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EXTRAVERSION AND NEUROTICISM AS PREDICTORS OF SALIVARY CORTISOL LEVELS IN PUBLIC SPEAKING

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RESUMEN

Se estudia el papel de la extraversión y el neuroticismo sobre las respuestas de cortisol salivar de 45 estudiantes que participaron en una presentación de hablar en público. Los ciclos de estrés (presentación oral) y no-estrés (participación normal) se compararon para todos los estudiantesa lo largo del semestre. Las variables independientes proceden del NEO-PI-R (Costa y McCrae, 1999) que evalúa neuroticismo, extraversión, apertura, cordialidad y escrupulosidad, y el EPQ-R (Eysenck & Eysenck, 1997) que evalúa neuroticismo, extraversión y psicoticismo. Los resultados demostraron que mientras la mayoría de los estudiantes (N=31) presentaron incrementos significativos de niveles de cortisol en la situación de hablar en público, algunos estudiantes (N=14) presentaron una

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disminución en los niveles de secreción cuando se comparó con las líneas basales sin estrés. Extraversión y neuroticismo fueron predoctores significativos de las respuestas de cortisol durante la situación de hablar en público.

Palabras clave: ***PSICOSIFIOLOGÍA DE PERSONALIDAD, EXTRAVERSIÓN Y NEUROTICISMO EN SITUACIONES DE ESTRÉS, CORTISOL Y PERSONALIDAD.***

SUMMARY

This study investigated the role of extraversion and neuroticism on the salivary cortisol responses of 45 students participating in a required public speaking presentation. Stressed (oral presentation) and nonstressed (normal participation) cycles were compared for all students throughout the semester. Independent variables were taken from the NEO-FFI (Costa & McCrae, 1999) that evaluated Neuroticism, Extraversion, Conscientiousness, Agreeableness and Openness to Experience and the EPQ-R (Eysenck & Eysenck, 1997) that evaluated Neuroticism, Extraversion and Psychoticism. The results showed that while the majority of students (n=31) displayed significant increases in cortisol levels in the public speaking situation, some students (n=14) actually showed a decrease in secretion levels compared with nonstressed baselines. Extraversion and Neuroticism were significant predictors of cortisol responses during the public speaking situation.

Key words: ***PSYCHOPHYSIOLOGY OF PERSONALITY, EXTRAVERSION AND NEUROTICISM IN STRESS SITUATIONS, CORTISOL AND PERSONALITY.***

INTRODUCTION

Over the past half century, the hypothalamus-pituitary-adrenal (HPA) axis has been considered the most firmly established and physiologically important stress neuroendocrine pathway. Cortisol, the end product from HPA axis, provides energy to the organism to

face those daily activities that demand effort and adaptation. Cortisol secretion is characterized by a marked circadian rhythm with heightened activity in the morning that decreases along the day. On top of this basal activity, there is an increase in the cortisol response to unpredictable, uncertain and novel psychosocial challenges. Cortisol changes from baseline levels to stressful situation levels are being considered a sensitive and objective index of physiological stress in psychoendocrine research (Ursin, 1998).

In his 1968´s influential review, Mason stated that psychological factors were among the most potent natural stimuli affecting the HPA activity. Particularly, states of emotional arousal, involvement, anticipation of activity, and coping lead to increased cortisol secretion. Our stressor, public speaking in front of an audience, produces all the states previously mentioned. Even though, the challenging quality of our psychological stressor have been incremented by two additional conditions: 1) the oral presentation was compulsory for all students, and 2) student performance was part of their *practicum* credits evaluation.

A considerable body of evidence strongly suggests that personality dispositions may play a significant role in differences in perception, appraisal and reaction to similar stressful events (Pelechano, 2000). Because relatively stable individual difference reactivity in cortisol response to acute stress has been established, it seems quite reasonable to assume that relatively stable personality predispositions are at work. Based on Eysenck's cortical arousal theory, introverts should exhibit higher levels of resting cortisol than extraverts (Eysenck, 1967) and show greater physiological reactivity to sensory stimulation than extraverts (Stelmack, 1990). Social situations, like public speaking in front of an audience, can be one of the most potent sources of arousal for introverts (Eysenck, 1984). Therefore, we expect that public speaking in front of an audience should produce a stronger cortisol base and trial response in introverts than extraverts.

On the other hand, neuroticism or emotional instability seems related to limbic activation particularly in the hippocampus, amygdala, singulum, septum and hypothalamus. Neurotics have greater limbic activity than emotional stables. Therefore we can expect that stressful events and negative affect or distressing

situations must produce a stronger cortisol response in the emotionally unstable than stable individuals.

Support for our hypothesis was given by Kirschbaum, Prussner, Stone, Federenko, Gaab, Lintz, Schommer, & Hellhammer (1995), who found significant correlations between introversion and cortisol secreted across five expositions to the same stressor (public speaking and mental arithmetic in front of an audience). In the same line, Houtman and Baker (1991) showed that higher neuroticism related to elevated cortisol reactivity to public lecturing. Other studies, however, have failed to demonstrate a significant relation between personality and cortisol reactivity to public speaking (Kirschbaum, Bartussek, & Strasburger, 1992; Schommer, Kudielka, Hellhammer, & Kirschbaum, 1999).

The assessment of cortisol in saliva has become very popular due to its non- invasiveness, laboratory independence, and almost unlimited saliva sampling compared to plasma and urine. Multiple saliva sampling allows us to study the dynamics of cortisol response to acute stressors (Kirschbaum & Hellhammer, 1994). Something that accumulative measures, such as urinary cortisol, do not allow.

The traditional physiological perspective asserts that cortisol secretion increases as part of the response to stressors. However there is growing evidence of decreased, rather than increased cortisol secretion in some individuals who have been exposed to traumatic stressors or suffer from stress-related disorders (Heim, Ehlert & Hellhammer, 2000; Gunnar & Vazquez, 2001). In fact, a previous study conducted by our group (García de la Banda, Martínez-Abascal, Riesco, & Pérez, 2004) surprisingly showed that 12 students, of a total of 32, actually decreased their overnight (12-h) urinary cortisol in anticipation to an academic exam.

Although cortisol secretion itself has been associated with stressor properties and personality traits, it could be that there are also associated consistencies in cortisol baselines. In fact, in the previously mentioned study (Garcia de la Banda *et al.* 2004), students who decreased cortisol levels under exam conditions had a significantly more elevated cortisol baseline than students who increased. Houtman & Bakker (1990) found that higher cortisol baselines predicted a lower cortisol response to lecturing in women subjects. Some years

before, Hellhammer, Kirschbaum & Belkien (1987) had already suggested a negative relationship between cortisol baseline levels and the height of stress-related changes.

In this study, students' free salivary cortisol secretion was examined in a stressful condition (public speaking) and compared with cortisol levels in a nonstressful condition. Cortisol changes between the two conditions were considered an index of "stress reactivity". Our hypotheses were threefold: (1) There may exist a subset of individuals that decrease instead of increase their cortisol levels in the public speaking condition compared to a nonstressful condition. (2) Decreased cortisol responses to public speaking would be related to higher baseline levels. (3) Cortisol changes produced by the public speaking challenge would be related to personality variables under study. Particularly, introverts would present higher cortisol secretion to public speaking condition than extraverts and emotional instable individuals than emotionally stable.

METHOD

Sample

Forty-five students, of whom 36 were females (80%) and 9 were males (20%), participated in this study. The mean age of the sample was 20.36 years (SD= 4.54) with a range between 17 and 45 years. All subjects were students of the *Universitat de les Illes Balears* (Spain) and majored in Psychology, Pedagogy, Education or Social Education.

Instruments

Neo Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1999) that evaluates Neuroticism, Extraversion, Conscientiousness, Agreeableness and Openness to Experience.

Eysenck Personality Questionnaire (EPQ-R; Eysenck, & Eysenck, 1997) that evaluates Neuroticism, Extraversion and Psychoticism.

Procedure

In the beginning of the academic year the students completed NEO-FFI and EPQ-R questionnaires.

Eight salivary samples were taken per student between 4 and 8 in the afternoon, four of them during the basal condition (non-stress normal class participation) and four during the stressful situation (oral presentations to the class). Stress salivary samples were obtained 1) at the beginning of class, 2) just before their oral presentation, 3) right after their oral presentation, 4) and at the end of the class period. Non stress salivary samples were taken one week later: 1) again at the beginning of class, 2) 10 minutes into the class, 3) 20 minutes into the class, 4) again at the end of the class period.

Student saliva samples were collected with a cotton swab chewed for one minute, stored in a capped plastic vial ("Salivette" Sarstdet Inc.), centrifuged, and frozen at -20ºC until analysis. The coat-a-count Cortisol procedure is a solid-phase radioimmunoassay, wherein 125I-labeled cortisol, which is immobilized to the wall of polypropylene tubes, competes for a fixed time with cortisol in the patient sample for antibody sites. The intra- and interassay coefficients of variation were less than 10%

RESULTS

Figure 1 shows the progression of cortisol responses over the four sample periods in the 45 participants under stressful and nonstressful conditions. Nonparametric analyses were used in our study because cortisol values were not normally distributed. A Wilcoxon test showed significant differences in cortisol means secreted at the third ($p< 0.009$) and fourth ($p< 0.029$) sample periods between the two conditions.

Although Figure 1 shows an increase in cortisol levels in the total sample, a more thorough individualized analysis revealed that some subjects increased and some decreased their cortisol response levels to the stressful condition. As expected, public speaking induced significant increases in salivary cortisol in the majority of students (31

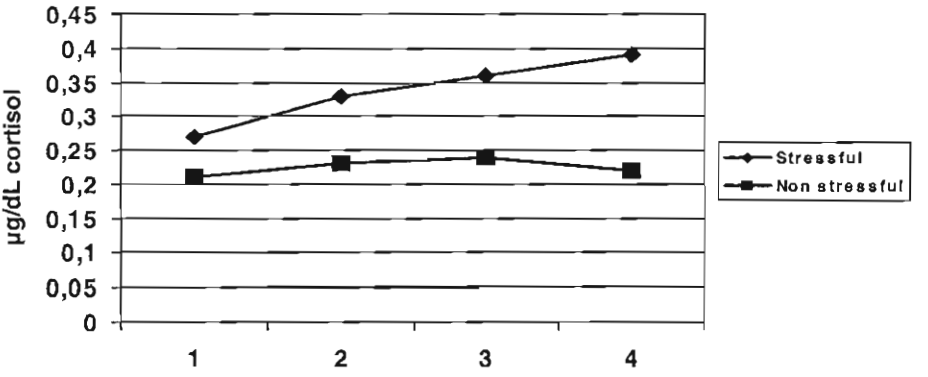

Figure 1.- Cortisol means in the four samples for stressful and non stressful conditions

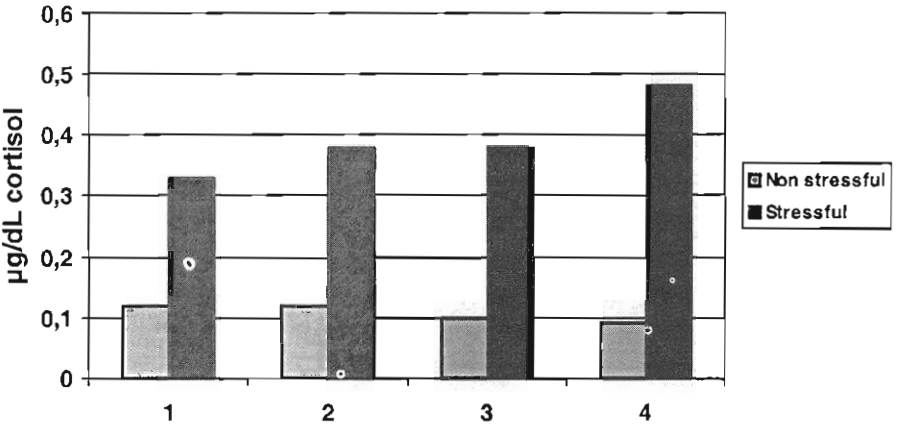

Figure 2.- Cortisol levels over four samples in stressful and non stressful conditions for responders

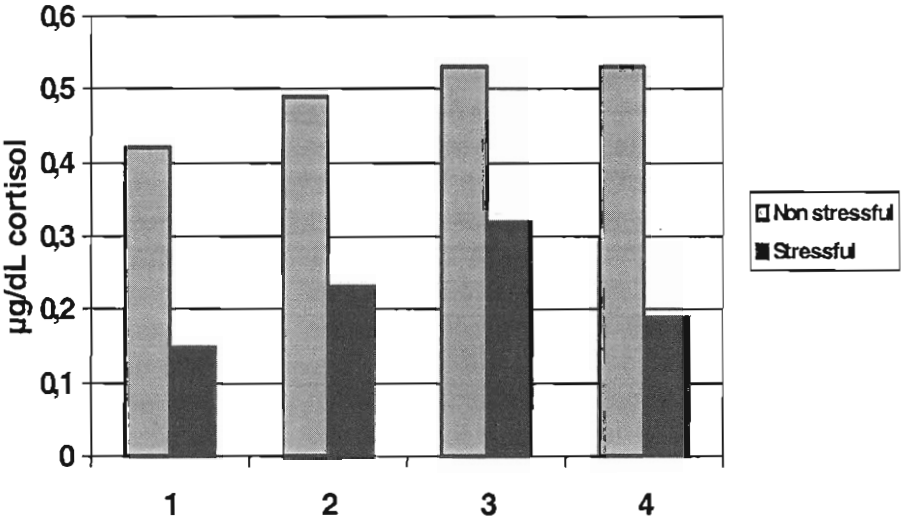

Figure 3.- Cortisol levels over four samples in stressful and non stressful conditions for blunters

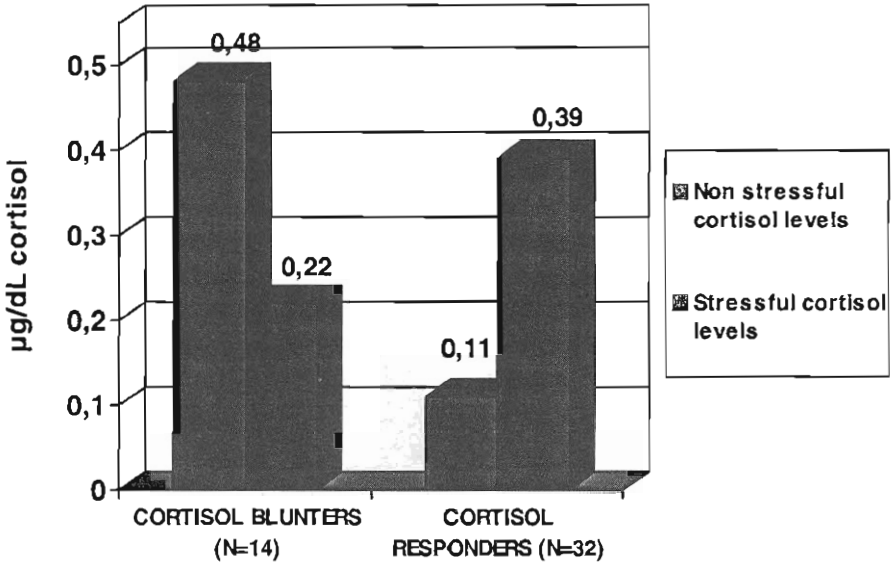

Figure 4.- Cortisol responders and blunters in stressful versus non-stressful conditions

of 45). This group was called the "responder" group (Figure 2). However, a substantial number of students (14 of 45) showed an actual decrease or flattening in their cortisol response under stressful conditions. This group was labelled as the "blunter" group (Figure 3).

When blunter and responder cortisol means were compared, the U of Mann-Whitney test showed a significant change in the responder group versus the blunter group ($p< 0.0009$) when public speaking and nonstressful situation are compared. Interestingly, blunter nonstressful cortisol levels were even higher than responder stressful cortisol levels (Figure 4) by the final assessment trial.

Correlations between personality variables and cortisol changes are shown in Table 1. Extraversion and Neuroticism (NEO-FFI) and Neuroticism (EPQ-R) were negatively correlated and significantly related to cortisol increases for responders but not for blunters (although the trend was the same). Stepwise regression analysis revealed Extraversion and Neuroticism (NEO-FFI) were significant predictors of increased cortisol for responders. Extraversion levels explained 22% of the variance in cortisol levels and Neuroticism 15% of variance in the responder group (see Table 2). No significant personality predictors showed up for the blunter group.

Table 1.- Stressful versus non-stressful levels and their relations with personality variables

	RESPONDERS CORTISOL CHANGES (N=31)	BLUNTERS CORTISOL CHANGES (N=14)
EXTRAVERSION (NEO-FFI)	**-.49****	-.36
NEUROTICISM (NEO-FFI)	**-.40***	-.31
EXTRAVERSION (EPQ-R)	-.28	-.30
NEUROTICISM (EPQ-R)	**-.36***	-.13

$*p< 0.05$; $**p< 0.01$

Table 2. Stepwise regression analysis with personality as predictor of cortisol differences for responders (n=31)

Criterion	Steps	Significative predictors	β	R^2	*F*
CORTISOL CHANGES	1	Extraversion (NEO-FFI)	-0,48	0,22	8,00**
	2	Neuroticism (NEO-FFI)	-0.39	0,38	8,14**

***p< 0.01*

DISCUSSION

This paper examined individual differences in salivary cortisol changes produced by lecturing in a group of students and studied if those changes were related to personality variables.

As expected, two groups of individuals with distinctive cortisol response patterns were identified: responders (increased cortisol from baseline) and blunters (decreased cortisol from baseline). These findings support our previous results in urinary cortisol (García de la Banda *et al.,* 2004). Although scarce, these results have been previously reported in the literature by Hellhammer, Buchtal, Gutberlet, & Kirschbaum (1997) who found blunted salivary cortisol responses to psychological and physical stress in subordinate compared to dominant soldiers during the first week of their boot camp training. In the same line, Berger, Bossert, Krieg, Dirlich, Ettmerier, Schereiber& von Zerssen (1987) found reactors and nonreactors in cortisol response to five different stress tests. Likewise, Gerra, Zaimovic, Timpano, Zambelli, Delsignore, & Brambilla (2000) reported "high- and low-responders" in cortisol habituation to repeated psychological stress.

Rose (1984), in an excellent review, pointed to the lack of systematic efforts to investigate these unexpected differences in cortisol responses. In our opinion, stress research reports overall group

tendencies in cortisol response but overlook individual cases, particularly decreases, that remain embedded and washed out by overall group changes. For instances, in our study, if we would have looked only to overall group tendency, we would have reported only an increase in cortisol response to stressful condition compared to the cortisol secretion in the nonstressful condition.

Another possible explanation can be related to what is considered baseline cortisol in stress research. In the majority of studies, cortisol baseline is the cortisol value before the stressor presentation. However this starting value is influenced by anticipation of the experimental task and by the novelty of the lab settings. In our opinion, this value cannot be considered a true cortisol baseline. In Young & Nolen-Hoeksema (2001) study, for example, participants were allowed a longer preparatory period before public speaking in front of an audience. What resulted was a markedly diminished saliva cortisol response compared with the initial secretion. Similarly in our results considering the starting cortisol value the cortisol baseline, all the individuals of our sample would have increased cortisol response during public speaking. The only difference would be that blunters would have had less cortisol secretion than responders in lecturing. Therefore to avoid this possibility, cortisol baseline should be taken one week before (if anticipation is not hypothesized) or one week after the experimental day (if anticipation and preparation is expected, as our study), although the same weekday and at the same hour of the experimental day, in order to control cortisol circadian fluctuation.

Another striking result was that the baseline for blunters was significantly higher than for responder baseline. As a matter of fact, blunter baseline cortisol was even higher than responder cortisol secretion to the stressor. Again these findings are in accordance with our results in urinary cortisol (García de la Banda *et al.*, 2004) and with previous research (Hellhammer *et al.* 1997) in which baseline cortisol levels increased for dominants and subordinates soldiers over the first five weeks of training indicating chronic stress in the sample. Likewise, they observed a blunted cortisol response for dominants to psychological and physical stress after six weeks of training. Schulz, Kirschbaum, Prübner & Hellhammer (1998) found

high baseline cortisol in individuals under work overload and interpreted it as a chronically stressed response. Some years before, Hellhammer *et al.* (1987) had already suggested a negative relationship between cortisol baseline levels and the height of stress-related changes.

Was personality related to these opposite changes? Extraversion and Neuroticism scores accounted for 37% of cortisol changes in the responder group. As expected, introverted students were the ones to significantly increased cortisol the day of the lecturing compared to the nonstressful day. Which is in agreement with the study of Kirschbaum et al. (1995) who found significant correlations between introversion and cortisol secreted across five expositions to the same stressor (public speaking and mental arithmetic in front of an audience). However, contrary to our expectations, increased cortisol secretion to lecturing was not related to neuroticism but to emotional stability.

Altogether, these results suggest that chronically high baseline cortisol is a form of dysregulation of the HPA axis as important as chronically low baseline cortisol. High and low baseline cortisol can be related to individual sensitivity of the HPA feedback system, and could explain some of the individual differences observed in the stress response. Moreover, differences in baseline cortisol and in the stress response could be consequence of neonatal stress experiences (Hennessy & Levine, 1979) or the outcome of some kind of traumatic stress (Yehuda, 2002). Forty years of research on humans have demonstrated that early trauma has long-term effects on the neurochemical response to stress, the duration and extent (magnitude) of the cortisol reaction. With this in mind, our next series of studies will include measures of developmental traumatic stress.

A limitation of this study was that stress cortisol sampling was not complete. In future research it should be necessary to assess at least 30-40 minutes after the end of the oral presentation to allow cortisol levels to increase to the maximum point and to start declining. Despite these methodological problems, our study has informed for first time that in front of a stressor some individuals decrease their cortisol secretion instead of increase it compared with their secretion during a nonstressful condition.

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