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Optimism and pessimism are related to different components of the stress response in healthy older people

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ABSTRACT

Some personality traits have key importance for health because they can affect the maintenance and evolution of different disorders with a high prevalence in older people, including stress pathologies and diseases. In this study we investigated how two relevant personality traits, optimism and pessimism, affect the psychophysiological response of 72 healthy participants (55 to 76 years old) exposed to either a psychosocial stress task (Trier Social Stress Test, TSST) or a control task; salivary cortisol, heart rate (HR) and situational appraisal were measured. Our results showed that optimism was related to faster cortisol recovery after exposure to stress. Pessimism was not related to the physiological stress response, but it was associated with the perception of the stress task as more difficult. Thus, higher optimism was associated with better physiological adjustment to a stressful situation, while higher pessimism was associated with worse psychological adjustment to stress. These results highlight different patterns of relationships, with optimism playing a more important role in the physiological component of the stress response, and pessimism having a greater effect on situational appraisal.

1. Introduction

Throughout life, people have to deal with psychosocial stressors from many sources and with different durations. The sympathetic nervous system (SNS) and the hypothalamus–pituitary–adrenal (HPA) axis, which regulates cortisol release, are activated in response to physical and psychological stressors (Dickerson and Kemeny, 2004; Kudielka et al., 2004b). Moreover, psychological (e.g. increases in state anxiety and negative affect) and behavioral (such as displacement and submissive behaviors) changes are also associated with acute stress exposure (Villada et al., 2014a, 2014b). In their meta-analysis, Chida and Steptoe (2010) concluded that greater cardiovascular (CV) reactivity to and poor recovery from acute stress are related longitudinally to unwell/unsatisfactory CV status. They reported that higher future blood pressure was associated with greater reactivity and poor recovery, although other CV alterations were related differently, thus contributing to an increased future CV risk status.

Some age-related changes in the stress response have been reported, as older people show higher stress-induced cortisol release (Almela et al., 2011b; Otte et al., 2005), higher sympathetic tone (Almela et al., 2011b), a decline in autonomic regulation of cardiac dynamic capacity (Laitinen et al., 2004) and changes in emotional regulation (Carstensen et al., 1999; Mather and Carstensen, 2005), all of which may affect the ability to cope with stress (Pardon, 2007). However, aging is only one of many factors that can affect the stress response. In fact, consistent individual differences in stress systems have been reported (Lovallo, 2011).

Individual personality differences are related to differences in stress perceptions (Connor-Smith and Flachsbart, 2007), which can also affect the biological stress systems (Carver and Connor-Smith, 2010; Dickerson and Kemeny, 2004). Chida and Hamer (2008) concluded that negative psychological states, i.e. anxiety and hostility, are related to higher CV response and poorer recovery after stress, while positive psychological states or traits (e.g. happiness and self-enhancement) are associated with reduced HPA axis reactivity. Given the important relationship between the acute stress response and health, the study of stress-related factors that can modulate this relationship acquires great relevance, especially in the most vulnerable life periods, such as old age. Specifically, interest in the relationship between personality characteristics and physical health has increased considerably in the past few decades (Rasmussen et al., 2009).

Optimism, a very influential trait in the way people perceive and conduct their lives (Carver et al., 2010), has been related to wellbeing and several stress-related diseases, such as metabolic syndrome (Cohen et al., 2010; Roy et al., 2010), cancer (Friedman et al., 1992; Rajandram et al., 2011) and cardiovascular diseases (Nabi et al., 2010; Tindle et al., 2010). One of the most widely used questionnaires to measure optimism is the "Life Orientation Test" (LOT) (Scheier and Carver, 1985), which was later revised (LOT-R) (Scheier et al., 1994). The LOT-R measures dispositional optimism, which involves generalized outcome expectancies. Originally, it was considered to be one-dimensional, with optimism and pessimism at opposite poles that showed a strong negative correlation in young people (Scheier and

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Carver, 1985). Thus, optimistic people tend to have positive generalized expectations about their future, while pessimists have negative expectations (Scheier and Carver, 1992; Scheier et al., 1994). However, other studies in middle-aged and older people revealed low shared variance between optimism and pessimism (Mroczek et al., 1993; Plomin et al., 1992; Robinson-Whelen et al., 1997), leading to their consideration as independent factors. Some theoretical formulations (Diener et al., 1999; Ryff and Singer, 1998) defended the independence of positive and negative mental states, based on several studies that reported this independence (e.g. Lai, 1994, 1997; Lai et al., 2005). Other authors have proposed that this age-related difference may be due to changes in metacognitive beliefs about optimism and pessimism, allowing people to adaptively use either of them to cope in different situations (Herzberg et al., 2006).

Research focusing on the relationships between optimism and the physiological stress response to acute stress is sparse and has shown mixed results. In young adults, Solberg Nes et al. (2005) reported an increased cortisol and HR response in participants who scored higher on dispositional optimism and self-consciousness. Moreover, Brydon et al. (2009) observed faster cortisol recovery after stress in young men with more dispositional optimism. These results suggest that the presence of optimistic beliefs affects HPA and sympathetic activity, along with self-consciousness, highlighting the protective role of optimism, given that slower recovery after stress can have negative health consequences (McEwen, 1998; Sapolsky et al., 2000). Therefore, optimism has been considered positive in the long run, given that, as behavioral self-regulation theory establishes (Carver and Scheier, 2000), an optimistic assessment of the situation produces confidence and facilitates the capacity to maintain an effort to achieve goals, increasing positive affect and wellbeing (Solberg Nes et al., 2005). By contrast, negative evaluations would increase a sense of doubt and facilitate the removal and disengagement impulse, reducing behaviors of effort (Carver and Scheier, 2000). Previous studies showed that optimism is related to better goal-readjustment (Aspinwall and Richter, 1999; Duke et al., 2002), which raises the hypothesis that the relationship between optimism and a person's quality of life depends on reengaging in new goals when valuable goals become unreachable (Rasmussen et al., 2006). Thus, the way people generate expectations would affect the perception of the situation, which in turn would have an influence on the psychophysiological response to acute stress.

However, this possible effect of optimism on the acute stress response has hardly been studied in older people. To the best of our knowledge, only one study has examined this relationship. Endrighi et al. (2011) analyzed the relationship between dispositional optimism and the cortisol awakening response (CAR), daily cortisol release and stress-induced cortisol release after exposure to two laboratory stress tasks (computerized color–word and mirror tracing task) in older people. These authors observed lower CAR in optimists, suggesting that dispositional optimism may have a protective role. However, unlike the studies with young people mentioned above, they did not observe significant relationships between dispositional optimism and acute stress-induced and daily cortisol release in older people. Thus, optimism seems to have a relationship with HPA-axis activity in older people, but not specifically with the stress-induced cortisol response. However, it should be noted that in this study, the authors considered dispositional optimism, and not optimism and pessimism separately, which seem to be different dimensions in older people (Herzberg et al., 2006). Thus, it would be advisable to consider them as two separate dimensions in order to more closely examine the relationships among optimism, pessimism and the stress response in older people.

With this in mind, the purpose of this study was to investigate how optimism and pessimism are related to the HPA and HR response, as well as situational appraisal, in a situation of acute social stress in older people. Healthy volunteers from 55 to 76 years old were exposed to a psychosocial stressor (Trier Social Stress Test, TSST) or a control task in order to study their stress-induced cortisol, heart rate (HR) response and situational appraisal. Based on previously mentioned results, we expected a positive relationship between optimism and HPA and HR reactivity (Solberg Nes et al., 2005), but also faster recovery (Brydon et al., 2009) after the stressful task, given that more optimistic people are better able to manage stress and overcome it successfully (Carver et al., 2010). On the other hand, we expected a negative relationship between pessimism and HR and cortisol recovery from the acute stress. Some authors have suggested that the stress response depends greatly on the way the event is interpreted (Salvador and Costa, 2009), so that the situational appraisal gains importance. Coinciding with Endrighi et al. (2011) we expected lower stress perceptions in optimistic people exposed to stress, as well as higher stress perceptions in pessimistic people. Additionally, in order to better understand the effect of these personality traits on the perception of the situation, we explored the effect of optimism and pessimism traits on the perception of how difficult, frustrating or important the stress task was, and how much effort it required.

2. Material and methods

2.1. Participants

For subject recruitment, informative advertisements were displayed on the University campus, especially directed to students of La Nau Gran, a study program for people over 55 years old. The exclusion criteria were: smoking over 10 cigarettes a day, abuse of alcohol or other drugs of abuse, severe vision or hearing problems, presence of severe CVD, an illness that involves HPA disturbance, and neurological or psychiatric disorders. Subjects were also excluded if they were being medicated with drugs related to cognitive or emotional functions, or with an influence on hormonal levels or cardiovascular function (such as glucocorticoids or b-blockers), or if they consumed psychotropic substances. All the female participants were postmenopausal, and none of them were receiving estrogen replacement therapy. Subjects who met the criteria were contacted by telephone and asked to participate in the study.

The final sample was composed of 72 participants randomly assigned to two conditions: 38 to the stress condition (19 men) and 34 to the control condition (17 men). 87.5% of the participants were students in the La Nau Gran program, and 12.5% were referred by these students (acquaintances, relatives or friends).

The study was performed according to the Declaration of Helsinki, and the Ethics Committee of the university approved the protocol. All participants received verbal and written information about the study, signed an informed consent form, and received a gift worth 15€ for their collaboration.

2.2. Procedure

In this study, each subject participated in an individual session lasting approximately 1 h and 30 min (between 16 and 20 h) in a laboratory at the School of Psychology. Upon their arrival at the laboratory, the height and weight of the participants were measured in order to calculate the body mass index (BMI), and the experimenter verified that they had followed the instructions given previously: sleep as long as usual, refrain from heavy activity the day before, and not consume alcohol since the night before. Additionally, they were instructed to drink only water and not eat, smoke or take any stimulants 2 h prior to the session.

2.2.1. Stress condition

We employed the Trier Social Stress Test (TSST, Kirschbaum et al., 1993; Kudielka et al., 2007) to provoke cortisol and cardiovascular responses (Almela et al., 2011a, 2011b; Hidalgo et al., 2012). The task consisted of 5 min of free speech (job interview) and a 5 min arithmetic task (serial subtraction), performed in front of a committee composed of a man and a woman. Interactions with participants were always performed by the committee member of the opposite sex. During the 5 min of free speech, the participants had to report what characteristics make them the best candidate for a fictitious position as a representative in the university. If the participant did not use up the 5 min, the committee asked a set of standardized questions about the participant's characteristics. In the case of the arithmetic task, the participant performed a serial subtraction, and the committee interrupted and urged the participant to start the subtraction again after each mistake. The participants remained standing at a distance of 1.5 m from the committee. Moreover, a video camera and a microphone used to film both tasks were clearly visible.

As Fig. 1 shows, the protocol started with a *baseline period* of 30 min to allow the participants to adapt to the laboratory setting. At the beginning of this phase, the experimenter placed the HR recording system on the participant, who completed the LOT-R, and the first salivary cortisol sample was taken. After the baseline, the *introduction phase* began (5 min), where participants were informed about the procedure for the stress task (instructions) in front of the committee in the same room where the task would take place. Next, the participants had 3 min to prepare the speech task (*preparation phase*). Then, the *stress phase* (TSST, speech plus arithmetic tasks) was carried out, and a saliva sample was collected. Finally, during the *recovery phase*, subjects had 45 min to recover, during which they answered several questionnaires, including the situational appraisal, and collected 5 saliva samples at 10 min intervals after the termination of the task.

2.2.2. Control condition

This condition followed the same schedule as the stress condition, but the TSST was replaced by an ad hoc control task that included a free speech task (5 min) and an arithmetic task (5 min), but without a committee. During the free speech, the participant talked aloud about a recent non-emotional experience, while the arithmetic task consisted of a counting by five aloud. The participants performed the free speech and arithmetic tasks in the same room as the stress task, but none of the stressful elements were present (video camera, microphone and committee), and the participants were informed before the task that their performance would not be recorded. This control task has been used in previous studies (see Pulopulos et al., 2013, 2015; Hidalgo et al., 2015), and was designed to maintain similar overall physical activity and mental workload, but without evaluative threat and uncontrollability, the main components capable of provoking stress (Dickerson and Kemeny, 2004).

2.3. Assessment and measures

2.3.1. Life Orientation Test Revised (LOT-R; Scheier et al., 1994)

This is a 10 item questionnaire answered on a 5-point Likert scale. Three items measure optimism (e.g. "In uncertain times, I usually expect the best"), and three other items measure pessimism (e.g. "If something can go wrong for me, it will"); the remaining items are distractors. This questionnaire provides a measure of optimism and pessimism or a total score of dispositional optimism, depending on whether it is considered as a two-dimensional or one-dimensional measure, respectively. We employed the Spanish version (Otero et al., 1998), which has shown adequate reliability ($\alpha = .75$) (Ferrando et al., 2002).

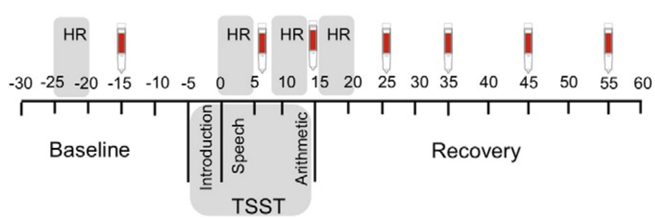

Fig. 1. Timeline of the stress and control conditions, with the 7 saliva samples for cortisol measurements, and the 5 min periods for HR measurements.

2.3.2. Perceived Stress Scale (PSS, Cohen et al., 1983)

This is a 14-item scale that measures the degree to which life situations are evaluated as stressful during the past month; the scores range from 0 to 40, with higher scores indicating more perceived stress. A Spanish version of the PSS shows an adequate internal consistency ($\alpha = .81$), and it was used to adjust for background stress (Remor, 2006).

2.3.3. Situational appraisal

Participants completed five questions on a 5-point Likert scale (not at all = 1 to extremely = 5) after the stress/control task, concerning: stress, difficulty, frustration, effort and how important the task had been to them (e.g. How much effort did the task require?). These questions were developed based on previous studies (Baggett et al., 1996; Gonzalez-Bono et al., 2002), taking into account the Lazarus coping model (Lazarus and Folkman, 1984) and behavioral self-regulation theory (Carver and Scheier, 2000), which have been employed in previous studies (Costa and Salvador, 2012; van der Meij et al., 2010).

2.3.4. Heart rate

Data for HR were continuously recorded throughout all the sessions using a Polar©RS800cx watch (Polar CIC, USA), which consists of a chest belt and a Polar watch. The transmitter is located on the chest belt, which is placed on the solar plexus and transmits HR information to the receiver (Polar watch). The Polar watch records R–R intervals with a sampling frequency of 1000 Hz, providing a time resolution of 1 ms for each R–R interval. The data collected by the Polar watch were downloaded and stored in the Polar ProTrainer^{5}™ program in the computer, and they were analyzed using Kubios Analysis (Biomedical Signal Analysis Group, University of Kuopio, Finland). We analyzed the HR in 5-minute periods during baseline (−25 to −20 min), speech (0 to +5 min), arithmetic (+7 to +12 min) and recovery (+15 to +20), all with respect to the beginning of the stress or control task. In the HR analysis, one woman (control condition) was excluded due to technical problems.

2.3.5. Cortisol

A total of 7 saliva samples were collected using salivettes (Sarstedt, Nümbrecht, Germany) to measure cortisol levels during the session. The timing of the saliva sampling was 15 min before the participants were exposed to the stress or control task (−15), between the speech and arithmetic task (+5), and at intervals of 10 min after the termination of the task (+15, +25, +35, +45 and +55 min). Participants were instructed to introduce the cotton swab of the salivette in their mouths for exactly 2 min, not chew the cotton, and move the swab in a circular pattern around in their mouths to collect saliva from all the salivary glands (see Nater and Rohleder, 2009). Samples were centrifuged at 3000 rpm for 5 min, resulting in a clear supernatant of low viscosity that was frozen at −80 °C until the analysis took place. The samples were analyzed in the Central Research Unit at the University by a competitive solid phase radio immune assay (tube-coated), using the commercial kit Spectria Cortisol RIA (cat. no. 06119) from Orion Diagnostica (Espoo, Finland). All the samples were analyzed in the same trial and in duplicate; assay sensibility was 0.8 nmol/L; and the inter- and intra-assay variation coefficients were all below 8%. One woman (control condition) was excluded because her cortisol values differed more than 3 SD from those of the rest of the subjects.

2.4. Statistical analysis

ANOVA with condition (stress vs. control) and sex (men vs. women) as between-subject factors was used to explore differences in demographics (socioeconomic status and age), anthropometric characteristics (body mass index), and psychological data (PSS, optimism and pessimism). We used a MANOVA with condition and sex as between-subject factors to explore differences in situational appraisal items (stressful, frustrating, difficult, effort and important). Cortisol data

Table 1
Correlation analyses performed between situational appraisal items and HR and cortisol reactivity and recovery indexes. All $p > .10$.

	Reactivity_{HR}		Recovery_{HR}		Reactivity_{C}		Recovery_{C}	
	Stress	Control	Stress	Control	Stress	Control	Stress	Control
Effort	$r = -.025$	$r = -.149$	$r = -.056$	$r = -.210$	$r = -.195$	$r = .113$	$r = -.207$	$r = .088$
Frustration	$r = -.094$	$r = -.221$	$r = -.032$	$r = -.203$	$r = .010$	$r = .004$	$r = -.206$	$r = .089$
Stressful	$r = .019$	$r = .036$	$r = -.123$	$r = -.099$	$r = .088$	$r = .217$	$r = .017$	$r = .158$
Difficulty	$r = -.104$	$r = .182$	$r = -.118$	$r = -.144$	$r = -.064$	$r = .036$	$r = -.104$	$r = .112$
Importance	$r = -.055$	$r = -.177$	$r = -.154$	$r = -.089$	$r = .020$	$r = .107$	$r = -.017$	$r = .003$

were square root transformed before the analyses because they showed abnormal distribution on the Kolmogorov–Smirnov test. For cortisol analyses, a repeated-measures ANOVA was calculated with condition and sex as between-subject factors, and time (−15, +5, +15, +25, +35, +45 and +55 min) as within-subject factor. HR data were analyzed using ANOVA for repeated measures, with condition and sex as between-subject factors and time (baseline, speech, arithmetic, recovery) as within-subject factor.

For the HR analyses, we also established the index of (i) reactivity_{HR} (maximum value to stressful task minus baseline period) and (ii) recovery_{HR} (recovery period minus baseline period) to measure the increase and the complete return to baseline levels. For cortisol, we calculated two indexes: (i) reactivity_{C} (maximum cortisol levels of +15, +25 or +35 min after the stressful task minus previous −15 min cortisol levels) and (ii) recovery_{C} (maximum cortisol levels of +15, +25 or +35 minus minimum cortisol levels of +45 or +55 min). The latter index is used as a measure of the capacity to reduce cortisol levels in a specified period of time. The recovery_{C} index was not calculated because of time limitations in the return to baseline levels.

To study the relationships among the psychological variables, Spearman's Rho correlation was used to test the relationship between optimism and pessimism, given that the Kolmogorov–Smirnov test revealed abnormal distribution in these variables. Pearson correlations were performed to test the relationship between situational appraisal items and cortisol and HR (reactivity and recovery indexes). Finally, we employed hierarchical regression analysis (Aiken and West, 1991) to investigate whether optimism and pessimism were related to HR and cortisol (reactivity and recovery indexes) and situational appraisal.

We used the Greenhouse–Geisser procedure when the requirement of sphericity in the Repeated-Measures ANOVA was violated. Post hoc planned comparisons were performed using Bonferroni adjustments. All p-values reported are two-tailed, and the level of significance was set at $p < .05$. When not otherwise specified, results shown are means (M) ± standard error of means (SEM). We used SPSS 22.0 to perform the statistical analysis.

3. Results

3.1. Sample characteristics

ANOVA did not show significant effects of condition (stress vs. control) or sex (men vs. women) on age (total sample: M = 63.99, SEM = .479), socioeconomic status (SES) (M = 5.58, SEM = .138), body mass index (BMI) (M = 26.86, SEM = .401) or PSS (M = 16.55, SEM = .866) (all $p > .05$).

We analyzed optimism and pessimism separately because: i) we did not find a significant correlation between optimism (M = 11.60, SEM = .244) and pessimism (M = 7.08, SEM = .286) ($rho = -.023$, $p = .849$); and ii) the previously mentioned literature shows that these traits may be independent (Mroczek et al., 1993; Lai, 1994, 1997; Lai et al., 2005; Plomin et al., 1992; Robinson-Whelen et al., 1997), at least in the aging population. No significant effects of condition were found on optimism and pessimism (stress vs. control: all $p > .550$). Sex did not show significant effects on optimism either ($F_{(1,70)} = .933$, $p = .338$), although women showed higher pessimism than men ($F_{(1,70)} = 5.273$, $p = .025$).

3.2. Situational appraisal

We observed a condition effect on the situational appraisal completed by the participants after the task: people exposed to the TSST perceived it as more stressful ($F_{(1,66)} = 53.114$, $\eta^2 = .446$, $p < .001$), frustrating ($F_{(1,66)} = 52.819$, $\eta^2 = .445$, $p < .001$), difficult ($F_{(1,66)} = 72.823$, $\eta^2 = .525$, $p < .001$) and involving more effort ($F_{(1,66)} = 40.731$, $\eta^2 = .396$, $p < .001$) than those exposed to the control situation. However, the stress task was perceived as being as important as the control task ($F_{(1,66)} = 2.601$, $\eta^2 = .038$, $p = .112$).

There were no significant effects of sex on the situational appraisal items (all $p > .459$). However, the sex × condition interaction had a significant effect on effort ($F_{(1,66)} = 4.424$, $\eta^2 = .063$, $p = .039$). Post hoc analyses showed that women exposed to the TSST perceived that the

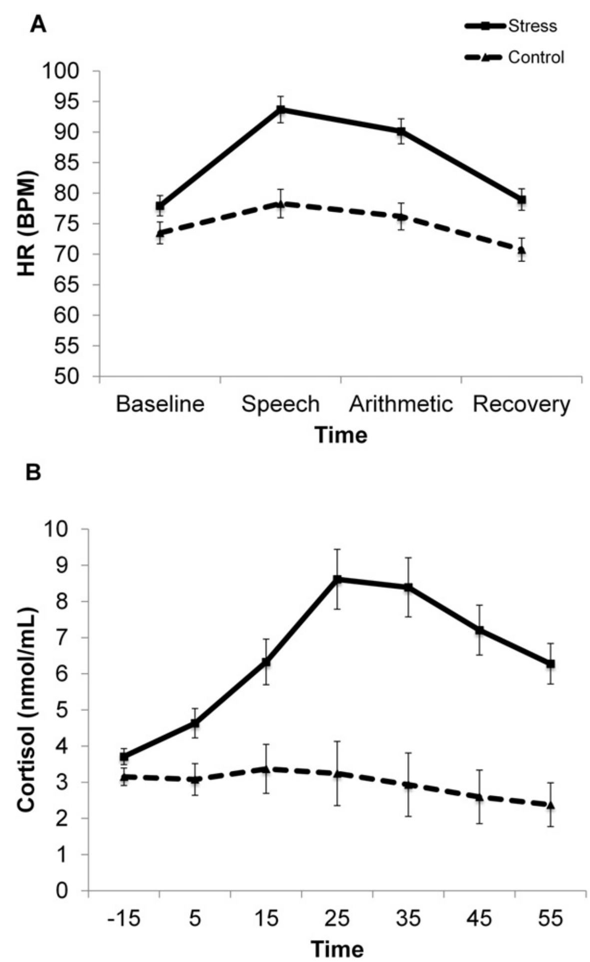

Fig. 2. Means of heart rate (A) and salivary cortisol concentration (B) (±SEM) in stress and control conditions.

Table 2
Regression analyses performed with optimism as predictor of HR and cortisol response to stress and control task. F values refer to the ANOVA of the model, and T to tolerance values. $p < .05$ are marked in bold.

	HR reactivity				HR recovery				T
	R^2	F	*p*	β	R^2	F	*p*	β	
Step 1	.350	8.892	<**.001**		.402	11.090	<**.001**		
Age				−.016			**.005**	.284	.97
Sex				−.016				.039	.95
BMI				.134			**.002**	.318	.91
Condition			<**.001**	−.562			<**.001**	−.407	.99
Step 2	.377	7.873	.098		.408	8.975	.403		
Pessimism				−.176				.086	.87
Step 3	.419	7.694	**.036**		.427	7.959	.151		
Optimism				−.208				−.140	.97
Step 4	.420	6.522	.727		.450	7.363	.112		
Condition ∗ optimism				.195				.873	.03
Stress			.088	−.244			**.033**	−.298	
Control			.204	−.175			.945	.009	
	Cortisol reactivity				Cortisol recovery				T
	R^2	F	*p*	β	R^2	F	*p*	β	
Step 1	.402	11.094	<**.001**		.295	6.583	<**.001**		
Age				−.156				−.116	.97
Sex			**.001**	−.349			<**.001**	−.485	.95
BMI				.069				−.164	.92
Condition			<**.001**	−.502			**.013**	−.264	.99
Step 2	.403	8.766	.782		.295	5.192	.926		
Pessimism				.028				−.010	.89
Step 3	.405	7.259	.629		.309	4.551	.255		
Optimism				.048				.121	.97
Step 4	.411	6.268	.442		.362	4.696	**.026**		
Condition ∗ optimism				−.434				−1.331	.03
Stress			.376	.126			**.017**	.363	
Control			.848	−.026			.461	−.106	

task required more effort than the women in the control group ($p < .001$) and the men exposed to the TSST ($p = .045$). No sex differences were found for the control task (all $p > .338$).

Correlation analyses did not show any relationship between situational appraisal items and cortisol and HR reactivity or recovery indexes in the stress or control condition (see Table 1, all $p > .163$).

3.3. Physiological response

3.3.1. Heart rate (HR)

Main effects of time ($F_{(1.63,109.23)} = 106.116$, $\eta^2 = .613$, $p < .001$), condition ($F_{(1,67)} = 15.635$, $\eta^2 = .189$, $p < .001$) and the time × condition interaction ($F_{(1.63,109.23)} = 22.755$, $\eta^2 = .254$, $p < .001$) were found, but there were no significant effects of sex or its interactions (all $p < .426$). Post hoc analyses showed that participants in the stress condition showed significantly higher HR during the speech, arithmetic and recovery (all $p < .002$) periods, except at baseline ($p = .073$) (see Fig. 2A).

3.3.2. Cortisol

ANOVA for repeated measures showed significant effects of time ($F_{(2.18,146.21)} = 17.208$, $\eta^2 = .204$, $p < .001$), condition ($F_{(1,67)} = 26.731$, $\eta^2 = .285$, $p < .001$), sex $F_{(1,67)} = 14.392$, $\eta^2 = .177$, $p < .001$), time × condition ($F_{(2.18,146.21)} = 21.799$, $\eta^2 = .245$, $p < .001$) and time × sex ($F_{(2.18,146.21)} = 6.754$, $\eta^2 = .092$, $p = .001$). The time × sex × condition interaction approached significance ($F_{(2.18,146.21)} = 2.825$, $\eta^2 = .040$, $p = .058$). Post hoc analyses showed that participants in the stress condition showed significantly higher levels of cortisol in all samples (+5, +15, +25, +35, +45 and +55 min; all $p < .004$), except at baseline ($p = .061$). Generally, men showed higher cortisol levels than women ($p < .001$). In the stress condition, men showed higher cortisol levels than women at baseline and in the rest of the samples (all $p < .025$). However, no significant differences between men and women were found in the control condition (all $p > .110$). There were no significant differences between the stress and control conditions in baseline cortisol levels for men and women (−15: $p > .155$). Higher cortisol levels in the stress condition than in the control condition were found in all samples after the beginning of the task (+5, +25, +35, +45 and +55) for men (all $p < .010$). For women, higher cortisol levels in the stress condition than in the control condition were found in +25, +35, +45 and +55 (all $p < .035$), but not in +5 ($p = .121$) (see Fig. 2B).

3.4. Relationships among optimism, pessimism and physiological activation[1]

We performed regression analyses to test whether optimism and/or pessimism played a role in HR and HPA reactivity and recovery, and whether these relationships were different for the stress and control conditions. In step 1, we added age, BMI, sex and condition as covariates because of their relationship with HR and cortisol release. In step 2, we added pessimism or optimism when the predictor in the following step was optimism or pessimism, respectively. In step 3, we added the optimism or pessimism score. Based on Aiken and West (1991), in step 4 we added the condition × optimism or condition × pessimism interaction when the predictor was optimism or pessimism, respectively.

Optimism was negatively related to reactivity$_{HR}$ (β = −.208, $p = .036$) in the entire sample. Therefore, people with high scores on optimism presented less HR reactivity to a stress or control task (see Table 2). Regarding recovery$_{HR}$, the condition × optimism interaction approached significance ($p = .112$), showing that higher optimism

[1] Additional regression analyses with dispositional optimism were performed for the psychological stress response, adding age, BMI, sex and condition as covariates in step 1 and dispositional optimism in step 2. Based on Aiken and West (1991), in step 3 we added the condition × dispositional optimism interaction. Our results did not show significant relationships between dispositional optimism and any of the HR or cortisol indexes, or the condition × dispositional optimism interaction (all $p > .173$).

scores were related to faster $recovery_{HR}$ (β = −.298, p = .033) in the stress condition, but not in the control condition (β = .009, p = .945).

Regarding cortisol indexes, the condition × optimism interaction was significant for $recovery_{C}$ (p = .026), showing a positive relationship between optimism and $recovery_{C}$ (β = .363, p = .017) in the stress condition. That is, higher scores on optimism were related to faster cortisol recovery after exposure to the TSST. This relationship was not significant in the control condition (β = −.106, p = .461) (see Table 2).

Finally, pessimism did not show any relationships with HR or the cortisol indexes (all p > .073) (see Table 3).

3.5. Relationships among optimism, pessimism and situational appraisal[2]

Regression analyses were used to analyze the relationship between optimism and pessimism and the situational appraisal. In step 1, we added sex, age and condition as covariates. In step 2, we added the score on optimism or pessimism when the predictor in the following step was pessimism or optimism, respectively. In step 3, we added the optimism or pessimism score; and in step 4, we added the condition × optimism or condition × pessimism interaction to analyze the possible effect of condition in the relationship.

Regarding optimism, regression analyses did not show significant relationships between optimism and the perception of the stress task as more stressful, frustrating, difficult, requiring more effort or important when considering both conditions together (all p > .235). The interactions between condition and optimism were not significant (all p > .246), except for difficulty (β = −.949, p = .049). However, the post hoc analyses did not show a significant relationship between optimism and difficulty perceived in any condition (both p > .067) (see Table 4).

By contrast, higher pessimism was related to perceiving that the task requires more effort (β = .214, p = .034). The condition × pessimism interaction was significant for difficulty (p = .016). Post hoc analyses showed that participants with higher pessimism perceived the stress task as more difficult (β = .270, p = .021). This relationship was not significant for the control condition (p = .262) (see Table 4). Although the condition × pessimism interaction was not significant for effort, participants with higher pessimism perceived that the stress task required more effort (β = .339, p = .011). This relationship was not significant for the control condition (p = .684) (see Table 4).

4. Discussion

The main purpose of this study was to investigate the role of optimism and pessimism in HR and HPA response in a controlled stressful situation. Moreover, we aimed to explore the relationship of these personality traits with the situational appraisal of the situation. To do so, healthy people aged 55 or older were randomly distributed into two groups and exposed to a standardized psychosocial stressor or to a non-stressful situation. First, we confirmed the stressful nature of the procedure, as exposure to the TSST produced changes in HR and cortisol release. At the same time, subjects assessed the TSST as more stressful, frustrating, difficult, and involving more effort than the control task. Second, and more importantly, in the stressful situation, we found that optimism was related to faster recovery of cortisol levels. Finally pessimism did not affect the HR or HPA function, but it was related to the perception of the stress task as more difficult and requiring more effort.

Table 3
Regression analyses performed with pessimism as predictor of HR and cortisol response to stress and control task. F values refer to the ANOVA of the model, and T to tolerance values. p < .05 are marked in bold

	HR reactivity				HR recovery				T
	R^2	F	p	β	R^2	F	p	β	
Step 1	.350	8.892	<**.001**		.402	11.090	<**.001**		
Age				−.016			**.005**	.284	.97
Sex				−.016				.092	.95
BMI				.134			**.002**	.318	.91
Condition			<**.001**	−.562			<**.001**	−.407	.99
Step 2	.389	8.270	**.047**		.422	9.487	.139		
Optimism				−.200				−.143	.97
Step 3	.419	7.694	.073		.427	7.959	.439		
Pessimism				−.187				.079	.87
Step 4	.420	6.529	.698		.429	6.758	.680		
Condition * pessimism				−.126				.134	.09
Stress				−.152				.116	
Control				−.230				.034	
	Cortisol reactivity				Cortisol recovery				
	R^2	F	p	β	R^2	F	p	β	T
Step 1	.402	11.094	<**.001**		.295	6.908	<**.001**		
Age				−.156				−.116	.97
Sex			**.001**	−.349			<**.001**	−.485	.95
BMI				.069				−.102	.92
Condition			<**.001**	−.502			**.013**	−.264	.99
Step 2	.404	8.815	.638		.309	5.825	.250		
Optimism				.046				.122	.97
Step 3	.405	7.259	.763		.309	4.780	.978		
Pessimism				.031				−.003	.89
Step 4	.416	6.399	.289		.311	4.065	.696		
Condition * pessimism				.346				−.138	.09
Stress				−.063				.035	
Control				.153				−.052	

The exposure to the TSST elicited higher cardiovascular activity, confirming previous results in the older population (Almela et al., 2011b; Kudielka et al., 2004b), but with no sex differences. We also showed that the TSST is potent enough to induce significant increases in cortisol levels in both sexes (Almela et al., 2011b; Kudielka et al., 2004a; Strahler et al., 2010). All these results confirm that the stress task used was able to produce an ANS and HPA-axis response. Finally, higher cortisol baseline and response to stress was found in men than in women, as in previous studies (Almela et al., 2011b; Strahler et al., 2010).

Regarding the relationship between personality and the physiological stress response, we observed a different pattern of relationships depending on whether optimism or pessimism was considered. Recently, Endrighi et al. (2011) reported that high dispositional optimism was related to lower perceived stress, but not to the stress-induced cortisol response in older people. Nonetheless, in the young population, high dispositional optimism was related to higher HR and cortisol reactivity (Solberg Nes et al., 2005) and faster cortisol recovery after stress (Brydon et al., 2009). Agreeing with Endrighi et al. (2011), who studied a similar sample, our results did not show any relationship between dispositional optimism and the physiological stress response in older people. However, when we explored the role of the optimism and pessimism factors separately, following the recommendations of Rasmussen et al. (2009), we found that optimism was related to faster recovery of cortisol levels afterwards, although we did not find significant relationships between pessimism and the physiological stress response. Thus, our results are in line with Carver et al. (2010), who suggested that analyzing optimism and pessimism separately can result in a better prediction of outcomes in some situations. Moreover, previous studies suggest that these traits are independent in older people (Mroczek et al., 1993; Plomin et al., 1992; Robinson-Whelen et al.,

[2] Additionally, regression analyses with dispositional optimism as predictor and situational appraisal items (stressful, frustrating, difficult, effort and important) as dependent variables were performed, adding sex, age and condition as covariates in step 1, dispositional optimism in step 2, and the condition × dispositional optimism interaction in step 3. Our results did not show any significant relationships between dispositional optimism and the situational appraisal items, or condition × dispositional optimism interactions (all p > .092).

Table 4

Regression analyses performed with optimism and pessimism as predictors of situational appraisal in stress and control conditions. C * optimism and C * pessimism refer to condition × optimism and condition × pessimism interactions respectively. F values refer to the ANOVA of the model, and T to tolerance values. $p < .05$ are marked in bold.

	Stressful				Frustration				Effort				Difficult				Importance				
	R^2	F	*p*	β	R^2	F	*p*	β	R^2	F	*p*	β	R^2	F	*p*	β	R^2	F	*p*	β	T
Step 1	.444	17.568	<**.001**		.422	16.316	<**.001**		.401	14.923	<**.001**		.528	25.004	<**.001**		.044	1.016	.391		
Age				−.079				−.022				−.152				.006				−.081	.99
Sex				.046				.063				.054				.064				<.001	.99
Condition			<**.001**	−.661			<**.001**	−.646			<**.001**	−.613			<**.001**	−.723				.191	.99
Step 2	.461	13.925	.151		.428	12.363	.401		.441	13.041	**.031**		.535	19.001	.322		.265	1.247	.173		
Pessimism				.141				.084				.215				.089				.174	.88
Step 3	.465	11.140	.499		.432	9.872	.543		.442	10.280	.902		.538	15.141	.531		.301	1.291	.235		
Optimism				−.063				−.058				−.012				−.054				.144	.97
Step 4	.477	9.566	.246		.432	8.115	.823		.447	8.635	.416		.565	13.876	**.049**		.303	1.082	.728		
C * optimism				.625				.121				.447				−.949				.238	.03
Stress				.048				−.080				.067			.332	.116				.101	
Control				−.167				−.037				−.087			.067	−.218				.185	
Step 1	.444	17.568	<**.001**		.422	16.316	<**.001**		.401	14.923	<**.001**		.528	25.004	<**.001**		.044	1.016	.391		
Age				−.079				−.022				−.152				.006				−.081	.99
Sex				.046				.063				.054				.064				<.001	.99
Condition			<**.001**	−.661			<**.001**	−.646			<**.001**	−.613			<**.001**	−.723				.191	.99
Step 2	.449	13.247	.441		.426	12.245	.509		.416	11.051	.804		.532	18.725	.493		.061	1.068	.274		
Optimism				−.072				−.063				−.024				−.059				.133	.98
Step 3	.478	14.658	.136		.432	9.872	.425		.457	10.280	**.034**		.538	15.141	.086		.090	1.291	.151		
Pessimism				.168				.080				.214				.344				.183	.88
Step 4	.491	12.702	.286		.434	8.164	.642		.473	9.094	.142		.578	14.632	**.016**		.091	1.072	.797		
C * pessimism				−.324				−.146				−.453				.674				.102	.09
Stress				.226				.120			**.011**	.339			**.021**	.270				.155	
Control				.024				.030			.684	.059			.262	−.143				.218	

1997). For these reasons, we have obtained a clearer picture of their importance in the stress response in older people and in foreseeable health consequences. Furthermore, it should be noted that differences in the nature of the stressor could also contribute to explaining the discrepancies between previous studies and our results. Previous studies employed a cognitive stressor (Endrighi et al., 2011; Solberg Nes et al., 2005), a kind of stress task in which increases in arousal could be adaptive for better performance on the task. Instead, in our study the stressor involves a social threat. Therefore, it is possible that an increase in arousal could be less adaptive and diminish the performance on the task. Thus, the context could play a determinant role in the way optimism affects the response to stress. Further research is needed to test this idea.

It is worth noting that a delayed return to baseline levels of cardiovascular function is currently thought to provoke increases in the risk of developing cardiovascular diseases (Esch et al., 2002; Heponiemi et al., 2007). Additionally, a delayed cortisol recovery is related to an increase in the risk of CVD development (Esch et al., 2002) and other stress-related pathologies, such as depression or type 2 diabetes (Gragnoli, 2012). According to the McEwen (1998), repeated or sustained stimulation results in *allostatic load*, which disrupts the dynamic responses to acute challenges or stress, resulting in impaired reactivity and recovery. Thus, the exposure to repeated acute stress has adverse consequences for health, due to an inadequate restoration of the stress response. In other words, a slow reduction in cortisol concentrations after stress results in adverse health consequences due to disruptions in the cardiovascular, metabolic, immune and nervous systems (McEwen, 1998). The HPA capacity to turn off after stress is reduced in aging (Aguilera, 2011). Therefore, factors that preserve the correct functioning of the negative-feedback effect of cortisol, such as optimism, become more important in older people.

Consequently, our findings suggest a protective role of optimism on health (Carver et al., 2010). At least in older people, positive expectations may contribute to generating an adaptive physiological adjustment, which would have a protective effect against stress-related diseases. This faster physiological recovery could be due to the fact that people with higher optimism take an active approach to problem solving, which is considered more adaptive coping (Scheier et al., 1994; for review: Solberg Nes and Segerstrom, 2006). Furthermore, further research is clearly needed to more thoroughly investigate whether the relationship between optimism and stress-induced physiological reactivity is different for young and older people.

Regarding the relationship between personality and situational appraisal, we observed that pessimism, but not optimism, was related to the situational perception. Endrighi et al. (2011) observed similar results, showing higher stress perception 20 and 45 min after stress in older people with low scores on dispositional optimism. Although our results showed that dispositional optimism did not predict the situational appraisal, analyzing the role of optimism and pessimism separately we observed that pessimism was related to perceiving more effort, regardless of the condition, and to more perceived difficulty in the stress condition. As we mentioned previously, studying the optimism and pessimism subscales separately might provide greater knowledge about their functions (Carver et al., 2010; Rasmussen et al., 2009), especially taking their independence in middle-aged and older people into account (Mroczek et al., 1993; Robinson-Whelen et al., 1997; Plomin et al., 1992). However, assuming that a one-dimensional perspective considers pessimistic people to be those with lower scores on dispositional optimism, our results agree with Endrighi et al. (2011). Some authors have proposed that erroneous stress perception and the tendency to use maladaptive coping strategies (Chico, 2002) make pessimists more vulnerable to health problems than optimists (Carver et al., 2010).

This study has several limitations that need to be addressed in order to properly interpret its results. In this study, we cannot determine causality, but we have made an effort to obtain a very homogenous sample and eliminate a number of possible confounding factors. However, the strict selection of participants increases the difficulty of generalizing our results to the general population. Moreover, due to the relevance of the return to baseline after a stressful event for health (Esch et al., 2002; Gragnoli, 2012; Heponiemi et al., 2007) and its relationship with optimism (Carver et al., 2010), we think it should be given greater importance in future studies. Clearly, more studies are needed to establish the relationship between optimism and the HPA axis and the way it can change across the life span. To the best of our knowledge, this is the first study to relate HR, cortisol release and situational appraisal to optimism and pessimism separately in stressful situations in healthy older people. Finally, it should be noted that we made an effort to reduce the possible confounding factors in order to have a clearer picture of the relevance of optimism and pessimism in the psychophysiological response to stress. Unfortunately, we did not measure the coping styles, which could be a mediator in this relationship (see Solberg Nes and Segerstrom, 2006). Another interesting factor to take into account is the socioeconomic position, given its important role in the physiological response (Castro-Diehl et al., 2014). In future studies, it would be interesting analyze the effects of these factors in the relationships between optimism and pessimism and the psychophysiological stress response.

In sum, we conclude that the relationships found contribute to clarifying the different mechanisms underlying stress-related disorders, due to: (i) the role of optimism in the physiological response in stressful situations; (ii) the importance of recovery in pathological processes; and (iii) the prevalence of disorders and pathologies in aging. In conclusion, our results emphasize that the optimism trait plays a significant role in cardiovascular and endocrine function, and that their protective effect on health could be especially relevant in the aging population. This personality trait, and probably the associated coping style, would contribute to an enhanced quality of life, reducing the development of diseases and, in turn, the personal and social costs associated with pathological aging.

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