

## **Psychophysiological effects of human-dog interaction in university students exposed to a stress-induced situation using the Trier Social Stress Test (TSST).**

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Enjoying the company of a good-natured dog can lend support to a person in a stressful situation. This presence brings benefits across different areas of human well-being and leads to a decrease in levels of sympathetic activation and subjective distress which are triggered in social anxiety situations. This study seeks to provide evidence of these benefits relative to physiological variables—heart rate and blood pressure—as well as a subjective variable, namely anxiety. Thirty-six university students (80% female,  $M=22.4$ ,  $SD=4,32$ ) exposed to a stress-induced situation using the Trier Social Stress Test (TSST) participated in the study. This type of scenario produces an increase in heart rate, blood pressure, and subjective anxiety levels. The decline in these variable levels was assessed based on whether the participants were alone or accompanied by a friendly dog. Through random selection, half of the students could pet the animal during the stress-induced phase (experimental group), whereas the other half had a toy dog to hold (control group). The levels of all three dependent variables were recorded at three different stages: the pretest relaxation phase, the stress- and anxiety-induced test phase, and the relaxation or return-to-calm posttest phase. The results revealed that the dog's presence during the test phase considerably reduced the levels of anxiety and heart rate experienced by the experimental group participants compared to the control group. No significant differences in blood pressure were observed between both groups during this phase. The results of this research coincide with earlier studies that report on the beneficial effects of human–animal interaction, while highlighting the importance of analyzing this interaction in the field of psychology.

*Keywords:* Dog, Human–animal interaction, Social anxiety, Stress, TSST

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Scientific evidence compiled in recent decades suggests that people and dogs have shared an ecological niche for 15,000 years across three different environments: Europe, Southeast Asia, and the Midwest region of the North American subcontinent (Yilmaz, 2017). Yet this does not rule out socialization that is simultaneous and subject to processes independent of one another. In 1941, fossil remains from a canine burial were found in Bonn-Oberkassel (Germany). It is estimated that these remains date back 14,000 years and reflect the importance of the human–pet bond in the funerary act (Janssens et al., 2016).

Attempts have been made to explain why people form bonds with non-human animals and vice versa through various theoretical proposals. Attachment theory (Bowlby, 1982) emphasizes the importance of attachment and caregiving behavioral systems. Attachment is an innate system that involves early bonding between the offspring and their caregiver(s), and serves an adaptive function in fearful or dangerous situations. This system is characterized by a lasting attraction toward the attachment figure. The caregiving system is a complementary system which sees the caregiver direct their behavior toward providing care and protection. Both systems clearly show the natural need for affiliation that people seek with other human beings and animals via behavioral patterns aimed at building cohesion with others. For its part, the biophilia hypothesis (Wilson, 1984) argues that people have an innate interest in other forms of life, which drives us to connect with other living organisms. As people we pay selective attention to—and interactive with—other types of life, actions which can impact significantly on our knowledge, health, and well-being. The presence of some animals represents a sense of security in people, and this is frequently accompanied by a sense of calm. It is apparent that this bond is the fruit of learning (Brickel, 1979), yet

cruelty to animals can also fall under this description.

According to the above author, the basic learning processes that initially take place at the heart of the family teach us how to connect with non-human animals. Principally, these are classical conditioning, operant conditioning, and observational learning processes. Lastly, social support theory (Beck & Katcher, 2003) maintains that social support is a set of human and material resources that people and groups have at their disposal to carry out their life project and which help them to overcome the difficulties and problems that life entails. Contact with a dog provides emotional support, love, acceptance, physical contact, and company to humans, which contributes to their physical and psychological well-being. It is proven that animals are also a source of social support, as demonstrated by the number of Americans who consider their pet “a member of the family”, talking to their pet as if they were a person and treating them like a trusted confidant (Cain, 1983). Pets also increase the frequency of human social support (Eddy, Hart, & Boltz, 1988). More recently, and from a psychobiological point of view, research has opted to address the human–animal bond as a result of a neurobiological process (Nagasawa et al., 2015). However, it is widely agreed that we as humans gain numerous benefits from interaction with animals and their company (Beetz, Julius, Turner, & Kotrschal, 2012; Beetz et al., 2011; Julius, Beetz, Kotrschal, Turner, & Uvnäs-Moberg, 2012; Silcox & Reed, 2014). These gains can be grouped into three categories: physiological, psychosocial, and psychophysiological.

In terms of physiological gains, pet companionship is related to a lower risk of cardiovascular disease, including obesity and high blood pressure (Levine et al., 2013). People with household animals exhibit lower blood pressure and heart rate levels (Virués-Ortega & Buéla-Casal,

2006). In one study, Friedman, Katcher, Thomas, Lynch, and Messent (1983) reported a fall in blood pressure among children accompanied by a dog when taking a stressful test (reading out loud) compared with the control group. Similarly, Jenkins (1986) observed how systolic and diastolic blood pressure in dog owners dropped when joined by their pets during a reading out-loud task.

As for psychosocial gains, pets act as social catalysts, promoting social cohesion, cooperation, and contact among people (Gutiérrez, Granados, & Piar, 2007). According to González-Ramírez, and Hernández (2011), owners who perceived their pets as members of the family showed significantly lower perceived stress levels compared with those who viewed their pets as guardians of the home.

Psychophysiologically, animals trigger an immediate state of relaxation just by merely capturing our attention. It is believed that they calm and reduce human stress in the short-term (O’Haire, 2010). People report feeling less alone around their pets, more useful, and with enhanced self-esteem (Wheeler & Faulkner, 2015).

Research on human-animal interaction has shown that a brief contact with a dog, especially when dealing with a pet, relaxes people and brings down their stress levels (Allen, Blascovich, Tomaka, & Kelsey, 1991). Regarding the concept of stress, Selye (1936) defined it as a reaction that gives us the necessary energy to successfully respond to environmental demands. Decades later, Lazarus and Folkman (1984) explained how events do not affect us directly. Rather, our interpretation of them is what has an impact. Ursin and Eriksen (2010) hold a similar view. They claim that the expectations we form about these events will determine the perceived stress. More modern definitions, including that provided by Echeburúa (2016), view stress as a question of environmental demands

and the resources that a person has to face up to these challenges.

The present study focuses on the emotional stress that arises in situations where conflictive social interaction comes into play. This can trigger various pathologies depending on the individual’s genetic predisposition, their own experiences, and the environment in which they interact with other individuals (Molina-Jiménez, Gutiérrez-García, Hernández-Domínguez, & Contreras, 2008). Speaking in public is an example of a social interaction situation that has seen a sharp increase in a person’s stress level. When performing this task, increased heart rate, breathing rate, electrodermal activity, muscle tension, and cortisol levels—among other psychophysiological variables—can be observed (Moya-Albiol & Salvador, 2001).

The resident–intruder paradigm is frequently used in the field of animal research to measure psychosocial stress. It involves exposing an individual to high demands up against their peers. The social defeat inflicted on the person who fails to complete the tasks successfully is a severe stressor. Availing of social support under these circumstances has a positive effect on health (Zarghani, Nazari, Shayeghian, & Shahmohammadi, 2016). Furthermore, this support is one of the most effective methods for tackling stress as it lessens the stressful experience (Sandín, 2008).

Today, scientific evidence points to a friendly dog as a figure capable of providing support in the previously mentioned situations (Nagasawa, Kikusui, Onaka, & Ohta, 2009). It is for this reason that its presence in therapy-based interventions has increased (for a review of the situation in Spain, see Martos-Montes, Ordóñez-Pérez, De la Fuente-Hidalgo, Martos-Luque, & García-Viedma, 2015). The beneficial role of a friendly dog in stressful situations has been demonstrated in research studies that use the Trier Social Stress Test (TSST) protocol designed by Kirschbaum, Pirke,

and Hellhammer (1993). The TSST is an experimental stress-inducing protocol that enables psychophysiological variables to be measured in a controlled manner. In this case, it allows us to empirically study how we as people can harness the benefits that human–animal interaction offers when up against a stressful social situation. This protocol may be modified depending on the aim and resources of each research study.

Various research studies have demonstrated the social support that dogs provide using the TSST protocol. According to Allen (2003), family dogs reduce the physiological indicators of stress, which is widely known as the “pet effect”. This was proven in a study involving 45 women who experienced work-related stress. Performing a task similar to the TSST protocol, participants accompanied by their pet perceived the task as less stressful than participants joined by their closest friend (Allen et al., 1991).

In a similar study, 294 university students were administered the TSST protocol. They were randomly assigned to three experimental conditions: performing the task in the company of a dog they did not know, in the company of a friend, and alone. The results showed lower levels in the cortisol and heart rate variables for the group that had contact with the dog, but not in anxiety levels (Polheber & Matchock, 2013). Wheeler and Faulkner (2015) applied this protocol to a similar sample of 223 university students with or without the presence of a dog. In this case, the experimental group exhibited a significant reduction in state anxiety, heart rate, and blood pressure level.

Another noteworthy example is a study involving children with separation anxiety. An adapted version of the TSST protocol was used, namely the Trier Social Stress Test for Children (TSST-C). Forty-seven children were randomly assigned to three conditions: in the presence of a therapy-dog, a toy dog, or a friendly

human. According to the results, a dog’s companionship was interpreted as the most beneficial (Beetz, Julius, Turner, & Kotrschal, 2012).

A more recent study (Fiocco & Hunse, 2017) also suggests that interacting with a therapy dog may buffer the stress response in university students exposed to a stressful situation through the “Paced Auditory Serial-Addition Test” (PASAT) protocol (Tombaugh, 2006). In this study, the exposure to a brief dog-assisted therapy significantly reduced the participants’ electrodermal activity compared to a control group without such exposure. Similarly, Wood, Ohlsen, Thompson, Hulin, and Knowles (2018), exposed 131 university students to a single 15-minutes interaction with a dog, showing a significant reduction in state anxiety levels and blood pressure immediately after the intervention.

In reference to the Wheeler and Faulkner’s (2015) study, those participants who presented high trait-anxiety levels experienced a significant decrease in the previously mentioned variables following interaction with a dog by applying the TSST protocol. The present study seeks to analyze the potential beneficial effects that human–animal interaction has on three variables: state anxiety, heart rate, and blood pressure (systolic and diastolic). In this case, participants are classified according to their state-anxiety levels and not their trait-anxiety ones. In fact, the focus is on establishing the one-off effect that a brief animal interaction can exercise in a stressful situation. To this end, a social stress-induced situation was created using the TSST protocol. Participants were divided into two groups: an experimental group (dog) and a control group (toy dog). The working hypothesis is as follows: The experimental group’s interaction with the dog should mitigate any social stress increases in the dependent measures. Confirming this hypothesis, the results would contribute new evidence to the scientific field with regards to the benefits

that human–animal interaction can bring people as a buffer against stress to improve well-being and quality of life.

### Method

#### *Participants*

Thirty-six students (N=36) studying a Degree in Psychology at the University of Jaén, Spain, participated in the study. Thirty were women and their ages ranged from 19 to 44 years (M=22.4, SD=4.32). Participants were rewarded with course credit for their participation and had no experience with the task before starting the experiment. Their participation was voluntary and an informed consent was sought from all the participants. This experimental study was approved by ethics committee of the University of Jaén.

Prior to study commencement, an email was sent to all possible participants requesting that they answer an online questionnaire designed to assess personal aspects that could influence the study. These aspects included hours of sleep, lifestyle habits (sedentary/physically active), tobacco use or drug treatment, as well as attitudes toward animals and, especially, toward dogs. The goal was to make sure that no participants had any heart-related illnesses or a dog allergy or phobia. The resulting sample was randomly selected for two conditions. In the first scenario, the control group would complete the test holding a toy dog (n=18, 14 women and 4 men). In the second scenario, the experimental group would complete the test accompanied by a real friendly dog that they could interact with (n=18, 16 women and 2 men).

#### *Apparatus*

Heart rate was recorded using a CMS-50F wristband pulse oximeter (CONTEC™). The different pulse variations were collected wirelessly and the data were downloaded onto a computer for subsequent analysis. It has a measuring range of 30–250 bpm (beats per minute), a resolution of 1 bpm, and a heart-rate accuracy of  $\pm 2$  bpm or  $\pm 2\%$ . The use of portable devices helps to measure the

variables of interest reliably and without needing to connect to any equipment.

Blood pressure was measured using the Omron M3-HEM-7051-E automatic digital blood pressure monitor. Readings were taken at the end of each phase by wrapping the monitor around the participant's arm and writing down the different values obtained at each phase onto a record sheet. It has a reliability range of 0-299 mmHG for measuring blood pressure and a pulse frequency range of 40-80 beats per minute. It has been clinically validated in accordance with the European Society of Hypertension International Protocol (Asmar, Khabouth, Topouchian, El Feghali, & Mattar, 2010). Data on systolic and diastolic blood pressure were obtained using this device.

The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1982; adapted version to a Spanish sample) was used to measure subjective anxiety. The instrument's reliability (alpha de Cronbach) reports an internal consistency of 0.90–0.93 (State subscale) and of 0.84–0.87 (Trait subscale). The State subscale (STAI-S) was used in this study. This subscale determines the actual intensity levels of anxiety induced by stress-loaded experimental procedures.

A Fujifilm FinePix S4500 professional digital camera and a standard tripod were used to create an experimental space to simulate the recording and evaluation of the participants' performance in the social anxiety tasks.

#### *Procedure*

Sessions were spread over two weeks. They were held at the University of Jaén's psychophysiology labs. Animals were allowed to enter the labs with the established protocol in place.

The experimental procedure was an adaptation of the standard TSST protocol (Kirschbaum, Pirke, & Hellhammer, 1993), in which the participants' performance was video recorded. Participants were informed that faculty staff would later assess them, thus lending

more credibility to the tasks (Birkett, 2011). This procedure achieves results comparable to those obtained with people actually present in the room (Kelly, Matheson, Martinez, Merali, & Anisman, 2007).

The total duration of each session was 50 minutes. Each session was distributed over three phases: pretest (15 min), test (20 min), and posttest or recovery period (15 min). Both the control group and the experimental group underwent the entire procedure following the same phases and the same cognitive tasks.

*Pretest phase (Relaxation period).*

On the day of their appointment, the participants arrived individually to the laboratory where they were met by the experimenter. This individual handed out the informed consent form which included authorization for taking photos and videos for the purpose of lending credibility to the experimental scenario. Once this was done, the participants sat comfortably in front of the computer screen and watched a relaxing 10-min video designed to lower their activation state (Helland, 2016). On completion of this phase, the participants filled in the STAI-S questionnaire and their heart rate and blood pressure were recorded. These readings were used to establish the baseline of each individual for reference.

*Test phase (Experimental phase).*

For this phase the participants moved to an adjacent room. Inside was a chair where they would take a seat and a camera in front of them which would record their performance on both tasks: a spoken task and a mental arithmetic task. The instructions provided were as follows:

*“The first task you have to complete is a short speech for a job interview. Before starting your presentation, you have five minutes to mentally prepare a speech in which you describe in detail why you would be the best candidate for your ideal job. You have some blank pieces of paper and a pen*

*should you wish to take some notes or draw diagrams to help organize your speech. However, you will not be able to use these notes later”.*

The experimenter left the room and this 5-min interval served as a pre-stress phase, a key step according to the first version of the TSST protocol (Kirschbaum, Pirke, & Hellhammer, 1993). Once this interval had elapsed, the experimenter entered the room again and relayed the following information:

*“We’re going to begin the task. Your responses will be recorded using the camera in front of you and you must talk in its direction. The recording of your intervention will be analyzed by faculty staff heading this research. Your time starts now”.*

The experimenter left the room again. Once the first task was completed (10-min speech), the participants moved immediately onto the second task with no rest period. The experimenter entered the room and gave the following instructions:

*“The second task requires you to mentally continue a sequence of numbers. Starting from the number 1022, you must subtract 13 each time. You must give your answers out loud and if you make a mistake you must go back to the beginning, to the first number. Your time starts now.”*

The researcher remained in the room. If the participants made a mistake, the researcher stopped them and they would go back to the start. It was important that the experimenter have a sheet of paper at hand with the correct series of numbers written down in order to correct the mistakes as they happened. Nobody managed to complete the task within the allocated time.

Once both tasks were over, participants were asked to repeat the STAI-S questionnaire and their heart rate and blood pressure were recorded.

During this phase, the experimental group performed each task in the presence of a friendly dog and their carer (handler). The participants were informed that they

could freely interact with the dog, stroking and petting it. The dog was positioned close to the participants' lap to facilitate interaction during the tasks. In the case of the control group, the participants were given a toy dog which they could hold during the tasks.

The participating dog was an eight-year-old friendly and trustworthy Golden Retriever, in order to promote a more fluid social interaction with it. The animal was up to date on its vaccinations and had undergone a thorough veterinary checkup, adhering to a complete animal health protocol in order to ensure the dog's and the participants' health. An animal welfare protocol was drawn up to safeguard the dog's comfort. Several aspects were taken into account, including fatigue. The sessions were spread across two weeks (Week 1=7 sessions, Week 2=11 sessions), with a minimum rest period of 40 minutes and a maximum rest period of 60 minutes between sessions. The dog was always assisted by its handler (owner) who closely monitored the dog's well-being and behavior adapted to the requirements of the interaction protocol.

*Posttest phase (Return to calm).* Next, the pulse oximeter was removed and the participants were accompanied to the starting room. They were told that the tasks were over and that they would now watch the relaxation video again. Once that was done they were given the STAI-S questionnaire to complete for the last time. Their heart rate and blood pressure were recorded.

#### *Data Analysis and Dependent Measures*

A mixed factorial experimental design was used. The experiment conditions (experimental group and control group) and the time points that make up the study's experimental protocol (pretest, test, and posttest) were the factors identified. The first factor had two levels with between-group manipulation. The second factor had three levels with within-subject manipulation. The study's dependent variables were anxiety level,

heart rate, and blood pressure levels (systolic and diastolic). These dependent variables were evaluated at the three time points: pretest, test, and posttest. The SPSS (version 22) statistical software was used for data analysis with a significance level set at 0.05.

#### **Results**

Table 1 shows the means and standard deviations of both groups (control and experimental) at each study phase (pretest, test, and posttest) for each dependent variable.

*State anxiety:* The mixed factorial Group x Phases analysis of variance (ANOVA) performed on the dependent variable State anxiety showed a significant main effect for the variable Phases,  $F(2,68) = 43.236$ ,  $p < .000$ . The same occurred in the interaction Group x Phases,  $F(2,68) = 3.951$ ,  $p < .024$ . The Group factor was not significant,  $F(1,34) = 2.803$ ,  $p < .103$ . An analysis of the Group x Phases interaction in this study prompted the testing of the Group effect at each phase. To achieve this, the independent-samples t-test was used and the analyses revealed no between-group differences at pretest,  $t(34) = -.65$ ,  $p < .543$ ,  $d = 0.21$  (Cohen's  $d$  for effect size). Nor were there differences at posttest,  $t(34) = 1.528$ ,  $p < .136$ ,  $d = 0.51$ . The between differences were observed at the test phase,  $t(34) = 2.161$ ,  $p < .038$ ,  $d = 0.72$ . State-anxiety levels were lower in the experimental group compared to the control group (see you Figure 1).

The Phases variable was significant for each group. Both groups' anxiety levels were higher at test compared to the other phases. Specifically, the control group yielded a significant effect for the Phases variable,  $F(2,34) = 34.139$ ,  $p < .000$ . These data revealed a significant quadratic trend component,  $F(1,17) = 40.020$ ,  $p < .000$ . A significant effect was also observed in the experimental group for the Phases variable,  $F(2,34) = 12.260$ ,  $p < .000$ ; the quadratic trend component was also significant,  $F(1,17) = 20.365$ ,  $p < .000$ .

Table 1.  
*Descriptive statistics*

	Group	M	SD
STAI-S_Prestest	C	11.89	5.476
	E	13.06	5.896
STAI-S_Test	C	28.83	9.593
	E	21.56	10.590
STAI-S_Posttest	C	15.44	5.913
	E	12.22	6.717
Heart rate_Prestest	C	75.722	10.4758
	E	74.778	10.0268
Heart rate_Test	C	96.944	12.4195
	E	89.044	11.2445
Heart rate_Posttest	C	77.500	10.6177
	E	72.000	7.9410
Systolic BP_Prestest	C	107.17	8.645
	E	109.39	6.260
Systolic BP_Test	C	109.32	26.867
	E	111.39	8.008
Systolic BP_Posttest	C	105.83	8.082
	E	105.11	5.860
Diastolic BP_Prestest	C	64.44	7.188
	E	64.44	6.233
Diastolic BP_Test	C	67.11	12.03
	E	66.89	6.738
Diastolic BP_Posttest	C	63.83	10.428
	E	63.94	6.384

*Note:* Descriptive statistics (Mean [M] and Standard deviation [SD]) for each group (Control [C] and Experimental [E]) across the different study phases (Prestest, Test, and Posttest) for each dependent variable (State anxiety [STAI-S], Heart rate, Systolic blood pressure, and Diastolic blood pressure).

*Heart rate:* The analysis of variance (ANOVA) performed on the dependent variable Heart rate showed a significant main effect for the variable Phases,  $F(2,68) = 109.299$ ,  $p < .000$ . The same occurred with the Group x Phases interaction,  $F(2,68) = 3.158$ ,  $p < .049$ . The Group factor was not significant,  $F(1,34) = 2.354$ ,  $p < .134$ . An analysis of the Group x Phases interaction, which used the

independent-samples t-test, revealed no significant differences at pretest,  $t(34) = .276$ ,  $p < .784$ ,  $d = 0.09$ , or posttest,  $t(34) = 1.760$ ,  $p < .087$ ,  $d = 0.59$ . Differences were found at the test phase,  $t(34) = 2.041$ ,  $p < .050$ ,  $d = 0.67$ . The average heart rate in the experimental group was lower compared to the control group (see you [Figure 2](#)).

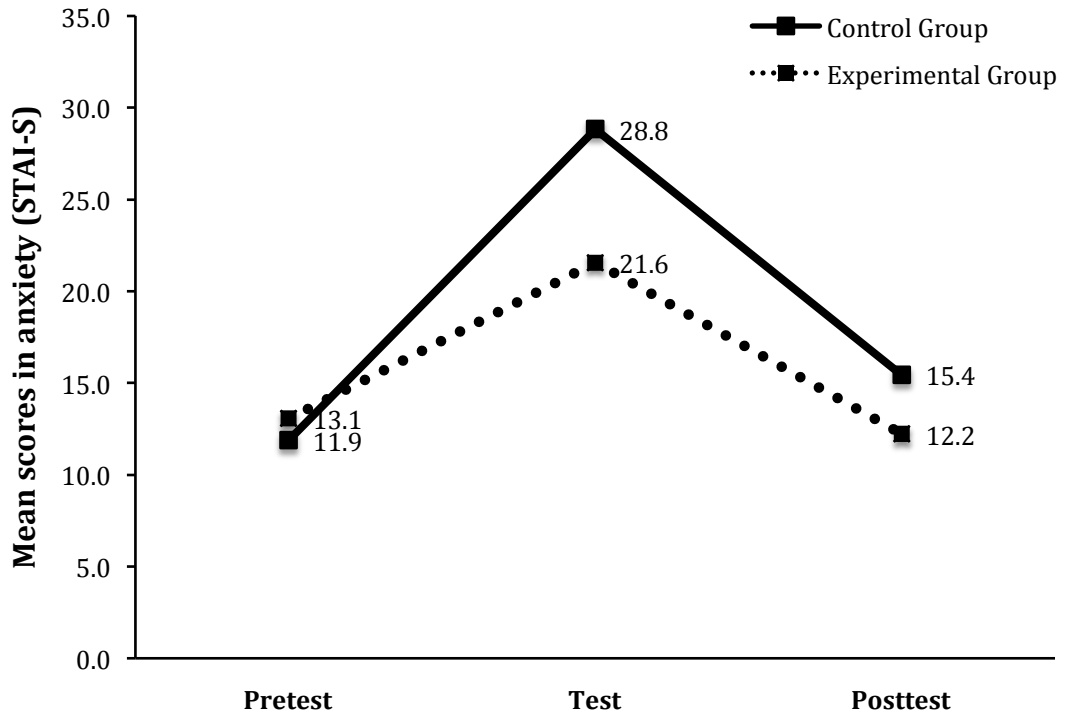


Figure 1. Mean values of state anxiety across the three phases (Pretest, Test, and Posttest) for each group.

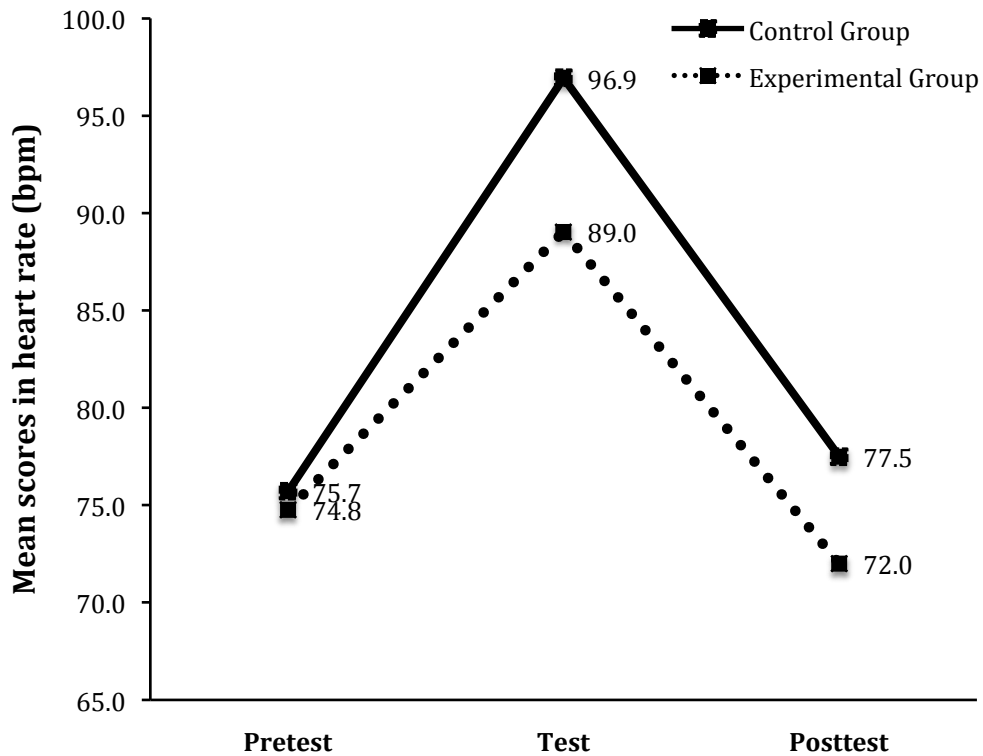


Figure 2. Mean values of heart rate (beats/min) across the three phases (Pretest, Test, and Posttest) for each group.

The Phases variable was significant for each group in the effects analysis. Both groups’ heart rate was higher at test compared to the other phases. The control group yielded a significant effect,  $F(2,34) = 63.217, p < .000$ . These data revealed a significant quadratic trend component,  $F(1,17) = 100.766, p < .000$ . A significant effect was also observed in the experimental group for the variable Phases,  $F(2,34) = 47.522, p < .000$ , with a significant quadratic trend component,  $F(1,17) = 75.708, p < .000$ .

*Systolic blood pressure:* The corresponding analysis of variance (ANOVA) for this variable showed no significant effect in the Group variable,  $F(1,34) = .244, p < .625$ , nor in Phases,  $F(2,68) = 1.260, p < .290$ , or in the interaction between both variables,  $F(2,68) = .144, p < .866$ .

*Diastolic blood pressure.* The corresponding analysis of variance (ANOVA) for this variable showed no significant effect in the Group variable,  $F(1,34) = 0.000, p < .987$ , nor in Phases,

$F(2,68) = 2,565, p < .084$ , or in the interaction between both variables,  $F(2,68) = 0.007, p < .993$ .

**Discussion and conclusions**

The results of this study partially support the posed hypothesis. The experimental group’s interaction with the dog would mitigate the participants’ stress levels compared to the control group’s interaction with the toy dog. Indeed, the participants in contact with the real dog showed lower levels of perceived anxiety and heart rate. In fact, the experimental group participants reported feeling less worried and nervous compared with their control group peers. The effect sizes were considerable in both dependent measures (state anxiety and heart rate; Cohen’s  $d$  was 0,72 and 0,67, respectively), what encourages us to continue with this promising research project. However, no significant differences were found between the groups in terms of systolic and diastolic blood pressure.

These results are similar to those obtained by Wheeler and Faulkner (2015).

Interacting with a dog while undertaking the TSST protocol significantly reduced the participants' degree of subjective anxiety compared to the group that did not avail of the dog's company. They also coincide with the results reported by Beetz et al. (2012). In this study, children with insecure attachment toward their parents largely benefited from a dog's company compared to the other groups when they took the adapted TSST test. This lends support to the idea that a dog can be a figure capable of providing psychophysiological benefits in stressful situations. In turn, and compared to the classical study proposed by Allen et al. (1991), no equivalent results were found for systolic and diastolic blood pressure. In this research, the experimental group showed significantly lower values than those of the other groups. Women who interacted with a dog exhibited lower stress levels compared to the group that remained alone or interacted with a friend. A possible explanation behind this difference could lie in the participants' degree of closeness with the dog. In their study, the participants completed the test joined by their own pet. However, the dog in the current study was unknown to the participants.

The results of this study also show differences and similarities to Polheber and Matchock's (2013) study, in which 294 university students engaged in the TSST protocol. The presence of a dog was compared to that of a friend or being alone. This research focused on identifying which type of company reports greater perceived (state anxiety) and psychophysiological (heart rate and cortisol level reduction) benefits. In this case, the presence of a dog reduced heart rate levels but not anxiety levels. This reaffirms that an animal's company can exert a positive effect on heart rate. Similar results were reported by Fiocco and Hunse (2017), who found that the presence of a dog significantly reduced the strength of the physiological stress

response (electrodermal activity) when exposed to a subsequent stressor. Additionally, the results of the current study do show also significant differences between both groups for perceived anxiety. The group that had the opportunity to interact with the dog reported lower state-anxiety levels. Grajfoner, Harte, Potter, and McGuigan (2017) demonstrated similar results. These authors confirmed that human-dog interaction reduces perceived anxiety levels. This positively impacts on a person's well-being and mood.

In short, the results partially support the hypotheses put forward. The animal's presence mitigated perceived anxiety and heart rate in a social stress situation (TSST). However, it did not have a significant effect on the measures of systolic and diastolic blood pressure. This allows us to suggest that the presence of a friendly dog has calming and dampening effects on social stress. Comparing these results with those of other studies which have introduced dogs that habitually live with the participants (pets) suggests that the effects can be strengthened further (Odendaal, 2000). Moreover, it would be interesting to allow the dog and participant more time to interact before entering the stressful situation. In line with Lass-Hennemann, Peyk, Streb, Holz, and Michael (2014), it is crucial to consider the type of contact that must be established between the participants and the dog to lessen the psychophysiological variables. As present study used a friendly dog, and not the participant's pet, more research will be necessary to analyse whether present results could be modulated by the type or the intensity of the human-animal bond.

Conneely and Hughes (2010) argue that the participation of university students in research studies is extremely useful when it comes to studying stress and anxiety. However, it would be desirable to use a wider sample that guarantees the confidentiality of the tasks included in the

study. Another limitation to consider when interpreting these results could be sample size. If the number of participants per group is not very large, this can represent a limitation (Ato, López, & Banevente, 2013). This could explain why in the study of Wood et al. (2018) with 131 university students both the reduction of state anxiety and blood pressure were statistically significant. Similar results were found by Wheeler and Faulkner (2015) with 223 university students with respect to measurements of anxiety, heart rate, and blood pressure level. However, differences in the intensity of the stressful situation could not explain the lack of stress effects on blood pressure obtained in the present experiment, since an effect of dog interaction on this measure has been shown in previous studies with similar samples and experimental conditions (Wheeler & Faulkner, 2015; Wood et al., 2018).

In order to make improvements to the design of research studies that implement the TSST protocol, it would be interesting to add a group in which the participants were alone (no dog or toy dog). It would also be desirable to include other variables that might be related to

human–animal interaction and the manifestations of stress; for example, cortisol levels (Barker, Knisely, McCain, & Best, 2005; Beetz et al., 2011) and oxytocin levels (Handlin, Nilsson, Ejdebäck, Hydbring-Sandberg, & Uvnäs-Moberg, 2012; Miller et al., 2009; Nagasawa et al., 2009).

To summarize, the results obtained are partially comparable to those achieved in previously conducted research (Beetz et al., 2012; Polheber & Matchock, 2013; Wheeler & Faulkner, 2015). A decrease in state anxiety and heart rate was observed in people who had the opportunity to interact with the friendly dog during the TSST protocol. Yet the results of this study are not comparable to earlier ones in which the animal's presence also had a significant effect on blood pressure (Allen et al., 1991). This could be due to the previously highlighted limitations. However, we can conclude that the results observed point to dogs being a source of social support when faced with conflict situations regardless of the person's age. For this reason, we are seeing more studies attempt to demonstrate their benefits on people's health from a psychological, physiological, and social perspective.

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