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Original article

## The Longitudinal Impact of Screen Time on Adolescent Development: Moderation by Respiratory Sinus Arrhythmia

Wesley Sanders, Ph.D.<sup>a,\*</sup>, Justin Parent, Ph.D.<sup>b</sup>, Jamie L. Abaied, Ph.D.<sup>a</sup>,  
 Rex Forehand, Ph.D.<sup>a</sup>, Sarah Coyne, Ph.D.<sup>c</sup>, and W. Justin Dyer, Ph.D.<sup>c</sup>

<sup>a</sup> Department of Psychological Science, University of Vermont, Burlington, Vermont

<sup>b</sup> Department of Psychology, Florida International University, Center for Children and Families, Modesto A. Maidique Campus, Miami, Florida

<sup>c</sup> School of Family Life, Brigham Young University, Provo, Utah

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### A B S T R A C T

**Purpose:** To date, little is known about underlying psychophysiological contributions to the impact of media content and overall screen time on adolescent psychological functioning. In the present study we examine respiratory sinus arrhythmia (RSA) as a moderator of the link between specific types of media content use, overall media exposure, and the development of internalizing and aggressive symptoms in youth.

**Methods:** A sample of 374 adolescents (mean age = 15) reported on their media use, internalizing behavior, and aggressive behavior at time 1 (2011) and 1-year follow-up (2012). RSA reactivity was gathered during a challenging laboratory task. Path analyses were conducted to test the hypothesized three-way interaction model between media use, media content, and RSA reactivity, separately for internalizing and aggressive problems.

**Results:** Significant interactions were found for aggressive, but not prosocial, media content. For aggressive content, youth exhibiting RSA withdrawal reported significantly greater internalizing and aggressive symptoms when exposed to higher amounts of screen time and aggressive content.

**Conclusions:** These findings suggest that profiles of heightened RSA withdrawal may place adolescents at greater risk to the negative impact of violent media, whereas prosocial media content may not significantly impact youth development of psychopathology. Implications for the role of psychophysiology in our understanding of media effects are discussed.

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### IMPLICATIONS AND CONTRIBUTION

This study identifies risk factors for media use and adolescent mental health based on underlying psychophysiology and exposure to media content. Findings suggest that adolescent psychophysiology may significantly affect the impact of problematic media use on adolescent mental health.

**Conflicts of interest:** The authors have no financial relationships or conflicts of interest relevant to this article to disclose.

**Disclaimer:** The views expressed in this article are those of the authors and do not necessarily represent the views of the Department of Veterans Affairs or the United States Government.

\* Address correspondence to: Wesley Sanders, Ph.D., National Center for PTSD, Women's Health Sciences Division, VA Boston Healthcare System, 150 S. Huntington Ave, Jamaica Plain, MA 02130.

E-mail addresses: [wesley.sanders@va.gov](mailto:wesley.sanders@va.gov), [wesley.sanders@uvm.edu](mailto:wesley.sanders@uvm.edu) (W. Sanders).

<sup>1</sup> Wesley Sanders is now at the Women's Health Science Division of the National Center for PTSD/VA Boston Healthcare System and the Department of Psychiatry at Boston University School of Medicine.

In only a few years, the use of mobile technology (e.g., smartphones, tablets, and e-readers) in the United States has changed dramatically. Total daily screen time, a metric of summed exposure to devices capable of displaying video content (e.g., smartphones, tablets, TVs) for children 8–18 years old, has nearly doubled since 1999 [1,2]. Screen time among adolescents is particularly high with recent reports suggesting that 97% of adolescents engage with media on a daily basis, averaging nearly 9 hours per day across all devices [1]. Increased exposure to media has been linked with a broad range of both beneficial and detrimental outcomes, depending upon the type of media content being examined [2,3]. For example, a robust literature suggests that excessive screen time exposure is

associated with increases in externalizing symptoms, particularly aggressive behavior [4,5], and recent evidence indicates that children may also suffer from increases in internalizing symptomatology, including depressive symptoms [6].

Past research has suggested that an individual's dispositional characteristics may impact his or her response to environmental influences, such that some children are much more sensitive than others to both harmful and beneficial contexts [7]. Youth who exhibit a sensitive profile may demonstrate the worst adjustment in negative environments but also superior adjustment in positive environments, a pattern of plasticity sometimes referred to as "for better and for worse" [8]. Given these nuanced findings, to examine independent contributions of youth characteristics and environments to youth development is likely insufficient. Rather, the incorporation of interactions with physiology is necessary to elucidate effects that would otherwise be obscured [9].

Researchers have explored a number of factors that may represent plasticity, including temperament, genetics, and psychophysiology [9]. In this study, we examined respiratory sinus arrhythmia (RSA) as an indicator of plasticity. According to Polyvagal theory, RSA is an indicator of the innervation of the vagus nerve, the 10th cranial nerve responsible for changes in heart rate in response to stress [10]. RSA reflects the amplitude of heart rate oscillations between inhaling and exhaling. RSA reactivity represents change in RSA from baseline to RSA measured during exposure to stress [11,12]. RSA reactivity has been conceptualized as an important mechanism by which the body physiologically allocates resources for self-regulation in times of stress [13,14]. RSA withdrawal reduces parasympathetic nervous system (PNS) activation, allowing for a potential increase in heart rate and subsequently more resources to devote to engaging in a challenging situation. Thus, a reduction of PNS activity, or a *withdrawal* of RSA, in response to stress allows for sympathetic nervous system activity to provide the body with resources to respond to a stressful situation, whereas increases of RSA in response to stress, or *RSA augmentation*, suggest an increase of PNS activity that deprives the body of physiological resources to manage challenge or distress [14,15]. We selected RSA reactivity as an indicator of plasticity given its relevance to psychosocial adjustment, our outcome of interest.

Although researchers have called for greater attention to psychophysiology to better understand media effects on psychosocial adjustment [16], few studies have addressed this gap in the literature. In one study, Coyne et al. [17] found that low RSA withdrawal (i.e., greater parasympathetic activation) was associated with more video game addiction symptoms in adolescents, a finding concordant with much of the literature suggesting patterns of parasympathetic activation in response to a stressor may be maladaptive [18]. To our knowledge, the present study is the first investigation of RSA reactivity as a moderator of the effects of media exposure on youth development.

The goal of the current study is to build upon prior research [19] and examine adolescent physiological stress response as a moderator of the association between exposure to media and psychosocial adjustment in adolescence. Further, we heed the call of previous researchers [20,21] by examining the role of both physically aggressive and prosocial media content as well as total screen time in order to better understand both potential positive and negative contributions of media to adolescents' adjustment behavior. By considering both adolescent physiological stress response and media content, we aim to better understand under what conditions and for whom excessive screen time in adolescence leads to detrimental outcomes. Using a multimodal, multi-informant,

longitudinal design, we tested whether the prospective association between screen time exposure and adolescent adjustment varied as a function of adolescents' RSA reactivity and media content (aggressive and prosocial content).

Given that RSA withdrawal reflects increased sensitivity to environmental stimuli, we hypothesized that adolescents displaying RSA withdrawal, but not augmentation, would exhibit heightened sensitivity to excessive screen time and that this would enhance the negative impact of aggressive media content, as well as the positive impact of prosocial media content. Specifically, we hypothesized that aggressive media content would predict *greater* internalizing and aggressive behavior symptoms at high levels of screen time among adolescents showing RSA withdrawal but not among adolescents showing RSA augmentation. Similarly, we hypothesized that prosocial media content would predict *fewer* internalizing and aggressive symptoms at higher screen time amounts among adolescents showing RSA withdrawal but not among adolescents showing RSA augmentation.

## Methods

### Participants

The participants for this study were taken from waves 5 (2011) and 6 (2012) of the Flourishing Families Project (FFP), a longitudinal study of inner-family life involving families with a child between the ages of 13 and 18 (N = 500). For the current study, families were included only if they participated in the physiological assessment at wave 5 (n = 374). The final sample of participants involved 181 boys and 193 girls (mean age 15.29; standard deviation [SD] 1.05; range 13–18). Sixty-five percent identified as white, 13% as African-American, and 22% as other or mixed race. Thirty percent were from single-parent homes and average combined monthly income (mother-reported) was ~\$5,500 (~\$66,000 yearly), but 21% of the sample reported making less than \$3,000 monthly.

### Procedure

Participant families for the FFP were selected from a large city in the Pacific Northwest and were interviewed during the first 8 months of 2007 at Wave 1. Families were primarily recruited using a purchased national telephone survey database (Polk Directories, InfoUSA, Papillion, NE). Families identified using the Polk Directories were randomly selected from targeted census tracts that mirrored the socioeconomic and racial stratification of reports of local school districts. All families with a child between the ages of 10 and 14 living within target census tracts were deemed eligible to participate in the FFP and no additional exclusionary criteria were utilized. Of the 692 eligible families contacted, 423 agreed to participate, resulting in a 61% response rate. However, the Polk Directory national database was generated using telephone, magazine, and internet subscription reports; so families of lower socioeconomic status were under-represented. Therefore, in an attempt to more closely mirror the demographics of the local area, a limited number of families was recruited into the study through other means (e.g., referrals, fliers; n = 77, 15%). By broadening the approach, the social-economic and ethnic diversity of the sample was increased. At each wave of data collection, interviewers visited the individual family's homes and conducted an assessment interview as well as questionnaires that were completed in the home. This study was approved by a University Institutional Review Board.

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