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Cardiovascular Response to Psychosocial Repeated Stress in Caregivers of Offspring with Schizophrenia

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Abstract. Taking care of offspring suffering a long-term illness such as schizophrenia is one of the more stressful life experiences. Care conditions may act as a protective factor in the health of the caregiver. The present study assesses heart rate (HR), blood pressure (BP), and mood responses to psychosocial stress in 16 mothers receiving specialised support for the care of their offspring (CARE+) and in 11 mothers caring for their offspring without support (CARE−). The CARE− group take care of less functional and more symptomatic offspring; and display higher basal, but lower HR, responses after stress than the CARE+ group. No significant group effects were found for BP. For mood states, there were significant decreases in the anger subscale in the CARE− group that were not found in the CARE+ group. HR was related to active and passive coping styles, trait anxiety, and years spent providing care. In the total sample, other significant relationships between cardiovascular responses and life events and personality traits have been found. In sum, the data suggests that specialised support for patients may modulate cardiovascular responses to repeated stress in caregivers.

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Cardiovascular diseases are one of the most frequent causes of mortality. The autonomic nervous system has been considered a potential mechanism connecting psychosocial stress to functional somatic disorders. Taking care of a relative suffering a long-term illness (Cacioppo et al., 2000) may be one of the most stressful and prolonged life experiences; especially in the case of offspring. Caregivers experience continuous feelings of worry during prolonged periods–together with periodic single episodes when the care recipient suffers a worsening of the symptoms. Thus, caring for a descendent with schizophrenia can combine chronic and acute stress.

Cardiovascular hyper-reactivity to acute stress as well as variations in chronic stress have been proposed as relevant in the development and etiology of cardiovascular heart disease and subclinical indexes of the illness. Exaggerated responses to acute psychological stress have been frequently associated with a high risk of future development of cardiovascular disease in healthy participants (Chida & Steptoe, 2010; Phillips, Der, & Carroll, 2009). Buffered cardiovascular reactivity has been proposed as a predictive variable for high depressive and anxious scores after a period of five years in a large sample of healthy individuals (Phillips, Hunt, Der, & Carroll, 2011). Thus, cardiovascular reactivity to psychological stress seems to have a relevant role as a predictor of different pathological profiles and/or unbalanced states, although the underlying mechanisms remain unclear (Chida & Steptoe, 2010; Hayashi et al., 2009).

However, results referring to the impact that life events exert on cardiovascular reactivity to a new potentially stressful stimulus are less homogeneous, suggesting that gender and psychosocial factors are involved. In healthy individuals, overall life events are related to a blunted cardiovascular response to mental stress, although factors such as gender and social support, among others, may also modulate cardiovascular reactivity (Carroll, Phillips, Ring, Der, & Hunt, 2005; Phillips, Carroll, Ring, Sweeting, & West, 2005). In addition, an enhanced reactivity in BP has been associated with chronic negative stress in adolescents (Low, Salomon, & Matthews, 2009), and no association between autonomic reactivity and chronic life stress has been found (Chida & Hamer, 2008). Thus, the factors involved in the habituation or sensitisation of life events on cardiovascular reactivity remain poorly understood.

Studies focused on cardiovascular reactivity to acute stress in samples suffering prolonged stressful periods are scarce. Since post-traumatic stress disorders (PTSD) or major depression disorders (MDD) are usually reported as a chronic stressful experience by patients,

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results referring to cardiovascular disturbances in this population may help improve understanding of the effects of chronic stress. However, data is scarce and results are far from unanimous. In PTSD patients, higher baseline heart rate (HR) and arterial BP reactivity to trauma interviews have been found in Katrina survivors (Tucker, Jeon-Slaughter, Pfefferbaum, Khan, & Davis, 2010). Elevated baseline HR as well as higher HR reactivity have also found in survivors of motor vehicle accidents (Rabe, Dörfel, Zöllner, Maercker, & Karl, 2006). However, no significant differences have been also found in cardiovascular parameters during baseline and response to mental stress (Klumpers et al., 2004). MDD has been associated with a decrease in parasympathetic tone: since diminished high frequency HR variability, less systolic BP, and less recovery in HR have been found (Ehrenthal, Herrmann-Lingen, Fey, & Schauenburg, 2010; Halaris, 2009; Salomon, Clift, Karlsdóttir, & Rottenberg, 2009) and this is mainly due to a similarity between reactivity and recovery response patterns. These results are in agreement with those found by York et al. (2007) who reported a negative relationship between depression scores and cardiovascular reactivity during mental stress found in coronary artery disease patients. Thus, prolonged stressful conditions such as PTSD and MDD can both sensitise and habituate cardiovascular reactivity to new stressful stimuli. The examination of populations with prolonged and potentially stressful vital experiences, but without a psychopathological diagnosis, can be especially useful to elucidate the interaction between chronic and acute stress.

Few studies on the cardiovascular system have been carried out in samples of caregivers. Recently, it has been reported that care giving is associated with cardiovascular risk in terms of a higher probability of falling into the top quartile of the Framingham score (Horwitz, Yogo, Juma, & Ice, 2009; von Känel et al., 2008**)**. Cacioppo et al. (2000) reported higher resting HR levels in 27 women who were long-term caregivers for demented spouses with specialised assistance; in comparison with 37 non-caregivers. However, no significant differences between groups were found for HR reactivity to psychosocial stress, HR being positively associated with negative affectivity. Another study carried out by Lucini et al. (2008) compared the psychological and cardiovascular measurements of 58 middle-aged caregivers of both genders with 60 similar healthy controls, during supine and active stand up positions. Caregivers were caring for relatives, mainly but not exclusively partners, with a diagnosis of cancer during an average period of 11.5 months. They presented an autonomic imbalance characterised by a sympathetic predominance at rest and a reduced vagal regulation of cardiac activity with lower cardiac responsiveness to standing up than controls. Furthermore, caregivers perceived more stress and less control over their lives, suffered more somatic symptoms, and worse quality of life than the comparison group. Changes in lifestyle were proposed as a mediator mechanism to prevent or buffer the effect of caregiver stress. More recently, Monin et al. (2010) worked with a group of 53 caregivers of partners with osteoarthritis and reported higher HR and BP levels in response to videos of the care recipients performing pain-eliciting tasks when compared with exposure to videos of strangers performing the same tasks.

In the light of the available data, results partially suggest higher resting HR levels in caregivers than in non-caregivers. However, results regarding HR reactivity to laboratory tasks are non-homogenous and it is difficult to make comparisons among the studies. Methodological aspects such as the characteristics of the stimuli that elicited a cardiac response can contribute to these divergences. Most of the stressful stimuli in a caregiver's life involve psychological aspects such as worry, fear, negative anticipation, or guilt. These aspects are more similar to psychosocial stressors than stimuli of a physical nature, and this may modify cardiac input. Additionally, the characteristics of caregivers differ, since the samples were composed of older women in one study and middle-age men and women in the other. These caregivers were caring for relatives (e.g., spouses, parents, etc.) with various pathologies, symptoms, and courses of the illnesses. In fact, distress in 3449 older caregivers has been associated with patient cognitive and functional status, as well as depressive and behavioural symptoms (Onder et al., 2009); although no cardiovascular data was reported. Finally, the results of the mentioned studies suggest that untested overlapping factors could at least partially explain differences in results. These factors may include: the severity of the symptoms, the functional autonomy of the patient, the amount of time the caregivers spend providing care, or the effect of repeated bouts of stress– as frequently occurs. An important factor related to these aspects, with consequences on the quality of life of the caregivers, is the availability of somebody able to offer qualified support in the care of their relatives. The impact of this support has not yet been studied to the best of our knowledge

The aim of this preliminary study consists in determining whether cardiovascular responses to repeated stressful stimuli are sensitive to an institutional support program that provides a resource for improving the quality of life for a group of mothers of offspring with a diagnosis of schizophrenia. In the light of available data, higher pre-stress HR in unsupported mothers in comparison with supported caregivers can be expected, since institutional support can be considered a palliative

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factor of chronic stress. Enunciating a hypothesis about cardiovascular reactivity seems venturous, if the previously mentioned results are considered. Furthermore, this study aims to provide preliminary data on the relationship between cardiovascular responses to stress and the characteristics of the care–such as symptom severity or functionality as well as personality traits and changes in mood. For this purpose HR and BP were recorded, and caregivers of schizophrenic patients performed two consecutive standard psychosocial stressors.

Method

Participants

The sample was composed of 27 caregivers, mothers of individuals with schizophrenia who were selected through the local Association of Relatives of Mental Illness Patients (ASIEM). All of the sample participants were voluntary and each completed an informed consent form. Criteria for inclusion included being a first-degree relative who is mainly responsible for managing the daily tasks for a son or daughter with diagnosed schizophrenia; and living with the patient in the same home.

The offspring of 16 women received institutional healthcare support (CARE+ group), while the offspring of 11 mothers did not receive this support and belonged to the CARE− group. The healthcare support was exclusively focused on the offspring with schizophrenia. This resource is provided by the Valencian health service on the basis of psychiatric reports and not all applicants qualify for this additional assistance. The support consists of a mental health program (social, cognitive, and interpersonal skills) that includes workshops and therapy with specialised assistance (medical and psychological staff) in a centre during weekdays. In the evening, the patients return home where they live with their family or relatives. Caregivers receive no assistance focused on their situation. Health care staff provides information in a single session about how the care program cares for patients and, occasionally, provide information about the evolution of their son/daughter. The care given to offspring provides caregivers with a long break from their care giving roles. The characteristics of the sample are presented in Table 1.

Procedure

In a previous session both groups answered questions regarding socio-economic aspects, time per week spent providing care, and also completed personality and situational questionnaires about stressful life events, caregiver burden, and other health aspects about themselves and their relatives with schizophrenia. The severity of schizophrenia was evaluated by clinical staff. In a second session, both groups of caregivers were exposed to two consecutive stressors. Subjects were accommodated in an experimental room and transducers were connected. A 10-minute period of habituation was registered and stability of the signal was checked during, at least, the last 5 minutes. Afterwards, HR was continuously registered during five minutes before (baseline 1), during (task 1), and five minutes after the first stressor (post-task 1). This pattern of assessment was replicated for the second stressor (baseline 2, task 2, and post-task 2). BP, state anxiety, and mood were evaluated before and after both stressors.

Stressors

Two bouts of stress were applied and these consisted in a modified version of the Trier social stress test (Kirschbaum, Pirke, & Hellhammer, 1993). According to this standardised stressor, each episode of stress consists of a five-minute mental arithmetic task performed orally and followed by five-minute speech task within a discussion in front of a committee. Researchers of both genders played this role during each experimental procedure. These researchers simulated recording the session with a digital camera in order to enhance the evaluative threat.

Before the application of both stressors, participants were told that hand movements would be limited in order to enable accurate measurements; and were also told that a committee would ask them some questions. To increase the evaluative threat, caregivers were encouraged to perform the task as best as they could as this would be relevant for the aim of the study. Both stressors contained a common part consisting of an arithmetic task, but the stressors differed in the topic of the speech. One of the speeches covered a neutral topic about socio-economical issues (general topic). To enhance the caregiver commitment to the task, the other speech was about the illness of their relative (specific topic). Thus, half of the sample was exposed to an arithmetic task and a general topic speech in a first stressor; and to an arithmetic task and specific topic speech in the second stressor. The other half of the sample performed the specific topic speech in the first stressor; and a general topic speech in the second stressor.

Apparatus and electrophysiological variables

A photoelectric transducer (TS100A) was used to evaluate changes in finger volume pulse (volts). The transducer was attached with an adhesive collar to the distal phalanx of the index finger of the dominant/right hand. Variations in the finger volume pulse were acquired

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Table 1. *Average and SD of age, body mass index (BMI), years providing care, number of hours per week providing care, cardiovascular symptoms, life events, burden, personality characteristics and symptoms of the care recipient in the CARE- and CARE+ groups*

Caregiver	CARE– (*n* = 11)	CARE+ (*n* = 16)
Age (years)	63.64 (6.00)	62.50 (7.26)
BMI (Kg/m^2)	26.54 (3.16)	28.53 (4.48)
Years caring	13.64 (5.92)	14.69 (5.57)
Time weekly caring (hours)	89.73 (79.25)	38.56 (57.29)
Cardiovascular symptoms	5.36 (5.80)	10.50 (9.42)
Number of events	25.18 (5.42)	25.19 (9.02)
Intensity of life events	38.91 (17.05)	41.25 (23.56)
Burden (scores)	38.73 (13.96)	40.06 (16.12)
Trait anxiety (scores)	23.18 (10.86)	23.63 (10.75)
Trait anxiety (percentiles)	42.27 (30.87)	46.44 (29.48)
Perceived self-efficiency (scores)	34.00 (5.06)	32.56 (6.64)
Perceived self-efficiency (T scores)	68.73 (10.07)	64.94 (12.56)
Behavioural coping	21.55 (5.18)	23.31 (3.84)
Cognitive coping	39.46 (7.15)	42.31 (5.04)
Emotional coping	36.00 (8.81)	38.69 (4.41)
Behavioural disengagement	-4.09 (2.95)	-6.13 (2.55)
Cognitive disengagement	22.46 (6.19)	21.06 (6.37)
Offspring cared for		
EAG	40.91 (12.21)	58.75 (14.08)
Positive symptoms (scores)	23.73 (5.37)	16.44 (7.30)
Positive symptoms (percentiles)	40.91 (22.67)	19.69 (23.34)
Negative symptoms (scores)	24.27 (6.28)	20.50 (9.23)
Negative symptoms (percentiles)	43.64 (19.38)	33.75 (25.20)
General psychopathology (scores)	52.18 (6.88)	38.50 (13.18)
General psychopathology (percentiles)	72.73 (15.71)	31.88 (32.50)

using a photopletysmograph amplifier (PPG100A). HR (bpm) was automatically extrapolated from finger volume pulse data using AcqKnowledge software for data registration. Modules of finger volume pulse were a part of a physiological recording system composed of 16 modules (BIOPAC Systems Inc., Santa Barbara, CA). This system was connected to a signal pre-amplifier (UIM100 universal interface module) that was connected to a computer for data acquisition (MP100) and storage (AcqKnowledge for Windows). Systolic (SBP) and diastolic blood pressure (DBP) were measured three times before and three times after both stress episodes using an Omron (model M6) semiautomatic sphygmomanometer.

Psychological variables

Psychological response to acute stress was evaluated by mood and state-anxiety assessment.

Mood was evaluated using the 'now' version of POMS for laboratory sessions (McNair, Lorr, & Droppleman, 1971). This questionnaire was initially composed of 65 items ranked on a five-point Likert scale rated for six subscales. In the present study an abbreviated version of 29 items was used. This version is composed of five subscales (tension, depression, anger, vigour, and fatigue), all of which have a Cronbach's alpha higher than .80.

State-anxiety was evaluated using the Spanish adaptation of the state-trait anxiety inventory (Spielberger, Gorsuch, & Lushene, 1982) composed of 20 items scored on a 4-point Likert scale. For the state-anxiety scale the reliability coefficients ranged from .16 to .62.

Personality traits evaluated in the present study include anxiety, coping styles and self-efficacy.

Trait-anxiety was evaluated using the Spanish adaptation of the state-trait anxiety inventory (Spielberger et al., 1982), composed of 20 items scored on a 4-point Likert scale. For the trait-anxiety scale the reliability coefficients ranged from .65 to .86.

Coping styles were assessed by means of the Cope scale (Carver, Scheier, & Weintraub, 1989). This scale contains 60 items ranked on a 4-point Likert scale and designed to assess 15 conceptually distinct styles of

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coping, with reliability coefficients ranged from .62 to .92. These dimensions are organised in five second-order factors that are focused on coping with the problem, cognitive coping, coping with emotions, behavioural disengagement, and cognitive disengagement.

Finally, self-efficacy was evaluated by means of the general self-efficacy (GSE) scale (Jerusalem & Schwarzer, 1992) consisting in 10 items scored on a 4-point Likert scale from 1 'not at all true' to 4 'exactly true'. The total score is calculated by adding the scores of the 10 items. The reliability coefficients ranged from .76 to .90.

Individual and contextual aspects of the caregivers assessed in the present study were cardiovascular complaints, perceived stress (life events and caregiver burden) and severity of the care recipient.

Cardiovascular symptoms of the caregivers were registered by means of 10 items scaled on a 5-point Likert scale – from 1 'nothing' until 5 'extremely' – supplied by psychosomatic symptoms scale (PSS) of Sandin and Chorot (1995). The reliability coefficients ranged from .73 to .82.

Stressful life events were evaluated using the general stress scale (EAE-G) designed by Fernandez and Mielgo (2001). The scale is composed of 53 items ranked on a 4-point Likert scale. Respondents weigh each item according to the actual importance the event has in their life (intensity). In this study the number of stressful events reported for the two-year study period and current perceived weights were considered. The reliability coefficient in the Spanish population is .83.

Caregiver burden was evaluated using Zarit's caregiver burden scale (Zarit, Reever, & Bach-Peterson, 1980). This scale touches on specific aspects of the caregiver's life, perceptions of physical and psychological health, as well as economic and social issues. This study employed the more frequently used 22-item version ranked on a 5-point Likert scale – from 0 'never' to 4 'nearly always'. The reliability coefficient is .92.

The severity of schizophrenia of the offspring was evaluated using a scale of positive and negative symptoms (PANSS), developed by Kay, Fizben, and Opler (1987) and composed of 30 items distributed into positive, negative (reliability coefficients ranged from .73 to .83, respectively), and general psychopathology scales, as well as the global activity scale (EAG) which offers a single item of global functionality ranked from 100 (without pathology) to 1 (extreme gravity) (Bobes, Portilla, Bascaran, Saiz, & Bousoño, 2002).

Questions about time from the diagnosis and time spent in providing care per week (number of hours) were asked together with general data.

Data reduction and analysis

The physiological recording system registered 500 samples per second. For HR, artefacts were eliminated and the average of each period before (baselines) during (tasks) and after both stressors (post-tasks) was calculated using the AcqKnowledge software. Thus, the HR variable presents two intra-individual factors: 'stressor' (1 and 2) and 'period' (baseline, task, and post-task for each stressor). Reactivity in each stressor was assessed calculating the average of HR during the task period minus the average of HR during the baseline period of this stressor. Recovery in each stressor was considered as the difference between the post-task average of HR and the average baseline of this stressor, following previous studies (González-Bono, Moya-Albiol et al., 2002; Moya-Albiol et al., 2001; Moya-Albiol, Salvador, Costa, Martinez-Sanchis, & González-Bono, 2003). For SBP and DBP, averages of the three pre-stress measurements and the three post-stress measurements were calculated in both stressors in order to offer a single measure pre- and post-stress for each stressor. Thus, the BP variables present two intra-individual factors: 'stressor' (1 and 2) and 'moment' (pre- and post-task, for each stressor). BP and mood changes for each stressor were obtained considering post-task scores minus previous scores.

Both groups differed in situational variables such as time spent in care and global functionality, as well as the positive and general symptoms of the care recipient. To determine whether these variables significantly contribute to the cardiovascular variables, they were included as covariates in the repeated ANCOVA measurements with 'period' as the within-subject factor for HR levels and 'moment' as the within-subject factor for BP levels. If a variable resulted significant, it was included as a covariate in a later analysis in order to isolate the possible effect of the 'group'. Additionally, possible differences between groups at initial levels and scores were tested using an independent t-test. If initial differences are found in a variable, the initial level or score should be considered as covariate in subsequent analysis for that variable.

Thus, repeated ANCOVA measurements with 'period' (task1, post-task1, baseline 2, task 2 and post-task 2) as the within-subject factor, 'group' as the between-subject factor and initial HR levels (baseline 1) as the covariate was carried out in the case of HR. For comparisons, univariate ANCOVAs and t-tests were performed. As far as situational factors of care resulted relevant for BP, repeated ANCOVA measurements (2 x 2 x 2) with 'stressor' and 'moment' within subject-factors, and 'group' between factor and situational variables as covariates were made. For mood scores, no initial differences between groups were found and no significant effects of the severity of the care recipient or weekly time spent in care were found. Thus, repeated ANOVA measurements with 'stressor' as the within-subject factor and 'group' as the between-subject factor were carried out.

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Independent and paired t-tests were carried out as post hoc comparisons. Greenhouse-Geisser adjustments were applied for the degree of freedom where appropriate for reporting corrected statistics and probabilities. Spearman correlations were carried out to examine relationships among variables and cardiovascular responses. All statistical analyses were performed with the 19.0 SPSS statistical package for Windows. The alpha level was set at .05.

Results

Descriptive characteristics

Non-significant differences between groups were found for age, BMI, years providing a caregiver role, number and perceived intensity of life events, burden, cardiovascular symptoms, trait anxiety, perceived self-efficiency or coping (for all factors, $p > .10$). The order of the stressor exposure was counterbalanced (general and specific) and no differences were found in function of the order neither in cardiovascular or psychological levels nor in responses. Results were reported only considering the first and second stressor.

As expected, the CARE− group spent more than twice as much time per week taking care of their relatives than the CARE+ group, although this difference did not reach statistical significance, $t(25) = 1.84$, $p < .08$. The offspring of the CARE− group were less functional, and suffered more positive symptoms and general psychopathology symptoms of schizophrenia than the CARE+ group, $t(25) = -3.41$, $p < .002$; $t(25) = 2.82$, $p < .009$ and, $t(25) = 3.15$, $p < .004$, respectively. Furthermore, weekly time giving care is positively and significantly related to the score of the positive symptoms of the offspring in the total sample, $r = .47$, $p < .02$.

Cardiovascular levels and response

Repeated ANCOVA measurements were carried out with cardiovascular levels in the total sample; weekly time spent giving care and the positive symptoms and general psychopathology symptoms of schizophrenia of the recipient as covariates in order to clarify whether these variables significantly explain the variance of cardiovascular data. No significant effects were found apart from a 'period' effect on HR levels $\varepsilon = .49$, $F(5, 18) = 5.85$, $p < .003$. A significant main effect of weekly time spent in care was found on SBP levels, $F(1, 22) = 4.85$, $p < .04$ and DBP levels $F(1, 22) = 6.31$, $p < .02$. Thus, future comparisons for BP variables will be performed considering 'weekly time spent in care' as a covariate to isolate possible 'group' effects. No significant effects of these variables were found on HR relativities, HR recoveries, and BP changes.

With regards to cardiovascular levels, significant differences between groups were found in the first baseline of HR with higher levels in the CARE− than in the CARE+ group (79.51 bpm versus 71.19 bpm, respectively, $t = 2.39$, $p < .03$). No initial differences were found in mood. For this, ANCOVAS with HR considering the first baseline as covariate were performed. The results showed significant effects of 'period' and 'period*group' interaction on HR, $\varepsilon = .61$, $F(4, 21) = 7.14$, $p < .001$ and $F(4, 21) = 4.96$, $p < .007$, respectively. Although no significant differences between groups were found in each period, the pattern of response was different for each group when they were considered separately (Figure 1). In the CARE+ group, a significant response to both stressors was found, $\varepsilon = .52$, $F(4, 11) = 6.99$, $p < .003$. This group showed significant increases from baseline to tasks in both stressors, $t = -3.74$, $p < .002$, and, $t = -3.77$, $p < .002$, for stressors 1 and 2 respectively and significant decreases from tasks for post-tasks in both stressors, $t = 4.65$, $p < .0001$, and, $t = 4.49$, $p < .0001$, for stressors 1 and 2 respectively. Nevertheless, the CARE- group showed a variation on HR for each stressor which did not reach statistical significance ($p > .07$).

When reactivity and recovery were considered, a significant effect of 'period' was found for HR $F(1, 25) = 32.81$, $p < .0001$, while no effects of 'stressor', 'group', or their interactions were found. In both stressors for the total sample, HR reactivity was higher than HR recovery. No significant effects were found on BP levels or response (Table 2).

Psychological scores and response

With regards to mood scores (Table 2), no significant differences between groups were found in the baseline. Repeated ANOVAS measurements (3 x 2) with 'stressor' as the within-subjects factor and 'group' as the between-subjects factor showed a significant effect of 'stressor' on fatigue and a nearly significant effect on anxiety in the total sample, $\varepsilon = .65$, $F(2, 24) = 4.13$, $p < .04$, and, $\varepsilon = .72$, $F(2, 24) = 3.49$, $p < .06$, respectively, with decreases after the second stressor – when compared with pre-stress scores (for all, $p < .09$). The 'group' or 'stressor*group' interaction was only significant on the anger scale, $\varepsilon = .70$, $F(2, 24) = 4.37$, $p < .03$, although no significant differences were found in post hoc comparisons. The CARE− group showed decreases in anger while CARE+ reported slight increases.

When examining differences in mood scores to isolate changes in both stressors, only the fatigue subscale showed a significant effect on 'stressor*group' interaction, $F(1, 25) = 4.65$, $p < .04$. No differences between groups were found in the second stressor, but the CARE− group showed decreases that contrast nearly significantly with the no changes observed in the CARE+

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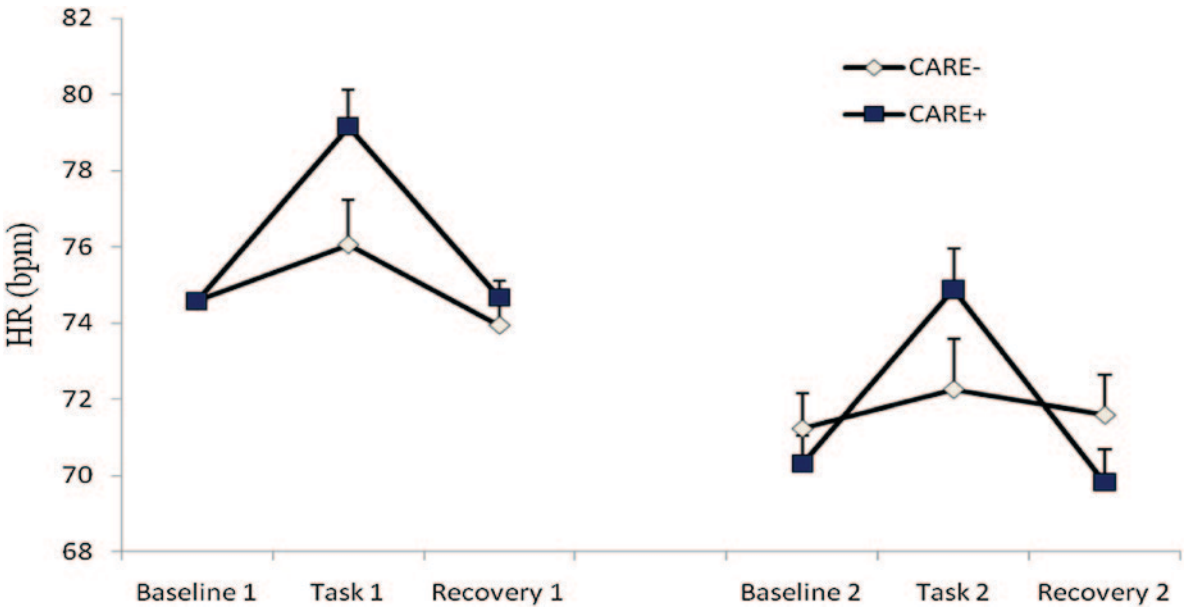

Figure 1. Estimated marginal average ± SEM of the HR during baselines, tasks, and post-tasks of both stressors in the CARE- and the CARE+ groups.

group after the first stressor, $t(15) = -1.84$, $p < .08$. Furthermore, anger showed a significant effect on 'group', $F(1, 25) = 5.03$, $p < .03$, with CARE− group showing greater decreases than the CARE+ group after the first stressor, $t(10) = -2.19$, $p < .04$ and no differences between groups for the second stressor (Table 2).

Relationships between variables

Cardiovascular differences between groups were only significant in the case of HR. HR levels or responses did not show significant relationships with psychological levels of responses during stress episodes, although care conditions such as years spent in care and personality traits are related to HR. All HR levels correlated positively with the scores of coping style focused on behavioural disengagement (for all, $r > .41$, $p < .03$); while there was a positive correlation between HR reactivity in the first task and cognitive coping ($r = .37$, $p < .05$). Furthermore, negative relationships were found between HR recovery in the first task and trait anxiety ($r = -.41$, $p < .03$); and between HR reactivity to the second task and years spent in care ($r = -.38$, $p < .05$). No other relationships were found with HR in the total sample.

With regards to BP, DBP changes during the second stressor were negatively related to decreases in anxiety and perceived self-efficiency ($r = -.38$, $p < .05$; $r = -.40$, $p < .04$, respectively) and positively associated with the number of stressful life events ($r = .38$, $p < .05$). Additionally, SBP in the second stressor was also negatively related to perceived self-efficiency ($r = -.41$, $p < .03$).

Discussion

The results of the present study suggest that care condition is an important variable that modulates cardiovascular response to repeated stress in a sample of mothers of individuals with diagnosed schizophrenia. In this setting, the specialised support and the personal autonomy of the offspring receiving care seem to play a role in the caregiver's response.

Care giving is a highly stressed situation especially when it is prolonged and the individual receiving care is an offspring who is losing functionality and autonomy. In this context, psychosocial stressors in the laboratory settings are a useful tool to examine the effect of chronic stress on rest levels and, from a dynamic point of view, response to an acute bout of stress. In the present study, the total sample displayed a significant reactivity of HR and BP to both bouts of stress. The stress stimuli used was efficient for eliciting endocrine response in previous studies (Kirschbaum et al., 1993), as well as cardiovascular changes in caregivers (Caccioppo et al., 2000; Lucini et al., 2008; Monin et al., 2010). Minor variations in the standard stressor have been applied with respect to the topic of the speech (specific or general stressor) and no significant differences for this aspect were found, contrary to results reported by Monin et al. (2010). Other aspects such as institutional healthcare support and the arithmetic task, common to both types of stress, could have overlapping effects on cardiovascular and psychological variables.

With regards to mood, acute psychosocial stress efficiently produces increases in negative mood scores in

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Table 2. *Average and SD of BP and state-anxiety and mood scales before and after both tasks in the groups of CARE+ and CARE–*

	CARE–				CARE+			
	Pre-task 1	After task 1	Pre-task 2	After task 2	Pre-task 1	After task 1	Pre-task 2	After task 2
Systolic blood pressure								
Levels	13.39(1.83)	13.75 (2.73)	13.75 (2.24)	14.17 (2.13)	14.93 (2.12)	14.95 (1.89)	14.68 (2.08)	15.18 (2.36)
Changes	0.36(0.90)		0.43 (0.11)		0.02 (0.23)		0.50 (0.28)	
Diastolic blood pressure								
Levels	8.59(3.30)	8.09 (1.23)	7.89 (0.84)	8.27 (0.98)	8.20 (1.02)	8.47 (0.87)	8.33 (0.82)	8.62 (0.93)
Changes	−0.50(2.07)		0.38 (0.14)		0.28 (0.15)		0.29 (0.11)	
State-anxiety								
Levels	21.50(9.65)	17.20 (6.70)	–	14.80 (4.82)	16.25 (12.69)	16.50 (11.30)	–	14.81 (10.05)
Changes	−3.91(2.95)		−2.40 (1.88)		0.25 (1.39)		−1.69 (1.25)	
Depression								
Levels	5.10(6.73)	3.80 (5.37)	–	3.00 (4.56)	2.56 (4.03)	2.25 (2.77)	–	2.06 (2.89)
Changes	−1.18(1.36)		−0.73 (0.81)		−0.31 (1.26)		−0.19 (0.12)	
Fatigue								
Levels	4.80(4.66)	1.80 (2.42)	–	1.30 (1.33)	4.06 (5.20)	4.06 (4.52)	–	3.00 (3.95)
Changes	−2.82(2.24)		−0.45 (1.09)		0.00 (0.68)		−1.06 (0.57)	
Tension-anxiety								
Levels	4.50(3.57)	2.90 (2.28)	–	2.30 (1.78)	3.88 (5.66)	4.13 (5.51)	–	3.38 (4.11)
Changes	−1.45(1.29)		−0.55 (0.50)		0.25 (0.15)		−0.75 (1.40)	
Anger								
Levels	1.50(2.34)	0.40 (0.92)	–	0.10 (0.30)	1.50 (4.07)	1.94 (4.39)	–	1.75 (4.42)
Changes	−1.00(1.42)		−0.27 (0.62)		0.44 (0.32)		−0.19 (0.03)	
Vigor								
Levels	10.40(5.61)	11.60 (5.82)	–	10.90 (6.21)	12.38 (5.07)	12.19 (5.26)	–	11.94 (5.97)
Changes	1.27(0.21)		−0.64 (0.39)		−0.19 (0.19)		−0.25 (0.71)	

healthy individuals (González-Bono, Moya-Albiol et al., 2002; González-Bono, Rohleder, Hellhammer, Salvador, & Kirschbaum, 2002). Surprisingly, a decrease of state-anxiety and fatigue were observed in the total sample during the second stressor applied in this study. One reason that may explain these results would be related to the experimental procedure itself. Once the novelty effect of the first stressor has been overcome, the opportunity to relate personal experience may have had a therapeutic effect on mood in the second bout of stress, as it has been described in trans-cultural and clinical contexts (Baikie & Wilhelm, 2005).

Higher HR levels in the baseline of the CARE- group have been found in comparison with the supported group of caregivers. Higher resting HR in caregivers with respect to controls was previously reported in samples of a similar age and younger than the sample in this study, suggesting a high tonic sympathetic activation (Cacioppo et al., 2000; Lucini et al., 2008). The range of resting HR in the CARE+ group is similar to that reported in older women caregivers (Cacioppo et al., 2000), but the CARE- group presents significantly higher levels than the other caregivers, suggesting that the variability of the resting levels of this population can be modulated by the conditions under which care is given.

Furthermore, after controlling resting levels, the CARE- group still showed a buffered HR response to stress which contrasted with the response to the task presented by the CARE+ group. The supported group of caregivers showed higher HR levels during tasks than in baselines and showed significant decreases in the post-task periods that reach rest levels. This pattern of responses has been previously reported in supported caregivers of dementia patients in comparison with controls; and it has been interpreted as an increase of activity in the sympathetic system (Cacioppo et al., 2000). However, the CARE- group of similar age did not show a significant response to tasks. This buffered response has been previously reported in other unbalanced states improved by chronic stress such as the more symptomatic patients of post-traumatic stress disorder (McTeague et al., 2009), and in caregivers of cancer patients (Lucini et al., 2008). Unfortunately, no studies about the effect of institutional support of patients on their caregivers are available to compare these results and further research is needed on this issue.

With regards to mood, only anger and fatigue scores showed subtle differences between both groups of caregivers, with decreases in the non-supported group.

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The beneficial effects of speech on mood were therefore restricted to this latter group. However, no significant relationships were found between these psychological scores and HR response. Relationships between both types of variables have been found in the case of DBP changes, despite of the fact that these changes do not show significant differences between CARE+ and CARE- groups. Thus, the role of mood dimensions in cardiovascular differences between groups has been considered with caution.

Other factors have to be considered in the present results. Firstly, both CARE+ and CARE- were taking care of their offspring during a similar period (13-14 years), and this is substantially longer than the caring periods in other studies. This may be a relevant factor in enhancing the comparability among studies of this population. In fact, significant relationships have been found between HR levels and the number of years spent caring. Secondly, as the CARE- group did not enjoy specialised support out of the home, the group was forced to spend more time giving care than the others because the patients were less functional. This makes it difficult to determine to what extent the observed differences are due to the lack of institutionalisation, time devoted to care, or the severity of the care recipient. Although the effect of time giving care and symptoms of the offspring also differed between groups, an examination has been made of cardiovascular variables and it seems that the groups do not significantly explain the HR variance. The severity of schizophrenia has been a relevant aspect in the variability of other physiological parameters that are more frequently associated with chronic stressful settings, such as cortisol awakening response in larger samples of caregivers (Gonzalez-Bono, De Andres-Garcia, & Moya-Albiol, 2011). Thus, discarding the symptoms of the care recipient on caregivers' health can be adventurous. Since a significant relationship between the weekly time spent giving care and positive symptoms of the offspring is found, the characteristics of the illness can explain, at least in part, the variability in cardiovascular levels. Results suggest that weekly time spent giving care is more relevant on BP variations than the institutional support itself, since this variable significantly explains BP variance without differences between groups. Further research is needed with larger samples to determine the potential role of these aspects on the cardiovascular response in caregivers. Thirdly, intrinsic variables among the caregivers such as age or gender cannot be discarded as relevant in terms of allostatic load, apart from trans-cultural and racial differences previously described (Horwitz et al, 2009; von Känel et al., 2008). Finally, autonomic response to stress may therefore have a component of heritability, since first-degree relatives of schizophrenia patients exhibit an abnormal pattern of protracted response to mental arithmetic stress, though less intense than that observed in patients (Castro et al., 2009).

No significant differences between groups have been found in personality traits examined in the present study. However, trait dimensions such as anxiety and coping seem to be involved in HR response in the total sample of caregivers. For anxiety, more anxious caregivers present lower HR recovery, in agreement with previous results found in young healthy women (Gonzalez-Bono et al., 2002a). For coping styles, passive styles have been positively associated with HR levels while active coping was positively associated with HR reactivity. These results are in agreement with those previously reported about positive associations between active coping and enhanced HR response (Pico-Alfonso et al., 2007).

The number of life events is positively related to DBP changes during the second stressor. Moreover, enhanced reactivity of BP has been non-homogenously associated with chronic negative stress in adolescents (Low et al., 2009). As the result is based on correlations with a discrete sample, conclusions cannot be extracted. Moreover, the fact that BP was assessed after the recovery period limits interpretation in terms of task reactivity. Future research considering the perception of life events, as well as their number, could shed light on this issue. Furthermore, the majority of associations between psychological state variations, personality traits, and life events were found with cardiovascular responses during the second stressor. These results suggest that the role of psychological variables on cardiovascular changes can become more relevant when stressful stimuli are repeated after a single stress episode. Finally, perceived cardiovascular complaints have been evaluated in the present study with no differences between groups and they were not related to cardiovascular parameters. It is possible that other psychological factors such as hypochondriac tendencies or social support, among others, could be mediating the health complaints in a higher degree than the stress-induced cardiovascular response itself. However, data regarding the present study does elucidate this issue, and a more exhaustive examination is necessary.

In summary, preliminary data suggests that specialised support can provide beneficial effects, not only on patient functionality, but also on the way in which caregivers cope with stress and, in turn, on their cardiovascular balance. However, care giving settings are complex and situational and personality factors have to be considered in studies with larger samples of this at-risk population to clarify individual differences, favour comparability between results reported in cardiovascular stress responses, and help prevent high levels of health risks.

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