Cardiac response and anxiety levels in psychopathic murderers

Resposta cardíaca e nível de ansiedade em homicidas psicopatas

Antonio de Pádua Serafim,[1] **Daniel Martins de Barros,**[1]
André Valim,[1] **Clarice Gorenstein**[2,3]

Abstract
Objective: *To compare the emotional response and level of anxiety of psychopathic murderers, non-psychopathic murderers, and non-psychopathic non-criminals.* ***Method:*** *110 male individuals aged over 18 years were divided into three groups: psychopathic murderers (n = 38); non-psychopathic murderers (n = 37) serving sentences for murder convictions in Maximum Security Prisons in the State of Sao Paulo; and non-criminal, non-psychopathic individuals (n = 35) according to the Psychopathy Checklist-Revised. The emotional response of subjects was assessed by heart rate variation and anxiety level (State-Trait Anxiety Inventory) after viewing standardized pictures depicting pleasant, unpleasant and neutral content from the International Affective Picture System.* ***Results:*** *Psychopathic murderers presented lower anxiety levels and smaller heart rate variations when exposed to pleasant and unpleasant stimuli than non-psychopathic murderers or non-psychopathic non-criminals. The results also demonstrated that the higher the score for factor 1 on the Psychopathy Checklist-Revised, the lower the heart rate variation and anxiety level.* ***Conclusion:*** *The results suggest that psychopathic murderers do not present variation in emotional response to different visual stimuli. Although the non-psychopathic murderers had committed the same type of crime as the psychopathic murderers, the former tended to respond with a higher level of anxiety and heart rate variation.*

Descriptors: *Multiple personality disorder; Heart rate; Anxiety; Murder; Violence*

Resumo
Objetivo: *Comparar a atividade cardíaca e nível de ansiedade de homicidas psicopatas e não psicopatas e não criminosos não psicopatas.* ***Método:*** *110 homens com idade superior a 18 anos, divididos em três grupos: homicidas psicopatas (n = 38), homicidas não psicopatas (n = 37) cumprindo pena por homicídio em Prisões de Segurança Máxima do Estado de São Paulo e não criminosos e não psicopatas (n = 35) de acordo com a Escala de Avaliação de Psicopatia. A resposta emocional foi avaliada pela variação da freqüência cardíaca e níveis de ansiedade após a observação por seis segundos de imagens padronizadas de diferentes conteúdos emocionais (agradáveis, desagradáveis e neutras) do* International Affective Picture System. ***Resultados:*** *Homicidas psicopatas apresentaram menores níveis de ansiedade e menor variação de frequência cardíaca quando expostos a estímulos agradáveis que os homicidas não psicopatas e o grupo de não criminosos e não psicopatas. Os resultados demonstram ainda que quanto maior o escore no fator 1 da Escala de Avaliação de Psicopatia, menor é a variação cardíaca e o nível de ansiedade.* ***Conclusão:*** *Os resultados sugerem que homicidas psicopatas não apresentam variação da resposta emocional frente aos diferentes estímulos visuais. Embora os homicidas não psicopatas compartilhem do mesmo tipo crime que os psicopatas, estes tendem a responder com maior nível de ansiedade e variação cardíaca.*

Descritores: *Transtorno de personalidade múltipla; Frequência cardíaca; Ansiedade; Homicídio; Violência*

[1] Forensic Psychiatry and Psychology Program, Institute and Department of Psychiatry, Medical School, Universidade de São Paulo (USP), São Paulo (SP), Brazil
[2] Laboratory of Psychopharmacology (Lim-23), Institute and Department of Psychiatry, Medical School, Universidade de São Paulo (USP), São Paulo (SP), Brazil
[3] Departament pf Pharmacology, Institute of Biomedical Sciences (ICB), Universidade de São Paulo (USP), São Paulo (SP), Brazil

Correspondence
Antonio de Pádua Serafim
Programa de Psiquiatria e Psicologia Forense
Instituto de Psiquiatria – USP
Rua Ovídio Pires de Campos, 785 - 1º andar, Bloco Sul
05403-010 São Paulo, SP, Brazil
Phone: (+55 11) 3069-7929; fax: (+55 11) 3069-7929
E-mail: apserafim@hcnet.usp.br

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Introduction

A number of studies have established a significant association between personality disorders (anti-social, dependent, paranoid and borderline personalities) and criminal behavior.[1-5] Psychopathy, the most severe degree of anti-social personality disorder, is the most strongly associated with violent crimes.[1,6,7]

The term psychopathy is used to describe individuals presenting a strong tendency towards criminal behaviors, high criminality recurrence rates, notable affective indifference (lack of remorse or guilt and shallow affect) and anti-social behaviors.[7,8] An estimated 20% to 40% of prison inmates fulfill criteria for psychopathy[1] according to the Psychopathy Checklist Revised (PCL-R), the most commonly used diagnostic instrument for psychopathy in the forensic field.[7-12]

The violent behavior of psychopaths is associated with a psychological profile characterized by pathological egocentrism and inability to establish affective bonds (their relationships serve to fulfill their own needs and interests), inadequate empathic response, complete absence of remorse, and deficiencies in emotional and anxiety responses.[8,11,13]

Studies on emotional responses in psychopaths suggest that during the perpetration of violent acts, including homicides, they do not manifest the normal emotional responses (usually fear) or physiological reactions (e.g. pupil dilation, tachycardia and tachypnea).[14] These individuals display violent behaviors in a pattern akin to predatory aggression, which is typically planned, purposeful, with little or no sympathetic activation, and emotionless – "cold-blooded".[12,14-16]

The emotional responses of psychopathic criminals also differ from those of non-psychopathic non-criminals under experimental conditions.[17] For instance, when viewing images with varied emotional content associated with unexpected sounds, non-psychopathic non-criminal individuals respond with more intense surprise reactions (blinking, for example) when exposed to negative or unpleasant images (blood or mutilation) than when observing pleasant or positive images. Affectively-neutral images evoke an intermediate response. Psychopaths, however, have a different reaction pattern, with minimal facial muscle activation regardless of the images presented.[17]

Studies of emotional responses in psychopaths have established skin conductance and heart rate as the main physiological markers of psychopathy. In general, these parameters are lower under experimental conditions than those of non-psychopathic criminals or non-criminals.[12,15,17-19] However, previous studies have analyzed heterogeneous samples of criminals, and have not controlled for crime typology (homicide, kidnapping, rape etc.), hampering assessment of specifically crime-associated aspects.

In this study, we have investigated anxiety response and heart rate during the viewing of neutral, pleasant and unpleasant stimuli drawn from the International Affective Picture System (IAPS) in psychopathic and non-psychopathic murderers convicted of homicide and serving sentences in Maximum Security Prison facilities in the State of Sao Paulo, compared to a group of non-criminal, non-psychopathic controls. This experimental procedure has allowed us to corroborate data from the literature on emotional aspects of psychopaths in a sample of criminals in the Brazilian context. We have verified that individuals who have committed the same type of violent crime, in this case homicide, have different anxiety and heart rate responses under controlled experimental conditions.

Method

Subjects for the criminal groups were selected from male individuals aged 18 years or older who had committed homicides, were serving prison sentences, and had their sanity attested by the Institute of Social Medicine and Criminology of São Paulo (IMESC), between 2002 and 2006. According to forensic psychiatry, sanity means that the person has critical understanding of or control over their actions and does not suffer from a psychiatric condition (otherwise the criminal would be sent to a Secure Hospital and not to jail).

Out of 146 individuals who met these criteria, 100 were randomly selected. Of these, 10 were not found by the IMESC (they had been transferred to other units or had escaped from prison) while 15 refused to participate. The control group comprised individuals without criminal records. The total of 110 subjects was divided into three groups, using the PCL-R criteria for psychopathy:

Group 1: psychopathic murderers – 38 individuals convicted of homicide in accordance with the Brazilian Penal Code (mean age 31.8 years, 95% CI [31.4;32.2]).

Group 2: non-psychopathic murderers – 37 individuals convicted of homicide in accordance with the Brazilian Penal Code (mean age 35.4 years, 95% CI [35.1;35.7]).

Group 3: non-psychopathic non-criminals (controls) – 35 male individuals (recruited from university students and staff from different occupations, technical professionals from hospitals and administrative services) without criminal records and without diagnosis of psychopathy (mean age 32.9 years, 95% CI [32.4;33.4]). Exclusion criteria for all groups were: previous psychotic episode, epilepsy, mental retardation, dementia, previous psychiatric hospitalization and use of psychiatric medication. This study was approved by the Ethics Commission for the Analysis of Research Projects of the Clinical Hospital of the School of Medicine of the University of São Paulo (CAPPesq, research project 144/02, approved on September 26, 2002). All subjects signed informed consent forms.

All murderers, psychopathic and non-psychopathic, were considered accountable, i.e., fully capable of understanding the illegal nature of their acts under the Brazilian Penal Code.

1. Material

1) Instruments

Psychopathy Checklist-Revised (PCL-R)[7,8] – structured interview containing 20 items evaluating the degree of psychopathy on a 40-point scale, examining two interrelated factors: Affective Insensitivity and Anti-social Behavior. An individual is considered a psychopath if they obtain a score $p \geq 30$, according to the cutoff point used for research into or forensic classification of psychopathy.[7,8]

State–Trait Anxiety Inventory (STAI)[20] – evaluates anxiety levels at a given moment (state anxiety; STAI-S) and the predisposition to anxiety states (trait anxiety; STAI-T). Brazilian normative data for the trait scale[21] are: low score ≤ 33, average score 33-49 and high score > 49.

International Affective Picture System (IAPS)[22] – composed of hundreds of color photographs depicting diverse aspects of real life (sports, fashion, landscapes, violence etc.) capable of inducing a broad spectrum of emotional states (pleasant, unpleasant and neutral). We selected 54 images (codes available upon request) from the neutral (domestic objects), pleasant (feminine nudity and erotic scenes) and unpleasant (mutilated people and scenes of aggression) affective groups of the Brazilian validated version of the IAPS.[23] Image selection was based on previous studies with psychopaths.[17,18]

2) Equipment

Dixtal Pulse Oximeter (1DX 2405 OXIPLETH) with portable monitor and internal printer calibrated to continuously monitor heart rate through a *Super-Bright* 8700 series digital sensor.

3) Experimental procedure

Images were presented on a notebook with a 14" screen, placed 40 cm from the observer, in three balanced sequences, each consisting of 3 blocks of 6 images (totaling 18 neutral, 18 pleasant and 18 unpleasant images). Each block was inserted randomly at the beginning, middle or end of each of the three sequences. Each image was shown for 6 seconds and each block was separated by a grey screen also lasting for 6 seconds.

Heart rate was monitored before the image presentation (baseline), and simultaneously with the visual stimuli, followed by STAI-T. The full experimental procedure was performed subject by subject in 6 Maximum Security prisons in the state of São Paulo.

2. Statistical analysis

The analysis was performed using SPSS for Windows version 14.0. Groups were compared according to their Anxiety and PCL-R scores through Analysis of Variance (ANOVA). A normal distribution was not rejected by the Kolmogorov-Smirnov test. A Two-Way Repeated Measures ANOVA, with group as the between-subject effect, and experimental situation as the within-subject effect, was used for heart rate, and Tukey's post-hoc test was performed. Correlation between factor 1 of the PCL-R and levels of anxiety and heart rate was measured by Pearson's Correlation Coefficient. Multiple Linear Regression was used to investigate the association of PCL-R (factor 1) with heart rate and level of anxiety. The level of significance was 5% in all tests.

Results

PCL-R scores for all three groups are shown in Table 1. The three groups differed on all parameters. Psychopathic murderers present higher scores than the other two groups (31.5, 95% CI [31.1;31.9] *vs.* 20.9, 95% CI [20.3;21.5] and 4.9, 95% CI [4.6;5.2] for non-psychopathic murderers and non-psychopathic non-criminals, respectively; ANOVA $p < 0.001$).

The average heart rate of psychopathic murderers presented no significant variation according to the type of image observed (62.9, 95% CI [62.0;63.8] for neutral images; 62.8, 95% CI [61.8;63.7] for pleasant images; and 62.1, 95% CI, [61.0;63.2] for unpleasant images), Figure 1. Non-psychopathic murderers showed a significant increase in heart rate during observation of pleasant images (64.2, 95% CI [62.8;65.6], $p < 0.001$). Heart rate of non-psychopathic non-criminals was always higher than baseline during image projection, regardless of emotional content (75.1, 95% CI [72.4;77.8] for neutral images; 71.2, 95% CI [68.6;73.8] for pleasant images; and 78.5, 95% CI [75.1;81.9] for unpleasant images), but lower for neutral images than for pleasant images ($p < 0.001$) (Figure 1).

The lowest average levels of anxiety in the STAI-trait and -state (Table 2) were found among psychopathic murderers (26.7, 95% CI [25.3;28.1] and 29.5, 95% CI [28.0;31.0], respectively, $p < 0.001$) while trait anxiety of non-psychopathic murderers was significantly lower than for non-psychopathic non-criminals ($p < 0.001$).

There was a negative correlation between factor 1 of the PCL-R of homicidal psychopathic murderers' heart rate during the viewing of neutral ($r = -0.640$, $p < 0.001$), pleasant ($r = -0.531$, $p < 0.001$) and unpleasant images ($r = -0.667$, $p < 0.001$). Although low, a negative correlation was also found between this factor and trait anxiety ($r = -0.375$, $p = 0.020$) of homicidal psychopathic murderers.

Multiple linear regression modeling showed that factor 1 of the PCL-R explained 44.8% (Prob $F < 0.0001$) of heart rate variance for neutral (coefficient: -0.326, $p < 0.001$) and pleasant images (coefficient: -0.354, $p < 0.001$) and state anxiety (coefficient: -0.118, $p < 0.01$).

Discussion

Using the PCL-R instrument (factor 1 affective insensitivity and factor 2 anti-social behavior) to evaluate psychopathy[7,8] demonstrated that individuals who committed the same type of crime (murder), living in the same environment (prison) and presenting the same behavior patterns (aggressive) are remarkably different in terms of factor 1 psychic characteristics. Psychopathic murderers present a much higher frequency and degree of superficial charm, excessive self-valuation, pathological lying, absence of remorse or guilt, affective insensitivity and lack of empathy. The two criminal groups were similar for factor 2 characteristics: parasitic lifestyle, need for stimulation, poor behavior control, impulsivity and irresponsibility.

The difference in the level of affective insensitivity (PCL-R factor 1) may explain the different homicidal behaviors of the two groups: while psychopathic murderers (highest level of insensitivity) tend to present operative or predatory aggression, i.e., planned and calculated acts,[18,24-27] the non-psychopathic murderers (higher level of sensitivity) fulfill criteria for reactive or affective aggression. This latter type of aggressive behavior tends to manifest as a response

Table 1 – PCL-R Scores for psychopathic murderers (n = 38), non-psychopathic murderers (n = 37), and non-psychopathic non-criminals (control group; n = 35)

Variable	Group	Mean	Standard Desv.	p	Multiple comparisons	
PCL1	Psychopathic murderers	13.9	1.1	< 0.001	P *vs.* NP	< 0.001
	Non-psychopathic murderers	8.8	1.4		P *vs.* C	< 0.001
	Controls	2.4	0.8		NP *vs.* C	< 0.001
PCL2	Psychopathic murderers	14.4	1.3	< 0.001	P *vs.* NP	< 0.001
	Non-psychopathic murderers	10.1	1.4		P *vs.* NP	< 0.001
	Controls	1.9	0.7		NP *vs.* C	< 0.001
PCLT	Psychopathic murderers	31.5	1.3	< 0.001	P *vs.* NP	< 0.001
	Non-psychopathic murderers	20.9	1.4		P *vs.* C	< 0.001
	Controls	4.9	1.0		NP *vs.* C	< 0.001

P: Psychopathic murderers; NP: Non-psychopathic murderers; C: Control group (Non-psychopathic non-criminals); PCL1: factor 1 – affective insensitivity; PCL2: factor 2 – anti-social behavior; PCLT: total score.
Differences were tested through ANOVA and multiple comparisons through Tukey´s test. P-values were described for both cases.
Obs: Psychopathy cutoff: PCLT ≥ 30[9]; Average score for general population PCLT ≤ 7); Total PCL score corresponds to the sum of factor 1 and 2 plus three additional aspects: Promiscuous sexual behavior, Many short-term marital relationships and Criminal versatility (Psychopathic murderers: 3.2; Non-psychopathic murderers: 2.0 e controls: 0).

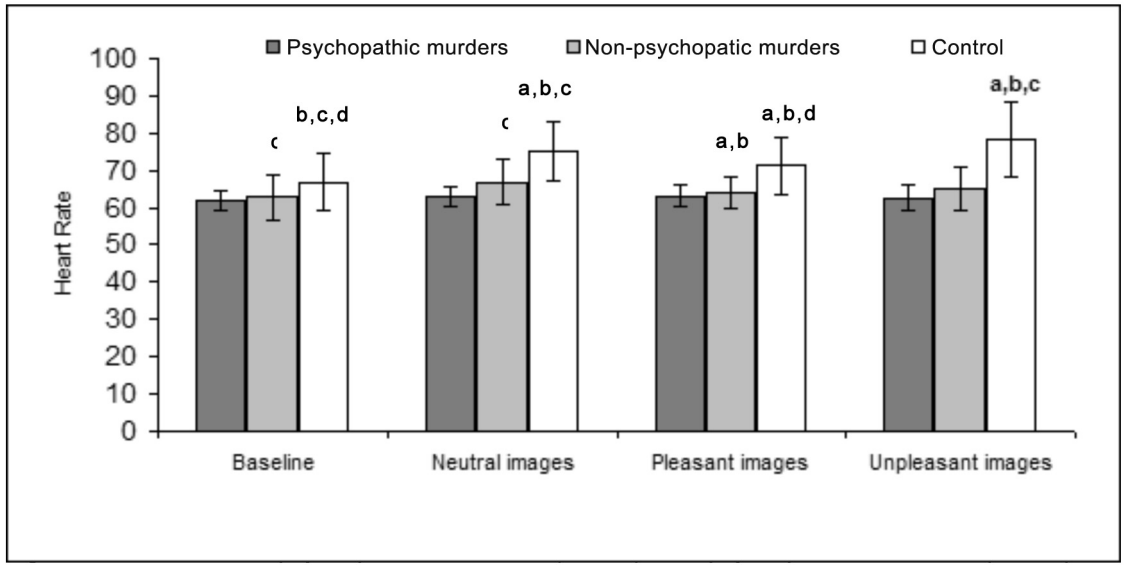

Figure 1 – Heart rate of psychopathic murderers (n = 38), non-psychopathic murderers (n = 37) and non-psychopathic non-criminals (control group; n = 35) during observation of pleasant, neutral and unpleasant images

Data express heart rate mean±standard deviation for each group (P: Psychopathic Murderers, NP: Non-Psychopathic Murderers, C: Control group – Non-psychopathic non-criminals); p < 0.05 was considered significant (two-way repeated measures ANOVA followed by Tukey´s test). a: different from baseline (p < 0.0001); b: different from neutral images (p < 0.001); c: different from pleasant images (p < 0.001); d: different from unpleasant images (p < 0.001).
Baseline: the heart rate of the subjects before the presentation of visual stimuli.

to frustration, that is, without previous planning. It is possible that non-psychopathic murderers present a higher level of impulsivity than psychopathic murderers, although further studies are required to verify this hypothesis.

The characteristics outlined above suggest that a possible difference between psychopathic murderers and non-psychopathic murderers does not lie in the behaviors themselves, since both groups can express their aggression violently. The central difference may be in the psychological constitution associated with PCL-R factor 1, that is, affective insensitivity (absence of remorse or guilt, lack of empathy, inability to accept personal responsibility). In fact, this factor proved to be negatively correlated with physiological and anxiety changes, and was corroborated by the multiple regression analysis.

Different emotional deficits in murderers were observed in the present study, evidenced by anxiety and heart rate response.[16,17,28] When exposed to images with varied emotional content, psychopathic murderers presented lower heart rates than controls regardless of the nature of the visual stimuli. The lack of variation in heart rate in relation to the type of image corroborates the affective indifference described in psychopaths.[12,16,17]

Non-psychopathic murderers fell midway between controls and psychopathic murders in terms of response to pleasant images (scenes of sex and nudity): they were less reactive than controls but presented significantly greater variation compared to psychopathic murderers. These images may have evoked affective memories of experiences inaccessible in their prison environment. On the other hand, it is possible that the unpleasant images (scenes of aggression and mutilation) used in this study were part of the everyday lives of these individuals and were therefore insufficiently intense to modify heart rate. The low anxiety scores presented by psychopaths compared to the other groups is also consistent with literature,[28-30] suggesting that psychopathic murderers have a lower capacity to experience anxiety in response to emotional stimuli, coupled with a low variation of heart rate in response to pleasant stimuli.[19]

In conclusion, this study found that psychopathic murderers present both low anxiety level and low heart rate variation when exposed to pleasant and unpleasant stimuli compared to non-psychopathic murderers and non-psychopathic non-criminals. In addition, although non-psychopathic murderers may commit the same crimes as psychopaths, their emotional responses are clearly distinct.

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Table 2 – State and Trait Anxiety Inventory scores for Psychopathic murderers (n = 38), Non-psychopathic murderers (n = 37) and Non-psychopathic non-criminals (control group; n = 35)

Variable	Group	Mean	Standard Desv.	Median	p	Multiple comparisons	
Trait-Anxiety	Psychopathic murderers	26.7	4.4	26.0	< 0.001	P *vs.* NP	< 0.001
	Non-psychopathic murderers	36.6	6.1	35.0		P *vs.* C	< 0.001
	Controls	43.9	12.0	44.0		NP *vs.* C	< 0.001
State-Anxiety	Psychopathic murderers	29.5	4.6	29.0	< 0.001	P *vs.* NP	< 0.001
	Non-psychopathic murderers	40.4	7.2	40.0		P *vs.* C	< 0.001
	Controls	41.8	10.1	42.0		NP *vs.* C	0.767

P: Psychopathic murderers; NP: Non-psychopathic murderers; C: Control group (Non-psychopathic non-criminals).
Differences were tested through ANOVA and multiple comparisons through Tukey´s test. P-values are described for both cases.

Disclosures

Writting group member	Employment	Research grant[1]	Other research grant or medical continuous education[2]	Speaker's honoraria	Ownership interest	Consultant/ Advisory board	Other[3]
Antonio de Pádua Serafim	IPq-HC-FMUSP	-	-	-	-	-	-
Daniel Martins de Barros	IPq-HC-FMUSP	-	-	-	-	-	-
André Valim	IPq-HC-FMUSP	-	-	-	-	-	-
Clarice Gorenstein	Instituto de Ciências Biomédicas - USP	-	-	-	-	-	-

** Modest*
*** Significant*
**** Significant. Amounts given to the author's institution or to a colleague for research in which the author has participation, not directly to the author.*
Note: IPq-HC-FMUSP = Instituto de Psiquiatria, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo; USP = Universidade de São Paulo. For more information, see Instructions for authors.

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