The role of dogs in modulating human affective reactivity and sense of safety in emotional urban public spaces.

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Abstract

We aimed to examine the role of dog presence in modulating human affective reactivity and sense of safety in emotional urban public spaces. College women (n=296) assessed valence, arousal, dominance, and safety in pictures depicting a man or a woman alone or accompanied by a small- or medium-sized dog in aversive and positive contexts. The results indicated that both dog sizes produce better assessments (i.e., higher valence, dominance, and sense of safety, and lower arousal) than the alone condition in high- and low- aversive (i.e., aversive/man and aversive/woman, respectively) and low-positive (i.e., positive/man) contexts. In highly positive contexts (i.e., positive/woman), the alone condition produces a similar assessment to small-sized dogs on arousal and dominance scales and medium-sized dogs on dominance and safety scales. When comparing dog sizes, small dogs produce better assessments in most emotional contexts. Those results overall indicated that dog presence itself (regardless of dog size) affects participants' assessment in aversive and low-positive contexts; however, specific dog features such as size, rather than dog presence itself, are more important in high-positive contexts, indicating a ceiling effect. This study highlights the need to consider the emotionality of public settings when assessing the positive dog effect in scenes in which people are portrayed.

Keywords: dog, emotional reactivity, urban public spaces, sense of safety, dog sizes.

Introduction

Dogs have held a close and important relationship with humans since prehistoric times (Radovanović, 1999; Perri et al., 2019). This human-dog interaction is a product of our coevolution with animals that was crucial to human evolution, e.g., they assisted humans with transport, hunting, and protection from other animals (Fogg et al., 2015). Despite this commensalism, some authors have stressed that dogs were also domesticated for their special role as 'companion' animals (Messent and Serpell, 1981; Serpell, 1986; 1995; Beck et al., 2000). Currently, dogs occupy a unique place in human society (Morey, 2006), given that dogs produce positive effects on the health and well-being of people of all ages (Barker and Wolen, 2008; Beetz et al., 2012).

One of the processes by which dogs influence well-being is through their role as social catalysts, given that dogs facilitate social interaction among humans; dogs increase interaction levels and nonverbal behaviors (Francis et al., 1985; McNicholas and Collis, 2000; Wells, 2004) and elicit higher rates of solicited and unsolicited helping behaviors from strangers (Guéguen and Ciccotti, 2008). In part, this effect might be based on dogs' ability to impart positive social attributes to the individuals they accompany (Wells, 2004; Guéguen and Ciccotti, 2008), e.g., dog ownership can be a signal of empathy and other emotional resources (Serpell and Paul, 2011). It has been shown that people accompanied by a dog elicit higher levels of tolerance (Lawson, 2001) and are viewed as more trustworthy (e.g., they are more often provided with phone numbers by strangers; Guéguen and Ciccotti, 2008) and likable (i.e., happier, friendlier, wealthier, and less dangerous) than individuals who are alone or with flowers (Lockwood, 1983; Rossbach and Wilson, 1992). Families with autistic children also benefit from the presence of a –service– dog, given that such dogs enhance families' social recognition and status (e.g., families received considerably more positive attention when accompanied by a dog; Burrows et al., 2008). In the same manner, the presence of a dog is beneficial in the context of therapy. For instance, Schneider and Harley (2006) examined the evaluations of psychotherapists by participants. Psychotherapists were videotaped in their own offices while introducing themselves, and describing their qualifications and approach to therapy; they were either alone or accompanied by a dog (in a calm state). The results indicated that the mere presence of dogs enhanced the therapist's image (i.e., they were assessed more favorably), thereby improving the client-therapist relationship and eliciting a stronger intent to self-disclosure.

Dog presence also influences how different types of contexts are perceived. Workplaces are perceived as more comfortable and pleasant when a dog is present (Perrine and Wells, 2006); likewise, perceptions of academic environment change when they are portrayed with a dog; college students perceived a professor's office as more comfortable when there was a dog,

compared with cats and no animals (Wells and Perrine, 2001a). Remarkably, participants' emotional reactions to scenes are influenced by the presence of a dog. For instance, dogs in workplaces seem to reduce stress (Wells and Perrine, 2001a; 2001b), and interaction with dogs in academic contexts seems to decrease cortisol levels (Pendry and Vandagriff, 2019).

Another benefit from human-dog interaction, which is frequently cited as one of the most important (Faver and Cavazos, 2008), is the increase in safety in owners at home and while out walking accompanied by a dog in the neighborhood (Cutt et al., 2008; Knight and Edwards, 2008), especially in women (Westgarth et al., 2014; Christian, Wood, et al., 2016). Dog presence not only increases the sense of safety of the person they accompany; in a recent study (Christian, Villanueva, et al., 2016), parents were provided with an increased sense of safety if their children were accompanied by the family dog while moving independently (i.e., walking alone from or to park, friends' or family house). This effect is also extended to the community, given that dog walking contributes to increased community perception of safety (Toohey and Rock, 2011). In the same way, people portrayed in scenes including a dog prompt a higher sense of safety than those portrayed without a dog (Rossbach and Wilson, 1992).

Although the presence of dogs increases the positive assessment of the environment and other people, improves emotional reactivity to scenes, and increases the sense of safety, it might partially depend upon the emotionality of the whole context (i.e., scenes and individuals who are portrayed in these contexts). For instance, dog presence specifically increases the assessment of therapists' likeability and trustworthiness in those participants who were less positive toward them (Schneider and Harley, 2006); in the same sense, dog ownership increases men's attractiveness, especially when they were previously perceived as less warm and caring (Tifferet et al., 2013). Moreover, Havener et al. (2001) found that dog presence produced a physiologically calming effect when participants found the situation especially stressful. These results were considered indicative of the ceiling effect (Schneider and Harley, 2006) and highlighted that the emotional context may modulate how dog presence affects participants. However, previous studies examined the dog-presence effect in general (i.e., without specifying the scenes; Wells and Perrine, 2001b; Knight and Edwards, 2008; Christian, Wood, et al., 2016), changing scenes (Rossbach and Wilson, 1992; McNicholas and Collis, 2000; Wells, 2004; Schneider and Harley, 2006), or in specific scenes (Wells and Perrine, 2001a; Perrine and Wells, 2006; Guéguen and Ciccotti, 2008; Tifferet et al., 2013; Pendry and Vandagriff, 2019) without considering the emotionality of the context. In other words, it is unknown whether the environment in which they assess the influence of dog presence is perceived as positive or negative by participants. Thus, it is still unclear whether the positive effect of dog presence remains regardless of the emotional level of the context.

To shed light on this field, we assessed the dog-presence effect on emotional reactivity and feeling of safety in contexts with different emotionality; a man and a woman were photographed standing alone or accompanied by a leashed dog in aversive (i.e., negative and threatening) and positive (i.e., positive and safe) scenes. We previously identified public urban contexts that were reliably assessed as aversive and positive according to previous literature that describes the main urban spaces' characteristics that modulate the sense of safety in women (Valentine, 1990; Blöbaum and Hunecke, 2005; Andrews and Gatersleben, 2010; Blom et al., 2010; Boomsma and Steg, 2014). A man and woman were portrayed in all affective scenes with a medium- or small-sized dog, which are dog sizes that prompt similar happiness, tenderness, and liking in observers (Gazzano et al., 2013). Two unpopular dogs differing in size were used to examine whether the positive dog effect is due to the dog presence itself (i.e., both sizes produce better assessment than the alone condition) or is rather due to the dog's features such size (indicating dog specificity). To the best of our knowledge, previous studies did not examine the influence of unpopular dog size in modulating the positive dog effect, even though dog size is a powerful aspect for companion dog owners (Balan et al., 2016). Emotional reactivity was assessed using the dimension of valence, arousal, and dominance (by means of the Self-Assessment Manikin/SAM scale; Bradley and Lang, 1994). While the valence dimension assesses the hedonic tone (pleasant vs. unpleasant) and reflects the motivational direction of behavior (i.e., approach towards the positive or withdrawal from the negative), the arousal dimension (relaxed vs. excited) indicates the level of activation associated with the emotional experience. According to the dominance (feeling dominated vs. feeling dominant), it is associated with the sense of control over emotion and helps to differentiate emotions under the control of the environment from those under the control of the subject. The use of the SAM scales while passively viewing pictures (see e.g., Bradley and Lang, 2007) is a widely used and robust methodology in emotion research to examine emotional cue processing. Contrary to previous studies that assess the sense of safety qualitatively using questions (see e.g., Cutt et al., 2008; Faver and Cavazos, 2008; Knight and Edwards, 2008; Christian, Villanueva, et al., 2016), we used a threatening/safe scale (TSS) that integrated well with the SAM and allowed us to assess the sense of safety using the passive viewing paradigm.

We expect that dog presence itself (regardless of dog size) will positively modulate emotional reactivity (i.e., increase valence and dominance, and decrease arousal ratings) and increase the sense of safety in aversive urban public spaces. In more positive contexts, a similar reactivity to the alone and dog presence conditions might be expected, indicating a ceiling effect. According to differences between dog sizes, although previous research indicated that medium- and small-sized dogs provoke similar emotional reactions in observers (Gazzano et al., 2013) and similarly affect people's perceptions of the work environment (Perrine and Wells,

2006), it is unknown whether they will differently affect emotional reactivity and sense of safety when modulating the emotional levels of contexts.

Materials and methods

Participants

A total of 303 female undergraduates from the University of Jaén (Andalusia, Spain) voluntarily participated in the study, receiving class credit as compensation. We excluded participants who reported visual problems (n=1), showed inconsistent responses to some images (i.e., assessing several images only on some scales; n=1) or had problems with the identification code (i.e., those that did not include the same code in the Google Form and Psychopy [Peirce et al., 2019] [n=4] or did not include any code in Psychopy [n=1]). The final sample was 296 female participants (age M= 21.28, SD= 2.74; age range from 18.3 to 45 years old). All participants provided virtual informed consent. We assessed only women since they tend to show a lower level of safety than men (Blöbaum and Hunecke, 2005; Boomsma and Steg, 2014), and they seem to benefit more (i.e., increasing sense of safety) from dog presence than men (Christian, Wood, et al., 2016). Moreover, most of the studies have pointed out that women have a significantly higher level of emotional intimacy (Holcomb et al., 1985; Gerwolls and Labott, 1994) and embraced dog companionship (Dotson and Hyatt, 2008) significantly more than men.

Materials

Stimuli

Block one. The participants viewed a total of 15 images belonging to four different categories: pleasant (n=3), neutral (n=3), and unpleasant (n=3) pictures were selected from the International Affective Picture System/IAPS[1] (Lang et al., 2008), and urban public spaces (aversive: n=3, and positive: n=3) were selected from the Library of Urban Public Spaces[2] (LUPS), a library that we created and validated in undergraduate students in a pilot study (see supplementary material). The urban space images were selected depending on their ratings on the valence, arousal, and TSS scales (Table 1).

Table 1
Ratings for image categories on each scale

[1] IAPS code for pleasant: 2045, 4697, and 5621. IAPS code for neutral: 7025, 7055, and 7950. IAPS code for unpleasant: 9163, 9341, and 9435.

[2] LUPS code for threatening: t_str2, t_park2, and t_sub1. LUPS code for secure: s_str2, s_park2, and s_parking2.

Scales	Pleasant	Neutral	Unpleasant	Aversive	Positive	*p*
Valence	7.08 (0.12)[a]	4.81 (0.07)[c]	1.45 (0.07)[e]	3.49 (0.15)[d]	6.15 (0.13)[b]	*p*<.001
Arousal	6.02 (0.15)[b]	3.49 (0.18)[c]	7.08 (0.16)[a]	6.92 (0.16)[a]	3.98 (0.17)[c]	*p*<.001
Dominance	5.84 (0.12)[ab]	5.50 (0.16)[b]	2.10 (0.12)[d]	2.57 (0.13)[c]	6.05 (0.14)[a]	*p*<.001
Threatening/safe	6.30 (0.11)[b]	5.83 (0.15)[b]	1.81 (0.09)[d]	2.43 (0.11)[c]	6.85 (0.13)[a]	*p*<.001

Notes: Letters might be interpreted in rows (equal letter means no significant difference; different letters mean significant difference). The scale definitions can be found in the assessment measures section.

The *p* values represent the results of the main effect of Category in each of the repeated ANOVAs for each scale (only for the images that were selected for the current study [three per category]). Ratings belong to the pilot study (supplementary material) with 82 subjects.

Values are presented in M (SD).

Block two. Using aversive and positive urban public spaces selected for block one as references, we created the categories shown in Table 2. We originally took photographs in the city of Jaén. The same actor (i.e., man or woman) and dogs (medium- and small-sized) were used across the pictures. Pictures belonging to the same urban space and emotional context (e.g., aversive park) were taken while maintaining the perceptual characteristics (e.g., position of the camera, distance to the camera, etc.) but changing the actors and dogs. We pictured a man and a woman to increase the variability in the emotional level of pictures, since unfamiliar men tend to be assessed as more threatening than unfamiliar women in urban public spaces (Blom et al., 2010; Roy and Bailey, 2021).

Table 2
Image categories presented in block two

Emotional context	Actor in image	Type of urban spaces
Aversive	Man walking alone	street, park, and suburb
	Man walking accompanied by a medium-sized dog	street, park, and suburb
	Man walking accompanied by a small-sized dog	street, park, and suburb
	Woman walking alone	street, park, and suburb
	Woman walking accompanied by a medium-sized dog	street, park, and suburb
	Woman walking accompanied by a small-sized dog	street, park, and suburb
Positive	Man walking alone	street, park, and parking
	Man walking accompanied by a medium-sized dog	street, park, and parking
	Man walking accompanied by a small- sized dog	street, park, and parking
	Woman walking alone	street, park, and parking
	Woman walking accompanied by a medium- sized dog	street, park, and parking
	Woman walking accompanied by a small- sized dog	street, park, and parking

There were no other people in pictures apart from the actor (i.e., man or woman) and dog (i.e., medium- or small-sized); moreover, given that humans' faces are powerful affective signals, we

pixelated actors' faces (Jack and Schyns, 2015). Dogs were adults, that is, dogs that did not have features directly related to puppyhood. The dog breeds were Wire Haired Dachshund (small-sized) and Portuguese Podengo-like mixed-breed (medium-size), breeds that are not in the top ten most popular breeds in Spain during 2020 (Wamiz, 2020). We selected medium- and small-sized dogs because they prompt similar happiness, tenderness, and liking in observers (Gazzano et al., 2013). Moreover, dogs were leashed, given that unleashed dogs are perceived as an owner's inappropriate behavior and are assessed negatively (Arnberger and Haider, 2007). The woman was 32 years old (1.61 m tall and weighed 78 kilograms), and the man was 39 years old (1.64 m tall and weighed 65 kilograms). Figure 1 shows picture samples.

Insert here Figure 1.

Fig. 1. Examples of picture categories used in block two. Women is portrayed alone, with a medium-sized dog, and with a small-sized dog in an aversive context (i.e., t_park2). Man is portrayed alone, with a medium-sized dog, and with a small-sized dog in a positive context (i.e., s_ parking2).

Assessment measures

The *Self-Assessment Manikin*/SAM (Bradley and Lang, 1994) is a nonverbal pictorial rating scale in which nine intensity levels are represented by 5 humanoid figures and the spaces between these figures. The SAM is often used along with the IAPS (Lang et al., 1997) to rate the valence (pleasant vs. unpleasant), arousal (relaxed vs. activated), and dominance (feeling in control vs. feeling controlled) elicited by images. Each SAM scale was explained following the same instructions as in the original IAPS validation study (Lang et al., 2008). For the valence dimension, participants were invited to click on one extreme (frowning figure) if they felt completely unhappy, annoyed, unsatisfied, melancholic, despaired, however, they had to click on the other end of the scale (smiling figure) if they felt completely happy, pleased, satisfied, contented, hopeful while viewing the picture. For the arousal scale, participants had to click on one extreme (calmed figure) if they felt completely relaxed, calm, sluggish, dull, sleepy, unaroused, however, they had to click on the other hand (excited figure) if they felt completely stimulated, excited, frenzied, jittery, wide-awake, aroused. For the dominance dimension, they were invited to click on one extreme (very small, dominated figure) if they felt completely controlled, influenced, cared-for, awed, submissive, guided, however, they had to click on the other extreme (very big, dominant figure) if they felt completely controlling, influential, in control, important, dominant, autonomous. The neutral responses in the three SAM scales were

represented by clicking on the central figure (if they felt neither unhappy/calm/controlled nor happy/excited/in control). The SAM rating scale has been widely validated and is extensively used in cue reactivity research (Bradley and Lang, 2007).

In addition to the three SAM scales, the threatening/safe scale (TSS) was developed previously by our group (see supplementary material) to assess "the threat/safety level that the scene causes you". In the TSS scale, participants indicate their threat/safety levels on a nine-point scale, ranging from 1 (very threatening) to 9 (very safe); a lower score indicates that images prompt a great sense of threat, and a higher score indicates that cues provoke a great sense of safety. Correlation analyses between TSS and SAM scores have shown significant linear correlations between TSS and valence, arousal, and dominance (see supplementary material).

The 10-item Animal Attitude Scale (AAS-10) (Herzog et al., 2015) assesses participants' attitudes toward animals with statements on a 5-point Likert scale. The Spanish validation (Suárez Yera et al., In press) of the AAS-10 indicated that it is a psychometrically robust short measure of attitude to animal welfare, with acceptable reliability (Cronbach's consistency was $\alpha = 0.8$). Total AAS-10 scores ranged from 10 to 50, with higher scores indicating more concern for animal welfare. The Cronbach's consistency of the AAS-10 in the current study was $\alpha = 0.77$.

Procedure

The University of Jaén Institutional Review Board approved the study (SEPT.21/1.OTR). We introduced the experiment to students in their lecture classroom. Those who were interested in participating were placed in groups of approximately 50 individuals in a Google Meet session. Participants were on Google Meet during the whole procedure to maximize control of the participants' environment while performing the experiment. They first received the informed consent (by means of a link to Google Forms). Afterward, they were presented with sociodemographic and dog-related questions (Table 3) using a second Google Form. Ultimately, we explained the scale instructions and the image assessment task.

Table 3
Participants' sociodemographic and dog/ownership-related information

Questions	Mean (SD)/Frequency
Age	21.28 (2.74)
Living area	Urban (>10.000 habitants): 183 Rural (<10.000 habitants): 113

Present dog ownership (Yes/No)	Yes= 143 No= 153
Importance attributed to dog (Yes/No)[1]	Yes= 142 No= 1
Past dog ownership[2]	Yes= 58 No= 95
Importance attributed to dog in the past[3]	Yes= 57 No= 1
Fear of dog	Yes= 37 No= 259
Victim of a dog attack[4]	Yes= 91 No= 205
AAS-10	39.83 (5.33)

Note: SD, standard deviation; AAS-10: Animal Attitude Scale, 10-items version. Excluding the age and AAS-10, the rest of the questions are expressed in frequency.

[1] Sample number is calculated among those that currently own a dog (n=143).

[2] Sample number is calculated among those that currently does not own a dog (n=153).

[3] Sample number is calculated among those that owned a dog in the past (n=58).

[4] We asked participants if they had been attacked by a dog, without providing an exact definition of "attack". It is worth noting since results (i.e., Yes = 91) might be inflated.

In the image assessment task, participants were first presented with four trial pictures (three pictures from the IAPS [1 pleasant, 1 neutral, and 1 unpleasant[3]] and 1 aversive scene) to facilitate their familiarization with picture presentation and scale usage. Trial pictures were followed by two blocks of images; the first block consisted of images of pleasant, neutral, unpleasant, and emotional urban space (aversive and positive). The first block aimed to control that the urban spaces that we selected from the LUPS were aversive (i.e., negative and threatening) and positive (i.e., positive and safe) cues for the current sample. In the second block, participants were presented with images depicting a woman or a man who was either alone or accompanied by a medium- or small-sized dog in an aversive or positive urban space (the same urban spaces that we presented in block one; see Stimuli section). In this block, participants were instructed to *imagine, while viewing each picture, that you are alone in this scene walking straight ahead to the man or woman (with or without dog)*. Images in both blocks were presented for 6 s and were assessed on the same scales (valence, arousal, dominance, and TSS). Scales appeared, one by one, after picture projection (they were presented until participants had introduced their responses). The experiment was conducted using Pavlovia (https://pavlovia.org/) and was programmed in PsychoPy 3.2.3 (Peirce et al., 2019). Responses

[3] IAPS code for pleasant: 8163. IAPS code for neutral: 7235. IAPS code for unpleasant: 9905.

from the second Google Form (with sociodemographic and dog-related questions) and image assessment (in PsychoPy) were joined using a personal ID code. Four pseudorandomized picture orders were used across the participants. Each order included 4 trial images, 15 images in the first block (3 from each category: pleasant, neutral, unpleasant, aversive, and positive urban spaces), and 36 images in the second block (3 from each category in both aversive and positive contexts: man alone, man with medium-sized dog, man with small-sized dog, woman alone, woman with medium-sized dog, and woman with small-sized dog) (Table 2). Each order started with a different image category, and more than two repetitions of the same category were avoided. At the end of the experiment, participants were debriefed and thanked.

Data analyses

Block1. To assess the emotional reactivity that LUPS and IAPS images prompt in the selected sample, we ran separate repeated ANOVAs for each emotional scale (valence, arousal, dominance, and TSS), which included Picture Category (pleasant, neutral, unpleasant, positive scene, and aversive scene) as a within-participant variable.

Block 2. Since we aimed to examine whether the presence of a dog (and its size) modulates the emotional reactivity and sense of safety depending on the emotional context (aversive vs. positive scenes) and the gender of the actor (man vs. woman), we ran separate repeated ANOVAs for each emotional scale (valence, arousal, dominance, and TSS), which included emotional context (aversive and positive scenes), gender of actor (man and woman), and dog presence (alone, medium-sized dog, and small-sized dog) as within-participant variables. To examine the relevance of dog presence at different emotionality levels (from highly negative to highly positive contexts), we ran extra analyses to rank contexts according to ratings on valence, arousal, dominance, and TSS scales. For this, we ran separate repeated ANOVAs for each scale, which included context/actor category (aversive/man [alone], aversive/woman [alone], positive/man [alone], and positive/woman [alone]) as within-participant variables.

For both blocks, the Greenhouse-Geisser correction factor was used to control for the violation of the sphericity assumption. Subsequent post hoc contrasts were performed using the Šidák procedure to adjust for multiple comparisons. To control for the impact of outliers, we winsorized scores greater than 3 SD. A small number of images were winsorized[4]. Significance

[4] Valence scale: in aversive context, man alone (n=2). In positive context, man (n=2) and woman (n=1) alone. Arousal scale: in aversive context, man alone (n=5). In positive context, woman alone (n=3). Dominance scale: in aversive context, man alone (n=6). In positive context, woman with medium dog (n=1). Threatening/Safe scale: in aversive context, man alone (n=6). In positive context, man alone (n=1), woman with medium dog (n=1) and small dog (n=1).

was set at $p<0.05$ for all analyses, and we used partial η^2 to report effect sizes. All data were analyzed using SPSS for Mac (Version 21, SPSS Inc.).

Results

Block 1

ANOVA yielded a significant picture category effect for valence, $F(4,1180)=1338.19$ $p<0.001$, $\eta_p^2=0.819$. As Figure 2 A shows, the pleasant images prompted the greatest valence, followed by positive urban space, neutral, aversive urban space, and ultimately, unpleasant images (all categories significantly differed from each other; all $p<0.001$) (PLEA > POSIT > NEU > AVERS > UNPL). For arousal, ANOVA showed a significant picture category effect, $F(4,1180)=388.06$ $p<0.001$, $\eta_p^2=0.568$, indicating that unpleasant and aversive urban space images provoked the highest arousal, which did not differ from each other ($p=0.663$), followed by pleasant and positive urban space (all $p<0.001$) images. Neutral cues prompted the lowest arousal reactivity (all $p<0.01$) (see Figure 2 B; UNP = AVERS > PLEA > POSIT > NEUT). ANOVA also showed a significant picture category effect for dominance, $F(4,1180)=455.79$, $p<0.001$, $\eta_p^2=0.607$. All picture categories significantly differed from each other in dominance (Figure 2 C); the positive urban space cues prompted the greatest dominance (all $p<0.001$, except for comparison with pleasant [$p<0.05$]). Pleasant cues provoked the second highest dominance rating (all $p<0.001$, except for the comparison with neutral [$p<0.01$]), followed by neutral (all s<0.001), aversive urban space and unpleasant cues ($p<0.05$) (POSIT > PLEA > NEU > AVERS > UNP). For the TSS scale, ANOVA yielded a significant picture category effect, $F(4,1180)=1065.93$ $p<0.001$, $\eta_p^2=0.783$ (Figure 1 D), indicating that positive urban space prompted the highest sense of safety, followed by pleasant, neutral, aversive urban space and unpleasant images (all picture categories significantly differed from each other and all $p<0.001$) (POSIT > PLEA > NEU > AVERS > UNP).

Insert here Figure 2.

Fig. 2. Subjective ratings across picture categories. **a** Represents mean valence ratings for IAPS and LUPS images, **b** represents mean arousal ratings for IAPS and LUPS images, **c** represents mean dominance ratings for IAPS and LUPS images, and **d** represents mean threatening/safe ratings for IAPS and LUPS images. Ratings in threatening/safe scale (d) must be interpreted as follows: lower ratings indicate pictures that prompted greater threat to participants, conversely, higher ratings indicate greater sense of safety.

Block 2

Emotional reactivity and sense of safety modulation by dog presence

Valence: ANOVA yielded significant main effects of emotional context ($F(1, 295)=362.49$, $p<0.001$, $\eta_p^2=0.551$), actor gender ($F(1, 295)=173.70$ $p<0.001$, $\eta_p^2=0.371$), and dog presence ($F(2, 590)=213.68$, $p<0.001$, $\eta_p^2=0.42$). Aversive contexts and man prompted lower valences than positive contexts and woman, respectively. According to dog presence, post hoc contrast indicated that pictures depicting actors alone provoked the lowest valence, followed by actors accompanied by medium-sized dogs and actors accompanied by small-sized dogs (all *p*s<0.001) (Alone < Medium Dog < Small Dog). ANOVA also showed a significant emotional context x actor gender x dog presence interaction, $F(2, 590)=17.901$, $p<0.001$, $\eta_p^2=0.057$. Because our main interest was to investigate the emotional modulation of dog presence (alone vs. medium dog vs. small dog), we examined post hoc comparisons within each emotional context (aversive and positive) and within each actor gender (man and woman). In the aversive emotional context, the *man* provoked the lowest valence when alone, followed by man with medium-sized dog, and, ultimately, by man with small-sized dog (all $p<0.001$) (aversive/man: Alone < Medium Dog < Small Dog). Regarding the *woman*, she prompted the lowest valence when alone (all $p<0.001$), followed by woman with medium- and small-sized dogs (which did not differ from each other; $p=0.758$) (aversive/woman: Alone < Medium Dog = Small Dog). In the positive emotional context, the *man* alone prompted the lowest valence, followed by man with medium-sized dog and, ultimately, man with small-sized dog (all $p<0.001$) (positive/man: Alone < Medium Dog < Small Dog). The same results were found for the *woman*; when she appeared alone, it prompted a lower valence than when she appeared with medium ($p<0.01$) and small-sized dogs ($p<0.001$). The woman with medium-sized dogs provoked a lower valence than the woman with small-sized dogs ($p<0.01$) (positive/woman: Alone < Medium Dog < Small Dog). See Figure 3 A.

Arousal: ANOVA yielded significant main effects of emotional context ($F(1, 295)=344.60$, $p<0.001$, $\eta_p^2=0.539$), actor gender ($F(1, 295)=131.21$ $p<0.001$, $\eta_p^2=0.308$), and dog presence ($F(2, 590)=69.71$, $p<0.001$, $\eta_p^2=0.19$). Aversive contexts and man prompted greater arousal than positive contexts and woman, respectively. According to dog presence, post hoc contrast indicated that the picture depicting an actor alone provoked the greatest arousal, followed by actors accompanied by the medium-sized dog and actors accompanied by the small-sized dog (all *p*s<0.001) (Alone > Medium Dog > Small Dog). ANOVA also showed a significant emotional context x actor gender x dog presence interaction, $F(2, 590)=15.801$, $p<0.001$, $\eta_p^2=0.051$. In the aversive context, the *man* alone provoked the highest activation, followed by man with medium-sized dog and man with small-sized dog (all *p*s<0.001) (aversive/man: Alone > Medium Dog > Small Dog). The picture of the *woman* depicted alone prompted significantly

and marginally higher arousal reactivity than woman with small- sized dogs (p<0.001) and woman with medium-sized dogs (p=0.051), respectively. Woman with medium and small-sized dogs did not differ (p=0.274) (aversive/woman: Alone > Medium Dog = Small Dog). In the positive emotional context, the *man* alone and the man with a medium-sized dog (which did not differ between them; p=0.233) prompted greater activation than the man with a small-sized dog (all p<0.001) (positive/man: Alone = Medium Dog > Small Dog). When pictures depicted *women*, participants reacted with more arousal to woman with medium-sized dogs (all p<0.01) than woman alone and with small-sized dogs (which did not differ between them; p=0.89) (positive/woman: Medium Dog > Alone = Small Dog). See Figure 3 B.

Dominance: ANOVA yielded significant main effects of emotional context ($F(1, 295)=405.10$, p<0.001, η_p^2=0.579), actor gender ($F(1, 295)=137.16$ p<0.001, η_p^2=0.317), and dog presence ($F(2, 590)=117.83$, p<0.001, η_p^2=0.285). Aversive contexts and man prompted lower dominance than positive contexts and woman, respectively. According to dog presence, post hoc contrast indicated that the picture depicting the actor alone provoked the lowest dominance, followed by actors with medium-sized dogs and actors with small-sized dogs (all ps<0.001) (Alone < Medium Dog < Small Dog). The ANOVA also showed a significant emotional context x actor gender x dog presence interaction, $F(2, 590)=26.20$, p<0.001, η_p^2=0.082. In the aversive context, *man* alone provoked lower dominance than man with medium-sized dog, followed by man with small-sized dog (all ps<0.001) (aversive/man: Alone < Medium Dog < Small Dog). *Woman* alone prompted a lower dominance reaction than woman with medium- and small-sized dog (all p<0.001), which did not differ between them (p=0.893) (aversive/woman: Alone < Medium Dog = Small Dog). In the positive emotional context, the *man* alone prompted the lowest dominance, followed by man with medium-sized dog and, ultimately, man with small-sized dog (all p<0.001) (positive/man: Alone < Medium Dog < Small Dog). Regarding the *woman*, pictures depicting woman with medium-sized dogs provoked lower dominance than woman with small-sized dogs (p<0.01) (positive/woman: Alone = Medium Dog < Small Dog [Alone and Small Dog did not differ; p=0.174]). See Figure 3 C.

Threatening/safe scale, TSS: ANOVA yielded significant main effects of emotional context ($F(1, 295)=711.12$, p<0.001, η_p^2=0.707), actor gender ($F(1, 295)=208.66$ p<0.001, η_p^2=0.414), and dog presence ($F(2, 590)=171.95$, p<0.001, η_p^2=0.368). Aversive contexts and man prompted a lower sense of safety than positive contexts and woman, respectively. According to dog presence, post hoc contrast indicated that participants felt the lowest sense of safety when viewing actors alone, followed by actors with medium-sized dogs and, ultimately, actors with small-sized dogs (all p<0.001; Alone < Medium Dog < Small Dog). ANOVA also showed a significant emotional context x actor gender x dog presence interaction, $F(2, 590)=29.5320$,

$p<0.001$, $\eta_p^2=0.091$. In the aversive context, *man* alone provoked the lowest sense of safety, followed by man with medium-sized dog and, ultimately, man with small- sized dog (all $p<0.001$) (aversive/man: Alone < Medium Dog < Small Dog). Compared with *woman* accompanied by medium- and small-sized dogs (which did not differ between them; $p=0.948$), woman alone prompted the least sense of safety (all $p<0.001$) (aversive/woman: Alone < Medium Dog = Small Dog). In the positive emotional context, the *man* alone prompted the lowest sense of safety, followed by man with medium-sized dog and, in the last place, man with small-sized dog (positive/man: Alone < Medium Dog < Small Dog). *Woman* alone and with medium-sized dogs prompted the least sense of safety ($p=0.308$) compared with woman with small-sized dogs (all $p<0.01$) (positive/woman: Alone = Medium Dog < Small Dog). See Figure 3 D.

Insert here Figure 3.

Fig. 3. Emotional ratings of pictures depicting man or woman alone, with medium- or small-sized dog. **a** Represents mean valence ratings, **b** represents mean arousal ratings, **c** represents mean dominance ratings, and **d** represents mean threatening/safe ratings. Ratings in threatening/safe scale (d) must be interpreted as follows: lower ratings indicate pictures that prompted greater threat to participants, conversely, higher ratings indicate greater sense of safety. We ran extra analyses excluding participants that had a fear of dogs or scored under the percentile 10 in the ASS-10 (n = 61) and results did not change for valence and threatening/safe scales. Results slightly changed for arousal (positive and man= Alone > Medium Dog > Small Dog; positive and woman= Medium Dog > Small Dog = Alone [Medium Dog and Alone did not differ between them] and dominance (positive and woman= Medium Dog = Alone < Small Dog [Medium and Small Dog did not differ between them]). The three-way significant interaction in each affective scale, also showed that man and woman always differ from each other within each emotional context x dog presence categories (all $p<0.001$). *Note:* MD, medium dog; SD, small dog.

Emotionality levels of context/actor categories

The repeated ANOVAs yielded a significant context/actor category effect for valence ($F(3, 885)=274.80$, $p<0.001$, $\eta_p^2=0.482$), arousal ($F(3, 885)=259.53$, $p<0.001$, $\eta_p^2=0.468$), dominance ($F(3, 885)=274.95$, $p<0.001$, $\eta_p^2=0.482$), and TSS ($F(3, 885)=417$, $p<0.001$, $\eta_p^2=0.586$) scales. Post hoc contrasts indicated that all categories significantly differed between them, showing the following trends for valence (all $p<0.001$, except comparison between aversive/woman and positive/man [$p<0.01$]), dominance (all $p<0.001$ except comparison between aversive/woman and positive/man [$p<0.01$]) and TSS (all $p<0.001$) scales: aversive/man < aversive/woman < positive/man < positive/woman. In the arousal dimension, post hoc contrast indicated that all categories significantly differed between them (all $p<0.001$) and showed the following trend: aversive/man > aversive/woman > positive/man > positive/woman. Based on these results on the emotional and TSS scales, we refer to aversive/man and aversive/woman as high- and low-aversive contexts, respectively. Likewise, we refer to positive/man and positive/woman as low- and high- positive contexts, respectively.

Discussion

We aimed to examine the role of dog presence in modulating human affective reactivity and sense of safety in emotional urban public spaces. Participants rated pictures depicting a man or woman alone or accompanied by medium- or small-sized dog in aversive (i.e., negative and threatening) and positive (i.e., positive and safe) urban public spaces. The results indicated that both dog sizes produced better assessments (i.e., higher valence, dominance, and sense of safety, and lower arousal) than the alone condition in high- and low- aversive (i.e., aversive/man and aversive/woman, respectively) and low-positive (i.e., positive/man) contexts. In highly positive contexts (i.e., positive/woman), both dog sizes only increased the valence assessment compared to the alone condition. Conversely, the alone condition produced the same assessment as small dogs on arousal and dominance scales and the same assessment as medium dogs on dominance and TSS scales in positive/woman contexts, indicating a ceiling effect in highly positive contexts. Comparing dog sizes, small-sized dog (vs. medium) produced a better assessment in most emotional contexts. The current study highlights the need to consider the emotionality of public scenes, as well as dog sizes, when assessing the positive dog effect in scenes in which people and dogs are portrayed.

Aiming to assess the dog presence effect in contexts differing in emotionality levels, we photographed a man and woman in aversive and positive urban public scenes. Moreover, we examined whether men and women (alone) in both emotional contexts differed from each other (on emotional and TSS scales) to create an "emotional rank" of contexts. It was important to explore whether a positive dog effect can be found across emotional levels. Our results indicated that all contexts significantly differ in valence, arousal, dominance, and TSS; therefore, they can be ranked as follows (from high aversive to high positive): aversive/man (high aversive) - aversive/woman (low aversive) - positive/man (low positive) - positive/woman (high positive). According to previously published qualitative findings, the presence of women in urban public spaces is normally assessed as less threatening than men's presence (Roy and Bailey, 2021); however, women and men are not compared in different emotional contexts. In this study, we objectively showed that men prompt more negative emotional reactions and a lower sense of safety than women within the same emotional scene (i.e., aversive or positive). However, men prompt more positive emotional reactions and a greater sense of safety than women when they are pictured in a positive scene and women in an aversive scene.

When actors were accompanied by medium- or small-sized dogs, they elicited more positive reactions than when they were alone in high- and low- aversive and low-positive

contexts. Specifically, participants felt more positive (i.e., more valence), more in control (i.e., more dominance), calmer (i.e., less arousal), and safer when they observed aversive and low-positive urban public scenes containing a dog. These results might reflect the consequence of the dog effect on people's image; dogs impart positive social attributes to individuals they accompany and these individuals are viewed as happier, friendlier, and less dangerous (Lockwood, 1983; Rossbach and Wilson, 1992). In the same manner, current results might be affected by the effect of dogs on environments, given dogs' ability to increase the comfort and pleasantness of different types of environments (Wells and Perrine, 2001a; 2001b; Perrine and Wells, 2006;). Our study expands on previous results, indicating that the positive dog effect seems to be powerful enough to remain in urban public spaces with different emotionality levels. These results have clinical implications for individuals who fear public places (e.g., agoraphobic patients and individuals with a pathological fear of crime); such people could benefit from this dog effect during the first sessions of exposure-based treatment (e.g., by decreasing the initial intensity of negative emotions when exposed to urban public spaces). However, as patients become more confident, the dog should be removed from the scene to ensure that the exposure conditions are reflective of real life; this would allow the phobia or fear to be truly overcome, given that the dog could become a safety cue (which has a deleterious effect on exposure-based therapy outcomes; Salkovskis et al., 1999; Helbig-Lang et al., 2014). These findings also have clinical implications with respect to more general contexts in which individuals might feel uncomfortable; for example, the positive effect of a dog's presence could be exploited to improve the perceptions of individuals who are not completely happy in their workplace. Dogs could also be useful in the context of therapeutic interventions, for example in hospitals or health clinics (e.g., psychology, dental or speech therapy clinics), as well as in the academic context associated with stressful activities such as sitting examinations while at university or high school. Moreover, incorporating dog parks into less safe urban spaces might increase safety and promote social enrichment in those areas.

Remarkably, the positive dog effect was less clear in highly positive scenes. In this sense, when the women were portrayed alone, they produced the same emotional ratings and sense of safety as small-sized dogs (on arousal and dominance scales) and medium-sized dogs (on dominance and TSS scales). These results are in line with the limited number of previous studies that found a greater dog effect in less positive contexts. For instance, men depicted in vignettes (short stories) were rated as more attractive by women if they were described as dog owners, and this effect was greater for men previously perceived as relatively less warm and caring (Tifferet et al., 2013). Similarly, the improved perceptions of psychotherapists (i.e., trustworthiness), and increased willingness to disclose on the part of the client, associated with a dog's presence seemed to be greater among individuals who were less positive toward them

(Schneider and Harley, 2006). There is also an example in the literature of the presence of a dog being beneficial only in an aversive situation; Havener et al. (2001) found that the presence of a dog during a dental procedure reduced psychological arousal in children who initially verbalized distress on arrival at the clinic; however, they did not such effect when comparing the group of children with and without the dog. The authors explained these results in terms of a ceiling effect of the dog's presence (Schneider and Harley, 2006), where the magnitude of the impact of the companion animal was influenced by contextual characteristics. We expanded previous findings by arguing that the presence of the dog is important in aversive and low-positive contexts; however, in highly positive contexts, the lack of a clear influence of the presence of a dog on emotional and safety scale scores indicates a ceiling effect; dog characteristics such as size, rather than the mere presence of the animal, seem to be more important in highly positive contexts.

We selected two unpopular, medium- and small-sized adult dogs (Portuguese podengo-like mixed-breed dog and wire-haired dachshund, respectively) to examine whether the positive dog effect was due to dog presence itself or dog specificity. Although medium and small dog sizes did not previously prompt different results in happiness, tenderness, and liking (Gazzano et al., 2013), the current study has shown that the small-sized dog prompts more positive emotional reactivity and higher levels of safety than the medium-sized dog in most emotional contexts, pointing out that emotional and safety benefits from dog presence might also be related to size. These contradictory results could be explained by the fact that the Portuguese Podengo-like mixed-breed is one of the largest breeds classified as medium-sized, such that it may have a similar effect to large-sized dogs, which have been shown to provoke more negative emotions (e.g., fear) than small-sized dogs (Gazzano et al., 2013). Alternatively, the effects of the different-sized dogs may depend on the specific characteristics of the animals. We selected two breeds of dogs sharing characteristics that might influence assessments thereof: they were both relatively unpopular breeds in Spain in 2020 (Wamiz, 2020) (i.e., breed popularity could affect observers' assessment; Perrine and Wells, 2006), floppy-eared (which is a characteristic associated with higher "agreeableness"; Hecht and Horowitz, 2015), adults (to avoid any effect of juvenile traits, which are perceived positively; Fridlund and McDonald, 1998), and non-stigmatized breeds such as the American Pitbull Terrier (which negatively impacts observer perceptions; Gazzano et al., 2013). However, the small-sized dog in the current study might have possessed additional characteristics that positively influence participants; for instance, the small-sized dog, despite being an adult, could have been perceived as cuter than medium-sized dogs. In this sense, the so-called "canine cuteness effect" posits that physical aspects that increase the cuteness of dogs (e.g., short limbs [shorter in the small-sized dog]), are related to better human-dog relationships and increase the perceived amicability of dogs (Wells, 2004;

Thorn et al., 2015). Another notable point is that dog size and/or physical features (other than color) seemed to be more important than coat color in the current study; although black dogs are normally perceived less favorably compared to yellow dogs (Fratkin and Baker, 2015), the Wire Haired Dachshund (small-sized black dog) elicited a more positive reaction than the Portuguese Podengo-like mixed-breed (medium-sized yellow dog). This study opens a new line of research, in which different dogs' physical features can be manipulated to examine their impact on emotional reactions and perceptions of safety in urban public spaces. In the same manner, it would be interesting to examine if adding characteristics that promote negative assessments of dogs (such as appearing unleashed in pictures (Arnberger and Haider, 2007), wearing a muzzle or a collar, or walking with a single-chain leash (Pyzer et al., 2016)), or depicting a stigmatized dog (such as a Staffordshire bull terrier) influence participants' assessments in emotional urban contexts.

Although the results showed the positive effect of dog presence across the whole sample, we ran extra analyses excluding those women who fell under the percentile score below 10% in the AAS-10 (i.e., worse attitude toward animal welfare) and reported a fear of dogs (n = 61) to avoid the possibility that a negative relationship with dogs might influence the results. The results mainly stayed the same. We argue that fear of dogs might be less important in the present study since the portrayed dogs were leashed, which could help to perceive that the dogs are under the control of their handlers (Arnberger and Haider, 2007). According to the literature that investigates the effects of attitude toward animals on the dog presence effect, our results might be in line with those studies indicating a lack of effect on participants' perception (Friedmann et al., 1993; Schneider and Harley, 2006). To support this idea, for each scale (i.e., valence, arousal, dominance, and TSS), we averaged responses to men and women with medium- and small-sized dogs in both aversive (aversive-dog) and positive (positive-dog) scenes, and they were included in multiple regression analyses with AAS-10 as the outcome variable (one regression for each scale); aversive-dog and positive-dog variables did not significantly predict the attitude toward animals in any regression model.

Another relevant strength of the current study is the procedure used to select emotional urban public scenes. A pilot study to create and validate the LUPS (see supplementary material) was previously performed to identify a set of threatening and safe urban public scenes[5]. From these cues, we selected 3 aversive and 3 positive scenes for the current study that significantly differed on the SAM and TSS scales; moreover, we tested them in the current sample, i.e., block one (following the same methodology as in the pilot study). The results from block one on the SAM scales were consistent with previous literature on emotion processing (Bradley et al.,

[5] LUPS images can be downloaded from https://osf.io/tqusb/?view_only=aa9dd8bef16c4fc5866819092007123f

2001): affective pictures from the IAPS prompted the expected patterns in valence (linear: PLEA > NEU > UNP) and arousal (quadratic: PLEA & UNP > NEU). Positive scenes were processed as moderately pleasant and arousing; however, aversive scenes were processed as moderately unpleasant and highly arousing. These results supported the methodological reliability of the selected urban public scenes and ensured that the urban spaces selected for block two reliably prompted positive/safe and negative/threatening reactivity.

The implications of the current results should be evaluated while considering some methodological limitations. First, we did not include male participants. Including men could be interesting since women and men tend to differ in cues that prompt threat (Blöbaum and Hunecke, 2005; Boomsma and Steg, 2014), and they differ in behaviors and attitudes toward animals (Herzog, 2007). The current results might be influenced by the positive attitude to dogs that current participants show (e.g., 68% of the sample has or had dogs as companion animals, and 99% of them attributed importance to dogs). In this sense, future research should also assess participants – women and men – who do not have a positive attitude toward dogs to examine whether the positive dog effect remains in this sample. Finally, we included only one animal for each dog size in the current study, so cannot generalize the size-related findings to all small- and medium-sized dog breeds.

Conclusions

Concluding, our results are significant as they show that dog presence (regardless of dog size) affects emotional reactivity and sense of safety in high- and low- aversive and low-positive urban public spaces. In highly positive contexts, dog features such as size seem to be more important than the dog's presence itself, indicating a ceiling effect. When comparing differences between dog sizes (small vs. medium), small-sized dogs enhance positive emotional reactions and sense of safety in most emotional contexts. The current study highlights the need to consider the emotionality of public scenes in which people and dogs are portrayed, as well as specific dog features (such as size), when evaluating the positive dog effect on participants' emotional reactivity and sense of safety.

Conflict of interest statement: none.

Authorship statement:

The experiments were designed by RDR, RCM, CVV, RMM, and DOP. The experiments were performed by RDR, RCM, CVV, RMM, and DOP. The data were analyzed by RDR. The paper was written by RDR, RCM, CVV, and RMM.

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The role of dogs in modulating human affective reactivity and sense of safety in emotional urban public spaces.

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Supplementary material

Library of Urban Public Spaces (LUPS)

This supplementary material presents a pilot study of the main experiment presented in the manuscript *The role of dogs in modulating human affective reactivity and sense of safety in emotional urban public spaces*, which aims to assess, in undergraduate women, the emotional and feeling of safety modulation of dogs in different emotional contexts (i.e., aversive and positive public urban spaces). For this study, we required the use of public urban locations that reliably prompt aversive/appetitive emotional reactivity and feelings of unsafe/safe in college women.

Aim: In the present pilot study, we created and validated a set of original urban public spaces (*Library of Urban Public Spaces*, LUPS) according to their emotional impact (i.e., valence, arousal, and dominance) and feeling of safety in a sample of college women. Urban spaces were presented intermixed with affective and neutral images from the *International Affective Picture System/IAPS* (Lang et al., 2008) using the IAPS passive viewing paradigm (e.g., Bradley and Lang, 2007). Images from the LUPS were selected according to urban locations that women experience as threatening or safe.

Method

Participants

A total of 91 college university women voluntarily participated in this study. They received class credit as compensation. Due to technical problems, nine participants were excluded from the analyses. The final sample consisted of 82 women with ages ranging from 20.3 to 26.8 (Mean=21.7, SD=1.42). All participants provided virtual informed consent. We rated only women since they are our target sample in the following study.

Materials

Stimuli

Participants viewed a total of 80 images belonging to five different categories. Pleasant (n=10), neutral (n=10), and unpleasant (n=10) images were selected from the IAPS[6](Lang et al., 2008). They were used as controls and served as reference points to allocate urban public space images in the bidimensional affective space defined by valence and arousal. Urban public space images (n=50) were originally taken from the city of Jaén and represented characteristics associated with safe and threatening urban locations described in previous studies (Valentine, 1990; Blöbaum and Hunecke, 2005; Andrews and Gatersleben, 2010; Blom et al., 2010; Boomsma and Steg, 2014). We selected five locations (streets, suburbs, squares, parking lots, and parks) for both safe and threatening urban spaces, and we took five pictures for each one (5 safe locations x 5= 25; 5 threatening locations x 5= 25). We kept the same types of locations for both safe and threatening parks (e.g., safe and threatening parking lot spaces, safe and threatening parks); however, they differed in characteristics that modulated the feeling of safety. Since lighting seems to be one of the most important variables predicting social safety (Loewen et al., 1993), all selected safe scenes were taken during the day (with high daylighting levels), and threatening scenes were taken after dark. Compared with safe scenes, threatening scenes have high levels of concealment (i.e., a physical occlusion of space big enough to hide a potential offender; Nasar, 2000) and entrapment (i.e., the difficulty a person would have escaping when confronted by a potential offender; Nasar, 2000); e.g., safe parking lots were open air, improving visibility, and other buildings such as shopping malls were nearby; conversely, threatening parking lots consisted of enclosed parking areas with low-artificial lighting levels and pillars, which decrease visibility and increase concealment. LUPS images can be downloaded from: https://osf.io/tqusb/?view_only=aa9dd8bef16c4fc5866819092007123f

Assessment measures

- The *Self-Assessment Manikin* (SAM; Bradley and Lang, 1994) consists of a set of humanoid figures representing three general dimensions, i.e., valence (pleasant vs. unpleasant), arousal (relaxed vs. activated), and dominance (feeling in control vs. feeling controlled). Each scale is scored from 1 (lower end) to 9 (upper end).

-The *threatening/safe scale* (TSS) asks participants to indicate "the threat/safety level that the scene causes you". It is a 9-point Likert scale ranging from 1 (very threatening) to 9 (very safe); a lower score indicates that images prompted a great sense of threat, and a higher score indicates

[6] IAPS code for pleasant: 4604, 4697, 4608, 5621, 2045, 8490, 2152, 8496, 2071, and 4694. IAPS code for neutral: 7950, 7010, 7185, 7059, 7187, 7175, 7025, 7055, 7000, and 7217. IAPS code for unpleasant: 9903, 9163, 9940, 2683, 9435, 9421, 9342, 9295, 9341, and 9611.

that cues provoked a great sense of safety. The TSS was designed to integrate well with the SAM, avoiding the need to use questionnaires or different questions to assess the feeling of safety (e.g., Boomsma and Steg, 2014).

Procedure

This study was approved by the University Institutional Review Board (SEPT.21/1.OTR). Participants were placed in groups of approximately 20 individuals to a Google Meet session, where they remained during the whole procedure to maximize the control of participants' environment while performing the experiment. Participants provided virtual informed consent.

Participants were presented with emotional (i.e., pleasant and unpleasant) and neutral pictures from the IAPS and urban public spaces (i.e., safe and threatening). Pictures were presented for 6 s. The scales, one by one, appeared immediately after the image projection and were presented until participants clicked on them. Before the assessment task, women were presented with four trial pictures (three pictures from the IAPS [1 pleasant, 1 neutral, and 1 unpleasant[7]] and 1 threatening scene) to facilitate their familiarization with picture presentation and scale usage. Those four pictures were not presented in the assessment task. The experiment was conducted using Pavlovia (https://pavlovia.org/) and was programmed in PsychoPy 3.2.3 (Peirce et al., 2019). Four pseudorandomized picture orders were used across the participants. Each order included 4 trial images, 20 emotional images (10 pleasant and 10 unpleasant), 10 neutral and 50 public urban spaces (25 safe and 25 threatening). More than two repetitions of the same category were avoided. At the end of the experiment, participants were debriefed and thanked.

Statistical analyses

We calculated the mean and standard deviation for each IAPS and LUPS image at each scale (valence, arousal, dominance, and TSS); ratings for each LUPS image can be found at the end of the current document. Then, we performed separate one-way ANOVAs for each scale (valence, arousal, dominance, and TSS), including picture category as a between-participant variable, to examine differences between picture categories. Subsequent post hoc contrasts were performed using the Šidák procedure to adjust for multiple comparisons. Afterward, we represent IAPS and LUPS images in the bidimensional space of valence and arousal, independently obtaining the regression coefficient between these dimensions for appetitive (pleasant and safe) and defensive (unpleasant and threatening) contents. Pearson correlations

[7] IAPS code for pleasant: 8163. IAPS code for neutral: 7235. IAPS code for unpleasant: 9905.

were then obtained between the TSS and the three SAM dimensions using the mean score of each IAPS and LUPS image as the measurement unit. Significance was set at 0.05.

Results

Table 1 shows the mean and standard deviation for each picture category on the valence, arousal, dominance, and TSS scale. In line with the emotion literature (Bradley et al., 2001), IAPS images showed the typical pattern in valence (PLEASANT > NEUTRAL > UNPLEASANT), arousal (PLEASANT & UNPLEASANT > NEUTRAL), and dominance (PLEASANT & NEUTRAL > UNPLEASANT). Safe LUPS were processed as medium-appetitive cues, causing greater valence than neutral images and lower valence than pleasant images. Threatening LUPS were processed as medium-aversive cues because they prompted lower valence than neutral images but higher valence than unpleasant images. A sense of safety caused low arousal (as neutral cues), and threatening was as activating as pleasant. According to the TSS scale, pleasant, neutral, and safe prompted the same sense of safety, followed by threatening and, ultimately, unpleasant cues.

Table 1

Mean and standard deviation (SD) for the IAPS and LUPS images on valence, arousal, dominance, and TSS scales.

IAPS and	Valence		Arousal		Dominance		TSS	
LUPS images	M (SD)	Pairwise test*	M (SD)	Pairwise test*	M (SD)	Pairwise test*	M (SD)	Pairwise test*
1 Pleasant	7.19 (0.47)	2, 3, 4, 5	5.82 (1.49)	2, 3, 4	6.17 (0.74)	3, 5	6.68 (0.23)	3, 5
2 Neutral	4.91 (0.13)	1, 3, 4, 5	3.71 (0.32)	1, 3, 5	5.50 (0.18)	3, 5	5.83 (0.23)	3, 5
3 Unpleasant	1.64 (0.21)	1, 2, 4, 5	6.97 (0.51)	1, 2, 4, 5	2.25 (0.52)	1, 2, 4, 5	1.97 (0.23)	1, 2, 4, 5
4 Safe	5.76 (0.50)	1, 2, 3, 5	4.07 (0.43)	1, 3, 5	5.63 (0.49)	3, 5	6.18 (0.14)	3, 5
5 Threatening	4.11 (0.51)	1, 2, 3, 4	5.94 (0.66)	2, 3, 4	3.48 (0.61)	1, 2, 3, 4	3.44 (0.14)	1, 2, 3, 4

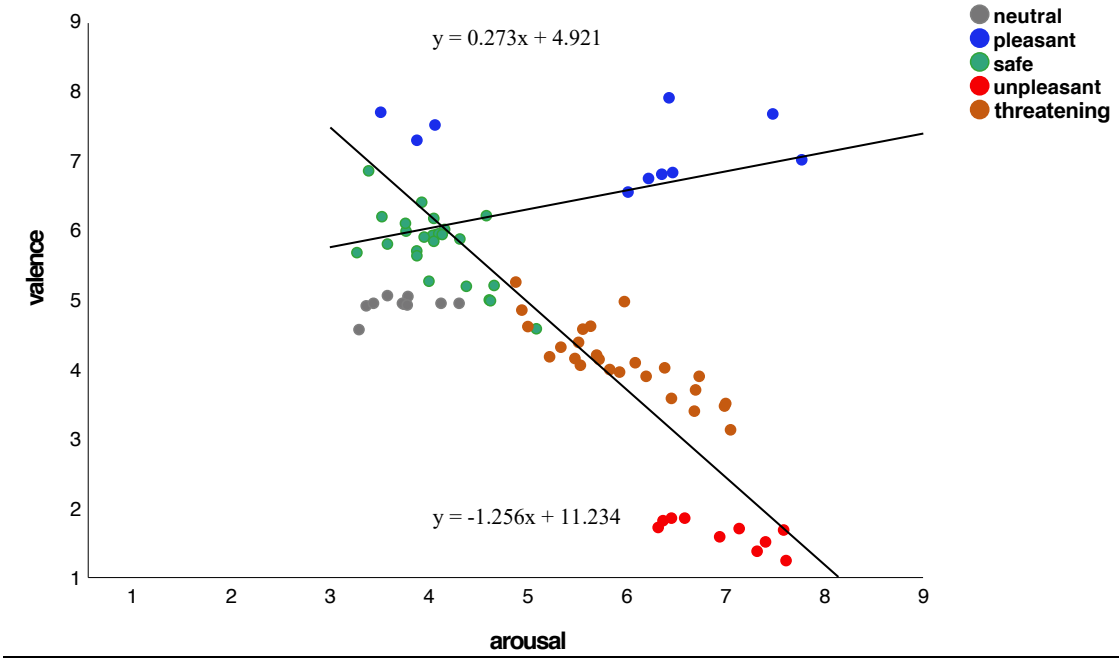
Note: IAPS, International Affective Picture System; LUPS, Library of Urban Public Spaces; TSS, threatening/safe scale; SD, standard deviation.

*Significant pairwise comparisons among categories are given under Pairwise test column.

Figure 1 shows the distribution of the 80 images in the bidimensional space of valence and arousal. Pleasant and unpleasant IAPS cues were situated in the upper and lower arms, respectively. The majority of safe LUPS are situated in the upper arm alongside pleasant images, except for five images (s_sub1, s_sub2, s_sub3, s_sub4, and s_squ4) that are around the neutral space and one (s_sub5) that is in the lower arm. Except for two images (t_str1 and t_squ4), all threatening LUPSs are situated in the lower arm. The standardized regression coefficient (β) yielded a positive (β= 0.391; R^2= 0.15; t= 2.44; p<0.05) and negative (β = -0.80; R^2= 0.64; t= 7.68; p<0.001) slope between valence and arousal for appetitive and aversive cues, respectively.

Figure 1

Affective space.



Bidimensional plot of each IAPS and LUPS image as a function of its mean valence and arousal ratings. Each point in the plot represents the valence and arousal ratings for an IAPS (blue, gray, and red) or LUPS (green and orange) image. Regression lines are plotted separately for appetitive (pleasant and safe) and defensive (unpleasant and threatening) contents.

Bivariate Pearson's correlation between TSS and SAM scales yielded that TSS significantly and positively correlated with valence (r=0.904, p<0.001) and dominance (r=0.991, p<0.001). However, TSS showed a significant and negative correlation with arousal (r= -0.785, p<0.001).

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Valentine, G., 1990. Women's fear and the design of public space. Built Environ. 16, 288–303. https://doi.org/https://www.jstor.org/stable/23286230

LUPS: Library of Urban Public Space. Normative ratings (n= 82 women) on the scale of valence, arousal, dominance, and TSS.					
Category	Slide name	Valence Mean (SD)	Arousal Mean (SD)	Dominance Mean (SD)	TSS Mean (SD)
safe	s_park1	6.84 (1.40)	3.39 (2.02)	6.29 (1.58)	6.85 (1.54)
safe	s_park2	6.16 (1.48)	4.05 (1.90)	5.83 (1.30)	6.51 (1.53)
safe	s_park3	6.09 (1.32)	3.76 (1.72)	5.94 (1.44)	6.63 (1.41)
safe	s_park4	5.62 (1.27)	3.88 (1.51)	5.66 (1.48)	6.00 (1.54)
safe	s_park5	5.93 (1.39)	4.13 (1.78)	5.76 (1.44)	6.26 (1.63)
safe	s_parking1	6.20 (1.62)	4.58 (2.16)	5.70 (2.09)	6.79 (1.81)
safe	s_parking2	5.89 (1.71)	3.95 (2.01)	6.15 (1.61)	6.95 (1.79)
safe	s_parking3	5.86 (1.75)	4.31 (2.11)	5.91 (1.77)	6.60 (1.83)
safe	s_parking4	5.94 (1.70)	4.10 (2.15)	6.06 (1.77)	6.79 (1.95)
safe	s_parking5	6.00 (1.52)	4.16 (2.13)	6.22 (1.56)	6.79 (1.65)
safe	s_squ1	6.18 (1.76)	3.52 (1.85)	5.60 (1.39)	6.33 (1.70)
safe	s_squ2	5.98 (1.31)	3.77 (1.81)	5.78 (1.57)	6.30 (1.67)
safe	s_squ3	5.79 (1.47)	3.58 (1.69)	5.88 (1.62)	6.54 (1.63)
safe	s_squ4	5.20 (1.54)	4.66 (1.84)	4.91 (1.57)	5.09 (1.69)
safe	s_squ5	5.83 (1.32)	4.05 (1.80)	5.66 (1.48)	6.22 (1.57)
safe	s_str1	5.67 (1.22)	3.27 (1.86)	5.65 (1.58)	6.32 (1.55)
safe	s_str2	6.39 (1.44)	3.93 (1.73)	6.17 (1.60)	7.09 (1.47)
safe	s_str3	5.69 (1.31)	3.88 (1.81)	5.58 (1.48)	6.09 (1.60)
safe	s_str4	5.93 (1.26)	4.07 (1.76)	5.54 (1.48)	6.16 (1.55)
safe	s_str5	5.91 (1.42)	4.04 (1.99)	5.98 (1.44)	6.62 (1.50)
safe	s_sub1	5.26 (1.11)	4.00 (1.76)	5.22 (1.58)	5.66 (1.67)
safe	s_sub2	5.18 (1.09)	4.38 (1.69)	5.20 (1.26)	5.40 (1.55)
safe	s_sub3	4.99 (1.21)	4.61 (1.78)	4.77 (1.31)	4.87 (1.48)
safe	s_sub4	4.98 (1.20)	4.62 (1.75)	4.98 (1.37)	5.24 (1.60)
safe	s_sub5	4.57 (1.34)	5.09 (1.83)	4.32 (1.43)	4.41 (1.56)
threatening	t_park1	4.96 (1.74)	5.98 (2.00)	3.89 (1.70)	3.72 (1.86)
threatening	t_park2	3.89 (1.86)	6.73 (1.84)	2.67 (1.36)	2.76 (1.52)
threatening	t_park3	3.89 (1.57)	6.20 (1.95)	3.21 (1.56)	3.09 (1.35)
threatening	t_park4	4.09 (1.78)	6.09 (1.96)	3.44 (1.74)	3.29 (1.49)
threatening	t_park5	3.99 (1.55)	5.83 (1.82)	3.60 (1.56)	3.43 (1.37)
threatening	t_parking1	4.20 (1.44)	5.70 (2.20)	3.61 (1.45)	3.71 (1.54)
threatening	t_parking2	4.15 (1.34)	5.48 (1.99)	3.93 (1.58)	4.07 (1.69)
threatening	t_parking3	4.05 (1.33)	5.53 (1.94)	3.73 (1.61)	3.86 (1.67)
threatening	t_parking4	4.60 (1.08)	5.00 (1.86)	4.56 (1.47)	4.43 (1.47)
threatening	t_parking5	4.17 (1.20)	5.22 (1.74)	3.99 (1.40)	3.91 (1.54)

threatening	t_squ1	4.61 (1.46)	5.63 (1.95)	3.84 (1.77)	3.89 (1.79)
threatening	t_squ2	4.01 (1.40)	6.38 (1.71)	3.21 (1.44)	3.30 (1.47)
threatening	t_squ3	4.57 (1.71)	5.56 (2.08)	3.63 (1.49)	3.65 (1.58)
threatening	t_squ4	5.24 (1.69)	4.88 (2.08)	4.54 (1.58)	4.59 (1.57)
threatening	t_squ5	4.13 (1.60)	5.72 (2.00)	3.61 (1.59)	3.50 (1.43)
threatening	t_str1	4.84 (1.41)	4.94 (1.93)	4.15 (1.63)	4.48 (1.71)
threatening	t_str2	3.12 (1.56)	7.05 (2.09)	2.33 (1.58)	2.04 (1.08)
threatening	t_str3	3.50 (1.69)	7.00 (1.84)	2.60 (1.42)	2.40 (1.16)
threatening	t_str4	3.70 (1.66)	6.70 (1.72)	2.85 (1.42)	2.80 (1.48)
threatening	t_str5	3.95 (1.31)	5.93 (2.07)	3.28 (1.51)	3.22 (1.46)
threatening	t_sub1	3.46 (1.53)	6.99 (1.93)	2.72 (1.87)	2.49 (1.40)
threatening	t_sub2	3.39 (1.51)	6.68 (1.74)	2.90 (1.39)	2.63 (1.21)
threatening	t_sub3	4.38 (1.19)	5.51 (1.85)	3.76 (1.45)	3.93 (1.32)
threatening	t_sub4	3.57 (1.71)	6.45 (1.85)	2.82 (1.42)	2.72 (1.38)
threatening	t_sub5	4.31 (1.19)	5.33 (1.67)	4.12 (1.48)	4.06 (1.57)