U.PORTO
FACULDADE DE PSICOLOGIA
E DE CIÊNCIAS DA EDUCAÇÃO
UNIVERSIDADE DO PORTO

RELATIONSHIP BETWEEN PSYCHOPATHIC TRAITS AND RESPONSE TO INDUCED PSYCHOSOCIAL STRESS

Diana Regina de Faria Leite

outubro, 2017

Dissertation presented at Master's Degree in Psychology, Clinical and Health Psychology, Faculty of Psychology and Educational Sciences, University of Porto, supervised by Professor ***Fernando Barbosa*** (University of Porto) and co-supervised by Professor ***Laura López*** (University of Murcia).

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Resumo

O estudo da psicopatia reveste-se de imensa importância dado o impacto dos comportamentos psicopáticos na sociedade. A compreensão dos seus mecanismos subjacentes tem vindo a ganhar prominência com diversa investigação e a baixa reatividade ao *stress* é um dos componentes que surge associado à psicopatia.

O presente estudo examinou a relação entre os traços fenotípicos da psicopatia, de acordo com o Modelo Triárquico (Patrick, Fowles, & Krueger, 2009), e a resposta ao stress, através da indução de stress psicossocial com o *Trier Social Stress Test* (Kirschbaum, Pirke, & Hellhammer, 1993). Foi examinado em que medida pontuações mais altas de psicopatia e, particularmente, pontuações maiores do traço Ousadia, eram responsáveis por uma menor reatividade, bem como uma maior habituação, ao *stress* induzido.

Vinte e quatro homens saudáveis da comunidade, com uma média de idades de 23.7 (18 – 33) anos, foram confrontados com o mesmo stressor duas vezes, com oito dias de intervalo. Em ambas as sessões, o nível de *stress* foi avaliado pela resposta cardiovascular, através da frequência cardíaca (atividade simpática) e variabilidade da frequência cardíaca (atividade parassimpática), endócrina (cortisol salivar) e psicológica (ansiedade-estado percebida) na linha de base, durante e após a tarefa.

Pontuações maiores e menores de psicopatia total apresentaram uma magnitude de resposta de frequência cardíaca diferente na segunda exposição ao stressor. Pontuação mais alta de Ousadia foi preditora de uma maior variabilidade de frequência cardíaca na primeira exposição ao stressor, mas não na segunda. Ansiedade-estado percebida mostrou um aumento acentuado durante a primeira indução de stress, em todos os participantes, mas estes valores habituaram na segunda sessão. Valores mais altos de Ousadia foram associados a uma ansiedade-estado percebida reduzida na segunda, embora não na primeira, exposição ao stressor.

As implicações destes resultados são discutidas, nomeadamente o reconhecimento do papel da Ousadia como traço influente dentro do construto da psicopatia.

Palavras-chave: Psicopatia; TriPM; Ousadia; TSST; Stress Psicossocial; Resposta Cardiovascular; Habituação.

Abstract

The study of psychopathy is of immense significance due to the impact of psychopathic-related behaviour on society. The understanding of its underlying mechanisms has gained prominence with varied research and low stress reactivity is one of the components that emerges associated with the psychopathic personality.

The current study examined the relationship between phenotypic facets of psychopathy, according to the Triarchic Model (Patrick, Fowles, & Krueger, 2009), and stress response, through the inducement of psychosocial stress with the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993). It was examined the extent to which higher psychopathy scores and particularly, higher triarchic Boldness scores, accounted for a lower reactivity, as well as a greater habituation, to induced stress.

Twenty-four healthy men from the community, mean age 23.7 (18 – 33) years, were confronted with the same stressor twice, eight days apart. At both sessions, stress level was assessed by cardiovascular, through heart rate (sympathetic activity) and heart rate variability (parasympathetic activity), endocrine (salivary cortisol) and psychological (perceived state anxiety) response at baseline, during and after the task.

Higher and lower psychopathy scores presented a different magnitude of heart rate response on the second exposure to the stressor. Higher Boldness score positively predicted a higher heart rate variability on the first exposure to the stressor, but not the second. Perceived state anxiety showed a marked increase during the first stress provocation, for all participants, but habituated in the second session. Higher Boldness scores were associated with reduced perceived state anxiety on the second, but not the first, stress provocation.

The implications of these results are discussed, including the acknowledgment of the role of Boldness as a valued trait domain within the psychopathy construct.

Key-words: Psychopathy; TriPM; Boldness; TSST; Psychosocial Stress; Cardiovascular Response; Habituation.

Résumé

L'étude de la psychopathie a acquis une énorme importance dû à l'impact des comportements psychopathiques dans la société. La compréhension de ses mécanismes sous-jacents devient de plus en plus fondamentale à travers de plusieurs recherches et la faible réactivité au stress est l'un des éléments qui surgit associer à la psychopathie.

Cet étude a examiné la relation entre les traits phénotypiques de la psychopathie, selon le Modèle Triarchique (Patrick, Fowles, et Krueger, 2009), et la réponse au stress par induction de stress psychosocial à travers le Trier Social Stress Test (Kirschbaum, Pirke et Hellhammer, 1993). On a examiné dans quelle mesure les scores les plus élevés de psychopathie et, en particulier, les scores les plus élevés du trait Audace étaient responsables par une réactivité plus faible ainsi qu'une plus grande habituation au stress induit.

Vingt-quatre hommes de la communauté, en bonne santé, âgés en moyenne de 23,7 (18-33) ans, ont été soumis au même facteur de stress à deux reprises, avec un intervalle de huit jours. Pendant les deux sessions, le niveau de stress a été évalué par la réponse cardiovasculaire, à travers la fréquence cardiaque (activité sympathique) et la variabilité de la fréquence cardiaque (parasympathique), endocrinienne (cortisol salivaire) et psychologique (état d'anxiété perçu) au départ, pendant et après la tâche.

Scores majeurs et mineurs de psychopathie totale avaient une amplitude de réponse de fréquence cardiaque différente à la deuxième exposition à l'agent stressant. Score plus élevé de l'Audace a été un prédicteur d'une plus grande variabilité de la fréquence cardiaque pendant la première exposition à l'agent stressant, mais pas pendant la seconde. L'état d'anxiété perçu a augmenté sensiblement au cours de la première induction du stress chez tous les participants, mais ces valeurs ont habitué pendant la deuxième session. Des valeurs plus élevées d'Audace ont été associées à une réduction de l'état d'anxiété perçu au cours de la seconde, mais pas pendant la première l'exposition à l'agent stresseur.

Les implications de ces résultats sont discutées, notamment la reconnaissance du rôle de l'Audace comme un trait marquant dans le concept de la psychopathie.

Mots-clés: Psychopathie; TriPM; Audace; TSST; Stress Psychosocial; Réponse Cardiovasculaire; Habituation.

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Abbreviations

ANS	Autonomic Nervous System
ECG	Electrocardiogram
HPA	Hypothalamic-Pituitary-Adrenal
HR	Heart Rate
HRV	Heart Rate Variability
LSRP	Levenson's Self-Report Psychopathy Scale
PCL	Psychopathy Checklist
RMSSD	Root Mean Square of Successive Differences
SDNN	Standard Deviation of NN Intervals
STAI-S	State-Trait Anxiety Inventory (State Section)
TSST	Trier Social Stress Test
TriPM	Triarchic Psychopathy Measure

Introduction

There is a great deal of conceptual mayhem involving the construct of psychopathy, despite of its long history.

The highly influential writings of Cleckley on *The Mask of Sanity* (1941) examine psychopathy and psychopathic-related behavioural phenomena by identifying specific characteristics that define the prototypical psychopath as, in essence, someone who has superficial charm and above average intelligence, absence of delusions or other signs of irrational thinking, absence of anxiety or other psychoneurotic symptoms, unreliability, untruthfulness and insincerity, inadequately motivated antisocial behaviour, lack of remorse and shame, poor judgment and failure to learn from experience, pathological egocentricity and incapacity for real love and attachment, general poverty of deep and lasting emotions, lack of any true insight, unresponsiveness in general interpersonal relations, fantastic and objectionable behaviour, no history of genuine suicide attempts, poorly integrated and trivial sex life and, finally, failure to have a life plan and live in any ordered way.

In conceptualizing psychopathy as a behavioural deviation of affective and interpersonal traits “masked” by a superficial appearance of adaptive psychological functioning, Cleckley provided a clinical conception of psychopathy while simultaneously establishing a sustainable foundation from which further in-depth research could build upon.

This was the case latter, with the development of the Psychopathy Checklist (PCL, Hare, 1980), a reliable and construct-valid measure of Cleckley’s criteria. However, due to the fact that PCL originated from adult criminal offender samples, it does not portray the positive adjustment indicators of psychopathy, previously established by Cleckley. For example, the absence of anxiety or nervousness, lack of irrationality or psychotic symptoms and immunity to suicide, constitute attributes that, when not associated with severe antisocial behaviour, facilitate functioning and are regarded as generally positive. By neglecting these, the PCL reinforces a unitary concept of psychopathy and withdraws the possibility of “successful psychopaths”, as appointed by Cleckley, that can partake in society.

Looking further into psychopathy literature and research will disclose a marked disagreement on several fundamental assumptions, namely whether psychopathy can be considered unidimensional or multidimensional (Neumann, Malterer, & Newman, 2008). To this day, there are still underway heated controversies and a sense of unease unveiling around

the nature, boundaries and definition of this construct, as well as the accurate means to assess it (Hare & Neumann, 2006).

Although the categorical approach makes up for the great majority of field research, the operationalization of this construct appears to be less accurate when resorting to instruments that classify psychopathy as a unitary or unidimensional construct and thus, better fitted when decomposing psychopathy in separate components or traits (Patrick, Fowles & Krueger, 2009).

Supporting a dimensional view, as opposed to a typological or categorical one, psychopathy can be understood as a collection of personality traits that vary along a continuum in the general population (Coid, Yang, Ullrich, Roberts, & Hare, 2009).

Based on an extensive review, and allowing for a self-report assessment of psychopathy, the Triarchic Model (Patrick et al., 2009) is brought forth and has shown applicability in research from community samples (Drislane et al., 2014; Poy, Segarra, Esteller, López, & Moltó, 2014; Vieira et al., 2013).

This model proposes a conceptual framework of psychopathy that encompasses three interrelated symptomatic constructs with distinct phenotypic identities, that can be understood and measured independently – Disinhibition, Boldness, and Meanness.

The nexus of Disinhibition is the most salient behavioural marker and encompasses a tendency toward impulsivity due to inadequate behavioural monitoring and constraint, irresponsibility, hostility, and poor affect regulation.

Meanness comprises a callous lack of empathy and concern for others, poor emotional attachment, contempt toward others, deliberate cruelty and predatory exploitativeness, with empowerment through cruelty or destructiveness.

Boldness is conceptually similar to the “mask” discussed by Cleckley (1941) and encompasses confident social dominance, thrill-seeking, tolerance of novelty or uncertainty, and resilience to stress. This facet of psychopathy was related to the low end of neuroticism and high end of extraversion, a constellation also referenced as fearless dominance (Lilienfeld et al., 2012) and stable extraversion (Miller & Lynam, 2012).

Being that psychopathy entails a pattern of irresponsible and impulsive behaviour that has been associated with a tendency for criminality, violence and aggression (Hare, 1980), its study is of vital importance for society as a whole. Improving our understanding of psychopathy by studying noncriminal populations will allow the outline of a more comprehensive definition of psychopathic traits and, at the same time, potentially offer a

valuable reference point for the study of basic affective and interpersonal processes that are the key components that have been shown to suffer deficits on psychopathic individuals.

Stress is an omnipresent phenomenon in everyday life and it is clear that all of us are exposed to stressful situations at a social and personal level. Although stress response constitutes a generally positive adaptive process that allows us to cope with a stressor in a better manner (Allen, Kennedy, Cryan, Dinan, & Clarke, 2014), psychologically speaking, it is a subjectively negative experience.

Following the perception of an acute stressful event in which the demands of the situation threaten to exceed the resources of the individual (Lazarus & Folkman, 1984), there is a cascade of various cognitive, emotional, behavioural and psychophysiological responses that subsumes the nervous, cardiovascular, and endocrine systems.

Stress reactivity can be studied by inspecting the alterations of these biological markers. More specifically, the activity of the autonomic nervous system (ANS), measured by the cardiovascular output, which translates into a faster heart rate (HR) and lower heart rate variability (HRV), and the activity of the hypothalamic-pituitary-adrenal (HPA) axis, measured by cortisol, which is released from the adrenal glands and accounts for higher cortisol levels in saliva (Takai et al., 2004). The HPA axis functioning is known to have a rapid response habituation after repeated stimulation (Hellhammer, Wüst, & Kudielka, 2009).

Using cardiovascular measures to study stress response can be done in a continuous manner, and represents an advantage over other less-practical measures. Nonetheless, heart rate has shown to be less specific to stressful stimuli when compared to the peripheral measure of cortisol (Gordis, Granger, Susman, & Trickett, 2006), and so, falling back upon the use of self-report measures like subjective mood may be of advantage.

Examination of changes in psychobiological stress reactivity also relies on the application of tools that induce stress in a valid and repeatable manner. However, and since novelty and unpredictability are substantial factors of stress inducement (Dickerson & Kemeny, 2004), repeated exposure represents an unavoidable challenge when choosing a stressor, and hinders resulting interpretation.

The Trier Social Stress Test (TSST, Kirschbaum, Pirke, & Hellhammer, 1993) is a powerful standardized protocol for the induction of psychosocial stress, with components of social evaluative threat translated in a mock job interview with a free speech and an arithmetic task performed in front of a panel. The TSST represents a reliable tool in eliciting stress responses (Dickerson & Kemeny, 2004), that has been successfully applied in clinical

as well as normative populations (Kirschbaum, 1995). The physiological effects yield by this task, both endocrine and cardiovascular, can avail the study of psychopathy (Kudielka, Hellhammer, Kirschbaum, Harmon-Jones, & Winkielman, 2007).

Psychopathy has, traditionally, been associated with a lack of anxiety or worry (Cleckley, 1941) and, as reviewed above, Boldness is thought to be underpinned by aberrant or blunted stress reactivity (Lykken, 1995; Patrick, Bradley, & Lang, 1993). The capacity of remaining calm on the face of threat and recover promptly from life stress, as descriptive components of the Boldness trait, are apparently linked to a reduced ANS response to aversive or negative valence stimuli (Brook, Brieman, & Kosson, 2013), translated into a deficient response in the production of cortisol (O'Leary, Loney, & Eckel, 2007; O'Leary, Taylor, & Eckel, 2010).

However, the effect of personality traits on stress response can be better understood through the repeated exposure to the TSST (Kudielka et al., 2007), since the novelty of the stimuli could mask the impact of personality traits on stress response in the first exposure. Thus, repeated stress exposures and data aggregation could enhance the likelihood of finding stable and meaningful associations between personality variables and stress responses (Kudielka, 2009).

While a single exposure may not be sufficient to observe the impact of psychopathy on stress reactivity, the differences in the ability to cope with a stressor may lead to distinct stress response patterns on following exposures. Adrenocortical stress response extinction in subjects exposed twice to psychological stress has been reported by Gerra and colleagues (2001). In contrast, some subjects do not seem to show habituation of adrenocortical stress response to repeated psychological stress (Kirschbaum et al., 1995) suggesting that stress adaptation may be influenced by specific temperamental traits (Kirschbaum, Wüst, Faig, & Hellhammer, 1992).

This study set out to measure possible individual differences regarding the total level of psychopathy and its phenotypes, measured by the Triarchic Psychopathy Measure (TriPM; Patrick et al., 2009) in response to psychosocial stress. This was investigated by observing changes in heart rate, salivary cortisol and stress perception during and after the application of the TSST. Intended to study the habituation pattern to repeated exposure to a psychosocial stressor, two sessions were performed, eight days apart from one another, with the same experimental protocol.

Since Boldness is described as being associated with the ability to remain calm and recover quickly from stressful events, as well as high tolerance to uncertainty and threats, it

is expected that this trait, unlike the Disinhibition and Meanness traits, arises associated with lower reactivity to stress.

It was predicted that (a) participants with higher scores on global psychopathy would display lower stress induced responses. This translates, in this study, into participants with higher scores on global psychopathy exhibiting lower heart rate, higher heart rate variability, lower salivary cortisol, and lower perceived state anxiety, in comparison with participants with lower scores on global psychopathy. Additionally, it was hypothesized that (b) a higher Boldness score was predictor of lower stress induced responses. This translates into higher Boldness scores being associated with lower heart rate, higher heart rate variability, lower salivary cortisol and lower perceived state anxiety. It was also predicted that (c) participants with higher scores on global psychopathy would display greater habituation to stress. This translates into participants with higher scores on global psychopathy displaying a greater reduction in heart rate, salivary cortisol, and perceived state anxiety, and a higher increment in heart rate variability, from the first to the second exposure to the stressor. Lastly, it was hypothesized that (d) a higher Boldness score was predictor of greater habituation. This translates into higher Boldness scores being associated with a greater reduction in heart rate, salivary cortisol, and perceived state anxiety, and a higher increment in heart rate variability, from the first to the second exposure to the stressor.

Methodology

1. Participants

The study comprised 24 healthy adult males, with ages between 18 and 33 ($M = 23.7$, $SD = 4.04$). The participants were recruited among students of the University of Porto by advertisement or direct contact. They received no monetary incentive for participation. However, there was a raffle for a 30€ gift card to be randomly drawn by one of the participants, at the end of the study. All volunteers were screened for psychological and physical conditions that could significantly interfere with the experimental procedure, such as psychopathology, neurological conditions and cardiovascular illness by the application of a general health questionnaire that also aimed to collect socio-demographic information, such as age, education level, occupation, among others.

Of the initial sample, two participants were excluded due to non-attendance at the second session, and another one because of excessive noise on ECG recording. Thus, the final sample comprised 21 participants. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Research Committee of the University of Valencia. All participants received verbal and written information about the study and signed an informed consent prior to the onset of the experiment.

2. Materials and Equipment

2.1. Psychological Assessment

Psychopathy. Psychopathy levels were assessed using the Portuguese version of the Triarchic Psychopathy Measure (TriPM; Vieira et al., 2014), conceptually based on the Triarchic Model of Psychopathy (Patrick et al., 2009). This is a self-report scale comprising 58 items, answered on a 4-point Likert scale (0 = true; 1 = somewhat true; 2 = somewhat false; 3 = false), in order to assess the level of psychopathy. The scale is composed by three subscales that operationalize the phenotypic traits of the Triarchic Model of Psychopathy: Boldness, Meanness and Disinhibition.

In addition, the Portuguese version of the Levenson Self-Report Psychopathy Scale (LSRP; Barbosa et al., 2014) was applied. This instrument is a self-report scale composed

of 26 items, rated on a 4-point Likert scale ranging from 1 (“strongly disagree”) to 4 (“strongly agree”), and is used for the assessment of psychopathic personality traits in non-criminal samples. The scale is composed of two subscales: Primary Psychopathy and Secondary Psychopathy.

Anxiety. The state-anxiety was assessed using the 20-item state-anxiety subscale (STAI-S) from the Portuguese version of State-Trait Anxiety Inventory (STAI; Silva & Spielberger, 2007). This self-report subscale is rated on a 4-point Likert scale ranging from “almost never” to “almost always.” Final scores range from 20 to 80 points, being that higher scores indicate increased levels of anxiety. Participants completed this questionnaire before and after the TSST on both sessions. It was clarified they should answer based on how they felt at that particular moment.

2.2. Physiological and Hormonal Assessment

HR and HRV were continuously measured during the entire experimental session as indices of ANS activity. Both indices were obtained using a Polar HR monitor (RS 800CX®, Polar Electro Oy, Kempele, Finland). This type of cardiac signal recording devices has shown good validity (Roy, Boucher, & Comtois, 2009).

Saliva was collected using Salivettes (Sarstedt, Rommelsforf, Germany). In total, for each session, five samples were collected: t_{-10} ($time_{-10min}$), t_0, t_{+15}, t_{+20}, t_{+40}, with reference to the start of the TSST (Preparation Phase). The saliva samples were stored at -20°C immediately after the completion of the experimental session, and were later transferred to another storing unit, where they are being kept at -80°C, until the analyses are possible.

The analysis of hormonal data is time consuming, involves additional costs and would be difficult to contemplate within the scope of the extent allowed for the current study. Therefore, data from the hormonal assessment was not worked on and only the physiological measures were used.

3. Procedure

3.1. Experimental Protocol

Experimental sessions, with the duration of approximately one hour, were conducted individually in two consecutive weeks (Moment 1 and Moment 2). The sessions happened between 2 pm and 6 pm, to control for the diurnal cortisol cycle, and took place on two

different rooms (Room A and Room B) both located at the Faculty of Psychology and Educational Sciences of the University of Porto. Participants were instructed not to eat or drink for at least two hours prior to the experiment. After arrival, anthropometric measures were collected and the ECG equipment was set up and activated.

The procedure was divided into the same five Phases for both Moments: Habituation, Preparation, Speech, Arithmetic, and Recovery.

The Habituation Phase took place in Room A and consisted of 10 minutes for collection of baseline measurements of the cardiac activity, while participants filled out the STAI-S before TSST, and a general health questionnaire.

The subsequent three phases (Preparation, Speech, and Arithmetic) consisted of the TSST, which was applied as described by Kirschbaum and colleagues (1993). The Preparation Phase took place in Room A, where the participants had a total of 10 minutes to prepare a 5-minute speech that simulated an interview for their dream job, which was later performed in the Speech Phase, in Room B. Changing rooms is intended to produce an unexpected and out of control environment. In Room B, participants were presented to a committee, composed of two gender-differentiated judges, dressed in white gowns, who were instructed to maintain eye contact and avoid any facial expressions or verbal encouragements for the full duration of the TSST. In the room, there was a video camera pointed at the participants, in their field of vision. Participants were informed that the recording would serve to analyse the performance with regard to nonverbal cues of stress levels, such as facial expressions and voice frequency, although the camera was turned off during the entire duration of the TSST. On the off-chance that the prepared speech did not fulfil the envisioned time, the female jury would ask standardized questions until the 5-minute mark. Immediately after, in the Arithmetic Phase, the participants were asked to sequentially subtract the number 13 from the number 1022, aloud. If at any time they missed a number, they were asked to start over from the initial number.

For the final phase (Recovery Phase), after the TSST, participants were accompanied back to Room A where they would abide, filling in the STAI-S once again, the TriPM and LSRP. They would read the day's newspaper for the remaining time, until a total of 20 minutes was fulfilled and the final sample of salivary cortisol could be collected. Then, participants were asked to return the next week, at the same time, to complete the experimental protocol.

For Moment 2 the Phases mentioned above were performed in the same manner, with minor changes. For the Speech Phase, participants were asked to apply for a different job

from the one they selected at Moment 1. To counterbalance, half of the subjects applied for their dream job at Moment 1 and a real job at Moment 2, whereas the other half did the opposite. For the Arithmetic Phase, the initial number was changed (from 1022 to 1202).

This ensured that the contents evocated during these tasks on Moment 2 were not influenced by the previous TSST. The experimental session concluded with a full debriefing. See Figure 1 for a schematic representation of the described procedure.

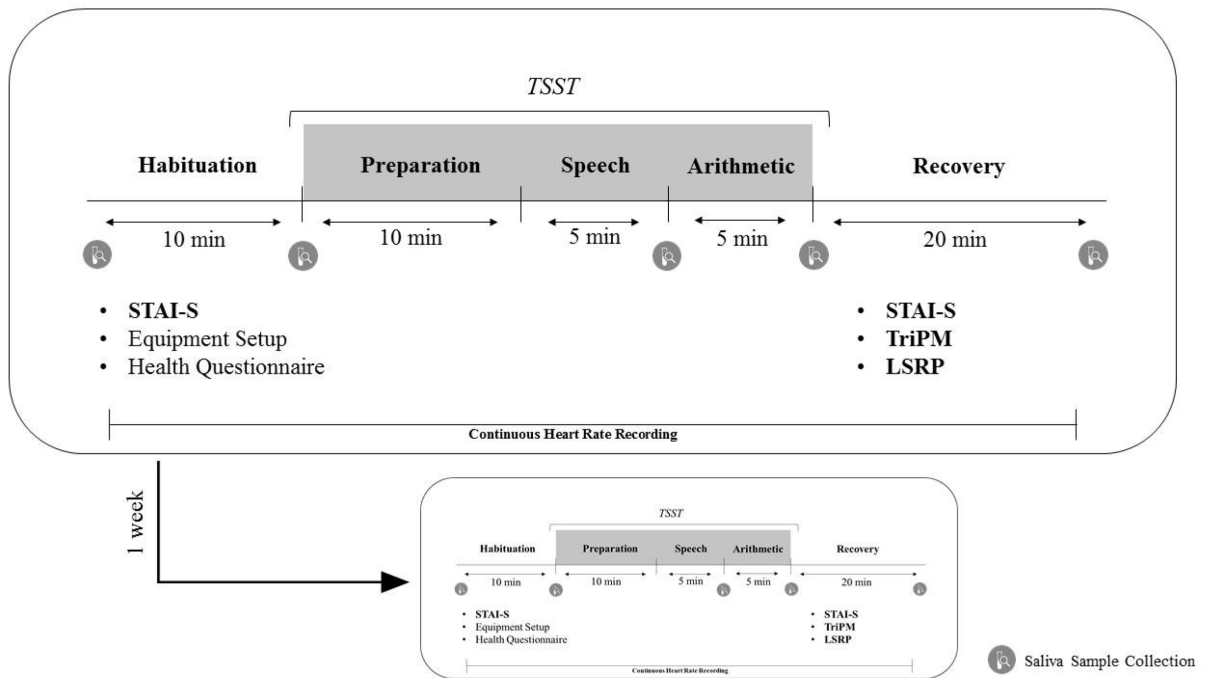

Figure 1. Schematic Representation of Experimental Protocol.

3.2. Data Processing and Analysis

For ECG, the KubiosVFC® Polar software V2.0 (Biomedical Signal Analysis Group, University of Kuopio, Finland) was used for signal filtering and analysis (Tarvainen & Niskanen, 2008). The sampling rate was set for 1000 Hz. Following the recommendation of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996), only the central five minutes of each phase were analysed: Habituation, Preparation, Speech, Arithmetic, and Recovery. The time domain parameters analysed were: mean HR, Standard Deviations of NN Intervals (SDNN), and the Root Mean Square of Successive Differences (RMSSD). The HR was computed in beats per second, as an indicator of autonomic activation. The SDNN is a measure of the

predominance of sympathetic over parasympathetic activity (Malik, M., 1996), while RMSSD measures the predominance of high frequencies with parasympathetic origin over sympathetic activity (Malik, M., 1996).

All statistical analyses were conducted using the SPSS V25 (2017, IBM Statistics, New York, USA) and Dell Statistica V13 (2016, Dell Inc, Texas, USA). Data was checked for normal distribution using the Shapiro-Wilk normality test.

Internal consistency of the state subscale of STAI, the TriPM and the LSRP (and respective subscales), was calculated using Cronbach's alpha. It was also computed the test-retest reliability of the TriPM, through the Pearson product-moment correlation between the scores of Moment 1 and Moment 2.

Convergent validity of the psychopathy measures was assessed using inter-correlations between total scores of TriPM and LSRP, as well as the corresponding subscales.

The analyses of the HR, RMSSD and SDNN were performed by conducting four independent repeated measures ANOVAs (one for each cardiac measure) with two within-subject factors: *Phase* (Habituation, Preparation, Speech, Arithmetic, Recovery) and *Moment* (Moment 1, Moment 2) and one between-subjects factor: *Psychopathy* (Lower, Higher). Significant effects were decomposed by means of post-hoc contrast analysis. Sphericity was assessed using the Mauchly's test. Whenever this assumption was violated the Greenhouse-Geisser correction was used and the value of epsilon reported.

For the STAI-S effects, a repeated measures ANOVA was conducted with *Moment* and *Time* (Before and After TSST) as within subjects factors. Whenever a significant effect was found, the Bonferroni adjustment for multiple comparisons was used.

For each cardiac measure three distinct indexes were calculated:

- Area under the curve with respect to the increase (AUCi) using the trapezoid formula [AUC_I = ((B+A)/2 + (C+B)/2 + (D+C)/2 + (E+D)/2) – 4 x A], as specified in Pruessner, Kirschbaum, Meinlschmid, and Hellhammer (2003);
- The change in each measure for Arithmetic Phase with respect to the baseline values (Delta Speech = C – A, where A = Habituation, B = Preparation, C = Speech, D = Arithmetic, and E = Recovery);
- The change in each measure for Speech Phase with respect to the baseline values (Delta Arithmetic = D - A).

These measures were introduced as dependent variables in independent best subset multiple linear regression models with Boldness, Meanness, and Disinhibition as predictors.

STAI-S Delta measures were also included as dependent variables in independent best subset multiple linear regression models with Boldness, Meanness, and Disinhibition as predictors.

In order to test the association between psychopathic traits and differences between Moment 1 and Moment 2 for the Delta STAI-S, AUCi and Delta cardiac indexes, a repeated measures model was used with *Moment* (1, 2) as within-subjects factors, and Boldness, Meanness and Disinhibition as continuous covariates for the within-subjects effect.

Results

1. Psychometric Analysis of the Self-Report Instruments

The internal consistency of the total TriPM scale was found to be excellent (58 items; α =.904). Cronbach's α for the Boldness subscale (19 items) was .717, which is acceptable, while for the Meanness (18 items) and the Disinhibition subscales (20 items) we obtained α = .881 and α = .866, respectively.

The internal consistency of the LSRP was also excellent (26 items; α =.858), with α = .876 for Factor 1 (16 items), and α = .619 for Factor 2 (10 items).

The State subscale of STAI consisted of 20 items and revealed good internal consistency in Moment 1, before TSST (α =.839) and after TSST (α =.843).

Regarding the reliability of the psychopathy measures, the TriPM revealed an excellent test-retest coefficient for the total scale (r = .953, p < .001), as well as for the Boldness (r = .914, p < .001), Meanness (r = .964, p < .001) and Disinhibition subscales (r = .903, p < .001). The LSRP also revealed excellent test-retest reliability coefficients for the total scale (r = .952, p < .001), for Factor 1 (r = .954, p < .001) and for Factor 2 subscales (r = .941, p < .001).

As to the convergent validity of the psychopathy measures, the inter-correlations between the TriPM total score, LSRP total score, and among the three TriPM subscales and the two LSRP subscales are shown in Table 1.

Table 1
Pearson's Correlation Coefficients for Psychopathy Measures: Total Scores and Subscales

	1	2	3	4	5	6	7
1. TriPM	-						
2. Boldness	.587 **	-					
3. Meanness	.853 ***	.258	-				
4. Disinhibition	.869 ***	.277	.672 ***	-			
5. LSRP	.648 **	-0.05	.828 ***	.595 **	-		
6. Factor 1	.527 **	-.077	.726 ***	.490 *	.926 ***	-	
7. Factor 2	.620 **	.120	-.703 ***	.561 **	.763 ***	.464 *	-

Note. * p < .05; ** p < .01; *** p < .001

2. Descriptive Statistics for Lower and Higher Psychopathy Groups

Descriptive statistics were performed for age, body mass index, LSRP and TriPM scores, for higher and lower psychopathy groups (based on the median split of the total TriPM score). The results of the t-tests show that lower and higher psychopathy groups are statistically matched regarding age and body-mass index. As expected, group scores are significantly different in every measure of psychopathy, as shown in Table 2.

Table 2

Sample Descriptives concerning Age, Body Mass Index and Psychopathy Scores, and t-tests concerning the difference of means between Higher and Lower Psychopathy Groups

	Psychopathy	*n*	Min	Max	*M*	*SD*	*t*	*p*
Age	Lower	13	18	33	23.7	3.75	.033	.974
	Higher	11	18	33	23.6	4.55		
BMI	Lower	13	19.40	31.40	23.8	3.29	.636	.532
	Higher	11	18.60	31.50	22.8	4.38		
LSRP	Lower	13	35	63	44.5	8.1	-3.06	.006
	Higher	11	42	81	57.1	11.92		
F1	Lower	13	20	40	25.6	5.85	-2.13	.045
	Higher	11	22	55	32.6	9.88		
F2	Lower	13	14	26	18.9	3.71	-3.30	.003
	Higher	11	19	35	24.6	4.63		
TriPM	Lower	13	34	55	46.9	7.63	-6.53	.000
	Higher	11	61	109	78.0	15.11		
Boldness	Lower	13	12	39	28.3	6.64	-2.45	.023
	Higher	11	27	42	34.5	5.68		
Meanness	Lower	13	1	19	8.23	5.97	-4.78	.000
	Higher	11	10	32	20.4	6.45		
Disinhibition	Lower	13	5	18	10.3	3.61	-4.64	.000
	Higher	11	11	43	23.1	9.16		

Note. BMI = Body Mass Index, *n* = Sample Size, Min = Minimum Value, Max = Maximum Value, *M* = Mean, *SD* = Standard Deviation.

3. Effects of Moment, Phase, and Psychopathy

3.1. Heart Rate (HR)

A mixed repeated measures ANOVA revealed a significant main effect for *Phase*, $F_{(4,72)} = 64.9$, $p < .001$, $\eta^2_p = .783$, $\varepsilon = .491$, best characterized by a quadratic trend, $F_{(1,18)} = 5.35$, $p = .033$, $\eta^2_p = .865$. No main effect was found for *Moment* or *Psychopathy* (both $F < 1$).

No first-order interactions were found (all $F < 1$), but we obtained a significant *Moment* * *Phase* * *Psychopathy* interaction, $F_{(4,72)} = 2.54$, $p = .047$, $\eta^2_p = .124$, best characterized by a cubic trend, $F_{(1,18)} = 10.8$, $p = .004$, $\eta^2_p = .375$.

Although the decomposition of the interaction did not yield any significant differences between higher and lower psychopathy groups during the TSST in both moments, the *Moment* * *Phase* * *Psychopathy* interaction suggests that high and low psychopathy differ on the *Moment* * *Phase* interaction. Figure 2 shows the HR response in Moment 1 and 2 for the TSST *Phases* (Preparation, Speech, and Arithmetic) by psychopathy group, where it seems that the significant interaction may be driven by a reduced HR response of the higher psychopathy group during the TSST *Phases* on Moment 2.

3.2. Root Mean Square of Successive Differences (RMSSD)

The test revealed a significant main effect of *Phase*, $F_{(4,72)} = 24.6$, $p < .001$, $\eta^2_p = .577$, $\varepsilon = .557$, best characterized by a quadratic trend, $F_{(1,18)} = 40.1$, $p < .001$, $\eta^2_p = .690$.

The test did not reveal a significant main effect for *Moment* nor for *Psychopathy* (both $F < 3.42$, $p > .080$).

No first-order nor second order interaction effects were found (all $F < 1.34$, $p > .265$).

3.3. Standard Deviation of NN Intervals (SDNN)

The test revealed a significant main effect of *Phase*, $F_{(4,72)} = 9.66$, $p < .001$, $\eta^2_p = .349$, $\varepsilon = .527$, best characterized by a quadratic trend, $F_{(1,18)} = 19.7$, $p < .001$, $\eta^2_p = .523$.

The test did not reveal a significant main effect for *Moment* or *Psychopathy* (both $F < 1$).

No first-order nor second order interaction effects were found (all $F < 2.05$, $p > .126$).

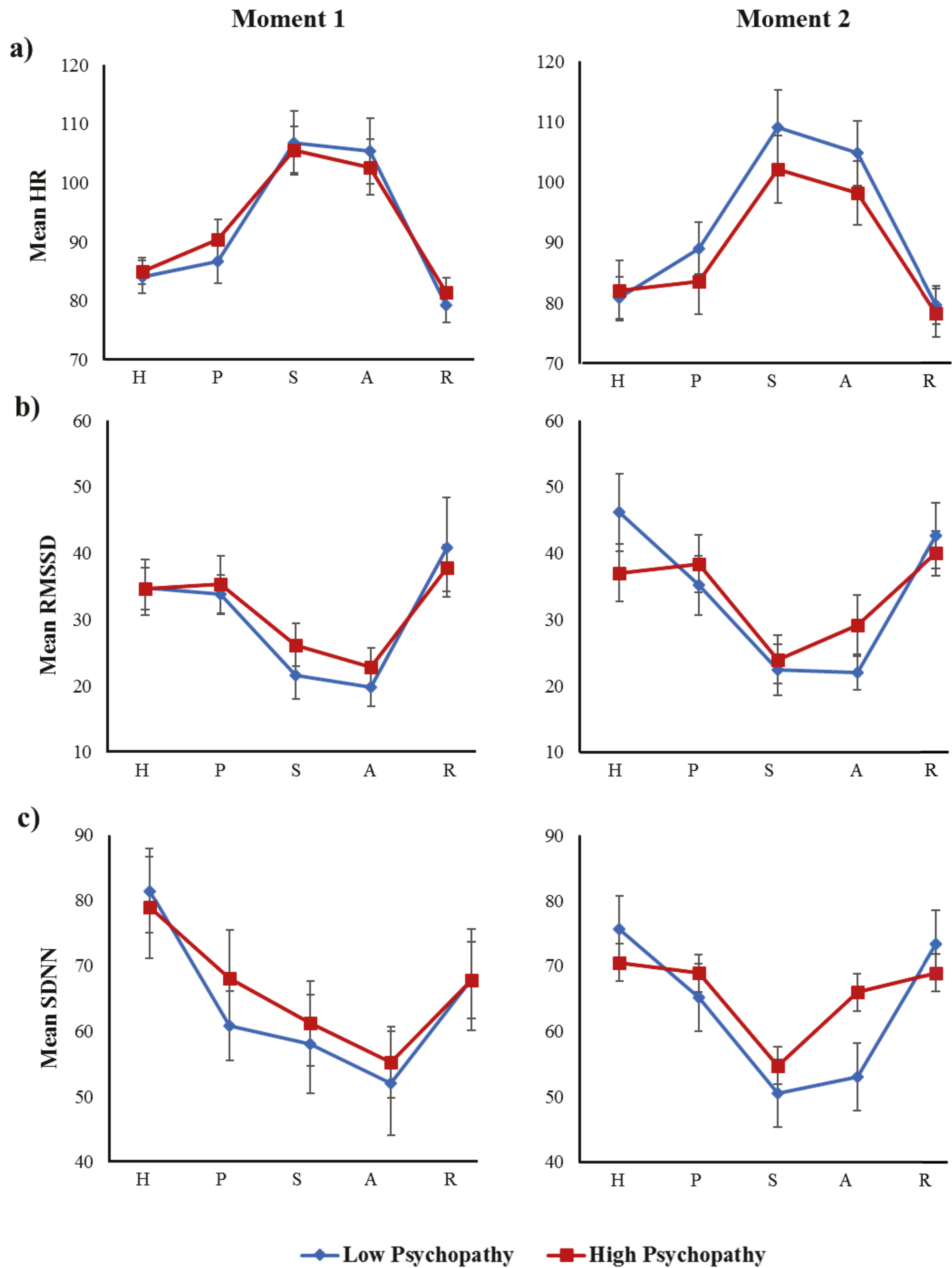

Figure 2. Mean Values for (a) HR, (b) RMSSD and (c) SDNN in the Habituation, Preparation, Speech, Arithmetic and Recovery Phases for Moment 1 (Left) and Moment 2 (Right) by Psychopathy Group. Error bars represent standard errors.

3.4. State Anxiety (STAI-S)

The repeated measures model revealed a significant main effect of *Time*, $F_{(1,19)}$ = 15.5, p = .001, η^2_p = .449, with multiple comparisons demonstrating that state anxiety is higher After the TSST (M = 40.2, SD = 7.68) when compared with Before the TSST (M = 33.4, SD = 6.75, p = .001). Furthermore, the test revealed a statistically significant *Moment* * *Phase* interaction, $F_{(1,19)}$ = 8.48, p = .009, η^2_p = .309, given that in Moment 1, state anxiety is higher After the TSST when compared with the state anxiety Before the TSST (p < .001), whereas in Moment 2 there were no statistically significant differences between the state anxiety Before the TSST when compared with the state anxiety After the TSST (p = .522). The test did not reveal a significant main effect of *Moment* or *Psychopathy* (both F < 1). No first-order nor second order interaction effects were found (all F < 1.15, p > .057).

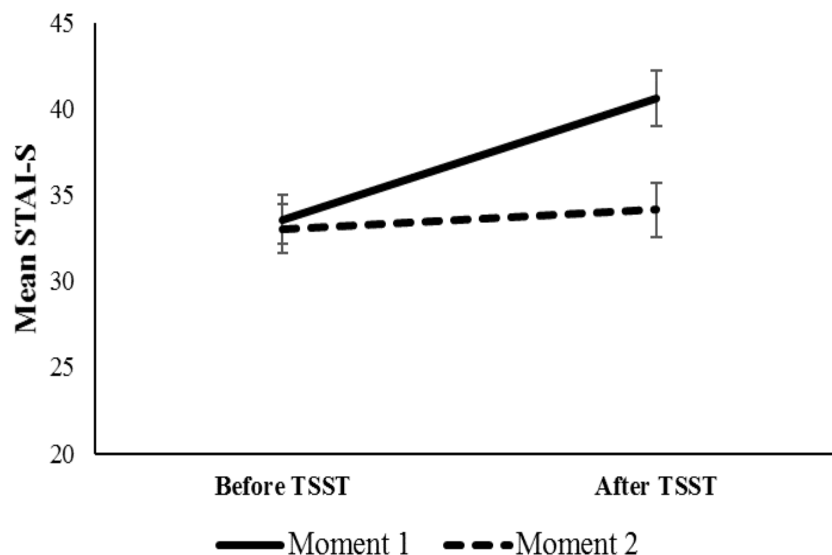

Figure 3. Mean Values for STAI-S Before and After the TSST for Moment 1 (Left) and Moment 2 (Right). Error bars represent standard errors.

4. Psychopathic Traits as Predictors of TSST Reactivity

4.1. Phenotypic Traits of Psychopathy as Predictors of HR and HRV

The regression models for HR and HRV delta indexes in response to the psychosocial stressor are displayed for Moment 1 (Table 3) and Moment 2 (Table 4), while Figure 4 and Figure 5 show the scatter plots for the significant predictor (Boldness).

Table 3

Linear Regression Statistics with Boldness, Meanness and Disinhibition as Predictors for HR, RMSSD and SDNN in terms of AUCi, Delta Speech, and Delta Arithmetic in Moment 1

Cardiac Index	Predictors	AUCi					Δ Speech					Δ Arithmetic				
		F	*p*	Adj.R^2	*β*	*β p*	*F*	*p*	Adj.R^2	*β*	*β p*	*F*	*p*	Adj.R^2	*β*	*β p*
	Boldness				-0.169	.482				-0.276	.232				-0.301	.193
HR	Meanness	0.317	.813	.048	0.186	.548	0.594	.626	.082	-0.044	.883	.649	.593	.089	0.133	.650
	Disinhibition				0.010	.975				0.198	.507				-0.042	.888
	Boldness				0.442	.055				0.462	**.023**				0.471	**.020**
RMSSD	Meanness	1.509	.244	.233	0.012	.967	5.962	.023	.213	-0.001	.996	6.273	**.020**	.222	-0.092	.647
	Disinhibition				-0.249	.388				-0.144	.477				-0.209	.296
	Boldness				0.422	**.045**				0.455	**.026**				0.476	**.019**
SDNN	Meanness	4.547	**.045**	.178	0.035	.870	5.741	.026	.207	0.016	.938	6.428	.019	.226	0.013	.950
	Disinhibition				-0.357	.084				-0.305	.125				-0.329	.092

Note: AUCi = Area Under the Curve with respect to increase, Δ Speech = Delta Speech, Δ Arithmetic = Delta Arithmetic, *F* = F Model, *p* = Significance value, Adj.R^2 = Adjusted R^2, *β* = Standardized beta coefficient, *β p* = Significance value of Standardized beta coefficient. Significant models refer to the best subset regression model; Non-significant models refer to the global model with the three predictors.

Table 4

Linear Regression Statistics with Boldness, Meanness and Disinhibition as Predictors for HR, RMSSD and SDNN in terms of AUCi, Delta Speech, and Delta Arithmetic in Moment 2

Cardiac Index	Predictors	AUCi					Δ Speech					Δ Arithmetic				
		F	p	Adj.R^2	β	$\beta\ p$	F	p	Adj.R^2	β	$\beta\ p$	F	p	Adj.R^2	β	$\beta\ p$
HR	Boldness	0.742	.542	.116	-0.046	.845	0.461	.713	.075	-0.063	.791	0.405	.751	.067	-0.152	.528
	Meanness				-0.024	.938				-0.022	.943				0.000	.999
	Disinhibition				-0.316	.310				-0.244	.439				-0.192	.543
RMSSD	Boldness	1.513	.247	.211	0.255	.259	1.290	.310	.185	0.203	.372	1.573	.233	.217	0.319	.160
	Meanness				0.406	.174				0.459	.133				0.296	.313
	Disinhibition				-0.101	.728				-0.218	.461				0.001	.996
SDNN	Boldness	1.601	.226	.220	0.407	.077	1.580	.231	.218	0.373	.103	4.436	.049	.189	0.435	.049
	Meanness				0.257	.379				0.307	.296				0.034	.877
	Disinhibition				-0.278	.339				-0.344	.242				-0.69	.749

Note. AUCi = Area Under the Curve with respect to increase, Δ Speech = Delta Speech*,* Δ Arithmetic = Delta Arithmetic*,* F = F Model, p = Significance value, Adj.R^2 = Adjusted R^2*,* β = Standardized beta coefficient, $\beta\ p$ = Significance value of Standardized beta coefficient. Non-significant models refer to the global model with the three predictors.

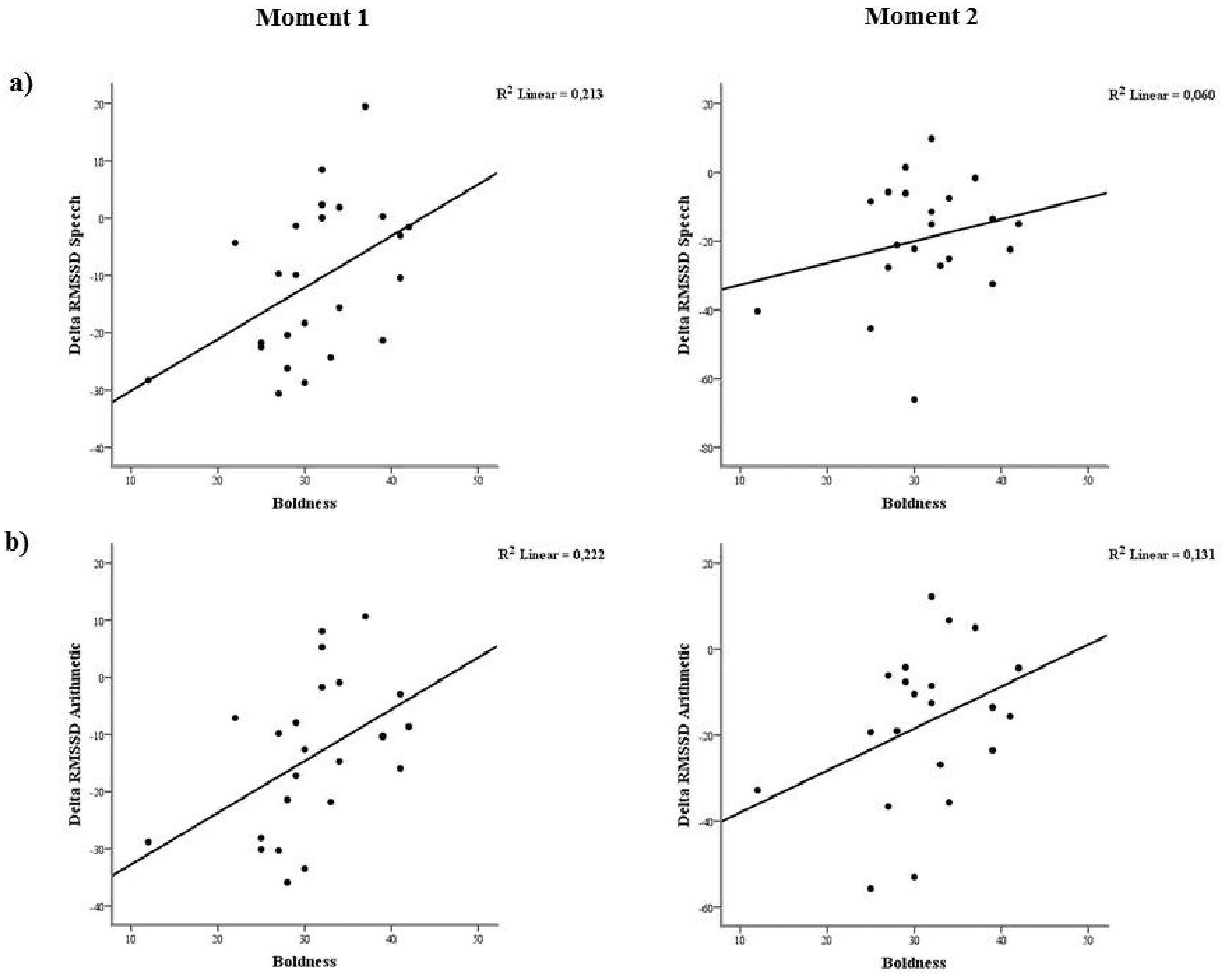

Figure 4. Scatter Plots for Boldness as a significant predictor of (a) Delta RMSSD Speech, and (b) Delta RMSSD Arithmetic, for Moment 1 (Left) and Moment 2 (Right).

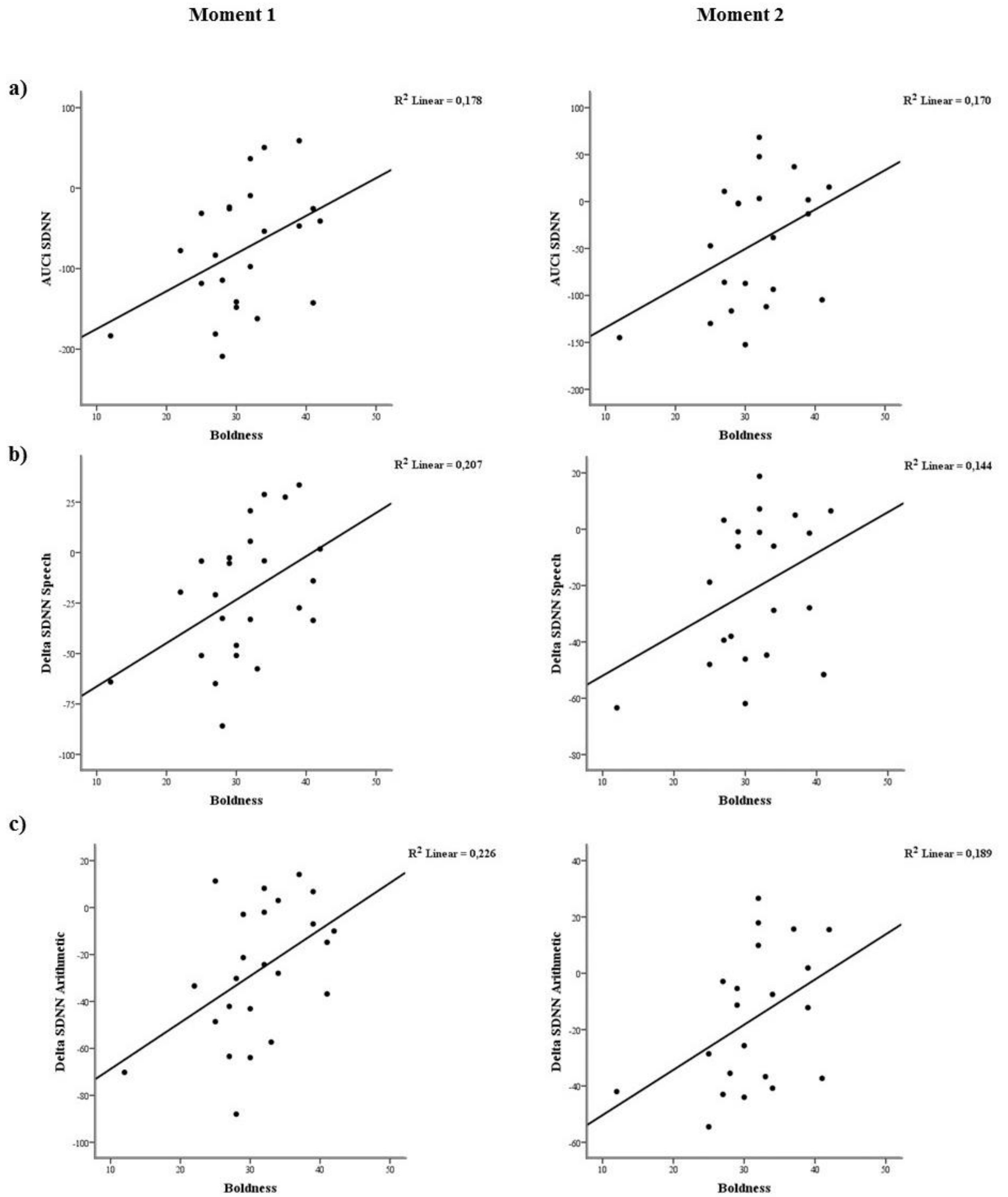

Figure 5. Scatter Plots for Boldness as a significant predictor of (a) AUCi SDNN, (b) Delta SDNN Speech and (c) Delta SDNN Arithmetic, for Moment 1 (Left) and Moment 2 (Right).

4.2. Phenotypic Traits of Psychopathy as Predictors of STAI-S Variance

The regression model of phenotypic psychopathy traits as predictors of STAI-S variance did not reach significance for Moment 1, ($F < 1$).[1] However, for Moment 2, the regression model of phenotypic psychopathy traits as predictors of STAI-S variance presents Boldness as a significant predictor of state-anxiety, $F_{(1,19)} = 6.96$, $p = .021$, adj$R^2 = .212$, $\beta = -.501$, indicating that higher Boldness values are associated with a lower variance of state anxiety from before to after TSST (Figure 6).

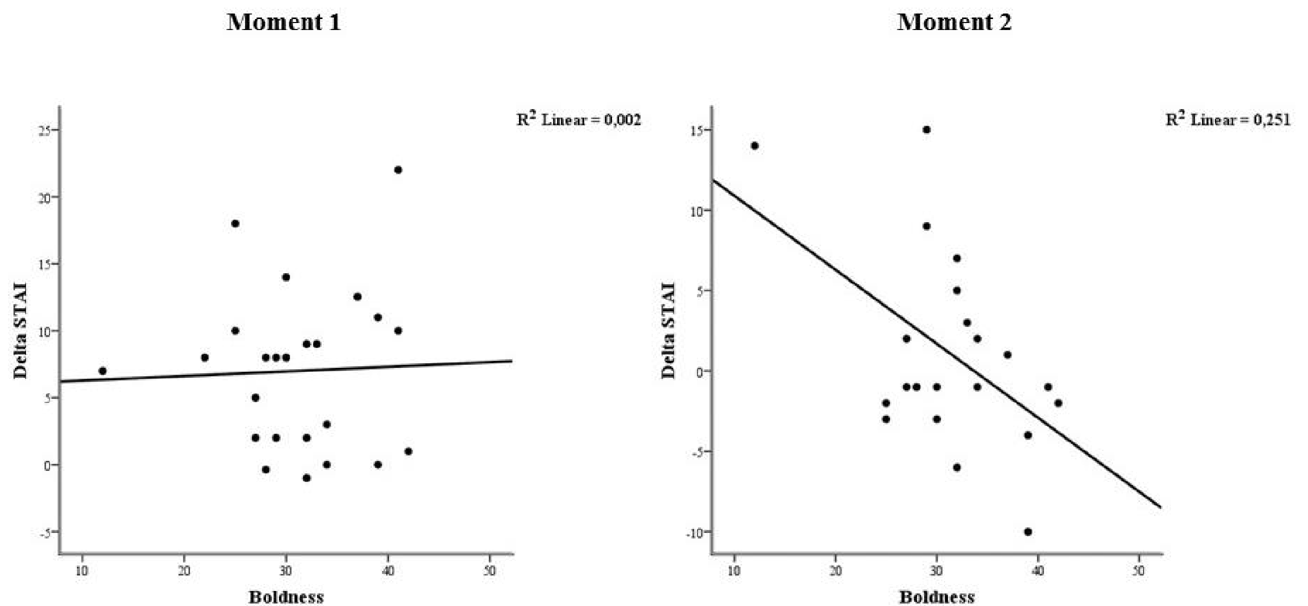

Figure 6. Scatter Plots for Boldness as a significant predictor of Delta STAI-S for Moment 1 (Left) and Moment 2 (Right).

4.3. Phenotypic Traits of Psychopathy as Predictors of Habituation

The results of the repeated measures ANOVAs revealed no significant effects of *Moment* nor interaction of *Moment* with the psychopathic traits included as covariates (Boldness, Meanness and Disinhibition) for neither the cardiac indexes of AUCi, Delta Speech and Delta Arithmetic of HR, RMSSD and SDNN, nor Delta STAI-S (all $F < 4.39$, all $p > .05$)

[1] Adj$R^2 = -.142$; Standardized β: .025 for Boldness; -.046 for Meanness; .095 for Disinhibition.

Discussion

The present study examined the influences of psychopathy traits on a community sample regarding the reactivity to repeated exposure to psychosocial stress, induced by the TSST, and habituation to such stressor.

With regard to stress induction, the cardiac measures, both heart rate and heart rate variability, measured by SDNN and RMSSD, and self-reported state anxiety, exhibited the expected significant increases associated with the exposure to the stressor, which demonstrates that the experimental protocol effectively induced stress responses.

On the first exposure to the stressor, there were no observable differences on stress responses between participants with higher and lower psychopathy scores. This goes against the hypothesis presented which stated that individuals scoring higher on psychopathy would should a lesser stress response than individuals scoring lower.

On the second exposure to the stressor, individuals with lower and higher scores of global psychopathy displayed distinct heart rate responses during the TSST. There were no differences accounted by both heart rate variability measures, SDNN and RMSSD, or for state anxiety. Due to the lack of a proper sample size to conduct a decomposition of the Phase * Moment * Psychopathy interaction on heart rate response, it was not possible to reliably confirm the hypothesis stating that individuals with higher scores on global psychopathy would display greater habituation to psychosocial stress. Nonetheless, it seems that the significant interaction that was encountered is mediated by a reduced heart rate response of the higher psychopathy group during the exposure to the stressor on the second session.

Further, when analysing psychopathy by its different traits, none appeared associated with the habituation response between exposures, which goes against the hypothesis regarding Boldness as a predictor of greater habituation to stress.

Although global scores of psychopathy were not associated to differences on the self-reported levels of state anxiety, the significant increase on state anxiety from before the TSST to after the TSST that appeared on the first exposure to the stressor, disappeared on the second exposure. In other words, the exposure to the TSST for a second time did not induce anxiety, and this was observed for all participants, regardless of psychopathy scores. Interestingly, higher Boldness significantly predicted lower levels of state anxiety after the TSST on the second exposure to the stressor, but not on the first.

Boldness also emerges as predictor of higher levels of heart rate variability on the first exposure to the stressor. For the second exposure, the higher heart rate variability response associated with the Boldness trait is no longer evident. This partially confirms the hypothesis stating higher Boldness score as a predictor of lower stress induced responses. As for the heart rate measure, none of the psychopathic traits emerged as a significant predictor.

Although the results from the first exposure to the stressor, concerning global psychopathy scores, do not add up to the empirical findings regarding the association between psychopathy and low stress response (Patrick, 1994; O'Leary et al., 2007), the second exposure to the stressor brings to light this association, albeit in a subtle manner, given that it is necessary to consider a cubic trend and this effect is only observable when analysing the graphics (see Figure 2).

The trait analysis provides further insight into the foundations of stress reactivity on psychopathy. Boldness appearing as a trait predictor of higher heart rate variability on the first exposure, but not the second, while at the same time predicting a lower perceived stress response on the second exposure but not the first, seems to be counterintuitive, at first sight. In fact, if we consider the role of heart rate variability in regulation (Porges, 1992), more specifically the association between higher heart rate variability and the regulation of stressful thoughts as an effective strategy to overcome demanding circumstances (Beauchaine, 2001; Segerstrom & Nes, 2007), as well as the ability to flexibly respond and adapt to environmental challenges (Thayer & Lane, 2009), it is coherent that lower perceived state anxiety levels do not appear contiguous to higher levels of heart rate variability. This could further highlight the importance of the Boldness trait relative to adaptive, and even advantageous, psychological functioning (Lilienfeld, Watts, & Smith, 2015).

The present results must be considered in light of study limitations. The modest sample size and high homogeneity of the sample in regards of age, gender, race and education, do not allow for generalization of the results and has prevented a more comprehensive investigation, which makes these results preliminary. The necessity of using multiple regressions in this study also represents a problem of multiple testing, given that a set of statistical inferences made simultaneously increases the likelihood of erroneous inferences to occur.

It is also of significance to comprehend that a social stress test performed in a laboratory setting cannot entirely reflect how individuals react on the day to day basis,

where real-life stressors have no time or space delimitations and, as so, generate more varied and longstanding responses.

Apart from the limitations it brings, using a sample composed solely of healthy, young, male subjects also means that the findings cannot be due to the influence of factors such as age, gender or clinical conditions. A young population, in addition to having a higher magnitude of heart rate responses (Carrol et al., 2000), has less likelihood of being affected by medical conditions or other somatic disorders, making it a favourable population to study the psychophysiological stress responses, as it minimizes confounding variables.

The findings attained succeeded in presenting additional evidence to support the usage of a psychopathic trait classification in psychopathy-related investigation, as different components of the triarchic model of psychopathy seem to enable the understanding of different aspects or associations to other continuum variables, such as stress.

Nonetheless, future research should be done on samples that are composed by a greater number of participants, to assess a wider range of scores, more heterogeneous in variables like age, gender, and education, in order to further investigate the interactive effects of psychopathic traits and induced psychosocial stress reactivity. Female subjects should be included in future studies to explore sex differences, taking into account the menstrual cycle, as it has been shown that menstrual cycle phases influence the HPA axis response to acute stress (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999; Kudielka & Kirschbaum, 2005). The habituation effects invoked by the repeated exposure to induced stress and its influence on physiological measures would also profit in being investigated more extensively.

Moreover, and although the assessment of singular contributions of the various components of the TSST (anticipatory period, public speaking and mental arithmetic) was not a primary goal of this study, doing so could grant a valuable insight to further understand certain aspects of the pattern of stress response.

The present findings preclude drawing any definitive conclusions, and replication is needed before further and firmer conclusions can be achieved. However, they offer interesting suggestions and increase the evidence concerning the relationship between psychopathic traits and overall psychophysiological response invoked by repeated exposure to induced psychosocial stress.

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