Universiteit Utrecht
Master psychologie, Toegepaste Cognitieve Psychologie

THESIS (30 ECTS)

Characterizing male adult convicts through psychophysiological measures: HR, HRV and PEP.

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15-08-2012

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Abstract

Psychophysiological measures are used in a variety of fields, one of which is criminology. Attempts to correlate such measures with aggression and psychopathy have shown promising results in children. This research tried to correlate heart rate, heart rate variability and pre-ejection period with aggression and psychopathy in adults. In an attempt to characterize a group of 19 male adult convicts, values significantly different from literature were found, which raised several questions. The various confounders which are known to influence heart rate variability were assessed and closely monitored. No significant correlations were found in this research, nevertheless raising several points of discussion. Concluding that heart rate variability is difficult to compare with other researches, this research focused on closely monitoring all methods and measures used and all variables present, to give a clear picture of this research, in order to be able to compare this with future researches.

Introduction

Psychophysiological measures are a popular way to research behavior. Promising results have been achieved with these measures. In medical fields, sports, business and even criminology several practical uses have been studied and applied. Creating insight into the human psyche often is the main reason for examining psychophysiology in humans. Psychophysiological research has enormous potential to give more insight into antisocial behavior, as it is at the interface of clinical-, cognitive- and neuroscience (Dawson, 1990). Psychophysiology is more suited than almost any other area of research to help explore the interplay between social and psychological processes on the one hand, and biological processes on the other, in relation to antisocial behavior (Raine, 1997). Important to note is that antisocial behavior encompasses a wide range of behaviors and diagnoses, among others aggression, crime, violence, psychopathy, antisocial personality disorder, conduct disorder and delinquency (Scarpa & Raine, 2003). One theory about antisocial behavior is that antisocials are chronically under aroused (Raine, 1997). This is known as the Arousal Theory, first coined by Lindsley (1951) and further researched by several other psychologists and sociologists. Raine (1998) summarizes two specific components of antisocial behavior: stimulation seeking and fearlessness. He explains that stimulation seeking behavior is hypothesized to compensate for chronically low physiological levels of arousal. And similarly, fearlessness is supposed to be due to a lack of fear conditioning. In his research, Raine (1998) also found relations between fearlessness, stimulation seeking and aggression, where increased values of fearlessness and stimulation seeking at age 3 are characteristics of aggressive children of age 11. Several other links between fearlessness, stimulation seeking and aggression, and different kinds of dimensions of aggression have been researched. Vitiello and Stoff (1997) identified two dimensions of aggression in children, namely reactive and proactive aggression. Although those terms date as far back as 1972 (Scott) and 1974 (Moyer) (Dodge & Coie, 1987).

Proactive aggression has been characterized as instrumental, organized, and "cold-blooded", with little evidence of autonomic arousal. Heightened and diffuse sensory awareness, loss of reality testing, ideational, and delusional thinking represent four core traits of reactive aggression (Raine, 2006). This is also coined as being "hot-tempered", creating the distinction between hot (reactive) and cold (proactive) aggression (Dodge, 1991).

Lorber (2004) mentions there are too few studies done to psychophysiological correlates of antisocial personality characteristics, which therefore lack contribution to his meta-analysis. Then there is also the problem of the measurement of psychophysiological measures,

especially heart rate variability. Berntson et al. (1997) warn for the complexity and pitfalls of this measure. The many possible ways of measuring heart rate variability could not only prove a difficulty in measuring, but also in comparing values with similar researches.
Traditional psychophysiological measures used to measure arousal are heart rate (HR), skin conductance response (SCR), and electroencephalogram (EEG) measures (Raine, 1997). The present research will focus on three specific types of psychophysiological measures, namely heart rate (HR), heart rate variability (HRV) and pre-ejection period (PEP).
Heart rate is usually measured in beats per minute (bpm), using the R-peak of the QRS-complex as a marker (figure 1). The time between two R-peaks are measured over a given period of time, resulting in a RR-interval (or NN-interval, referring to Normal beats). Variability of this inter beat interval (IBI) is known as the HRV. This is usually measured as the standard deviation of the RR-interval (SDNN) or the root mean squared of the standard deviation (RMSSD). The pre-ejection period (PEP) is defined as the time interval from the beginning of electrical stimulation of the ventricles to the opening of the aortic valve.
Because of the variety in measuring methods it is necessary to have consistency in psychophysiological research, which appears to be complicated. In addition to the numerous kinds of measurement of HRV, there are also different kinds of baseline (rest) and action measurements as well as various other factors, like age (e.g. O'Brien, 1986; Jensen-Urstad, 1997; Umetani, 1997), day-night periodicity (Sapoznikov, 1992) and the 10 second rhythm (de Boer, 1985). Also respiratory sinus arrhythmia (RSA) and ill health are known factors. RSA is the variation in heart rate as a result of breathing in and out. The 10 second rhythms are also known as Mayer waves, which are oscillations of arterial pressure occurring spontaneously in conscious subjects at a frequency lower than respiration (~0.1 Hz in humans).

The prognostications of these measures in relation to antisocial and aggressive behavior have been examined numerous times (Raine, 1997). Raine (1997) found that lower resting heart rate correlates with a high amount of aggression in children. He also found that aggressive behavior relates to fearlessness and stimulation-seeking characteristics. Thayer (2009) found that resting HRV was able to predict the outcome of a modified Stroop task.
Raine (2006) developed a questionnaire in order to categorize reactive and proactive aggression, namely the reactive proactive aggression questionnaire (RPQ). But the effectiveness of this questionnaire for research is questioned; correlation between reactive and proactive aggression is supposed to be too high to be useful in discrimination of different behavioral distinctions (Oosterwaal, 2010), and Oosterwaal therefore suggests to only use the RPQ as a screening device rather than a research tool. In 2010, Scarpa et al. showed that children with proactive and reactive aggression differed significantly in HRV, where reactive aggression was related to decreased HRV and proactive aggression with increased HRV. Often children (Vitiello & Stoff, 1997; Beauchaine, 2000; Oosterwaal, 2010; Scarpa, 2010; De Vries-Bouw, 2011), but also adults (Chambers & Allen, 2002; Hansen, 2007) are subject of research in these kinds of researches. In his research for correlations between psychopathy and psychophysiological measures, Hansen (2007) found a correlation with HRV at baseline and a form of psychopathy in adults. He noted however that psychopathy is complex and different facets of psychopathy might have different underlying characteristics.
Because of this debate on the complexity of psychopathy, Patrick et al. (2009) tried to establish a triarchic model for psychopathy (Tri-PM) in order to provide a basis of reconciling and accommodating alternative descriptive accounts of psychopathy. The essence of the triarchic model is that psychopathy encompasses three distinct phenotypic constructs (figure 2): disinhibition, which reflects a general propensity toward problems of impulse control; boldness, which is defined as the nexus of social dominance, emotional resiliency, and

venturesomeness; and meanness, which is defined as aggressive resource seeking without regard for others ("disaffiliated agency").

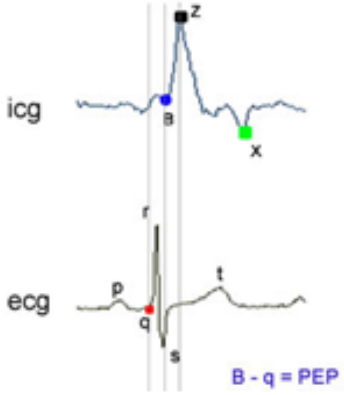
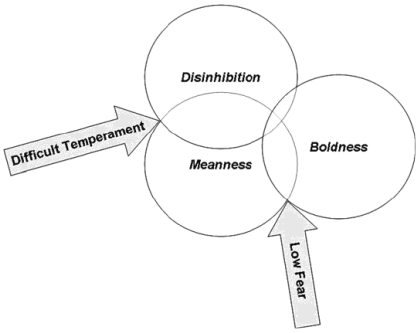


Figure 1. *Schematic representation of a heart beat measurement, usually performed by an electrocardiogram (ECG) and a blood flow measurement usually performed by an impedance cardiogram (ICG). The R-peak is normally used to assess the IBI which, over time, is used to assess the HRV.*
The time between point B of the ICG and point q of the ECG is known as the PEP.

Figure 2. *Schematic representation of the triarchic psychopathy model (Tri-PM) of Patrick et al. (2009). Arrows depict contributions and the overlapping circles depict relative interrelations with each phenotypic construct.*



All factors mentioned above together show that characterization through psychophysiological measures is all but standard. And because the Arousal Theory is predominantly researched on children, research on adults concerning this subject could prove an important addition to the existing literature. This research will therefore focus on answering the following question:

Can psychophysiological measures be used to characterize male adult convicts?

The goal to this main research question is thus to get an as accurate as possible characterization of a group of antisocials by measuring their HR, HRV and PEP. Research on the statistical impact of known confounders will be done, and appropriate measures will be taken in order to get an as accurate as possible result. In order to get an accurate characterization, rest and action values will be researched. And with these values a distinction between antisocials on a behavioral level will be tried to be made.
More specifically, the following two sub questions will be addressed. The first will focus on the relation between psychophysiological measures and aggression:

Can psychophysiological measures be used to differentiate reactive versus proactive aggressive personalities?

The second sub question will focus on the relation between psychophysiological measures and psychopathy:

Can psychophysiological measures be used to differentiate between meanness, boldness and disinhibition?

The expectation is that characterization of a group of antisocials is possible, but could prove difficult taking the various methods and measures for HRV into account. The hypothesis about the differentiation is that reactive aggression will correlate with lower HRV and proactive aggression with higher HRV. Also proactive aggression should correlate with a lower HR, and reactive with a higher HR. On the Tri-PM scale boldness is expected to correlate with higher HRV and lower HR, and disinhibition with lower HRV and higher HR. Meanness is hypothesized to not correlate with HRV. These hypotheses are amongst others based on Patrick's schematic representation (figure 2). Because, according to Patrick's schema, meanness is supposed to be contributed by both difficult temperament and low fear, these effects are thought to cancel each other out, resulting in no correlation with HRV. Because disinhibition is supposed to only be contributed by difficult temperament, lower HRV and higher HR are expected there.

Method

As mentioned above, this research tried to answer two main questions. The first focused on whether it is possible to characterize a group of male convicts by their psychophysiological measures, to see whether or not, and if so how much, their values differ from control subjects. Given these comparisons or differences correlations were made between two kinds of questionnaires and their psychophysiological measures to get a further characterization, characterizing the group of male convicts by aggressive and psychopathic sublevels.

Subjects

Nineteen male adult convicts, all imprisoned for at least another six months, with an average age of 25.11 +/- 4.788 (mean +/- SD), took part in this research. Seventeen of them were smokers, bringing an average of 9 cigarettes per day (9.18 +/- 6.835) for the entire group. Sixteen did regular exercise, bringing an average of 4.06 +/- 3.848 hours per week. Five took medicine (sleeping pills, Seroquel, Ritalin or antihistamine).

Measurements

For the cognitive assessment the RPQ- and Tri-PM questionnaires are used. The RPQ is used to discriminate between reactive and proactive aggression. Twenty-three questions are asked, where the subject can answer from 0 (never) to 2 (often). Half of the questions are used to assess their reactive aggression, and half to assess their proactive aggression. The Tri-PM is used to discriminate between three facets of psychopathy, namely boldness, meanness and disinhibition. The subjects are asked to answer fifty-eight questions, choosing from 1 (totally not true) to 5 (totally true). One third of the questions relates to boldness, one third to meanness and one third to disinhibition. For the ECG- and ICG measurements the VU-AMS[1] is used (figure 3; de Geus et al., 1995). The specific measures used in this research are average HR (bpm), SDNN (msec), RMSSD (msec) and PEP (msec). Because RSA is a known influence on HRV and automatically measured by the VU-AMS, this measure is also used in this research.

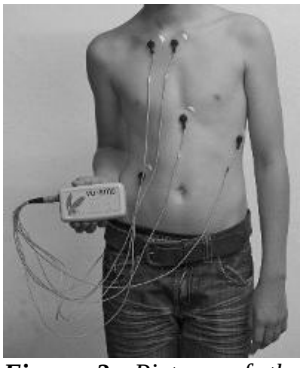


Figure 3. *Picture of the VU-AMS with electrodes placed on the body.*

[1] www.vu-ams.nl

The average HR is calculated by the amount of beats per minute, using the R-peak of the QRS-complex (figure 1) as a marker. Since a baseline is being assessed three times, the three averages will be averaged, yielding one average HR for the baseline. The SDNN is calculated by taking the standard deviation of the time between two R-peaks, also known as N-peaks (normal peaks). This measure is used to assess the HRV. The three values yielded by the three baselines are averaged, resulting in a single value for baseline SDNN. The root of the mean of the standard deviation squared, or RMSSD, is another way to assess the HRV. The PEP is calculated by measuring the time between the beginning of the electrical stimulation (q) of the ventricles and the moment the aortic valve opens (B). Figure 1 shows this calculation. The RSA is the sinus arrhythmia caused by respiration. Breathing in accelerates the heart beat, and breathing out slows it down. This causes different values in HR and HRV, therefore this measure is also being monitored.

Procedure

Before taking part in the experiment, subjects were screened at an intake meeting and when they agreed on taking part in the experiment, several questionnaires, amongst others the RPQ and Tri-PM, were given to the subject and they were asked to fill them in before attending to the experiment. However, for the first few subjects the questionnaires were given after the experiment.
At the day of the experiment the subjects were welcomed and asked several general questions. Humidity and temperature in the room were measured. Before the start of the experiment, the subjects were explained how and where the electrodes of the VU-AMS would be placed. The electrodes were placed on the subject, the VU-AMS was hooked on a laptop and the measurement of the heart was checked. During the tasks markers were sent to the VU-AMS via E-Prime 2.0[2] to pinpoint the start and finish on the ECG-measurement of every task performed. When the experiment started a first baseline of six minutes was assessed. This baseline consisted of sitting comfortably watching a computer monitor displaying several nature pictures and listening to classical music. Thereafter several tasks (e.g. Stroop-task, Tower of Hanoi, Iowa Gambling Task) were performed, amongst others the D2-task[3]. This task was the task used for the assessment of the action values and is approved by the COTAN documentation[4].
The D2-task is a concentration- and attention task which focuses on speed, accuracy, concentration and tempo variation. The task is to strikethrough the ‘d’s with two stripes surrounding it, either above, underneath or both. The task consists of 14 lines where the subject is given a maximum of 20 seconds per line. In total, thus, this task takes 4 minutes and 40 seconds. The solidity of the time taken for this task is one of the reasons it is being used in this research, because of the practicality for calculation and comparison between subjects. This task was performed on paper. The first of two main reasons why this task was used in this research was that it encompasses various cognitive processes like problem solving, selective attention and inhibitory control. Because proactive aggression was characterized as instrumental and organized, and reactive aggression as ideational and with heightened and diffuse sensory awareness (Raine, 2006), different approaches are expected, resulting in interesting values when correlating it with the questionnaires. The second reason was because of the comparability. Since the baselines had a set time, it was preferred to also have a set

[2] http://www.eprime2.eu/
[3] The other tasks in this experiment are used in a different research, as this research is part of a bigger research, only focusing on a specific part of the experiment. This research only focuses on the baselines and one specific task, namely the D2-task.
[4] www.cotandocumentatie.nl/

time for the action task. Since the D2-task has a set time (4:40), no extra calculations had to be performed in order to compare the values of the task. In between the experiment (which takes between 2 to 3 hours in total) the subjects were asked whether they needed a break. After that a second baseline was assessed - similar to the first - and several other tasks were performed. At the end of the experiment a third baseline - again similar to the previous two - was assessed, and after that the subject was thanked, the electrodes were removed and the subjects were instructed about future developments concerning the experiment.

Figure 4. *Example fragment of the D2-task. In this example one should strikethrough the first, third and sixth element of the first row, the fourth of the second row and the first, fourth and sixth of the third row.*

RPQ & Tri-PM

Despite clear instructions, several questions were either blank or answered twice. This resulted in facing the problem of wrong data. That is, any answer replacing the blank or double answer would result in a (slightly) different outcome. For this problem, there are four solutions: the first and most apparent was to go to the subject and ask him to fill in the blanks. This worked for most of the blanks, but not for all. Then there are three statistical solutions to deal with those blanks. The first is to calculate the results with the blanks taken out. This, however, would mean a bigger deviation as, for instance, the RPQ-questionnaire would now yield 22 instead of 23 answers, of which 10 and 11 proactive and reactive questions, respectively, instead of 11 or 12. This impact was thought to be too big[5], so the second solution was to remove all participants with missing data (i.e. 6 in total) from the research. However, this could also not be done, as there were only 19 subjects gathered, and it would result in a 32% loss. The third solution, and the solution used, was a regression analysis. This, again, resulted in three options: taking the average of the other answers of that question, taking the median, or calculating the pattern of the answers of the subjects, following the same trend as a subject with the same pattern. The latter would mean too much extra calculation for which was not enough time anymore. There were also questions raised about whether this would have any impact on the outcome, and whether this approach was any better as it still would not be a totally correct answer. Either way one remains with a guess. Ultimately, the average was chosen, resulting in the data shown below.

Data analysis

For the data analysis SPSS 19 was used. The characterization was done by descriptive analysis using descriptives. Correlation was performed by bivariate correlation with Pearson's correlation coefficient. Also, in order to be able to compare values of this research, control values were searched. These control values had to comply to several factors, in order to be an accurate control value. As this research has got healthy male adult subjects, control values must be from healthy (no heart diseases), adult (ages of 18 years and above) human (no

[5] 1 out of 11 questions is 9%; although below 20% is considered to be not too consequential (Arbuckle, 1996), it was still advised to use a solution for the missing data.

animals) male (no females or male and female combined) subjects. Also control values measured by the VU-AMS used in this research were preferred. All values are baseline (rest) values, which also differ slightly from the baseline used in this research; both in duration and in the manner a baseline is presented.
Finding good control values was difficult as, especially PEP, is not being researched often. Most researches who did research PEP used subjects with bad health (various kinds of heart diseases). Also a reliable reference to heart rate control values was hard to find, as it seems to be common knowledge that the average resting heart rate lies between 60 and 80 beats per minute, ignoring any reference to this premise. But a control value for the HRV proved most difficult to assess. Values vary from research to research, using different methods and different calculations. The control values used for this research are however thought to be the most reliable, as it is performed by a Task Force established solely for the purpose of standardizing HRV-measurement. Thus these values are thought to be good control values, and are used as such.

Results

Confounders

To eliminate confounders as much as possible, temperature and humidity were monitored and stabilized. Also because the experiments were performed during the day (between 9:00 and 16:00), the day-night periodicity was minimized. Age was nevertheless a factor, and will be discussed below. Also smoking, sporting, drug-, caffeine- and medicine use were closely monitored, although caffeine use was not monitored for the first subjects, which therefore will not be discussed. These confounding effects were explored, correlating age, smoking, sporting and medicine use against the heart rate values. This resulted in a significant positive correlation between smoking and average HR ($r=0.588$, $\alpha=0.008$).
Also an elevated PEP correlated with higher age ($r=0.577$, $\alpha=0.010$). All these correlations, however, never exceeded $r=0.6$, which therefore would not be described as strong (a strong correlation is coined when $r>0.8$) or as weak ($r<0.4$).

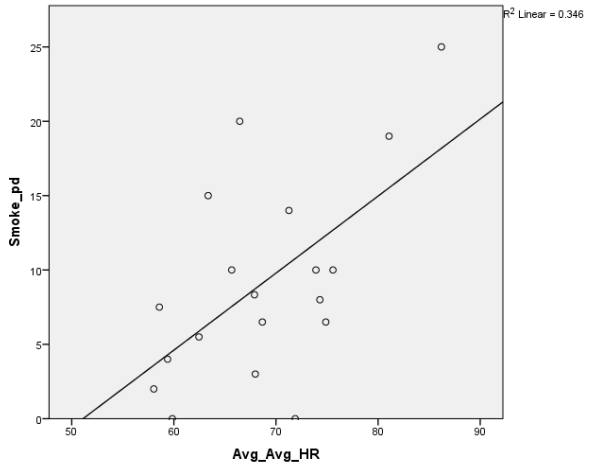


Figure 5. *Scatterplot of Average Heart Rate against the number of smokes per day. A fit line was added, displaying a linear correlation.*

Characterization

The main question in this research is whether psychophysiological measures can be used to characterize a group of male adult convicts. In this research, HR, HRV and PEP are used for this purpose.
The means and standard deviations of the HR, HRV and PEP are shown in table 1. Control values were derived from several sources and all involve resting (baseline) values. Action

values were not derived as the difference in tasks is thought to be too significant to compare, as every research uses a different kind of action task, resulting in different values, which would be difficult to compare to our action values. Only action values also derived from performing the D2-task would qualify for an accurate comparison. Unfortunately, reliable psychophysiological measures during a D2-task have not been found in literature, ergo no action values have been compared.

As seen below, significant differences in SDNN, RMSSD and PEP appear. Significantly lower SDNN was found, compared to the control values found in literature, and significantly higher RMSSD and PEP were found.

The differences were highly significant, giving the idea the methods and/or measurements used differ too much from the methods and measurements used in this research, so it was decided it was not plausible to compare these values with control values. Despite searching for methods and measurements closely similar to the methods and measurements used in this research, the idea that it is a significantly different population used in this research seemed unlikely[6]. Natural logarithm transformation for right skewness was performed in an attempt to acquire comparable values, but this gave no result and thus was not used for further research.

In order to find out the reason for these significant differences in values between this experiment and control values found in literature, expert advice was acquired. One of the developers of the VU-AMS, René van Lien, was visited to check the methods and measures used for this experiment. According to him neither anomalies in the method nor in the measures are present. Publication bias was coined as a reason for these anomalies, however an unlikely explanation for the magnitude of the difference. Having ruled out apparatus failure and mistakes in the methods used, the decision was made to accept the significantly different values and use those for correlation with the questionnaires. This answered the first question, saying it is possible to characterize a group of male convicts through psychophysiological measures. However, it appeared to be not possible to compare these measures with control values.

Measure	Mean +/- SD	Control mean +/- SD
Baseline HR (bpm)	68.8 +/- 7.8	71.5 +/- 1.5[7]
Action HR (bpm)	73.5 +/- 8.6	
Baseline SDNN (msec)	84.1 +/- 28.7**	141 +/- 39[8]
Action SDNN (msec)	64.1 +/- 32.3	
Baseline RMSSD (msec)	61.6 +/- 33.1**	27 +/- 12[4]
Action RMSSD (msec)	56.2 +/- 45.0	
Baseline PEP (msec)	120.5 +/- 10.5**	102.9 +/- 21[9]
Action PEP[10] (msec)	116.5 +/- 17.1	

Table 1. *Means and standard deviations of the HR, SDNN, RMSSD and PEP during baseline and action (D2-task). At the left are the values resulting from the experiment performed in this research, at the right control values found in the literature. ** $\alpha < 0,01$.*

[6] The values were significantly different, yielding an alpha of below 0,000, according to the SPSS output, figuring it would be statistically practically impossible that it would be due to a significantly different population rather than a different method and/or measurement used.

[7] Handbook of Psychophysiology, 2nd ed. Ch.9 Cardiovascular Psychophysiology

[8] Control values are extracted from the *Heart Rate Variability, Standards of measurement, Physiological Interpretation, and Clinical Use* of Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology. (http://circ.ahajournals.org/content/93/5/1043.full)

[9] Houtveen, Groot & de Geus, 2005

[10] N=17, all other values have N=19

Correlation

Having answered the first question, concerning characterization through psychophysiological measures, a further characterization was attempted, trying to answer the second question. The second question in this research consists of two subdivisions, concerning correlating psychophysiological measures with the RPQ- and Tri-PM questionnaires.
Correlation calculation between the HR-, HRV- and PEP values and the RPQ- and Tri-PM questionnaires was performed. The results are shown in table 2. No significant correlations were found. Subsequently, following the Arousal Theory, the difference between baseline- and action values were assessed and checked on correlation with the two questionnaires. According to the Arousal Theory, subjects react differently on a task, which should show in the amount of rise or decline between baseline and action in terms of percentage. The results of these calculations are shown in table 3, showing no significant correlations.

	RPQ Pro		RPQ Re		Tri-PM Bold		Tri-PM Mean		Tri-PM Disinh	
	r	α	r	α	r	α	r	α	r	α
BHR	0.043	0.860	0.289	0.230	0.239	0.324	-0.030	0.903	-0.125	0.610
AHR	0.022	0.927	0.158	0.517	0.275	0.254	0.117	0.634	0.040	0.870
BSDNN	0.326	0.173	0.141	0.565	0.145	0.553	-0.341	0.153	0.027	0.914
ASDNN	0.209	0.391	0.110	0.652	0.065	0.790	-0.298	0.215	-0.074	0.763
BRMSSD	0.363	0.127	0.130	0.595	0.187	0.444	-0.331	0.166	-0.098	0.690
ARMSSD	0.288	0.232	0.174	0.477	0.077	0.755	-0.306	0.202	-0.160	0.514
BPEP	-0,180	0.460	-0.335	0.160	-0.184	0.450	0.449	0.054	0.415	0.077
APEP[10]	-0.133	0.611	-0.141	0.589	0.246	0.341	0.066	0.800	0.232	0.370
BRSA	0.278	0.250	0.055	0.824	0.338	0.157	-0.360	0.130	0.094	0.701
ARSA	0.196	0.422	0.078	0.750	0.119	0.627	-0.274	0.257	-0.076	0.757

Table 2. *Heart rate measures correlation values compared with questionnaire subdivisions. BHR = Average Heart Rate at Baseline; AHR = Average Heart Rate at Action; BSDNN = Baseline SDNN; ASDNN = Action SDNN; BRMSSD = Baseline RMSSD; ARMSSD = Action RMSSD; BPEP = Baseline PEP; APEP = Action PEP; BRSA = Baseline RSA; ARSA = Action RSA.*
RPQ Pro = Score on Proactive questions of the RPQ; RPQ Re = Score on Reactive questions of the RPQ;
Tri-PM Bold = Score on Boldness questions of the Tri-PM; Tri-PM Mean = Score on Meanness questions of the Tri-PM; Tri-PM Disinh = Score on Disinhibition questions of the Tri-PM.

	RPQ Pro		RPQ Re		Tri-PM Bold		Tri-PM Mean		Tri-PM Disinh	
	r	α	r	α	r	α	r	α	r	α
HR	-0.038	0.878	-0.251	0.299	0.076	0.758	0.302	0.210	0.306	0.202
SDNN	-0.048	0.845	0.013	0.957	-0.092	0.708	-0.141	0.565	-0.255	0.292
RMSSD	-0.032	0.897	0.131	0.594	-0.131	0.594	-0.152	0.534	-0.186	0.445
PEP[10]	-0,066	0.800	0.062	0.812	0.349	0.170	-0.223	0.390	-0.052	0.844
RSA	-0.012	0.961	0.119	0.627	-0.218	0.369	-0.078	0.750	-0.384	0.105

Table 3. C*orrelation values of the difference of heart rate measures between baseline and action in terms of percentage compared with questionnaire subdivisions. HR = Difference between the Average Heart Rate at Baseline and the Average Heart Rate at Action in terms of percentage; SDNN = Difference between the Baseline SDNN and the Action SDNN in terms of percentage; RMSSD = Difference between Baseline RMSSD and Action RMSSD in terms of percentage; PEP = Difference between Baseline PEP and Action PEP in terms of percentage; RSA = Difference between Baseline RSA and Action RSA in terms of percentage.*
RPQ Pro = Score on Proactive questions of the RPQ; RPQ Re = Score on Reactive questions of the RPQ;
Tri-PM Bold = Score on Boldness questions of the Tri-PM; Tri-PM Mean = Score on Meanness questions of the Tri-PM; Tri-PM Disinh = Score on Disinhibition questions of the Tri-PM.

Discussion

The goal of this research was to characterize a group of male adult convicts. The questions which were tried to be answered in this research were whether psychophysiological measures can be used to characterize a group of male adult convicts, and whether they can be correlated with different subdivisions of the RPQ- and Tri-PM questionnaires.
Results show that characterization is questionable, noting the significant differences between the values measured in this research and the control values found in the literature. Although the control values were carefully assessed, the significant differences give rise to discussing the validity of these values, especially when noting other researches (e.g. Scarpa, 2010) show comparable values to the values found in this research. Albeit a research performed on children, these values in the research of Scarpa (2010) show that the values found in this research might be valid, and the method used by the Task Force is somehow significantly different to the method used in this research. This, again, shows the importance of standardizing the methods of measuring HRV.
Correlation of these values with the RPQ- and Tri-PM questionnaires could however still be performed. The expectation was, considering the Arousal Theory, that hot (reactive) aggression correlates with lower HRV, and cold (proactive) aggression correlates with higher HRV. The results showed no significant correlation between the measured psychophysiological measures and the elements of the questionnaires. But because other researchers found different values, it might be that using the methods resulting to those values, other correlation results might be extracted.
As often the method and/or apparatus used is not mentioned fully (e.g. Task Force[4]), comparison between values is questionable. Also various kinds of apparatus (e.g. Beauchaine, 2000) and various forms of transformation of values are used (e.g. de Vries-Bouw et al., 2011). And often children (e.g. Scarpa, 2010), ill (e.g. Chambers & Allen, 2002) or other than standard subjects, like athletes (e.g. Aubert, 2003) are used for research, which all could account for differences in values.
Nevertheless characterization of a population is possible, closely monitoring every method used and variable present during the research. Especially for the HRV it is important to describe as much as possible for future references. Although comparison with other populations was thus far not possible, using this specific apparatus, method, measures and variables could characterize different or equal populations in future researches.
The use of researching these measures and the characterizations they make is that they could be used to, for instance, predict reoffending (De Vries-Bouw, 2011) or predict the chance a treatment would be successful or not. De Vries-Bouw showed that reduced HR response and increased HRV response to stress predicted higher reoffending rates.
All in all, the results show that correlations between psychophysiological measures and aggression or psychopathy were not possible in this research. Although these results may indicate that psychophysiological measures cannot be used to differentiate between different kinds of aggression or psychopathy in adults, further specific research is advised, as the sample size (N=19) is rather small.

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