

1992] as well as in laboratory studies employing time reaction [Gladue et al., 1989] and luck-controlled tasks [McCaul et al., 1992]. In other studies, however, this effect has not been found and the importance of the subjective experience of the competitive outcome has been stressed to understand the hormonal response [Suay et al., 1999]. Mood, from the first, was considered a possible variable mediating between outcome and testosterone response [Mazur and Lamb, 1980]; however, other psychological processes more related to the appraisal of the situation and the subjects' own performance have shown an association with the competition-induced hormonal response such as causal attribution [González-Bono et al., 1999, 2000; Serrano et al., 2000; Suay et al., 1999].

Studies examining the effects of sports outcomes have shown that winners attributed the result to more global, stable, and controllable causes than losers [Grove and Prapavessis, 1995; Grove et al., 1991], although it has also been reported that internal attributions of winners did not differ from those of losers and that attributions to ability and effort vary over time [Zientek and Breakwell, 1991]. Failure has been more attributed to lack of ability and task difficulty and less to lack of effort [Yamauchi, 1990].

Despite the fact that in the biosocial hypothesis of status formulated by Mazur [1985] there was an explicit reference to the sympathetic responses and stress coping in addition to testosterone responses, this point has not been studied in the research on this topic. In fact, studies on physiological reactivity to competitive stressors are very scarce [Beh, 1998].

This study aimed to analyse the cardiovascular response (HR and BP) to a competitive task as well the role of anxiety and causal attribution of the outcome in these responses. Subjects were university students who participated in pairs in a competitive role-playing task. Previous studies have shown that intergroup relations are more competitive than interindividual relations [Pemberton et al., 1996]. Additionally, because the meaning that the competition has for individuals is an important mediator of the arousing effects, be they participants [Mazur et al., 1992; Salvador et al., 1987] or observers [Branscombe and Wann, 1992], a nonphysical competition was chosen due to the fact that verbal contests are the most common in everyday social situations. Clearly, this election permits the improvement in external validity, as has been proposed by studies on cardiovascular reactivity to stress [Al'Absi et al., 1997; Smith et al., 1996].

MATERIALS AND METHODS

Subjects

The sample was originally composed of 80 university students, but, due to different reasons (mainly ambiguous/missing responses to questionnaires and smoking 1 hr before session), the final sample that entered the analyses was composed of 66 subjects (13 males and 53 females) with an average age of 21.35 ± 2.17 years. They practised sports an average of 2 hr/wk and smoked fewer than five cigarettes per day. Subjects were informed about normal intake (food, caffeine) and sleep patterns (7.04 ± 1.23 hr) the day of the experiment. All participants were normotensive: diastolic BP (DBP) for men and women, 76.15 ± 9.9 and 68.13 ± 7.5 mmHg, respectively; and systolic BP (SBP) for men and women, 129.2 ± 11.7 and 114.2 ± 10.7 mmHg, respectively).

Procedure

Subjects were recruited in their classrooms and were asked to participate in a study about group communication involving various social tasks and were assigned randomly to 20 groups of four persons. Before the experimental sessions, subjects were briefed about the general procedure to be

used in the study, and informed consent was obtained. The subjects were told that they could earn a monetary reward of 20,000 pesetas (approximately \$125) for the best group throughout the study.

Participants were instructed to relax for baseline recordings and were left alone during this phase of the experiment, although they were observed through a monitor placed in a different room. The HR recordings were performed continuously 5 min before, during (30 min on average), and 5 min after the tasks. The BP levels were obtained 1 hr before the tasks (baseline), 15 min before the tasks (pretask), and 5 min after the tasks (posttask). The BP levels were not registered immediately after the tasks in an attempt to avoid an alteration of the HR recovery due to the cuff inflation of the BP device. At the end of the experiment, subjects were debriefed and asked not to discuss details concerning the study with others.

Competitive Task

The task was presented as a role-playing game and it was the second where subjects participated within a group of six tasks. Subjects were informed on paper that they were members of two different chemical enterprises (subgroups of two experimental subjects) in need of, for different purposes, a concrete quantity of a rare product. The two enterprises were told that a person (roled by an experimenter) had that desired quantity of product. Both enterprises had the same amount of money for its purchase and could make a maximum of three offers to the owner/experimenter. Once instructions were read and the two groups had thought of their first offers, they wrote their proposals in two different computers (subjects were not able to read rivals' screen contents) connected to the experimenter's computer placed in another room. This manner of communication eliminated possible effects due to different experimenters' characteristics. Although the two enterprises could make their offers at different times, the experimenter answered both offers simultaneously, 1 minute after the last group proposition so that the time for starting to think about the following offers was the same for both enterprises. This same procedure took place three times (all groups reached the third round). When the two groups in competition had made their last offers, the experimenter took a final selling decision guided by a preprogrammed diagram based on economical interests. The group whose final offer was accepted was the winner, and if the same amount of product was sold to both groups there was a draw. All subjects knew the result immediately after the end of the task.

Noncompetitive Task

Two weeks before the competitive role-playing task was run, subjects participated in a non-competitive task under the same circumstances (procedure, experimenters, recording variables, timetables, experimental place and conditions, and team distributions). The data from this task is offered as a reference of cardiovascular response to a noncompetitive social stressor under similar "work" conditions but no direct comparison between tasks has been considered appropriate. Briefly, in this task, the four subjects of each group had to resolve a problem, all having the same information, which they had to share and use together to obtain one final answer (only one correct solution was possible). Based on seven parameters, they had to put in the correct order the different alternative zones appropriate to install a new business. The cardiovascular response was evaluated in the same conditions and temporal periods as in the competitive task; however, nonsubjective appraisal about this task was collected.

Psychophysiological Recording

The HR (beats/min) was recorded by means of a Polar Vantage NV™ Cardiac Monitor (Polar Electro Oy, Finland), which allows continuous free-hands HR measuring with electrocardiographic

accuracy. Immediately after each session the data were stored in an Inves Computer (model UIP5-96-95W-13C2-16/2G) and were visualised on an Inves Colour Monitor (model VGA-1451CLR) by means of the Polar Precision Performance Software™ for Windows (copyright by Electro Oy, Finland), which allowed the edition and reduction of data.

The BP (mmHg) was recorded by means of an autoinflation digital BP monitor (DS-143D) while subjects were sitting. The accuracy of Cuff pressure was of ± 3 mmHg. A presetable exhaust system for deflation (3 mmHg/sgs) was used. The cuff was of a standard adult size with a coverrange arm circumference of 12 to 14 cm. The BP monitor employed the oscillometric method to determine BP, inferred from changes in the intensity of pulse oscillations in the occluding cuff. The validity of this method has been previously established [Fowler et al., 1991; Light et al., 1988].

Subjective Measures

After competition, subjects filled in the STAI-S [Spielberger et al., 1982] and answered questions about their attributions of the result. The scale was constructed according to the bidimensional model of causal attributions [Weiner et al., 1971]. Two questions screened an internal attribution pattern: “How important was your personal effort/abilities for your result?” and another two questions explored an external attribution pattern: “How important for your result was luck/the mistakes of your rivals?” Subjects answered employing a Likert-type scale choosing between 1 (minimum importance) to 5 (maximum importance).

Data Analyses

For the competitive task, a mixed MANOVA was performed with Outcome (winning/losing) and Gender (male/female) as between-subject factors and Period (baseline, task, posttask) as the within-subject factor. For the noncompetitive task, the same analysis was performed but without the Outcome factor. The normal distribution of dependent variables was confirmed by means of the Mauchly Sphericity test, and Post-hoc tests were performed by simple contrasts.

All statistical treatment was performed by SPSS for Macintosh, and $P < .05$ was considered significant.

RESULTS

Cardiovascular Response to the Outcome of the Competitive Task

Of 66 subjects of the final sample, 21 were winners, 23 were losers, and 22 were drawers. There were 4, 5, and 4 men, respectively, which supposed a very similar percentage of male/female in each group.

The HR evolution was different depending on the outcome, as the interaction Outcome \times Period revealed ($F_{2,72} = 4.03$, $P < .02$). Post-hoc analyses showed that, once the competition started, a significant rise in HR levels was only found in the winning group ($F_{1,18} = 5.13$, $P < .04$). On the contrary, the average HR for losers during the competition period was lower compared with their baseline values. After finishing the task, HR decreased in both groups, although significantly only for winners ($F_{1,18} = 4.30$, $P < .05$) (Fig. 1).

Period showed significant effects on SBP ($F_{2,80} = 4.52$, $P < .01$), with decrements from baseline to pretask values ($F_{1,72} = 28.32$, $P < .001$) and no differences between the pretask and posttask values, showing the lowest values after the task ($F_{1,72} = 29.73$, $P < .001$) (Table I). Men showed higher SBP and DBP levels throughout recordings compared with women ($F_{1,40} = 23.08$, $P < .001$; $F_{1,40} = 6.17$, $P < .02$, respectively).

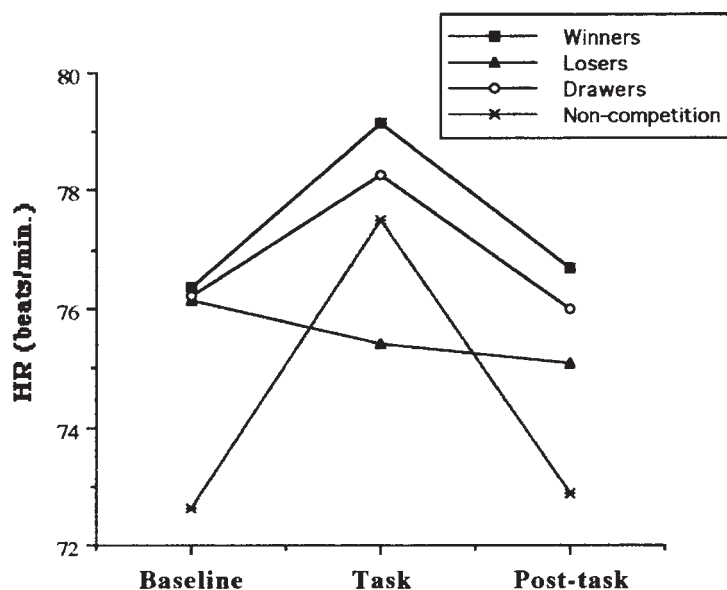


Fig. 1. Means of heart rates in the competitive and noncompetitive tasks. In the competitive task, subjects were separated depending on the outcome.

As could be expected, winners showed minor anxiety-state after competition (14.80 ± 8.02) than the other two groups (18.34 ± 7.3 and 16.59 ± 7.7 for losers and drawers, respectively).

The causal attribution was different depending on the outcome. Winners presented a higher internal attribution of the outcome compared with losers and drawers ($F_{2,62} = 5.1$, $P < .01$) when the two items of internal attribution were added together. Losers tended to a higher external attribution ($F_{2,62} = 2.56$, $P < .08$) compared with winners and drawers (again with the two items of the external dimension considered together). Item-by-item analyses showed that winners trusted more in their personal effort compared with losers and drawers ($F_{2,63} = 4.05$, $P < .02$) and in their own ability compared with losers ($F_{2,62} = 2.99$, $P < .05$). However, there were no significant differences between groups in attributing their results to the mistakes of their rivals or luck, although losers tended to believe that their outcome depended more on luck and rivals' mistakes than the other two groups, indicative of some degree of external attribution and lack of controllability.

TABLE I. Mean DBP and SBP Registered in Both Tasks

	Competitive task	Non-competitive task
DBP, mmHg		
Baseline	69.56	72.43
Pretask	68.47	69.64
Posttask	66.95	70.74
SBP, mmHg		
Baseline	116.90	119.15
Pretask	109.09	108.82
Posttask	109.11	108.64

Cardiovascular Response and Causal Attribution of the Outcome

To study the relationship between attributions and the cardiovascular response to competition more deeply, subjects were distributed into four groups depending on their scores in internal and external attribution variables. Each variable had two levels: High and Low, using the percentiles 70 and 30 as cutoff points, respectively. Based on this, the four groups were High Internal Attribution (HIA), Low Internal Attribution (LIA), High External Attribution (HEA), and Low External Attribution (LEA).

The clearest differences appeared between extreme groups in external attribution (Fig. 2). After the competition, the LEA subjects did not decrease their HR significantly compared with during the task and it was even higher than in baseline ($F_{1,18} = 4.74, P < .04$), while the HEA group presented a significant HR drop ($F_{1,13} = 8.82, P < .01$). In fact, the LEA group displayed higher HR values than HEA subjects ($F_{1,32} = 5.03, P < .03$) in the recovery.

Cardiovascular Response to the Noncompetitive Task

For HR, Period had significant effects ($F_{2,70} = 33.43, P < .001$), with increments during ($F_{1,35} = 52.58, P < .001$) and decrements after the task ($F_{1,35} = 58.38, P < .001$). No differences between baseline and posttask values were found (see Fig. 1).

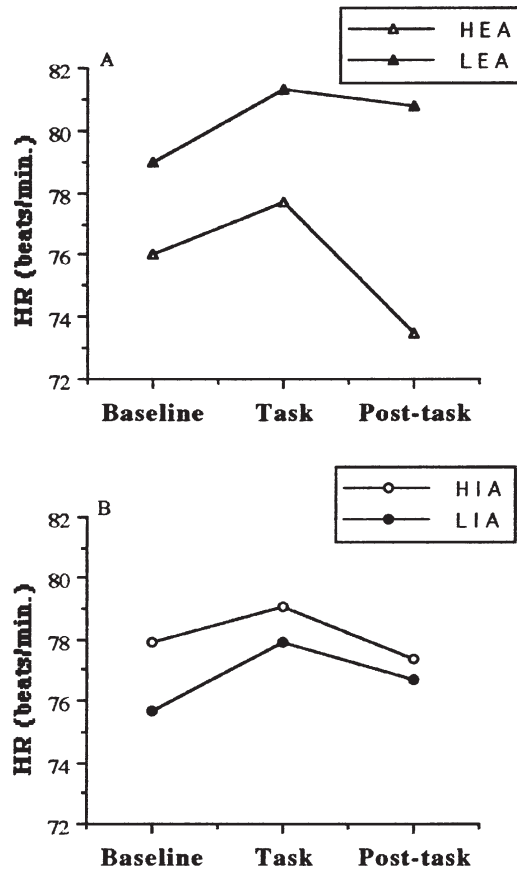


Fig. 2. Means of heart rates in the competitive task according to high/low external/internal attribution. HEA = High External Attribution; LEA = Low External Attribution; HIA = High Internal Attribution; LIA = Low Internal Attribution.

With regard to BP, Period showed significant effects only on SBP ($F_{2,42} = 6.61, P < .003$), with decrements from the baseline to the pretask period ($F_{1,38} = 26.04, P < .001$). Although pretask and posttask values did not change significantly, the latter were lower than the baseline ones ($F_{1,38} = 15.42, P < .001$) (Table I). Gender had significant effects on SBP, with men showing higher SBP levels than women ($F_{1,21} = 4.71, P < .042$).

DISCUSSION

The evolution of HR in the competitive task was different depending on the outcome: only winners presented significant increments during the competition and decrements afterward. Conversely, losers showed a surprising decrease even during the task. A rise in HR during competition together with a decrement during recovery could be considered a typical “adaptive” response to stress that has been found with different stressors such as reaction time, and cognitive and social tasks [Al’Absi et al., 1997; Bongard, 1995]. This is also the response displayed by our subjects in the noncompetitive task; this task was also a social interaction, which, although not identical to the competitive one, was presented under the same experimental conditions. It is worth noting the differences in the baseline that maybe could be part of the preparatory response to competition described by Booth et al. [1989].

On the contrary, BP values were not affected by the outcome and showed a gradual decrement throughout recordings. The time intervals chosen or the low number of measures taken derived from the noncontinuous BP recording employed could be making it difficult to get a response. However, it is worth noting that nondifferences in BP depending on the outcome were found in women who did not participate but were highly identified with opponents in a competition [Branscombe and Wann, 1992]. Men showed higher BP levels than women in both the tasks employed in our study, as has been reported elsewhere [Litschauer et al., 1998; Tersman et al., 1991].

As for attributions, winners displayed a clear internal attribution profile that differed from that presented by losers. In addition, a high external attribution was associated with lower HR levels in the posttask phase, whereas a low external attribution appeared related to the highest activation. The subjects who presented less external attribution not only did not significantly show reductions in HR after the task but even experienced higher values than at baseline. More internal attribution in winners than in losers has been found previously in studies employing sports competitions [González-Bono et al., 1999; Serrano et al., 2000], as well as a negative correlation between testosterone and external attribution of the outcome in team contests [González-Bono et al., 1999, 2000]. It seems that in competitions between groups the external attribution is more clearly related to physiological changes, whereas in individual competitions it is the internal attribution that is involved [Serrano et al., 2000].

Different physiological profiles, including HR and several hormones, have been associated with susceptibility for cardiovascular diseases and social position, this latter being predicted by the behavioural coping strategy, active or passive [Koolhaas, 1994; Koolhaas and Bohus, 1989]. In this framework, animals with an active strategy would take the dominant and subdominant positions, whereas passive animals would occupy the subordinate positions. Physiologically, the active strategy supposes high sympathetic reactivity, whereas with the passive strategy, in stressful situations the individuals react predominantly with a parasympathetic response and very little social activity.

In humans, the tendency to react with sympathetic activation and catecholamines has also been reliably related to the Type A behavioural pattern [Ursin and Olf, 1993]. It is widely

accepted that subjects show more cardiovascular reactivity if they cope with a situation actively than if they cope passively [Bongard, 1995]. The HR rises experienced by winners in our study could be reflecting an active strategy, a greater effort, and a greater involvement in the task, and as a result of the display of more available resources, subjects were rewarded with a victory. Effective performance under stress is typically accompanied by high physiological activation and subjective strain, with active coping (or control) typically related to sustained effort and elevated catecholamine response, without increases in cortisol [Hockey, 1997]. However, losers showed an HR drop throughout competition and recovery that may be related to the findings reported by Light and Obrist [1983], who found a reduction in cardiovascular responsiveness during an impossible task compared with a challenging but solvable task. It is possible to speculate that losers perceived that they would not win, "gave up," and adopted a passive strategy, with the consequent diminution in their cardiovascular responses. This type of response could be related to the perceived self-efficacy where performance depends on beliefs of subjects about their capacities to mobilise his or her motivation or cognitive resources to exert control over the demands of a task more than in the available resources per se [Bandura, 1990]. The differences found in the posttask between winners and losers could be explained by the suppression of activation among winners because they were dealing with stress effectively [Ursin and Olf, 1993].

In sum, according to our data, winners of a competitive encounter showed a higher cardiac reactivity, a faster recovery, and more internal attribution compared with losers. These dimensions characterise an active coping strategy, whereas responses found in losers could be related to a passive strategy. Psychophysiological arousal through a social competitive confrontation appears to be associated with the attributions about the outcome. Previously, we have also found an association between testosterone response to competition and causal attribution. In our opinion, these findings deserve now a study that takes into account a more specified task, controlling coping strategies as well as using cardiovascular and hormonal measures simultaneously to get a more complete view of the response to outcome.

ACKNOWLEDGMENTS

The authors wish to thank Ms. Miriam Phillips for the revision of the English text.

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