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Psychosocial correlates of peripheral vegetative activity and coordination

Miguel Angel Gandarillas

Resumo: O presente estudo examinou a relação entre aspectos psicossociais e padrões de reação fisiológica (frequência cardíaca, pressão arterial, condução cutânea e medidas respiratórias) para quatro tipos de contingências operantes (recompensa, extinção, punição e evitação) registrados durante um teste de computador em uma amostra de 32 calouros universitários holandeses. Práticas educativas parentais (cuidado, controle e proteção), variáveis familiares, sociodemográficas e o significado emocional foram utilizados como preditores de reações fisiológicas. Como medidas de coordenação vegetativa foram comparados os coeficientes entre medidas fisiológicas com máxima correlação. Os resultados confirmam a relevância de práticas educativas parentais no desenvolvimento da ativação autônoma do adulto, em especial o papel do cuidado. Dentre os preditores sociodemográficos, a renda familiar foi o mais relevante. As atitudes dos sujeitos em relação às emoções positivas e negativas também aparecem relacionadas a índices fisiológicos de coordenação cardiovascular. Os sujeitos classificam-se em dois tipos de coordenação vegetativos ligados a características psicossociais.
Palavras-chave: sistema nervoso autônomo, educação infantil, operante condicionante, psicofisiologia, ambiente social

Aspectos psicossociais relacionados à atividade vegetativa periférica e coordenação

Abstract: The present study examines psychosocial correlates of physiological reaction patterns (heart rate, blood pressure, skin conductance, and respiratory measures) to four types of operant contingencies (reward, extinction, punishment, and avoidance) recorded during a computer test to a sample of 32 Dutch university freshmen. Child-rearing factors (Warmth, Control, and Protection), family and demographic variables, and affective meanings of emotions were used as predictors of physiological reactions. As measures of vegetative coordination, maximum cross-correlation coefficients between physiological measures were used and compared. Results support the relevance of child-rearing practices in the development of adult autonomic activation, in particular the role of parental Warmth. Among socio-demographic predictors, family income was most relevant. Subjects´ attitudes towards negative and positive emotions also appear related to physiological indices of cardiovascular coordination. Subjects fell into two vegetative coordination types linked to psychosocial characteristics.
Keywords: autonomic-nervous-system; child-rearing; operant-conditioning; psychophysiology; social-environment.

Introduction

Nowadays there is little doubt about the relevance of the psychosocial domain when explaining differences among individuals and groups in Autonomic Nervous System (ANS) activity and reactivity, approached within solid theoretical models especially from the field of emotions (e.g., Cacioppo, 1994; Jahoda and Lewis, 1989;

Kemper, 1987; Perris, 1998; Triandis, 1977), where most consistent empirical findings have been found (Norris et al., 2004). For example, Gray's (1971, 1981) Behavioral Inhibition (BIS) and Behavioral Activation Systems (BAS) model is one of the most empirically studied emotional theory and has been linked to specific autonomic indices (Fowles, 1980) and to personality traits such as extroversion and neuroticism (Larsen and Ketalaar, 1991). However, an actual merging effort between main social and physiological fields is not so evident in the literature on empirical studies testing major emotional theories (Tsai, Levenson, and McCoy, 2006). Frequently they focus on very concrete single variables, such as Socio-Economic Status (e.g., Kalimo and Vuori, 1993; Krantz and McCeney, 2002; Raine, 1988), negative vs. positive life events (Theorell and Emlund, 1993), or quality of social support and warmth (e.g., Knox, 1993).

There is consensus among a majority of authors pointing to social characteristics during childhood as main predictors of the development of adult emotional patterns. Most of these studies focus on variables such as family extension, child-rearing practices, the role of the mother, number of children, parents´ level of education, or changes of residence (e.g., Tzeng, Jackson, and Karlson, 1992; Gandarillas, Camara, and Scarparo, 2005; Polansky, Gaudin, Ammons, and Davis, 1985; Whiting and Whiting, 1992). Perhaps the most cited psychosocial shaping factors of emotional development in literature are the conditioning types of punishment and reward by parents during the process of child-rearing. The field of child-rearing practices provides many clues regarding psychological and emotional impact on the child. Low levels of affection appear to be related to adult depression (Perris, 1998; Richter, Richter, Eisemann, 1990; Rohner, 1986), whereas high levels foster intrinsic motivation (Tzeng, Jackson, and Karlson, 1992; Whiting and Whiting, 1975). Control and discipline are reported to be related to the development of fear, aggression, and anxiety (Perris, 1998; Whiting and Edwards, 1988) and moderate levels to self-control (Peisner, 1989). Protection seems of importance to dependency and passiveness of the child (Dielman and Barton, 1983; Parker, 1983; Perris, 1998). The literature in the field of child abuse and neglect (as extreme forms of child-rearing) points in general to similar results (Brown, Cohen, Johnson, and Smailes, 1999; Erickson, Egeland, and Pianta, 1989; Heim, et al. 2000; Tzeng, Jackson, and Karlson, 1992; Polansky, Gaudin, Ammons, and Davis, 1985; Pollak, 2003; Pollak, and Tolley-Schell, 2003; Pollak, Cicchetti, Klorman, and Brumaghim, 1997; Rogosch, Cicchetti, and Aber, 1995).

Considering the importance of social and childhood experiences on emotional development, and the large body of knowledge on the relationship between emotions and autonomic activity (Cacioppo, 1994; Kemper, 1987), one might expect important links between social variables such as child-rearing practices and the development of physiological activity. However, there are few studies dealing with these relationships, and most are only partially related to this topic. Consistent findings show high physiological arousal during negative situations and low arousal under positive situations in children as well as in adults, as shown by heart rate, skin conductance, blood pressure, and respiratory indices (e.g., Grings and Dawson, 1978; Levenson, 1992; Schwartz, 1986), with differential typologies of responses across individuals (Pérez et al., 1998). These arousal levels have been related to psychological traits such as hostility, introversion, or neuroticism (Richards and Eve, 1991), but may be better explained by cultural factors (Tsai, Levenson, and Kiberly, 2006).

However, different combinations of parental support and control levels may facilitate different types of reward internalization at the cortical level, which could function as a cortical barrier to exciting punitive stimuli, triggering not only the sympathetic but also the parasympathetic branch in specific types of (co-activating or reciprocal) coordination (as suggested by models such as Gray's). This would explain individual differences such as those found in vagal tone levels under stress (Pérez et al., 1998). In fact, the relationship between child-rearing practices and physiological activity might be especially evident in ANS coordination patterns (understood as the common joint action of the vegetative organs in response to a given type of situation or purpose). For example, Kennedy, Rubin, Hastings, and Maisel (2004) point to clear relationships between autonomic feedback mechanisms, child rearing practices, and the ability of the child to regulate the experience of emotion, finding an association between low parental support, high control, low cardiac vagal tone, and inhibited, fearful child behavior. However, child-rearing practices did not appear to be a causal factor of autonomic tone.

The present exploratory study represents an attempt to point to possible directions to advance in the knowledge of such research fields. Based on the indirect evidence from the literature, and on previous studies (Gandarillas, 1995), a set of relevant social and physiological variables were selected. Retrospective child-rearing factors (Emotional Warmth, Control, and Protection), and social and family characteristics (familial extension, economic level, educational levels of father and mother, number of times the family changed residence, and number of siblings) are expected to have a significant relationship to adult psycho-physiological activity and coordination indices. Specifically, parental support and positive family conditions are expected to show a significant negative relationship excitatory physiological reactions and a positive relationship to coordination indices. Physiological variables were recorded during an experimental situation in which a gambling test designed for this study allowed us to expose the participant to four types of contingencies (Reward, Avoidance, Extinction, and Punishment).

Method

Subjects

Thirty-two Dutch freshmen (19 women and 13 men, mean age 20.3 years) from the Psychology Department of the University of Amsterdam (Netherlands) volunteered for this study.

Materials and Apparatus

<u>Questionnaire</u>. A short version of the EMBU questionnaire (Winefield, Goldney, Tiggemann, and Winefield, 1989) (a set of 27 four-points Likert-type scale) was chosen to

measure the three most important dimensions of child-rearing in the literature (Emotional Warmth, Control, and Protection) as it has good psychometric properties (Arrindell et al., 1989; Winefield, Goldney, Tiggemenn, and Winefield, 1990). A set of socio-demographic questions were also included: (1) Frequency of contact with grandparents, uncles/aunts, cousins/nephews, and other relatives ("Family Extension"); (2) Family economic level during childhood; (3) Educational level of father and mother; (4) Number of times the family changed residences during subject's childhood ("Family Mobility"); and (5) Number of siblings. Childhood was defined as between 0 and 16 years. The Semantic Differential of three emotional concepts was included: Pain, Pleasure, and Courage, as used in Osgood´s Atlas of Affective Meanings (Osgood and Tzeng, 1990). These concepts were selected as representing best the three basic affective meaning factors of emotional concepts identified in a cross-cultural study (Gandarillas, 1995) with samples of 30 cultures from the Atlas of Affective Meanings using the three affective dimensions: Evaluation (with items such as "good vs. bad"), Potency ("strong vs. weak"), and Activity ("active vs. passive").

Experimental Variables and Material. In order to measure physiological reactions, skin conductance (SC), heart rate (HR), mean blood pressure (MBP), diastolic blood pressure (DBP), systolic blood pressure (SBP), Respiratory Cycle Duration (RCD) and Minute Ventilation Volume (Vmin.) were selected as physiological measures. For the respiratory measures, only the grand means (and not the means for each trial of the experimental task) were included, since the trial duration was too short to calculate reliable mean respiratory parameters.

Experimental task. A deceptive computer game (named "Happy Face Test") supposedly measuring "probabilistic intelligence" was developed for this study, consisting of set of 21 trials. Each trial included a "question screen" and an "answer screen". In each "question screen" there were 4 numbered "doors" with one face "behind" each one. The task of the participant was to "open" (select) a door with a right answer (a happy face) behind, avoiding a wrong (an angry face) or a neutral (a serious face) answer. The 4 faces (a different combination during each trial) "behind" the 4 doors were also presented in the "question screen" without specifying their location. This allowed to set the expectation levels on the probability the subject had to obtain the right or wrong answer according to the number of happy or angry faces previously presented. The participants would then make a bet based on the probabilities to get the right answer (a happy face). In the answer screen the chosen door would "open" and a face appeared "behind". The reward (a right answer) would consist of adding the points wagered to the total points accumulated up to that trial. The punishment (wrong answer) would lead to the subtraction of points. The neutral answer would neither add nor subtract points. In order for the participants to become more involved in the test, each trial of the answer screen would include a percentage of people obtaining less points than them up to that trial. In reality, the face behind each selected door and the percentages were always the same in each trail across subjects regardless their selections. Thus, four types of contingencies could be included in the answer screen independently of the subject's performance: Reward, (getting the right answer); Avoidance (high possibilities of punishment but neutral solution); Punishment (getting the wrong answer); and Extinction (high possibilities of reward, getting the neutral face). After several pilot studies with different trial orders, an optimal trial order which maximized the physiological impact of punishment and reward (as well as the optimal presentation time: 10 sec. for each question screen and 7 sec. for each answer screen, fixed and same through all trials) was selected, with 21 trials.

Experimental Equipment. A Finapres Ohmeda 2300 Blood Pressure Monitor was used to measure mean blood pressure (mmHg) and heart rate (beats/minute). The Finapres finger cuff was attached to the middle phalanx of the nondominant hand. SC was recorded with a alternate-flow voltage (30Hz, +/-0.75V) with Ag/ClAg electrodes (1 cm2 of contact area) filled with 0.05 M NaCl unibase electrolytic paste. The output of the resistance-to-voltage convector was integrated (time constant = 3D 300 ms.), adjusted to 0.2 V/mS (linear within a dermic resistance range of 5-200 K), and digitized (40 Hz). Two electrodes were attached to the volar side of the index and forth finger of the nondominant hand. Respiration was recorded with two strain gauges (pneumograph). One strain gauge was attached circumferentially around the chest the other around the abdomen. Calibration against spirometry was accomplished by the least-squares method (Morel, Forster, and Suter, 1983). The signals from the pneumograph were recorded on a polygraph, and simultaneously sampled by a microcomputer (IBM PC-386) at a rate of 40 points/sec. and stored on hard disk for off-line analyses. The laboratory where the experiment was carried out was isolated from external interferences (e.g., noises, changes in light or temperature).

Procedure

After attachment of the electrodes the subjects were instructed to sit down and the equipment was tested for about 20 minutes, during which subjects were given written instructions about the experimental task. Afterwards, a resting condition was recorded for four minutes. When the subjects were sure they understood the instructions, they were given two trials to practice, while the experimenter left the room. Through an intercom the subject was instructed when to start the test. After the test, the questionnaire was administered.

Whereas the values of HR, BP, and SC were estimated automatically by the experimental equipment, for the respiratory activity a special computer program was used in order to decompose the respiratory cycle into several measures (Boiten, 1993). Respiratory Cycle Duration (RCD) and minute ventilation volume (Vmin) were selected for further analysis.

Statistical Analysis

Three sets of stepwise multiple regressions were carried out with child –rearing factors, socio-demographic variables, and semantic differential emotional factors as predictors, and with the following variables as DVs in all cases: Physiological means during baseline and experimental task, means of the physiological reactions to the 4 operant contingencies, maximum and absolute (without sign) maximum cross-correlation coefficients (MCCs), and maximum and absolute maximum 1-differenced cross-correlations (MDCCs) of physiological measures during the experimental task.

As child-rearing factors, in order to obtain the factor scores of the EMBU, the questionnaire items were factor-analyzed, with VARIMAX rotation. In general, the same structure as reported in Winefield et al. (1989) was obtained (with three factors named Emotional Warmth, Control, and Protection), although some of the items were not included in further analyses as they did not load high enough (above .40) on either factor. The means of the items included in each factor were used as factor scores. To obtain the scores of the semantic differential emotional factors, means for the Evaluation, Potency, and Activity factors were obtained as in Osgood and Tzeng (1990).

The mean values of the physiological measures during exposure to the different types of answer screens were obtained and transformed (across trials) into Z scores in order to cancel the variance due to the dependence of changes on individual differences in the basal level (as recommended by Wagner and Calam, 1988). The mean Z scores were then grouped according to the four types of operant contingencies and mean indices were estimated. The first 4 trials of the test were not included in the analyses as a possible contamination of the physiological reactions by novelty effects was to be avoided.

MCCs were included as indices of vegetative coordination patterns. Time series from HR (always in beats per minute), mean, diastolic, and systolic blood pressure (although only mean blood pressure was included in the regressions), and skin conductance during the experimental task were used, with the 1-second mean as time unit in all recordings, and cross-correlations and 1-differenced cross-correlations between these physiological measures were obtained (except between those of blood pressure). Physiological maximum (highest, either positive o negative) cross-correlation coefficients were selected in analyses including +/- 100 lags. Theses indices have been reported as used in the field (Shioiri et al., 2004). All MCCs were significant at $p > .01$. "Absolute" MCCs were the absolute numbers of MCCs. It was important in this study to have measurements of the absolute amount of cross-correlation that two physiological measures may reach, apart from measurements of the sign (or direction) of the cross-correlation, implying different interpretations (see below). In order to explore coordination profiles and patterns, lag numbers of MCCs and MDCCs were also recorded, and Repeated Measures MANOVAs among MCCs, MDCCs, absolute MCCs, absolute MDCCs, and among lags of each set were conducted separately. Mann-Whitney analyses were carried out dividing subjects in two groups using the lags medians as grouping criteria and with MCCs and MDCCs as DVs.

Results

The means of the socio-demographic and child-rearing variables for the whole sample (N=32) were as follows: Number of siblings, 1.69; Family income during childhood (1=very high, 5=very low), 3.28; Number of residences during childhood, 1.91; Education of father (1=elemental; 5=Post-graduate), 3.78; Education of mother, 2.84; Frequency of contact with extended family ("Family Extension", 1=Almost never, 5=daily), 2.33; Mother's Emotional Warmth (1=Never, 4=Always), 3.00; Father's Emotional Warmth, 2.78; Mother's Control, 1.55; Father's Control, 1.66; Mother's Protection, 2.04; and Father's Protection, 1.88. Pearson's correlation between father's and mother's factors were as follows (N=31) for Emotional Warmth, .60 ($P<.001$), for

Control, .50 (P<.01), and for Protection, .66 (P<.001). Means of the emotional concepts were: Evaluation, 2,2; Pain Potency, 4,8; Pain, Activity, 3,8; Pleasure Evaluation, 6,3; Pleasure Potency, 4,3; Pleasure Activity, 5,5; Courage Evaluation, 5,5; Courage Potency, 5,4; Courage Activity, 5,1.

Table 1 shows significant multiple regressions (p<0.1) with child-rearing factors as predictors, which were as follows: RCD in baseline, with Mother's Protection reaching significant levels ($t(26)=3.74$, $p<.001$); MBP in Punishment, with significant Father's Emotional Warmth ($t(28)=3.52$, $P<.01$) and Mother's Emotional Warmth ($t(28)=-2.7$, $P<.05$); MBP during Extinction, with Mother's Emotional Warmth ($t(28)=-3.46$, $P<.01$); and 1-differenced HR-SC cross-correlation, with Father´s Protection as the significant variable ($t(28)=-2.84$, $P<.01$). Also, the numbers of multiple regressions reaching p>.05 with child-rearing factors as predictors were as follows: 5 out of 10 predicting physiological means, 5 out of 12 predicting physiological activity on operant contingencies, and 1 out of 12 predicting MCCs.

Table 1 – Child-rearing factors predicting means of physiological indices through experimental conditions, through types of operant contingencies [(1)], and through maximum cross-correlations between physiological indices. Largest significant multiple regressions (p<.01).

Predictors	***RCD Baseline** (N=29)*	***RCD Test** (N=29)*	***MBP Pun.** (N=31)*	***MBP Ext.** (N=31)*	***HR-SC MDCC** (N=31)*
Warmth Father	-.25	-.11	.67**	.40*	,12
Warmth Mother	.13	.21	-.51*	-.66**	-,07
Control Father	.21	.06	.00	.07	-,06)
Control Mother	.00	.01	-.02	.10	,07
Protection Father	-.03	.01	.02	-.29	-,47**
Protection Mother	.58***	.54**	-.15	-.13	-,21
F (1,27) / *F* (1,29)	13.97	11.20	6.57	6.00	8,04
Multiple *R*	.58***	.54**	.56**	.55**	,47**

* p < .05; ** p < .01; *** P < .001
RCD = Respiratory Cycle Duration, MBP = Mean Blood Pressure
HR-SC MDCC = Maximum 1st-Difference Correlation between Heart Rate and Skin Conductance
Pun. = Punishment, Ext. = Extinction.
(1) Respiratory measures were not included in the analyses on operant contingencies.

Table 2 shows the following physiological variables significantly predicted (p<.01) by demographic variables: Mean RCD during baseline, with Family Income as significant predictor ($t(26)=3.07$, $P<.01$); HR during situations of Reward at the experimental tasks, with Family Income ($t(27)=3.85$, $P<.001$) and Family Extension ($t(27)=2.39$, $P<.05$) as significant predictors; and MBP-SC absolute (without +/- sign) MDCC, with Family Income as significant predictor (t(28)=3.15; p<.01). Also, the number of multiple regressions reaching p>.05 with demographic variables as predictors were as follows: 5

out of 10 predicting physiological means, 2 out of 12 predicting physiological activity on operant contingencies, and 2 out of 12 predicting cross-correlations.

Table 2 – Multiple regressions. Socio-demographic variables predicting means of physiological indices through experimental conditions, through types of operant contingencies [(1)], and through maximum cross-correlations between physiological indices. Largest significant multiple regressions (p<.01)

Predictors	*Beta Coefficients* **RCD Baseline** (N=29)	**HR Reward** (N=31)	**Abs. MDCC MBP-SC** (N=31)
Family Extension [(2)]	.25	.37*	,209
Family Income	.51**	.61***	.51**
Family Mobility [(3)]	.03	-.05	-,22
Education of Father	.12	-.13	-,18
Education of Mother	.27	-.12	-,17
Number of Siblings	-.19	.06	,160
F (1,27) / *F* (1,29)	9.41	8.20	9.94
Multiple *R*	.51**	.61**	.51**

* p < .05; ** p < .01; *** P < .001
RCD = Respiratory Cycle Duration, HR = Heart Rate.
Abs. MDCC MBP-SC = Absolute Maximum 1st-Differenced Cross-Correlation between Mean Blood Pressure and Skin Conductance
(1) Respiratory measures were not included in the analyses on operant contingencies.
(2) 'Family Extension' refers to frequency of contact with extended family.
(3) 'Family Mobility' refers to number of times the family changed residences.

Table 3 shows the significant multiple regression (p<.01) with the semantic differential emotional concepts predicting the following physiological measures: RCD baseline with Pain Potency (t(29)= 2.30, p<.01) and Pain Evaluation (t(29)=3.35, p<.01) as significant predictors; HR-MBP MCC with Evaluation of Pain (t(29)=4,98, p<.01), Pleasure Evaluation (t(29)=3,51, p<.01), and Potency of Courage (t(29)=-2.81, p>.05) as significant predictors. Also, the number of multiple regressions reaching p>.05 with emotional factors as predictors were as follows: 5 out of 10 predicting physiological means, 2 out of 12 predicting physiological activity related to operant contingencies, and 2 out of 12 predicting MCCs. Table 4 shows the differences of means among MCCs between physiological measures and among lags, tested through repeated measures analyses. Table 5 includes all Mann-Whitney analyses of (non-absolute) MCCs and MDCCs with their lags as grouping variables (lag median as criterion).

Table 3 – Multiple Regressions. Emotional concepts (through Semantic Differential) predicting means of physiological indices through experimental conditions, through types of operant contingencies (1) and through maximum cross-correlations among physiological indices. Largest significant multiple regressions (p>.01).

	Beta Coefficients	
Predictors	**RCD Baseline**	**HR-MBP MCC**
PAIN Evaluation	0,59**	,84***
PAIN Potency	0,40**	-,13
PAIN Activity	,01	-,05
PLEASURE Evaluation	-,17	,64**
PLEASURE Potency	-,19	,02
PLEASURE Activity	,16	,06
COURAGE Evaluation	-,02	-,28
COURAGE Potency	,00	-,43*
COURAGE Activity	,12	,15
F (1,27)	6,46	9,65
Multiple *R*	.44**	,74***

* p < .05; ** p < .01; *** P < .001
RCD = Respiratory Cycle Duration,
HR-MBP MCC = Maximum Cross-Correlation between Heart Rate and Mean Blood Pressure
(1) Respiratory measures were not included in the analyses on operant contingencies.
(2) 'Family Extension' refers to frequency of contact with extended family.
(3) 'Family Mobility' refers to number of times the family changed residences.

Table 4 – Repeated Measures MANOVAs among Maximum Cross-Correlations (MCC), Maximum First Differenced Cross-Correlations (MDCC) between physiological variables, among absolute numbers of each one (absolute MCC and absolute MDCC) and among lag positions of each index (1 lag = 1 second). Means.

	Heart Rate-Mean Blood Pressure	***Heart Rate-Diastolic Pressure***	***Heart Rate-Systolic Blood Pressure***	***Heart Rate – Skin Conductance***	***Mean Blood Pressure – Skin Conductance***	F
MCC	-0,03	-0,06	0,07	0,27	-0,12	4,91***
MCC Lags	3 (1)	3,52 (1)	0,39 (1)	-2,16 (1)	-4,9 (2)	,84
Absolute MCC	0,40	0,42	0,44	0,46	0,49	5,68***
Absolute MCC Lags	20,23	17,39	22,68	20,42	22,45	,57
MDCC	0,1	0,11	-0,03	0,06	-0,05	1,73
MDCC lags	2,23 (1)	-0,74 (1)	-0,65 (1)	-3,80 (1)	-5,81 (2)	-
Absolute MDCC	,36	,39	,36	,21	,24	33,25***
Absolute MDCC lags	4,03	1,90	2,19	17,87	13,10	-

* p < .05
** p < .01
*** p < .001
(1) Positive lags meaning heart rate before in time. Negative lags, blood pressure is previous.
(2) Positive lags meaning blood pressure before skin conductance. Negative lags, skin conductance goes previous.

Table 5 – Mann-Whitney. Differences between physiological maximum cross-correlations coefficient groups with the lag median as grouping criteria.

	-	+	*U*
HR-MBP	-,3470	,3105	81,5
N	10	21	
HR-DBP	-,3830	,3443	98,5
N	10	21	
HR-SBP	-,3763	,3340	56,0*
N	16	15	
HR-SC	,3895	,090	74,5
N	19	12	
MBP-SC	-.02	-.33	73,0
N	21	10	
Dif. HR-MBP	-,3470	,3105	7,0***
N	10	21	
Dif. HR-DBP	-,3830	,3443	6,0***
N	10	21	
Dif. HR-SBP	-,3763	,3340	0,0***
N	16	15	
DIf. HR-SC	-,0153	,1662	61,5*
N	17	13	
Dif. MBP-SC	-,0935	,0725	48,0*
N	23	8	

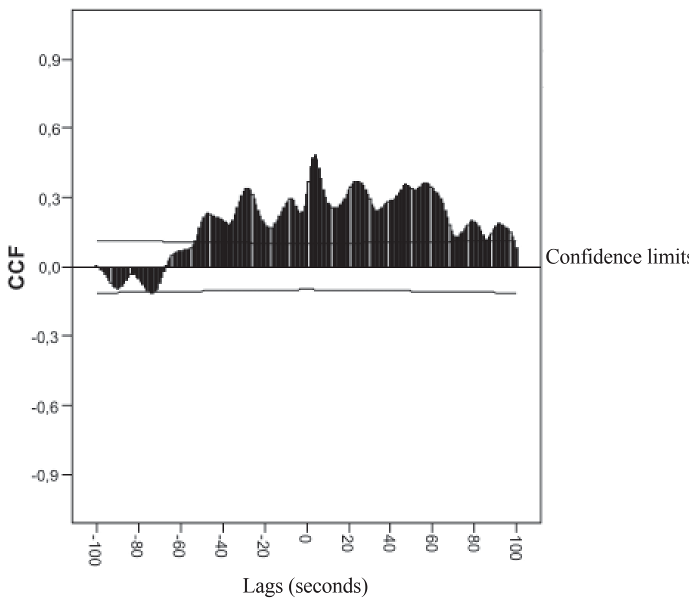
* p <.05
** p <.01
*** p < .001

Case studies. Graphics 1 and 2 depicts the results of two cases selected as illustrating the two most frequent types of subjects according to their most significant social, psychological, and physiological variables.

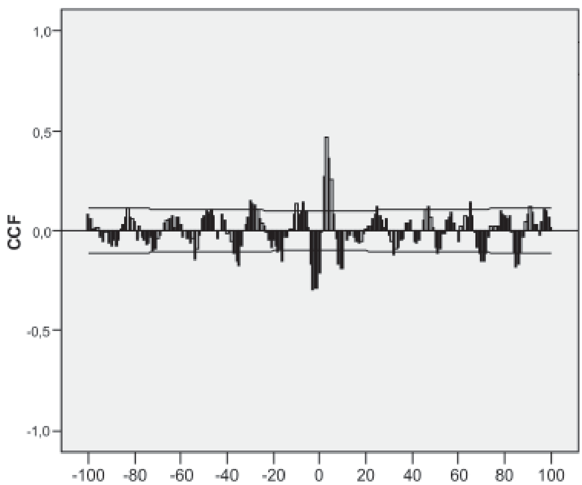
Graphic 1 – Case nº 26
1.1. Psychosocial Variables

Gender	***Female***	***Age***	***20***
Family income	High - middle level.	Father educational level Mather educational level	5/5 4/5
Pain Evaluation ("bad vs. good")	2.0/7	Pain Potency ("weak vs. strong")	5.7 / 7
Pleasure Evaluation ("bad vs. good")	7.0 / 7	Pleasure Potency ("weak vs. strong")	4.0
Father Support	2.3 / 4	Mother Support	3.9 /4
Father Control	1.5 / 4	Mother Control	1.3 / 4
Father Protection	1.2 /4	Mother Protection	1.8 / 4

1.2. Cross-Correlations Coefficients - Heart Rate with Mean Blood Pressure (positive lags meaning heart rate before in time).



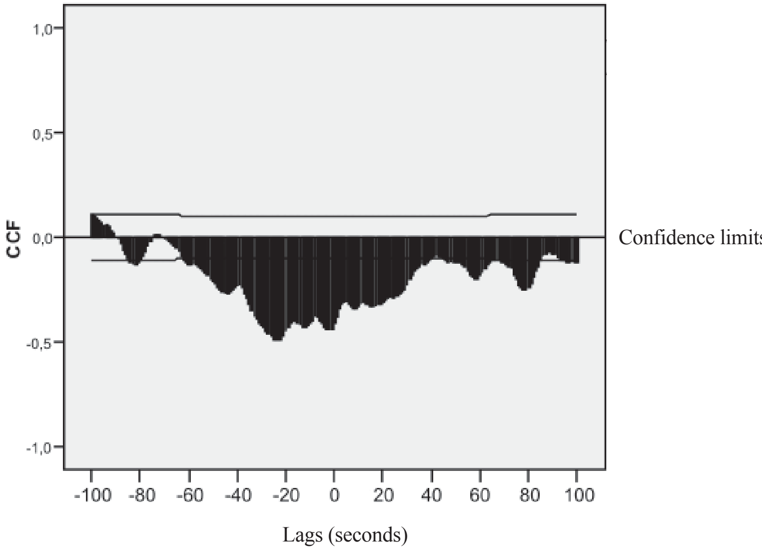
1.3. 1st-Differenced Cross-Correlations – Heart Rate with Mean Blood Pressure (positive lags meaning hear rate going before in time).



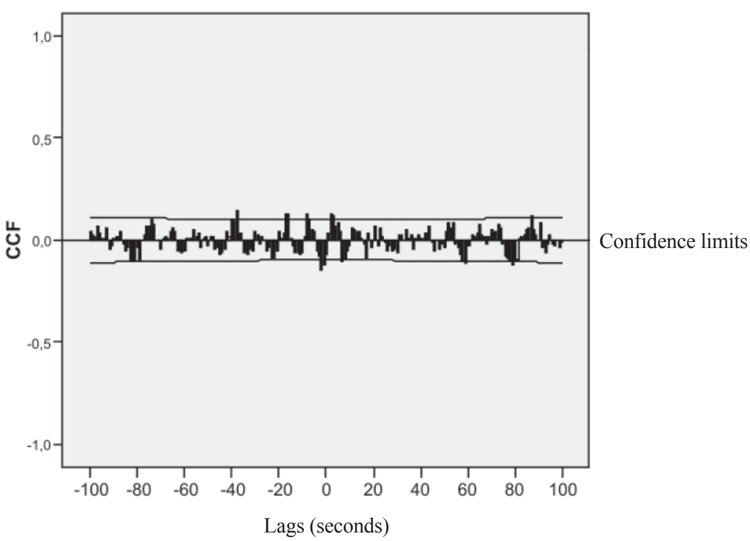
Graphic 2 – Case nº 12
2.1. Psychosocial variables

Gender	***Female***	***Age***	***20***
Family income	Middle level.	Father educational level Mother educational level	3/5 2/5
Pain Evaluation ("bad vs. good")	3,3/7	Pain Potency ("weak vs. strong")	5 / 7
Pleasure Evaluation ("bad vs. good")	6 / 7	Pleasure Potency ("weak vs. strong")	3.5
Father Support	2.3 / 4	Mother Support	2.9 / 4
Father Control	2.3 / 4	Mother Control	1.0 / 4
Father Protection	2.2 / 4	Mother Protection	3.6 / 4

2.2. Cross-Correlations – Heart Rate with Mean Blood Pressure (positive lags meaning hear rate going before in time).



2.3. 1st-differenced Cross-Correlations – Heart Rate with Mean Blood Pressure (positive lags meaning hear rate going before in time).



Discussion

It is worth noting that the sample represents a quite homogeneous group of university students from "normal" family environment. This may be important to keep in mind when analyzing Table 1. Out of 34 regressions carried out with child-rearing factors as predictors of physiological activity indices, 11 (34%) were significant at $p < .05$, and 5 (16%) at $p< .01$, which points to the general relevance of perceived child-rearing patters on general physiological activity. Father´s and Mother´s Warmth appear as strong predictors of MBP under punishing (and non rewarding) stimuli, but with opposite signs, which suggests the relevance of the different parents´ roles significance in the emotional reactions to negative outcomes, with father´s support being excitatory and mother´s support inhibitory. This difference in sign and strength of the relationship between father and mother may reflect complementary roles of Father's and Mother's Warmth, as perceived by the child, affecting the development of a balanced reaction to negative outcomes. The difference in the significance of father as a source of power and mother as a source of affection found in most cultures (Lamb, 1987, Whiting and Whiting, 1975) may underlie these results. A show a strong positive relationship was shown between Mother's Protection and respiratory period (RCD), which could reflect either a higher ability to relax or a lower involvement in the experiment. These results (with moderately protected individuals) do not suggest the reported tendency of highly protected individuals to show higher stress under non-familiar situations (Dielman and Barton, 1983; Parker, 1983; Sebald, 1976). Father´s Protection showed a negative relationship to HR-SC MDCC, which could imply a lower focus on excitatory reactions, supporting the lower involvement hypothesis.

Regression analyses with demographic variables as predictors show fewer significant results, albeit also important ones (28% with $p>05$, 16% at $p <.01$). Table 2 shows the most significant regressions, with family income as the main predictor, suggesting a tendency for higher income subjects to remain physiologically more relaxed during resting situations, but to be more responsive to rewarding stimuli. Also, higher correlation levels between BP and SC changes might imply a more focused SNS activation, perhaps due to higher motivation levels towards the game.

Regarding emotional affective meanings as predictors (28% regressions with $p>.05$ and 6% less than .01), indices of negative emotions ("Pain") appear especially important, followed by positive emotions ("Pleasure"). People placing meanings of less negativity and higher strength to pain show higher excitatory reactions to the experimental situation, and more important, more positive MCC between HR and MBP. The very highly significant prediction of emotional conceptual evaluations to HR-MBP MCC provides support for the thesis that a positive attitude towards one´s own emotions is related to a positive type of cardiovascular coordination (Gandarillas, Camara, and Scarparo, 2005).

Tables 4 and 5 depict results of additional within-subject oriented analyses, related to psycho-physiological coordination indices, which allow a deeper interpretation of the results. The highest MCCs are found between heart rate and skin conductance, perhaps reflecting a more linear physiological relationship than for example, between HR and BP. Especially interesting is to find "plain" MCC higher than MDCC (Table 4), which would suggest a vegetative system coordinating itself based more on physiological activity levels than on physiological activity changes. There are no significant differences among lag numbers of the MCCs and MDCCs, which may be due to the wide distribution of values. However, Table 5 shows a solid consistent tendency for negative cross-correlation to be found under negative lags and vice versa, especially in MDCCs. These results suggest certain hemodynamic profiles and physiological activation pattern types across individuals. About half show a tendency for the heart to react in opposite direction to blood pressure following changes of BP, which may be well explained by peripheral negative feedback mechanisms such as baroreflex (Davydov, Shapiro, Cook, and Golstein, 2007; Guyton and Hall, 2000; Ferrari, Daffonchio, Albergati, and Mancia, 1987). The other half of the subjects showed a tendency for blood pressure to react along with the heart in the same direction.

Case studies. Two cases have been selected to illustrate and deepen in the analysis of these types. Graphic 1 shows case number 26, with a clear tendency for heart rate and mean blood pressure to behave in the same direction, especially when blood pressure seems to respond right after heart rate. Graphic 2 (case number 12) shows a very different tendency, with both indices behaving in opposite direction, especially with heart rate following the changes of blood pressure some seconds afterwards. The later type of behavior is well known as a peripheral balanced reaction, and the former type could respond to a more central drive, a cortical "mediator" role (Cacioppo, 2004). Could this imply two types of persons in the way their vegetative system reacts, one with a more balancing, peripheral "strategy", and another more centrally oriented? If we take a look to the social and psychological data of each case, we obtain a more complete picture of both cases which fit well with the previous discussed results: The "Central" case (number 26) reports higher family income, higher parents´ education, higher Pain Potency and Pleasure Evaluation and Potency (although lower Pain Evaluation), higher Father´s and Mother´s Warmth, lower Father´s Control (although a little higher Mother´s Control) and lower Father´s and Mother´s Protection. These results portray two prototypes of subjects: A "peripheral" type, coming from a less comfortable and stimulating family environments, more prone to a failure-avoiding motivation, and with a less risk-taking and more psycho-physiological "balancing" strategy; and a "central" subject type, perhaps with reward more cortically internalized, higher intrinsic, success, and reward-oriented motivation, with a psycho-physiological "goal-driven" strategy.

As a whole, the results of this study support, at psycho-physiological levels, main findings in the research literature on the functions of child-rearing practices in the development of socio-cultural fitness (Whiting and Whiting, 1975) through a physiological development mediated by emotional learning. Each social and cultural group might use a certain combination of child-rearing patters in order to nurture an optimal physiological adaptation to the specific characteristics of the social and ecological environments in which the individual grows. From this point of view, this study suggests the existence of a physiological stratum to these dynamics. High parents´ stimulation and emotional support and low parental protection would be more effective in fostering highly intrinsic and success-oriented motivated persons, a goal of post-industrial cultures (Whiting and Edwards, 1988) or in families with higher socio-economic support and expectations (Kalimo and Vuori, 1993; Rohner, 1986). Medium parental support along with high protection, the most common combination in rural areas (Whiting and Edwards, 1988), seems optimal to develop an emotional binding to the family and more failure-avoiding strategies, functional within a social context with more risks and lower expectations.

In conclusion, the results of this study support our previous hypotheses, and show that the child-rearing factors here included (from a retrospective approach) appear as very relevant social modulators, not only for cognitive and emotional (as pointed by literature), but also for psycho-physiological development. This study suggests that models such as Gray's may apply better to some social groups and individuals than to others when explaining certain psycho-physiological reactions. Each person develops a unique 'physiological personality', understood as a specific set of psycho-physiological response patterns. The results suggest that this set of patterns appears strongly linked to its socio-cultural background.

Limitations of the study and further directions.

Even though the results of this pilot study suggest the existence of stable and coherent social-psycho-physiological patterns, the limited scope of this study (small sample size and limited results) does not allow us to jump to solid conclusions, and raises more questions than answers. With bigger samples, it could be possible to define specific individual and social psycho-physiological prototypes. Furthermore, cultural conflicts reflected within a specific social group could be expected to develop on disfunctional physiological reactions within each individual. Further studies of different combinations of the patterns here found might help us understanding better the hemodynamic profiles reported in disorders such as hypertension (Calhoun and Oparil, 1996; Ottaviani et al., 2006, Pérez et al., 1998), psychological stress (Shioiri et al., 2004; Ziegler, 1996), coronary heart disease (Krantz and McCeney, 2002) or depression (Davydov, Shapiro, Cook, and Goldstein, 2007; Krantz and McCeney, 2002). For example, we could hypothesize that the "peripheral" type of individual may be at higher risk for blood pressure disorders, and the "central" type being more prone to heart diseases.

Another limitation of this study is the linear statistical approach used here to analyze non-linear physiological relationships, which allows a very narrow interpretation of the results. New methodology is needed to describe these physiological coordination dynamics, by taking advantage of modern computer power to process large amounts of data, and to identify and classify patterns, which may be more useful for understanding, diagnosing, and predicting physiological activity than an approach based on the identification of non-linear functions (e.g., Gilmour, 1996; Yang, Zhang, and Coote, 2002).

The theoretical approach of this study, ranging from a cultural to an ecological psychophysiology, appears very fruitful at both theoretical and applied levels, and it aims at integrating findings and methodologies from different disciplines. Here the fields of child-rearing practices, child abuse and neglect, operant conditioning, and psychophysiology were integrated. This study suggests the usefulness to develop data banks of human ecological physiology integrating cultural, social, psychological, physiological, and health data, and especially centered on physiological coordination patterns and their relationship with disorders. This would allow us to search for physiological prototypes and taxonomies, helping us to understand human physiology from a integral perspective, and therefore to diagnose and prevent illnesses more effectively. Considering the situation of segmentation among social and health sciences nowadays, which may partly explain the lack of studies addressing these topics, this type of inter-disciplinary integration will be very fruitful. It will help each discipline to strengthen its theoretical basis and to bring in fresh empirical findings from other fields. But what is more important, it may provide social and health sciences with a more global and integrated perspective which could help understand many of these findings currently explained from limited standpoints.

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