BLOOD PRESSURE REACTIVITY TO SOCIAL STRESS IN AN EXPERIMENTAL SITUATION

REATIVIDADE CARDIOVASCULAR AO STRESS SOCIAL EM SITUAÇÃO EXPERIMENTAL

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ABSTRACT

Objective

This study tested the hypothesis that the stress created by social interactions could increase cardiovascular reactivity and that the magnitude of this increase would depend on whether the interaction offers social support or if it presents a social conflict.

Methods

The finger blood pressure and heart rate of 58 subjects were recorded continuously before, during and following a structured interview and a role-playing task, involving socially stressful interactions between the subjects and a confederate. The twenty-four-hour ambulatory cardiovascular activity was also monitored for all the subjects in their natural environment. The participants were divided into two groups according to the mean ambulatory arterial blood pressure.

Results

The blood pressure increased during the role-playing task, and to a lesser extent, during the interview, with no sustained increases in heart rate. Subjects with higher ambulatory blood pressure and Negro subjects did not show greater blood

pressure reactivity than subjects with lower ambulatory blood pressure or Caucasian subjects. Women showed greater heart rate changes as compared to men during scenes that involved social conflict and Caucasian men showed greater heart rate reactivity as compared to Negro men during social challenge.

Conclusion

These findings indicate that socially stressful situations may represent a different kind of stressor and suggest the need for further research to directly compare responses to social and mental challenges.

Indexing terms: blood pressure, cardiovascular reactivity, experimental stress, interpersonal stress, social stress.

R E S U M O

Objetivo

O presente estudo teve por objetivo testar a hipótese de que o stress *gerado por interações sociais é capaz de aumentar a reatividade cardiovascular e que a magnitude do aumento dependerá desta interação envolver conflito ou apoio social.*

Métodos

A pressão arterial e a freqüência cardíaca de 58 participantes foram registradas continuamente antes, durante e após uma entrevista estruturada e uma sessão de role play (dramatização) que envolveu interações socialmente estressantes entre o participante e um confederado. A atividade cardiovascular foi monitorada por 24 horas no ambiente natural de cada participante. Os participantes foram divididos em dois grupos de acordo com a média da pressão arterial ambulatorial

Resultados

A pressão arterial aumentou durante a dramatização e durante a entrevista, sem se registrar aumentos significativos de freqüência cardíaca. Participantes no grupo de pressão ambulatorial acima da média do grupo e aqueles da raça negra não mostraram reatividade maior do que os do outro grupo ou os da raça caucásia. Mulheres revelaram maior freqüência cardíaca quando comparadas com os homens durante as cenas que envolviam conflito interpessoal, da mesma forma que os homens da raça branca também mostraram maior reatividade de freqüência cardíaca quando comparados com homens da raça negra durante as cenas de stress social.

Conclusão

Os dados indicam que situações socialmente estressantes podem se constituir em um tipo diferenciado de estressor e sugerem a necessidade de pesquisas adicionais que comparem especificamente a reatividade cardiovascular frente a situações de stress *social e outros tipos de* stress, *como o mental.*

Termos de indexação: *pressão arterial, reatividade cardiovascular,* stress *experimental,* stress *interpessoal,* stress *social.*

INTRODUCTION

Increases in blood pressure caused by emotional events have been widely recognized[1] and a number of studies have investigated the ways in which cardiovascular function is affected by stress-induced laboratory procedures[2]. One research practice in this area is to make use of stressors like mental arithmetic tasks[3], cold forehead presses, aversive reaction time tests[4] and stressful films[5].

Another trend in studies of cardiovascular reactivity is that of increased attention to the effects of social stimuli. For example, two experimental studies[6,7] illustrating the beneficial "effect of person" on blood pressure are consistent with epidemiological findings which link social support to decreased cardiovascular morbidity and mortality. However, some social interactions may have adverse effects on blood pressure. Of particular interest in this regard is the venerable hypothesis relating anger inhibition to chronic hypertension[8]. Questionnaire studies consistently find a positive correlation between the tendency to inhibit anger in social situations and resting blood pressure levels[9,10]. Some investigators believe that inhibitory social habits play a significant role in the development of chronic hypertension[11]. One study, which found that the "assertiveness" level is inversely related to the rate of rise in blood pressure over the following 10 years[12], is in agreement with this view.

The physiological mechanisms by which social interactions might contribute to the development of hypertension remain to be determined. Previous studies of the cardiovascular effects of social interactions have shown that the simple act of speaking acutely increases both blood pressure and heart rate[13]. It has been shown that discussing events of personal significance can produce substantial pressure responses which are reliable over time[14], even in the presence of a supportive interviewer. It has been found that interviews[15] or group discussions[16] produce blood pressure responses, which are at least equivalent to those evoked by video games or mental arithmetic, but smaller changes in heart rate. It has also been shown[17] that female, older and Negro subjects tend to react more intensively, in terms of heart rate, to social stress than their male, younger and Caucasian counterparts. Social interactions may include a larger vascular component because of intermittent "sensory intake" behaviour[18]. Investigations of functional relationships between experimental situations are needed, which generate emotional states linked to hypertension and physiological mechanisms involved in blood pressure

regulation. Although one study reported that simply imagining being the object of social aggression was sufficient to cause peripheral vasoconstriction[19], few studies have focused on the cardiovascular consequences of simulated social conflict. Morrison et al.[20] developed a role-playing paradigm to analyse the blood pressure concomitants of assertive behaviour. Their method involved presenting verbal descriptions of a series of common social situations involving infringement of the subject's rights, aimed at prompting dialogues between the subject and a confederate. The confederate's oppositional behaviour was standardised but the subject was free to respond spontaneously. These interactions were found to generate large magnitude increases in blood pressure in both normotensive and hypertensive subjects. This methodology appears to provide a systematic approach preserving at least some of the spontaneity of human communication.

The present study extends this role-play methodology to the investigations of cardiovascular responses to common social conflicts. Blood pressure and heart rate were monitored continuously before, during and after listening to tape recorded presentations of conflict situations, followed by dialogues with a confederate. The situations were designed to provide the opportunity for assertive responses by the subjects, as defined by Rathus[21]. In addition, physiological measurements were also recorded during a structured interview, which was designed to assess the individual history and assertiveness level.

The study tested the hypotheses that the stress created by social interactions can increase cardiovascular reactivity and that the magnitude of this increase will depend on whether the interaction offers social support or presents a social conflict.

METHODS

Fifty-eight adults were recruited from the surrounding hospital community, including 19 Caucasian females, 16 Caucasian males, 14 Negro

females and 9 Negro males, ranging in age from 21-70 years (mean + S.E.= 40.8 +/- 1.4 yr). None were taking anti-hypertensive medication at the time of testing.

Finger blood pressure and heart rate were monitored continuously in each subject during the laboratory session using the Finapres methodology (Model 2350, Ohmeda, Denver, CO). A small finger cuff equipped with an infrared photoplethysmograph measured arterial blood volume under the cuff around the middle finger of the left hand, maintained at heart level by resting the hand on an adjustable table. The finger cuff was attached to a small box containing a pneumatic valve connected to a source of compressed air, an electro-pneumatic transducer and the electronics for the plethysmograph. The volume clamp-point was periodically adjusted to allow the cuff pressure to continuously reflect intra-arterial pressure. In this study, the systolic, diastolic and mean pressures and the heart rate were recorded every 10 seconds in a dedicated computer.

The blood pressure and heart rate were monitored in the natural environment using an Accutracker II system (Suntech Medical Instruments, Raleigh, NC). The blood pressure was sensed at the non-preferred upper arm via auscultation, using a standard inflation cuff, a piezoelectric Korotkoff sound microphone, electrocardiograph electrodes, a micro-switch cuff pressure transducer and a silent motorised pump. Computer software identified the cuff pressure at the onset and disappearance of the Korotkoff sounds for each deflation cycle, as the systolic and diastolic pressures, respectively.

The experiment included 3 procedures: psychological interview, role-playing and twenty-four hour ambulatory blood pressure monitoring.

Each subject was brought to a 10x10 laboratory room by a Caucasian female technician, questions about the study were answered, the informed consent form was signed and the physiological monitors attached. While the subject remained standing, the cuff for ambulatory monitoring of blood pressure was wrapped around the non-preferred upper arm, and the

electrocardiograph leads applied to the chest. The subject was then seated, and a pressure cuff wrapped to the middle finger of the dominant hand, which then rested on an adjustable platform at heart level. The ambulatory blood pressure system was calibrated prior to the beginning of the experimental session.

The technician then departed from the room and the subject remained alone for 10 minutes (BL1). A Caucasian female investigator (MNL) then entered the room and conducted an interview (INT), which included a series of questions concerning demographics and physical and psychological health history, and administered the Inventory of Stress Symptoms and the Rathus Assertiveness Schedule orally. Following a brief description of the experimental procedures, the investigator then left the room.

The subject remained alone for a second 10-minute interval (BL2), after which the interviewer re-entered the room accompanied by a 30 year old, Negro male confederate, and turned on a tape recorder, which presented a series of 1-minute audiotape recordings consisting of narrations of eight possible social interactions. The first two situations were presented to provide practise in role-playing, and did not involve social challenges. The next six scenes included four focusing on infringement of the subject's rights. The experimenters developed these social challenge scenes according to Rathus' analysis of the components of assertive behaviour; that is, they were designed to evoke (a) forceful, goal-oriented responses, (b) expression of negative affects, (c) disagreements, or (d) discontinuation of disagreeable interactions. The other two scenes involved social support and the expression of positive feelings. The sequence of social challenge situations was varied for partial counterbalancing.

The tape-recorded description of each situation lasted an average of one minute. In a role- play situation (CRP), the subject responded verbally, after which the confederate and subject engaged in a dialogue in which the confederate took an opposing orientation and made standard comments to evoke a total of four verbal responses

by the subject. The interactions were videotaped to differentiate physiological responses during listening, from those occurring during vocal responding. The role-play task lasted 10-20 minutes, depending on the duration of subject responses. At the conclusion of the role-play task, the experimenter and confederate left the room and the subject remained alone for a third 10-minute interval (BL3). The technician then returned to remove the finger blood pressure sensors.

Since the twenty-four hour ambulatory blood pressure is the best predictor of the future development of hypertension[22], the blood pressure of each subject was monitored for 24 hours in his/her natural environment immediately following the laboratory session.

The present manuscript analyses the mean cardiovascular responses to these experimental procedures as a function of subject demographics and ambulatory blood pressure. Correlations between rated or observed subject assertiveness and the various measurements of physiological reactivity were described in a previous paper[22].

One-minute interval means were the basic unit of analysis for each physiological measurement (systolic pressure, diastolic pressure and heart rate) during the laboratory session. Technical malfunctions resulted in the loss of blood pressure and heart rate data in six subjects. Each of the three isolation intervals lasted 10 minutes, but the duration of the interview and role-playing tasks varied from subject to subject, typically exceeding 10 minutes. To ensure that each group minute mean included data from all subjects, only the first 10 minutes of each condition were analysed. The significance of the differences in mean levels between the five experimental conditions was determined by repeated analyses of variance. Multiple comparisons were performed to determine differences between individual pairs of condition. An index of the direction of the trend within each condition was provided by linear regression, applied to the successive one-minute interval group means for each measurement.

Inspection of the ambulatory blood pressure data typically indicated parallel variations in systolic, mean and diastolic pressure during the 24-hour monitoring period. The measurement selected to categorise each subject was, therefore, the mean arterial pressure. Two equally sized groups of subject were composed of those whose 24-hour mean arterial pressures were above (1st group) and below (2nd group) the group median of mean arterial pressure (i.e. 85 mmHg).

Reactivity scores were calculated for each subject as the difference between peak role-playing level and the mean of the first 10 min isolation interval. Pearson product moment correlation coefficients were computed to determine whether systolic or diastolic pressure or heart rate reactivity were significantly associated with either the initial laboratory level or the 24 hour-mean ambulatory monitoring level of each measurement. Unpaired, two tailed Student t-tests, were applied to determine whether race or sex was a significant determinant in the initial level of each measurement or the reactivity scores.

R E S U L T S

Finger blood pressure and heart rate responses to social challenge

Figure 1 shows the means for systolic and diastolic pressures under each of the five experimental conditions. The mean systolic pressure was significantly higher during the interview - INT - (132.7 +/- 4.0mmHg) than during the first social isolation interval - BL1 - (122.8 +/- 3.6mmHg), and did not decrease significantly after the interview, during the second isolation interval - BL2 - (130.5 +/- 4.3) (F $(4,357)$= 195.0; p<.001). The mean systolic pressure during the role-playing task - RP - (146.4 +/- 5.0mmHg) was higher than during the isolation interval immediately preceding (130.5 +/- 4.3) and following (136.4 +/- 4.7mmHg) (BL3) this task.
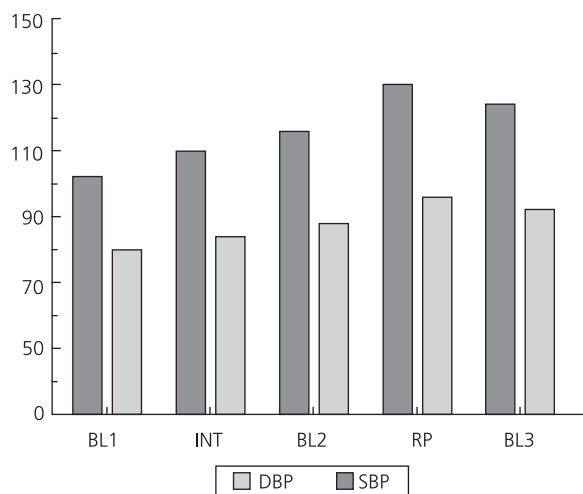
Figure 1. Means for systolic and diastolic blood pressures during the various moments of the experimental session: baseline 1(BL1), interview (INT), baseline 2(BL2), the social stress role-play and the final baseline (BL3).

Figure 1 also shows an identical pattern for diastolic pressure (F (4,357) = 152.9; $p<.001$). The mean diastolic pressure during the interview (82.2 +/- 2.7mmHg) was significantly higher than during the preceding isolation interval (76.5 +/- 2.5mmHg), but not significantly higher than during the second isolation interval (80.3 +/- 2.9mmHg). The mean diastolic pressure during the role-playing task (89.6 +/- 3.3mmHg) was significantly higher than during the preceding (80.3 +/- 2.9mmHg) and following (84.2 +/- 3.1mmHg) isolation intervals.

The mean heart rates during the interview (73.9 +/- 2.6bpm) and the role-playing task (73.3 +/- 2.2bpm) were not significantly different from those during the first (72.9 +/- 2.0bpm) or second (71.9 +/- 2.0bpm) isolation intervals. The mean heart rates were lower during the final isolation period (70.4 +/- 1.9bpm) than during the other four intervals (F (4,357) = 45.5; $p<.01$).

Figure 2 shows the means and standard errors for the systolic and diastolic blood pressures and heart rate reactivity scores for social support (left side) and social conflict (right side) interactions. The mean systolic pressure reactivity (t= 3.48; $p<.001$), diastolic

pressure reactivity (t= 3.83; $p<.001$) and heart rate reactivity, were all significantly greater during social conflict episodes than during social support episodes.

No significant differences between younger and older subjects were observed for systolic pressure reactivity (t= 0.28; NS), diastolic pressure reactivity (t= 0.35; NS) or heart rate reactivity (t= 0.59; NS) during the role-playing of social conflict. No significant differences between women and men were observed for systolic pressure reactivity (t= 0.39; NS) or diastolic pressure reactivity (t= 0.70; NS), but women showed greater heart rate reactivity than men (t= 2.25; $p<.03$) during the role-playing of social conflict. No racial differences in systolic pressure reactivity (t= 0.21; NS), diastolic pressure reactivity (t= 0.10; NS) or heart rate reactivity (t= 1.46; NS) were observed during the role-playing of social conflict.

Ambulatory blood pressure: associations with the physiological response to social challenge.

Table 1 presents the means and standard errors for the 24-hour ambulatory mean pressures and heart rates, initial (i.e. first isolation interval) finger systolic and diastolic pressures levels and heart rates, and the reactivity scores for the high and low ambulatory blood pressure groups.

Table 1 shows that the initial mean finger systolic (t= 3.62; $p<.01$) and diastolic (t= 4.18; $p<.01$) pressures of the subjects in the high ambulatory blood pressure group were higher than for the subjects in the low ambulatory blood pressure group, and that no significant differences between high and low ambulatory blood pressure groups were observed for the systolic and diastolic reactivity scores. No significant difference was observed between the groups for the initial heart rate level or in heart rate reactivity, although the low pressure group showed a tendency for greater heart rate reactivity (t= 1.80; $p<.07$).
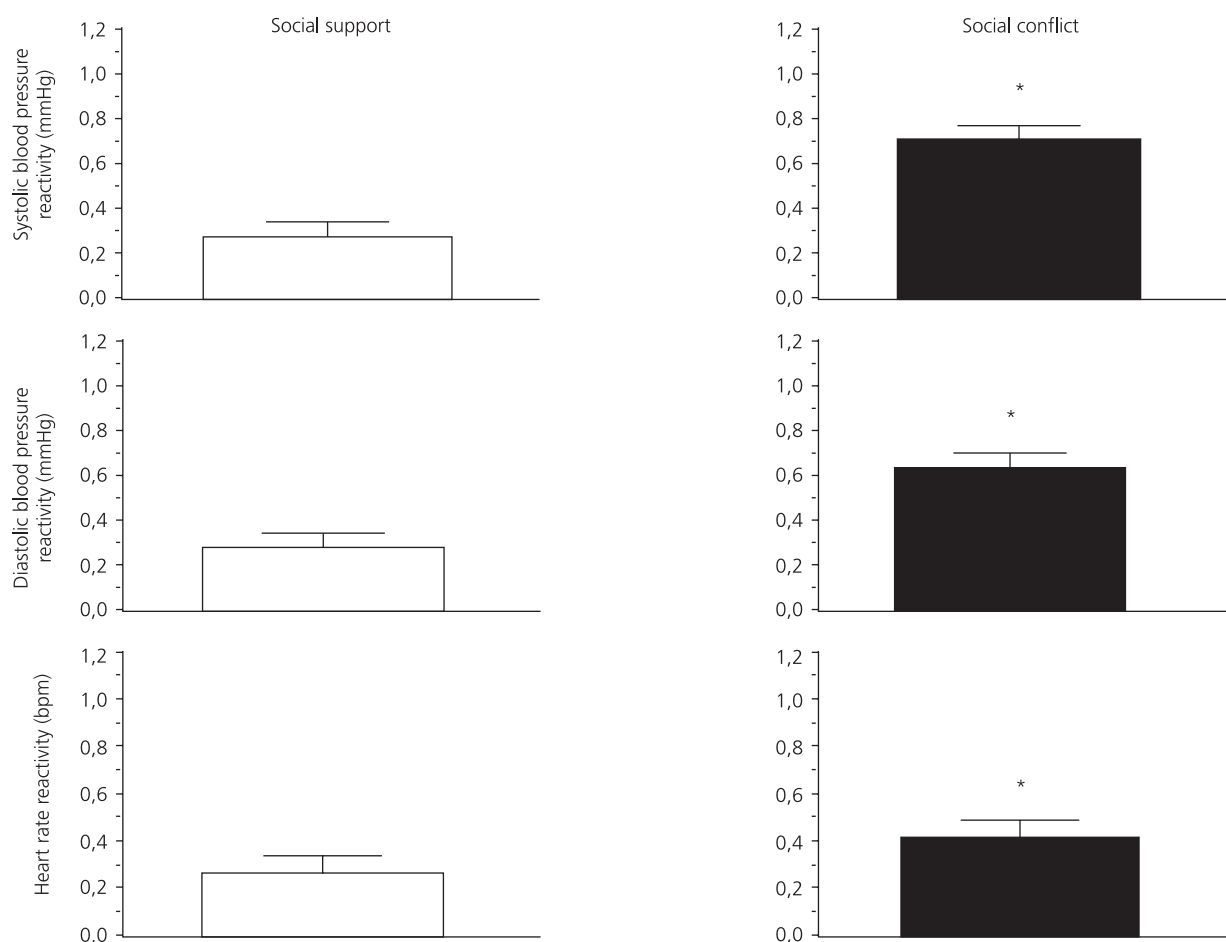
Figure 2. Means and standard errors for systolic and diastolic blood pressures and heart rate during role-playing of social support (left side) and social conflict (right side) •= *p*<.001 compared to reactivity of the same measurement under other conditions.

Table 1. Means and standard errors (SE) for systolic pressure, diastolic pressure and heart rate during the first isolation interval and the increases during social challenge, for the lower and higher ambulatory blood pressure groups.

		High Amb MBP		Low Amb MBP	
		X	SE	X	SE
Ambulatory MBP (mmHg)		97.5•	2.4	78.1	0.9
Ambulatory HR (bpm)		76.4	2.3	75.1	2.3
Systolic	Basal	129.4•	3.3	113.3	3.0
(mmHg)	Challenge	23.5	3.0	23.8	3.1
Diastolic	Basal	81.7•	2.5	69.0	1.8
(mmHg)	Challenge	17.0	1.9	20.1	1.9
Heart Rate	Challenge	72.5	2.4	77.3	2.5
(bpm)	Challenge	1.8	0.6	3.8	0.9

• =>.01; MBP= mean blood pressure.

Race: associations with physiological responses to social challenge

Table 2 shows the racial differences between the means and standard errors for the 24-hour ambulatory mean pressure and heart rate, initial finger systolic and diastolic pressure, heart rate and reactivity scores as a function of race. The mean 24-hour ambulatory blood pressure was significantly higher in Negro than in Caucasian subjects (t= 2.37; $p<.01$), while no significant difference in ambulatory heart rate was observed.

Table 2 shows no significant racial differences in the initial levels of either finger systolic or diastolic pressures, or in the magnitude of the systolic or diastolic reactivity scores. The initial heart rates of Caucasian subjects were significantly higher than those of Negro subjects (t= 4.91; $p<.01$), and

Caucasian subjects showed significantly greater heart rate reactivity to social challenge than Negro subjects (t= 3.41; $p<.01$).

Gender: associations with physiological responses to social challenge

Table 3 shows the means and standard errors for the initial finger systolic and diastolic pressures and heart rate, and reactivity scores, for male and female subjects. No significant differences between the sexes in either ambulatory mean pressure or heart rate levels were observed. Similarly, no significant differences between the sexes were observed for the initial levels of finger systolic or diastolic pressures, nor were there significant sex differences for the finger systolic or diastolic reactivity scores.

Table 2. Means and standard errors for systolic pressure, diastolic pressure and heart rate during the first isolation interval and the increases during social challenge, for Caucasian and Negro subjects.

		Negro		Caucasian	
		X	SE	X	SE
Amb MP (mmHg)		93.0●	3.9	83.7	1.7
Amb HR (bpm)		73.5	2.0	77.2	2.3
Systolic	Basal	121.1	4.1	122.7	2.8
(mmHg)	Challenge	19.9	2.8	26.7	2.7
Diastolic	Basal	77.5	2.7	75.0	2.0
(mmHg)	Challenge	19.4	1.9	18.0	1.9
Heart Rate	Challenge	72.6	2.2	77.5	2.3
(bpm)	Challenge	1.4	1.2	4.8	1.0

● =>.01.

Table 3. Means and standard errors for systolic pressure, diastolic pressure and heart rate during the first isolation interval (basal) and the increases during social challenge, for male and female subjects.

		Male		Female	
		X	SE	X	SE
Amb MP (mmHg)		90.2	2.3	85.8	2.7
Amb HR (bpm)		74.8	2.6	76.4	2.1
Systolic	Basal	123.9	3.0	120.6	3.4
(mmHg)	Challenge	19.5	3.6	25.1	3.3
Diastolic	Basal	77.8	2.3	74.6	2.2
(mmHg)	Challenge	14.5	2.4	17.4	1.6
Heart Rate	Challenge	71.5	1.8	77.9●	2.4
(bpm)	Challenge	2.3	0.8	6.6●	0.9

● =>.01.

Table 3 shows, however, that the initial heart rate levels were higher in females than in males (t= 2.00; *p*<.05), and that females showed significantly greater heart rate reactivity to social challenge than males (t= 4.4; *p*<.01).

DISCUSSION

The social stress paradigm was effective in producing significant systolic and diastolic blood pressure reactivity. However, contrary to studies that made use of mental and physical stressors and obtained heart rate reactivity, the social stress session did not produce significant changes in the heart rate levels. Considering the results obtained, it would be interesting to compare the effects of social stress with those of mental or physical stressors, using the same subjects. Based on this observation, a study is now being undertaken in our laboratory to assess and compare the differential effects of different types of stressors. The psychological interview, which was very basic, involving only very factual information, also gave rise to blood pressure increases, but not to significant heart rate changes, indicating a possibly differential effect of the type of stressors used. Considering that inter-personal contacts of the type used in the present study, are frequently encountered in everybody's lives, the results could indicate that stress interventions should include training in social skills, especially considering that the social conflict interactions generated higher blood pressures and heart rate reactivity than the social support situations.

Also, women showed greater heart rate reactivity during the role-playing of social conflict, indicating a greater level of arousal in the female subjects, which might reflect a cultural effect.

An inspection of the data showed transient increases in heart rate for all the subjects while they were speaking, increases not observed when the subjects were engaged in other activities, notably listening. The fact that the group mean heart rate did not significantly increase during the first 10 minutes of interview or role-playing might reflect the fact that only a minority of time was spent speaking.

Whether the blood pressure increases occurring under these conditions were mediated by increases in total peripheral resistance or not, will require additional observations of changes in the stroke volume under these conditions.

The greatest heart rate reactivity showed by Caucasian subjects during social tasks differed from that found in studies which have shown Negro children to have greater heart rate reactivity[23]. However such difference may be due to the fact that the present study added a new dimension to the stressful situation when it used social challenges, instead of competitive video games.

Blood pressure reactivity to role-playing was not positively correlated with either the 24-hour ambulatory pressure or the initial laboratory finger blood pressure levels. The latter two were, however, correlated with each other, providing concurrent validation for both measurements. The Finapres system is a significant methodological advance for studies in blood pressure change, since it measures pressure continuously. Studies with indwelling catheters have shown that the Finapres blood pressure measurements are highly correlated with direct recordings[24]. Measurements of the blood pressure in arteries more distal to the heart may yield a greater magnitude of response to stimuli than more traditional methods, for anatomic reasons. However, the magnitude of the blood pressure response to social challenge in the present study was within the range of that reported in similar studies using other methods.

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