietly and comfortably while breathing normally during data collection. HRV analyses were performed offline.

Data Collection

Self report questionnaires and behavioral task instructions were translated by multi-lingual Waves for Change staff from English into Xhosa and Afrikaans. Behavioral measures were modified to account for low reading and computer literacy. To address computer literacy, tablet keyboards were given color coded stickers on certain keys to indicate which keys the participants were instructed to press during behavioral tasks. Data was collected by select Waves for Change full-time staff and a subset Waves for Change surf mentors, (i.e. Peer Youth Researchers) who expressed interest in research. Data collectors were trained in-person in psychophysiological data collection by members of the New York City-based research team. Waves for Change staff and Peer Youth Researchers were trained on the background science and rationale of each measure, on rapport building and neutrality during data collection, and on the data collection protocol.

Procedure

Psychologists at The New School for Social Research with expertise in program evaluation were recruited to design and conduct a program evaluation for Waves for Change in order to understand the target population needs and program effects. Program evaluation does not require IRB approval given that the project aimed to assess quality assurance through systematic, data-guided activities implemented to improve practices and reveal effects of current program delivery at Waves for Change. The New School's IRB approval affirmed this understanding at the outset of the project. After findings appeared to be of larger interest, we consulted with The New School's IRB who determined that use of the present data were exempt from IRB approval as they were archival program evaluation data with no identifiers.

As part of the consent to participate in the Waves for Change surf-therapy, parents or guardians of the child participants provided consent to participate in assessment and evaluation. Youth participants' assent was verbally collected in English, Xhosa, or Afrikaans at the start of the evaluation session. During consent, participants were informed that they could discontinue the tasks at any time and that all of the information would be kept private, including from parents and teachers.

Data collection was conducted in participants' schools or in Waves for Change headquarters in small groups of ten participants. Participants completed the self report questionnaires as a group, spaced to ensure privacy. A research assistant read questions aloud in English, Xhosa, and or Afrikaans depending on participants' preferred language and participants answered questionnaires on paper surveys. Physiological data was collected by a research assistant using a Heartmath emWave ear-clip for a two minute baseline period. Participants, facilitated by a research assistant, completed the behavioral tasks on Windows 8 tablets using the Inquisit Lab 5 software.

Data Reduction and Analyses

HRV data reduction was completed by use of a distribution-based artifact-detection algorithm, which interpolated heartbeat outliers through the interbeat interval (IBI). Outliers were defined as a heart rate below 40 beats per minute and above 200 beats per minute (Fleming et al., 2011). The resulting heart period series were examined for artifacts visually and the IBI were then processed using Kubios HRV Standard (Kuopio, Finald). Any recording that upon visual inspection did not have normally distributed IBI series was not submitted to analyses.

Power spectral density of heart rate was analyzed using fast Fourier transformation according to published standards of high frequency (0.15-0.40 Hz) and low frequency (0.04-0.15 Hz) IBI bands (Camm, 1996). The current evaluation used RMSSD, and high frequency (HF ms^2) and low frequency (LF ms^2) heart rate as time domain and frequency domain indexes of parasympathetic nervous system activity (Berntson et al., 2005).

IBM SPSS Statistics Version 24 was used for all statistical analyses. Independent t-tests and analysis of variance were used to assess differences between participants according to location, gender, age, and other salient group memberships. Correlations were used to examine the strength and direction of linear relationships between variables.

Results

Exposure to Violence

All 83 participants had witnessed violence, and all but one had experienced violence directed at them. The amount of reported types of direct violence participants endorsed experiencing ranged from zero ($n = 1$) to nine ($n = 1$), with an

average of 3.75 types of violence directly experienced. The two most commonly endorsed direct violence experiences were being hit and having an object like a rock or bottle thrown at them. Of participants, over two thirds endorsed being hit at least once by an undisclosed person [$n = 45$] and having an object thrown at them at least once [$n = 44$]. Witnessed types of violence ranged from one ($n = 1$) to 14 ($n = 8$), with an average of 8.99 types of violence witnessed by participants. Most participants had heard gunshots at least once [$n = 58$], had witnessed someone be hit, punched, or slapped [$n = 58$], or had seen someone be arrested or taken away by the police [$n = 52$].

Participants' origin location was correlated with frequency of witnessed violence, $r = .28$, $p = .023$, with participants from Hangberg endorsing slightly higher frequency ($M = 2.38$, $SD = .66$) than those from Khayelitsha ($M = 2.01$, $SD = .62$). Gender was not related to either endorsed direct, $r = .06$, $p = .607$, or witnessed, $r = -.11$, $p = .389$, exposure to violence between male and female participants. Participant age was not correlated to exposure to direct violence, $r = .02$, $p = .85$, nor to witnessed violence, $r = .42$, $p = .73$.

Self Report

Because scale reliability for self report was lower than in prior studies, the validity of utilizing self report measures in this context is uncertain. Therefore, all findings related to self report measures (means as well as correlations with behavior and physiology) are reported in the Supplement.

Behavioral Measures

Risk-taking. Seventy-two participants completed the BART-Y. In the present study, BART-Y's adjusted average pump count for the first block (10 balloons) is strongly correlated with the adjusted average pump count for all fifteen balloons, $r = .97$, $p < .001$. Average adjusted pump count is 23.91 ($SD = 13.77$) and ranged from 2.67 - 67.33. Average total exploded balloons is 2.56 ($SD = 1.68$) and ranged from 0 - 7 explosions. The number of balloon explosions during the BART-Y was significantly correlated with adjusted average pump count, $r = .77$, $p < .000$. Participant age was correlated with adjusted average pump count, $r = .27$, $p = .02$, and total exploded balloons, $r = .29$, $p = .01$. Adjusted average pump is correlated with gender, $r = -.23$, $p = .049$, with female participants demonstrating greater risk taking propensity ($M = 23.32$, $SD = 11.57$) than male participants ($M = 18.37$, $SD = 11.57$). Significant differences in adjusted average pump count were observed depending on the participants' home townships, $t(70) = -2.21$, $p = .031$, 95% CI [-11.77, -.59]. Participants from Khayelitsha had significantly higher average adjusted pump count ($M = 28.45$, $SD = 14.68$) than those from Hangberg ($M = 21.35$, $SD = 12.68$), $t(70) = -2.15$, $p = .044$, 95% CI [-13.67, -.52]. Differences according to township were not present in the total exploded balloons count, $t(70) = -1.45$, $p = .15$, 95% CI [.42, -1.45].

Independent t-tests reveal participants from the current study had significantly lower risk taking propensity than Black (Mdiff = 11.29, $t(166) = 4.51$, $p < .001$) and White (Mdiff = 10.49, $t(204) = 5.56$, $p < .001$) American participants of a similar age reported by Collado et al. (2017). Adjusted average pump count in the first ten balloons was 35.2 ($SD = 17.4$) for Black youth and 34.4 ($SD = 12.3$) for White American youth (Collado et al., 2017).

Self-Esteem. Seventy-one participants completed the IAT and 65% made incorrect associations as per instructions 75% or more of the time. Given the high rates of incorrect responses, the data poses difficulty in interpretation. However, poor performance accuracy on the IAT does not appear to result from low motivation, determined by the lack of relationship between participants' correct responses and their task reaction time. Instead, IAT summary D score and IAT percent correct were significantly correlated, $r = .36$, $p = .002$. Participants with percent correct equal to or above 70% had significantly more positive IAT summary D scores ($M = .54$, $SD = .54$) than those whose correct percentage was below 70% ($M = .05$, $SD = .49$) (see Table 1 for these results).

Physiology

All 83 participants completed HRV measurements; 59 HRV files yielded normally distributed IBI and were included in analyses. Average resting heart rate ranging from 64 - 105 beats per minute ($M = 81.73$, $SD = 9.26$) was normally distributed among participants. Consistent with existing literature (Fleming et al., 2011), age and mean heart rate were correlated, $r = -.26$, $p = .045$. High frequency ($M = 0.25$, $SD = 0.07$) and low frequency hertz ($M = 0.11$, $SD = 0.03$) measures were both normally distributed.

RMSSD ranged from 41.06 - 233.23 ($M = 113.33$, $SD = 51.26$). For quartile ranges see Table 1. Leppänen et al. (2020) found mean RMSSD in a population-based sample of 6-8 year old children to be notably lower ($M = 67.40$, $SD = 40.2$) than that of the current study's population, $t(500) = 9.96$, $p < .001$. In the current sample, 80% of mean RMSSD falls above average RMSSD identified by Leppänen et al. (2020).

In the present study, male participants overall had significantly higher RMSSD ($M = 140.03$, $SD = 58.76$) than female participants ($M = 101.61$, $SD = 43.37$), $t(57) = -2.80$, $p = .017$, 95% CI [-65.87, -10.98]. Consistently, male participants evidenced notably higher HF (ms^2) ($M = 7526.89$, $SD = 6918.85$) than female participants ($M = 3868.49$, $SD = 3197.04$), $t(57) = -2.79$, $p = .007$, 95% CI [-6280.65, -1036.15] and significantly higher LF (ms^2) ($M = 2691.25$, $SD = 2399.07$) than females

Table 1 IAT Correlations Matrix

	IAT Percent Correct	IAT Time	IAT Summary
IAT Percent Correct			
Pearson Correlation	1	–.083	.357**
Sig. (2-tailed)		.493	.002
N	72	71	72
IAT Time			
Pearson Correlation	–.083	1	–.145
Sig. (2-tailed)	.493		.229
N	71	71	71
IAT Summary			
Pearson Correlation	.357**	–.145	1
Sig. (2-tailed)	.002	.229	
N	72	72	72

Bivariate correlations of time elapsed, percent correct, and summary score IAT variables among all participants

*$p < .05$; **$p < .001$

($M = 1660.68$, $SD = 1484.10$), $t(57) = -2.02$, $p = .048$, 95% CI [-2053.20, -7.94]. Such gender differences are consistent with other child samples (Semizel et al., 2008). RMSSD and HF (ms^2) values of both male and female participants' were notably higher than reported RMSSD and HF (ms^2) among comparably aged, healthy children who were not considered to be at-risk youth, as in the present study (Gąsior et al., 2015).

There was a significant relationship between township and HRV. Data reveal higher HRV among participants from Hangberg compared to participants from Khayelitsha, across LF (ms^2), $t(57) = 2.05$, $p = .045$, 95% CI [24.19, 1969.41], HF (ms^2), $t(57) = 2.04$, $p = .046$, 95% CI [46.35, 4560.52], and RMSSD, $t(57) = 2.21$, $p = .032$, 95% CI [2.57, 54.07] (Fig. 1).

Discussion

By implementing implicit behavioral, autonomic physiological, and self report measures, the present study builds upon existing literature to demonstrate the adverse impacts of violence exposure as well as to emphasize the resiliency among South African youth. To our knowledge, the present study is the only evaluation that has measured self-regulation with a physiological measure, HRV, and risk taking propensity using the behavioral measure, BART-Y, among violence-exposed South African youth in a naturalistic environment.

To contextualize the current data vis a vis adversity, we examined community violence exposure. Participants of the present evaluation endorsed very high rates of exposure to violence, with all of the children endorsing exposure to witnessed or experienced violence. This finding is consistent with other reports, including that by Ensink et al. (1997) who found that 95% of Xhosa speaking South African youths had been exposed to violence.

The physiological findings illustrate the biological toll of participants' exposure to violence. The parasympathetic nervous system, which activates the self-soothing process in response to sympathetic stress activation, was elevated among 80% of participants while no participant had underactive parasympathetic activity. Participants' high HRV reflects their psychophysiological adaptation to stress and adverse environments (Hill & Thayer, 2019). Elevated HRV suggests that participants' experience a heightened need to regulate emotional responses to injurious or overwhelming experiences (Hoggard et al., 2015). Although there were no significant differences between genders in exposure to violence, overall male participants showed higher resting parasympathetic activity than females, a finding that is consistent with existing child cardiac literature (Gąsior et al., 2015).

Along with heightened autonomic control, participants' performance on the BART-Y is suggestive of low risk taking. Participants' overall low risk-taking propensity is in contrast to a wide body of research showing elevated risk taking among South African youth (e.g. Eaton et al., 2003; Shilubane et al., 2013), among individuals who experienced childhood trauma (e.g. Roos et al., 2016), and among people who grew up with low socioeconomic status (Griskevicius et al., 2013).

While all participants endorsed exposure to violence, exhibited high autonomic control, and demonstrated low risk taking, children from Hangberg reported greater rates of witnessed violence, had significantly higher HRV, and evidenced lower risk taking propensity compared to children from Khayelitsha. Low risk taking and high HRV in the context of community violence may reflect participants' need to self-regulate (Hoggard et al., 2015) and avoid taking risks (Guyer et al., 2006) to protect themselves in the context of adversity.

The evaluation also offers an opportunity to examine methodological questions of measure relatedness in a context of multiple languages and other on-the-ground complexities (e.g. time constraints, malfunctioning technology) in a community-based environment. The disparity in self report, behavioral, and physiological data illustrates the benefits of implementing a wider range of assessment tools to generate a deeper understanding of individuals' risk and resilience factors. If only one method of assessment had been conducted, data on participants' well-being could have been misleading. Most notably, if the present study had relied solely on self report measures, data would suggest participants take risks and experience mild stress. The physiological and behavioral assessments, however, reveal youths' elevated stress and low risk taking tendencies in the context of community violence.

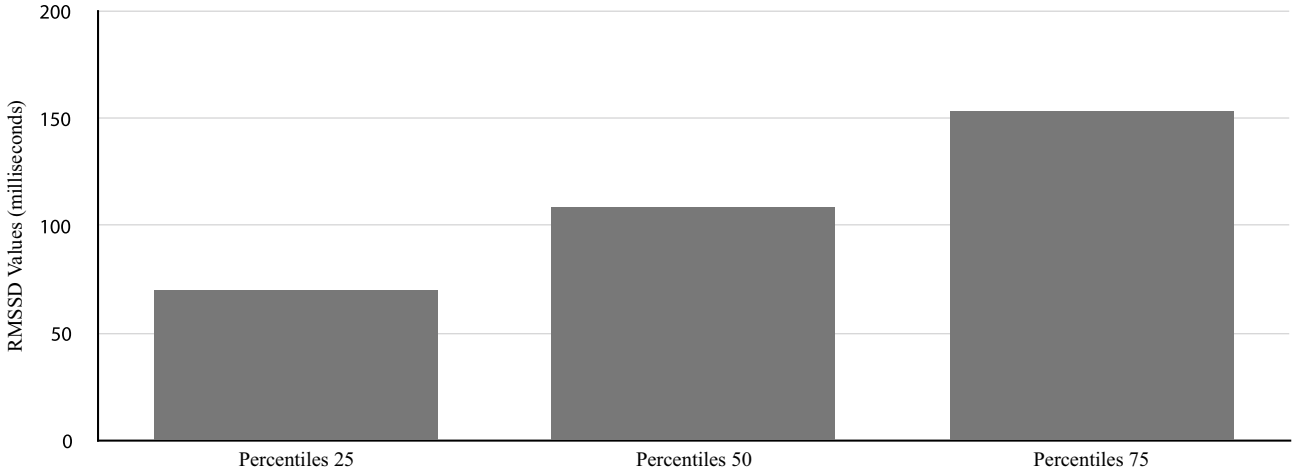

Fig. 1 RMSSD quartiles

Limitations

These data are limited for several reasons. Firstly, the current study had limited access to participants' demographic information including race, religion, family constellation, and socioeconomic status, which inhibited analyses related to salient identities. Secondly, the small sample size limits the analyses to better understand any psychophysiological differences according to salient participant identity and township of origin.

Additional task-related limitations arose due to technological malfunctions, which reduced the sample size for tasks like the BART-Y. Such complications speak to the need for ongoing conversation and procedural adaptation with the on-the-ground evaluation team. The Self-Esteem IAT, which on-the-ground researchers reported was confusing for participants, yielded unreliable data due to low accuracy rates and limited the interpretability of the task. Finally, the study relied on measures and related norms from other countries and contexts, which may have impacted cross-measure relatedness. Low internal reliability on the PSS (*stress*) and BSSS-C (*sensation seeking*) highlight the importance of administering tasks that are culturally relevant and suggest that the current questionnaires were not appropriate for South African youth.

Future Directions

Further research on risk taking propensity and HRV among South African youth may offer a deeper understanding into childrens' seeming overregulation in the face of stress. As more research incorporates measures like the BARTY and HRV, which participants were reported to have enjoyed according to on the ground researchers, there will be an opportunity to establish contextualized norms among South African youth. Contextualized norms will strengthen the interpretability of data collected from various communities of young people within South Africa. Such research may also help to clarify the study's preliminary finding that risk taking behavior differed according to participant township, which historically differ in racial and linguistic norms, and in the current sample, differed in exposure to violence and gender representation. Finally, the relationship between low self-esteem and poor accuracy on the task, which may be related to pronounced difficulty associating oneself positively, ought to be further assessed.

Conclusion

When data are examined in aggregate, a picture begins to be painted of violence exposed youth who may have adapted to present stressors through elevated parasympathetically mediated regulatory capacity and lower risk taking propensity. The results counter the traditional narrative that violence exposed youth lack emotional regulation skills and experience elevated risk taking. Instead, data highlight both the resilience and physiological adaptation to living under threat of violence among the current sample of youth who exhibit caution in the face of danger-free risk and physiological overcontrol in daily life. High emotion regulation and low risk taking may serve as protective factors that minimize further exposure to violence and maltreatment among participants.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40653-021-00426-1.

Declarations

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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