Biological Psychology 103 (2014) 242–247

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Oppositionality and sympathetic skin response in adolescents: Specific associations with the headstrong/hurtful dimension

Nanucha Teixeira da Silva[a,d,*], Pedro Schestatsky[a,b], Pablo Brea Winckler[c], Giovanni Abrahão Salum[a], Alana Wypyszynski Petroceli[d], Elizeth Paz da Silva Heldt[a,d]

[a] Postgraduate Program in Medical Sciences: Psychiatry, School of Medicine, Federal University of Rio Grande do Sul (UFRGS), 2400 Ramiro Barcelo Street, 90035-003 Porto Alegre, RS, Brazil
[b] Department of Internal Medicine, UFRGS, 2400 Ramiro Barcelo Street, 90035-003 Porto Alegre, RS, Brazil
[c] Postgraduate Program in Medical Sciences, School of Medicine, Federal University of Rio Grande do Sul (UFRGS), 2400 Ramiro Barcelo Street, 90035-003 Porto Alegre, RS, Brazil
[d] Research Group on Child and Adolescence Behavior (GECIA), Hospital de Clínicas de Porto Alegre, 2350 Ramiro Barcelos Street, 90035-903 Porto Alegre, RS, Brazil

ARTICLE INFO

Article history:
Received 7 January 2014
Accepted 16 September 2014
Available online 5 October 2014

Keywords:
Oppositional defiant disorder
Aggression
Adolescent
Sympathetic skin responses
Electrodermal response

ABSTRACT

Oppositionality encompasses distinct dimensions, and few studies have investigated the validity of such distinctions from a pathophysiological perspective. Our aim was to investigate the association between sympathetic skin responses (SSR) and distinct oppositional dimensions in a community sample of adolescents. Forty adolescents aged 13.84 ± 1.46 years participated in this study. Oppositionality was measured by externalizing behavior and bullying scores (dependent variables), while SSR was recorded by electrical changes at the skin level (independent variables). Results showed that increased SSRs were associated with oppositionality; however, these associations were specific to the headstrong/hurtful dimension. Further exploratory analyses demonstrated that increased SSRs were associated with several types of headstrong/hurtful behaviors and underscore the importance of the first aversive stimuli to differentiate groups with low and high headstrong/hurtful behaviors. There were no differences between groups regarding time until habituation. This study provides insights about how dysfunctions in autonomic balance may contribute to the emergence of oppositional behavior among adolescents.

1. Introduction

Pathological oppositional behaviors in childhood are common and can lead to a variety of negative outcomes in early adult life, such as antisocial and criminal behavior (Aebi, Plattner, Metzke, Bessler, & Steinhausen, 2013; Moffitt, Caspi, Harrington, & Milne, 2002), bullying behavior (Vaughn et al., 2010), major depression, and substance abuse and dependence (Aebi et al., 2013; Biederman et al., 2008). In children, oppositionality is associated with both internalizing and externalizing symptoms (Burke, 2012; Kessler, Petukhova, & Zaslavsky, 2011; Nobile et al., 2013). This pattern of associations has led to the proposition that oppositionality is a heterogeneous psychopathological dimension that might encompass qualitatively distinct expressions of disruptive behaviors (Rowe, Costello, Angold, Copeland, & Maughan, 2010). Understanding distinct sub-dimensions within oppositionality might have important implications for both etiology and therapeutic strategies.

Recently, a study proposed that oppositionality encompasses three distinct dimensions with different predictive values regarding comorbid psychopathology: *irritable*, *headstrong*, and *hurtful* (Stringaris & Goodman, 2009). The *irritable* dimension is associated with emotional disorders that include symptoms of temperamental outbursts, anger, and touchiness. The *hurtful* dimension is associated with callousness and is characterized by vindictiveness and spitefulness. The *headstrong* dimension is associated with ADHD and aggressive behaviors that include behaviors such as arguing with authority figures, annoying others on purpose, and refusing to follow rules. Such classifications, with some modifications, were recently adopted by the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and were validated in different cultural contexts (Krieger et al., 2013). However, until now, few studies have investigated the validity of such distinctions from a pathophysiological perspective (Scarpa & Raine, 1997).

* Corresponding author at: Postgraduate Program in Medical Sciences: Psychiatry, School of Medicine, Federal University of Rio Grande do Sul (UFRGS), 2400 Ramiro Barcelo Street, 90035-003. Porto Alegre, RS, Brazil. Tel.: +55 5191992905.
E-mail address: nanuchats@gmail.com (N.T.d. Silva).

http://dx.doi.org/10.1016/j.biopsycho.2014.09.009
0301-0511/

In fact, little is known about the pathophysiological basis of disruptive behavior. Longitudinal studies have shown a relationship between reduced electrodermal responses and antisocial behavior in early adolescence (Fung et al., 2005) and crime involvement and arrests in early adult life (Gao, Raine, Venables, Dawson, & Mednick, 2010; Raine, Venables, & Williams, 1996). Another study found that girls with blunted skin conductance responses (SCRs) are more prone to relational aggression, while girls with heightened SCRs are more prone to physical aggression (Sijtsema, Shoulberg, & Murray-Close, 2011). A study with children demonstrated associations between high levels of reactive aggression and higher SCRs during a video game task where participants lost because of cheating (Hubbard et al., 2002). These studies suggest that the way arousal relates to oppositionality may differ from one dimension to another.

Electrodermal activity (EDA) is a general term used for defining autonomic spontaneous activities recorded by electrical changes at the skin level. When this background activity is abruptly synchronized, either by electrical (external) stimuli or by emotional (internal) trigger, this activation gives raise to galvanic skin response or sympathetic skin response (SSR) that is more easily recorded with skin electrodes (Critchley, 2002). Usually the SSR is measured by the peak-to-peak amplitude, preferably from the first skin potential, considering the habituation of SSR to repetitive stimuli (Schestatsky, Ehlers, Rieder, & Gomes, 2006; Schestatsky, Kumru et al., 2007; Schestatsky, Valls-Sole et al., 2007; Schestatsky et al., 2009, 2013).

The SSR, can be defined as the summation of function within the sympathetic cholinergic sudomotor glands after a phasic stimulus (Schestatsky, Kumru et al., 2007; Schestatsky, Valls-Sole et al., 2007). This measurement is a simple index of peripheral arousal associated with emotional and attentional states (Vetrugno, Liguori, Cortelli, & Montagna, 2003). The SSR is the net result of eccrine sweat gland activation (EDA–SSR) in response to physical activity, stressful stimuli or situations and by cognitive-emotional process (Dawson, Schell & Filion, 2000). Therefore SSR might relate more closely to more 'anger out' forms of emotion dysregulation (i.e., reactive aggression) within oppositionality (such as headstrong/hurtful behavior), which have been linked to physiological hyperreactivity and hostile behavior toward non-harmful stimuli (Hubbard et al., 2002; Loney, Frick, Clements, Ellis & Kerlin, 2003; Marsee & Frick, 2007), instead of more 'anger in' forms of emotion dysregulation (that does not necessarily result in aggression) such as irritability.

In the current study, we investigated the validity of distinct oppositional dimensions in a community adolescent sample using electrodermal responses to mild electrical stimuli. These stimuli did not cause pain or discomfort, just an annoying sensation to generate an autonomic response that tends to habituate over time. Through examination of previous findings, we developed two hypotheses: (a) oppositionality is associated with increased levels of SSR; (b) this association is specific to headstrong/hurtful behaviors and not to irritability. Related to hypotheses (a) and (b), we addressed three related questions: (i) Are there specific types of headstrong/hurtful behaviors, such as verbal, physical, and social aggression, associated with increased responses? (ii) Is the trajectory of habituation associated with headstrong/hurtful behaviors? (iii) Is the number of stimuli necessary for habituation associated with headstrong/hurtful behaviors?

2. Methods

2.1. Participants

A total of 40 6th–10th grade school students participated in this study. We selected a random sample of participants from a larger community study (Salum et al., 2011) performed in six public schools in the coverage area of Hospital de Clínicas de Porto Alegre (HCPA), Porto Alegre city, south Brazil. All participants were contacted previously by phone about the experiment and visited the laboratory to clarify possible doubts.

We explained by phone that participants would be asked to respond to some questionnaires; afterwards, they would be invited to enter a dimly lit room of neutral temperature and asked to lie down on a bed. A researcher (NTS), who was a trained nurse, attached electrodes to each participant's skin, which was followed by a sequence of ten mildly unpleasant sensations provoked by a very mild electric current (10 mA) applied by a trained neurologist (PBW) in order to access SSRs to external stimuli. We explained that these stimuli would not cause pain, but would merely provide an annoying sensation. Adolescents were instructed to interrupt the experiment if they were feeling any discomfort, emphasizing that interruptions would not lead to any sort of punishment. No student interrupted the experiment or reported any type of pain. Participation in this study was voluntary, and no monetary reward was offered.

We decided to use a mild electrical current (10 mA) as a stimulus because it generates SSRs without pain. This stimulus is able to modify the SSR wave form, making it possible to observe habituation (Toyokura, 2006). Trials for adults tend to use higher electric currents, such as 20–30 mA (Schestatsky et al., 2006; Toyokura, 2006). One study, encompassing subjects aged 15–60 years old, used electrical stimuli of 20–100 mA (Gomes et al., 2003). Students and their parents were previously interviewed to assess students' health status. All students gave verbal informed consent, and their parents gave written informed consent. The HCPA institutional review board approved this study (registration number: 120074).

2.2. Oppositionality assessment

Oppositionality was measured using two instruments. The first was the Youth Self Report (YSR; Achenbach & Dumenci, 2001). The YSR is a self-report measure with 113 items composed of statements with three response options: *not true* (score 0), *somewhat true* (score 1), and *very true* (score 2). The YSR has been validated for use with Brazilian Portuguese-speaking participants (Bordin, Mari, & Caeiro, 1995). In order to investigate dimensions within oppositionality, we used the two-dimensional structure proposed by Stringaris, Zavos, Leibenluft, Maughan, and Eley (2012) for this instrument: irritability and headstrong/hurtful. The irritability scale is formed by summing five items from the YSR aggression subscale: *argues a lot*, *hot tempered*, *easily annoyed*, *stubborn*, and *experiences sudden changes in mood or feelings*. The headstrong/hurtful dimension is formed by summing five items from the YSR aggression subscale (*argues a lot*, *teases a lot*, *disobeys at home*, *disobeys at school*, and *destroys things belonging to one's family or others*), one from the rule-breaking behavior scale (*breaks rules at home*, *school*, *or elsewhere*), and one from the other problems scale (*engages in cruelty*, *bullying*, or *meanness to others*).

The second instrument was the Brazilian modified version of the Olweus Bully/Victim Questionnaire (Olweus, 1993; Fischer et al., 2010). We only used the Bully questionnaire to measure aggressive behavior through frequency in bullying behavior. This measure is a self-report questionnaire consisting of 24 items that measure physical (e.g., how often the child physically hurts or took belongings away), verbal (e.g., name calling, teasing in a hurtful way, or threatening), social (e.g., spreading rumors, not talking to someone on purpose or excluding them from their group of friends), sexual (e.g., sexual harassment), and cyber bullying (e.g., the use of internet and mobile phones to hurt others). Due to a very low frequency of sexual and cyber bullying, we restricted our analysis to the physical, verbal, and social subtypes of bullying. Response options included: (0) *never*, (1) *once or twice in the previous year*, (2) *3–6 times in the previous year*, (3) *many times a week*, and (4) *every day*. Recorded answers were rated on a continuous scale, ranging from zero to 96 points.

2.3. Sympathetic skin response

The SSR data (represented by wave's oscillation in response to a stimulus) were collected under controlled environmental conditions, within a silent room with a constant temperature and dim lighting. Equipment included Ag/AgCl electrodes and electrolyte isotonic gel to attach electrodes to the skin surface (Boucsein et al., 2012). After preparing the participant, we applied a sequence of 10 very mild electric stimuli of 10 mA, with an interval of approximately 30 s. Upper limb recordings were performed with surface Ag/AgCl electrodes placed on the right side palmar region (second interdigital space, 3 cm proximally to the metacarpophalangeal articulation), and reference electrodes were placed on the dorsum of the hand. A 5-s screen with 200–1000 μV sensitivity and amplifier bandpass filter was of 0.1 and 2 kHz. SSR recording was conducted using Nihon Kohden Neuropack MEB 9400® equipment and software, and data were collected and analyzed by two researches (NTS and PS).

We measured the latency and amplitude of the first wave generated (the wave after the first of 10 stimuli). Habituation to a stimulus refers to the phenomenon whereby wave amplitude reaches 50% of the first wave amplitude after exposure to several aversive stimuli.

2.4. Statistical analysis

In order to investigate if overall oppositionality was associated with SSR we used a multivariate general linear model (MGLM) with both irritability and