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Research Paper

Paradoxical effects of exposure to nature in "haunted" places: Implications for stress reduction theory

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HIGHLIGHTS

- Paranormal beliefs moderate the *stress reduction theory* proposed by Ulrich (1983).
- Environments considered to be "haunted" increase the anxiety levels of subjects who believe in the paranormal.
- Paranormal beliefs affect the sense of place.

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ABSTRACT

Stress Reduction Theory (SRT) ostensibly explains why natural environments have positive effects on mental health. However, there is debate about the particular characteristics of natural environments that best foster psychological well-being. In this research, we analyze the effects of supposedly "haunted" natural environments on people's stress levels. The abandoned village of *Marmellar* was chosen because it is a protected natural area, has numerous associated supernatural legends, and the popular media claims it is actively "haunted." This site was visited by a total of 208 participants, evenly balanced by self-reported believers in the paranormal vs. non-believers. Before and after the visits, the participants completed three questionnaires that measured their (a) stress levels, (b) suggestibility, and (c) neurasthenia (i.e., general fatigue or irritability). As predicted, the paranormal-believers showed significantly higher levels of stress, suggestibility, and neurasthenia than the non-believers. Paranormal-related beliefs and attributions related to the *Marmellar* environment specifically predicted 39% of the increase in stress levels. Paradoxical to SRT, our findings suggest that beliefs can override the role of biology in appraisal processes responsible for "sense-of-place." The risks and benefits of paranormal attributions in the context of personality are discussed.

1. Introduction

Urbanized environments — highly developed areas with a density of built structures such as houses, commercial buildings, roads, bridges, and railways - affect people's mental well-being and are correlated with incidence rates of psychiatric disorders (e.g., Chen & Chen, 2015; Ventriglio et al., 2020; Verheij et al., 2008). In contrast, research suggests that natural environments or green places tend to reduce perceived stress (e.g., Huang et al., 2020; Lin et al., 2019; Thompson et al., 2012). This is the rationale of so-called "biophilic design" that aims to capitalize on the hypothesized tendency for people to seek out connections with nature or naturalistic features (Wilson, 1984). Such efficacious effects tend to be documented over short periods of time, so it is not clear-cut whether stress reductions are stable over the longer term (Norwood et al., 2019). Nevertheless, urban planning schemes routinely take into account the assumed positive influences of natural environments on the psychological well-being of residents (e.g., Kaplan, 1995; von Lindern et al., 2013). This approach is primarily grounded in *Stress Reduction Theory* (SRT: see Ulrich, 1983, 1984) and perhaps secondarily in *Attention Restoration Theory* (ART: see Kaplan & Kaplan, 1989).

According to SRT, natural stimuli that are considered harmless (e.g., water, flowers, trees, etc.) and those that signify the presence of

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resources, generate an emotional response in people that rebalances their physiological stress levels and fosters pleasurable or otherwise efficacious feelings (see Ulrich et al., 1991). Several psychological theories related to SRT help to explain the observed positive effects of nature. For instance, ART is one of the best known and is complemented by SRT. ART is based on two types of attentions: *voluntary* and *involuntary* (Kaplan, 1995). Involuntary is a type of attention that an individual automatically and unconsciously develops. Normally, involuntary attention occurs when the intensity of a stimulus is excessively high and thus unavoidable to one's detection or attention. Voluntary is a manipulable type of attention that an individual uses consciously (for a review, see Rydstedt & Johnsen, 2019). ART can explain the positive emotional effects of natural environments on people because it assumes that people interact with nature automatically, i.e., via involuntary attention (e.g., Weeland et al., 2019). Unlike voluntary attention, this automatic interaction with nature promotes the balancing of individuals' stress levels (Kaplan & Kaplan, 1989; Kaplan, 1995). Therefore, ART similarly assumes that stress levels may increase if a person focuses exclusively on the use of voluntary attention (Igarashi et al., 2014; Kondo et al., 2020).

Despite the apparent validity of SRT and ART, it is challenging to confirm which characteristics of natural environments best sustain people's psychological well-being (e.g., Joye & Dewitte, 2018; Mochizuki-Kawai et al., 2020; Tyrväinen et al., 2014). Likewise, research suggests that some variables can moderate the relationship between environmental features and perceived stress (e.g., Meidenbauer et al., 2019). One such important moderator in SRT is sense-of-place (Gatersleben et al., 2020; Grahn & Stigsdotter, 2010; Liu et al., 2020). To clarify, *sense-of-place* denotes the connection that a person develops with a specific space or setting. Several approaches that define and explain this concept can be found in the scientific literature (e.g., Adams et al., 2017; Ratcliffe & Korpela, 2016; Nisa et al., 2020). In the present study, we define sense-of-place as the degree to which an individual identifies subjectively with the different stimuli and characteristics of a given environment (cf. Lengen and Kistemann, 2012; Zia et al., 2014). This definition of sense-of-place can also be understood as place attachment and/or place identity. In other words, the characteristics of an environment essentially condition a person in either positive or negative ways (Costlow et al., 2020). On the one hand, if the stimulation is positive, the individual will be more motivated and his or her well-being correspondingly increases (Morton et al., 2017). Conversely, if the stimulation is negative, the person will have higher levels of stress and an efficacious sense-of-place decreases (Quinn et al., 2019). Positive or negative conditions vary according to the beliefs, memories, and attributions of people to specific locations or settings (Adams et al., 2017; Knez et al., 2017, 2018).

One particularly important and positive psychological effect of sense-of-place is the perception of security (e.g., Bonaiuto et al., 2016; Quinn et al., 2019). For example, Andrade et al. (2017) observed that stress levels decreased in hospitalized patients when positive natural elements were incorporated into their rooms. These stimuli reinforced the sense-of-place and, consequently, increased the patient's sense of safety. Similarly, certain natural elements promote a sense-of-place that apparently triggers a feeling of security in people that itself serves as one of the mechanisms related to the restoration of stress levels (e.g., Scannell and Gifford, 2010). In fact, the way that human beings acquire feelings of security and control is a learning process dependent on the interaction between environmental stimuli, individual perception, and the causal attributions that people apply to their own local inputs (Irwin et al., 2013; Ross et al., 2017). For instance, Barclay and Barker (2020) found that individuals who practiced "ecological values" had greater psychological well-being than non-ecological individuals when they were in natural spaces. In the same vein, Bilewicz and Klebaniuk (2013) placed religious symbols in a university classroom and observed a reduction in negative affect only in "believing" university students.

Some natural places with minimal urbanization have been infused with religious, historical, or magical attributes (Houran et al., 2020). This concept of "paranormal legends" can be defined as a narrative that mixes historical and true facts about a certain place with certain fantasy and supernatural aspects that are ostensibly impossible in scientific terms (Irwin, 2009). Related attributions in the context of developed environments are often classified as "urban legends." Dagnall et al. (2017) noted that these particular legends have three characteristics: (a) they aim to stimulate emotional reactions in visitors to the place, typically fear or horror predominate (Heath et al., 2001), (b) their main contents are usually stable over time and only peripheral details or those intrinsically related to a popular fad are variable (Brunvand, 2012; Tucker, 2005), and (c) these types of legends usually convey a paranoid-type message of warning, and people who accept its veracity think that the urban legend affects people's lives (Tree & Weldon, 2007). These three points raise the question of how an urban or paranormal legend causes a harmless, natural place to be perceived by believers in the legend as a dangerous environment (see e.g., Dagnall et al., 2017). These theoretical foundations support the hypothesis put forward in this research (see the subsection 1.1.).

When a place has a history of paranormal legends and its structural and accidental characteristics facilitate anomalous perceptions (interpreted as "supernatural" phenomena), the place is called a "haunted environment" (Dagnall et al., 2020; Houran et al., 2020; Jawer et al., 2020). This resultant belief or attribution is not necessarily irrational; however, as McAndrew (2015), McAndrew (2020) argued from an evolutionary-environmental standpoint that an adaptive sense of "creepiness" often results from the top-down processing of physical features that reliably activate people's threat detection systems, including darkened settings, moldy odors, unfamiliar layouts, or culturally-programmed cues such as antiquated Victorian or Gothic architecture. Analogous to religious symbols that psychologically influence believers, we contend that the physical (or psychological) cues in "haunted" locations often affect the attitudes and behaviors of paranormal believers. We should note that some academic authorities question whether anomalous experiences, such as reported at haunted places, can be explained entirely as cognitive biases or illusions but instead might represent genuinely parapsychological phenomena (e.g., Cardeña, 2018; Maher, 2015; Storm & Tilley, 2020). Nevertheless, most recent research focuses on understanding the psychological effects of these kinds of experiences-beliefs and not on contrasting their authenticity or ontological validity (for an overview, see Laythe et al., 2021).

1.1. The present study

Our objective was to analyze the influence of a "haunted" label on the perceived stress levels of believers and non-believers in the paranormal who are immersed within natural features that should otherwise have a calming effect. We predict that such natural environments (i.e., forests, mountains, etc.) that carry "haunted" reputations will paradoxically increase the stress levels of paranormal believers, who either attribute negative and supernatural powers to such places or exhibit strong physiological arousal due to expectancy-suggestion effects. Conversely, people who do not believe in the paranormal are not expected to have increased stress levels because they do not attribute paranormal qualities to haunted environments (although their stress may be reduced simply by being in a natural space). These hypotheses imply a moderation model between variables as represented in Fig. 1.

Stress can be measured via multiple psychological indicators (Padmanabhan, 2021). The most frequent forms of stress in paranormal believers arguably derive from suggestibility and neurasthenia (e.g., Betsch et al., 2020; Escolà-Gascón, 2020a). Neurasthenia is a clinical attribute characterized by intermittent states that fluctuate between maximum stress and extreme exhaustion (Escolà-Gascón, 2020b). In contrast, suggestibility is the degree of emotional susceptibility felt by an individual due to the influences and intensity of environmental stimuli (Hergovich, 2003). Neurasthenia differs from suggestibility in

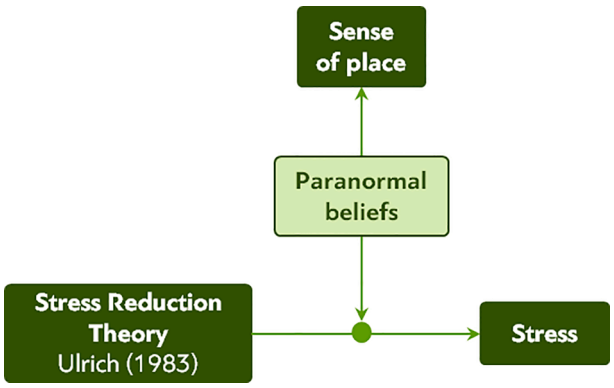

Fig. 1. The hypothetical and psychological model that explains why certain places are considered "haunted environments". Paranormal beliefs are a moderating variable between the effects of the natural environments and the levels of stress assessed. The dashed line represents the relationship between the natural elements and the sense-of-place.

that levels of stress and fatigue are not explained by environmental influences, but by other factors related to personality traits (see e.g., Overholser & Beale, 2019). Accordingly, this study measured three facets or dimensions that characterize stress states in the context of paranormal beliefs: (a) environmental stress, (b) suggestibility, and (c) neurasthenia.

2. Method

2.1. Participants

Data derived from 208 participants (59.6% women, 40.4% men, 50% believers in the paranormal, 50% nonbelievers), who resided in Barcelona (Spain) and were over 18 years old (M = 35.41, SD = 8.954). Furthermore, 56.3% said they had completed or were in the process of completing university studies, and 43.8% said they had received only vocational training. Participants signed a written consent form authorizing their participation in this study and self-reporting no psychiatric history.

2.2. Measures

2.2.1. Spielberger's 20-item State-Trait anxiety inventory (STAI)

Originally developed by Spielberger et al. (1970), this questionnaire measures the levels of stress (also called anxiety in this survey) present in a subject from two dimensions: trait-type anxiety (consisting of 20 items) and state-type anxiety (consisting of 20 items). We used only the state-type version in this study. State-type anxiety measures the environmental stress symptoms typified in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (see American Psychiatric Association, 2013). The responses are coded using a 4-point Likert scale (ranging from 0= "nothing" to 3= "very much"). The participant must indicate the intensity with which he or she perceives each symptom described in the items. Specifically, we use the Spanish version updated by Guillén-Riquelme & Buela-Casal (2011), which presents satisfactory psychometric properties, with reliability and internal consistency indices above 0.9 (*Omega* coefficients for this sample was > 0.8). In addition, this test has been used in numerous researches related to environmental psychology (e.g., Andrade & Devlin, 2015).

2.2.2. Multivariable multiaxial suggestibility Inventory-2 (MMSI-2)

The MMSI-2 is a questionnaire made up of 174 items and 21 scales. Only the scales of suggestibility (called "Su" and composed of 7 items) and neurasthenia (called "Nt" and composed of 15 items) were applied since they are frequent variables in subjects who believe in the existence of the paranormal (see Irwin, 2009). The Su scale allows for measuring the degree to which an individual is emotionally influenced by the inputs of the environment. The Nt scale allows us to evaluate the lability of moods, which fluctuate between fatigue (both psychological and physical) and emotional excitement. The responses are coded using a scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), and a participant must use this scale to indicate his or her level of agreement with what is stated in each item (Escolà-Gascón, 2020a). The MMSI-2 was developed and validated for more than eight years by Escolà-Gascón (2020b). It has excellent reliability and internal consistency indexes since they are higher than 0.9 in all scales (*Ordinal alphas* for this sample were > 0.85). Similarly, the psychometric properties of the MMSI-2 are satisfactory and have been shown to be effective in this type of research (see Escolà-Gascón et al., 2020, 2021; Escolà-Gascón, 2021).

2.2.3. Australian Sheep-Goat scale (ASGS)

The ASGS scale is an 18-item test originally developed by Thalbourne (1981). This questionnaire examines paranormal beliefs and experiences. The subject must indicate whether the contents of each item are true or false according to his or her own beliefs. The answers have various types of codifications. In this research, we used the proposal of Drinkwater et al. (2018), which consists of three alternatives: "true"= 2, "I doubt my answer"= 1 and "false"= 0. In the most updated validation carried out by Drinkwater et al. (2018), the indices with internal consistency>0.8 (obtained for all ASGS items) were used. This study used the unpublished Spanish adaptation by A. Escolà-Gascón and Lance Storm, which has equally acceptable reliability indices (>0.7) (*Ordinal alphas* for this sample were > 0.7).

2.3. Procedures

There was no random assignment of participants to the categories of independent variables, so this study used a quasi-experimental design and is based on comparative group analysis. The sample was recruited using two resources: (1) social networks were used to contact some of the participants, and (2) a database from *MAGIC International, Inc.* (based in Barcelona) was also used to identify potential believers in the existence of the paranormal. Over five years, the 208 participants who made up the final study sample were progressively contacted. We used a five-phase procedure as follows:

Phase 1: The candidate was contacted. If the participant agreed to collaborate in the research anonymously, he or she would sign the informed consent form.

Phase 2: The ASGS questionnaire was applied and corrected. Scores higher than 6 points (out of 36) indicated that the participant believed in the existence of the paranormal, and he or she was thus classified in the "believers" group. In contrast, participants with scores below this cut-off point were classified in the nonbelievers group. This cutoff point was chosen based on statistical evidence from this study's sample. Specifically, the 50th percentile of the response distribution was used as the cutoff point. For a better understanding of this criterion, Fig. 2 shows the histogram of the responses to the ASGS questionnaire. Likewise, the distribution of the participants was calculated after the application of this questionnaire.

Phase 3: A description of the "haunted places" characteristics was given to the participants, and the logistic and organizational decisions were made. The abandoned village of *Marmellar* was selected as the "haunted place" for two reasons: First, there were numerous legends on social networks that attributed paranormal and supernatural events to this place. In addition, it was frequented by sectarian groups, and a woman was murdered in the ruined church of this town during the 1990 s (see LaVanguardia, 2020); this last fact reinforced the mysterious and paranormal value of the place. Second, *Marmellar* is currently a protected "natural area," and the abandoned village itself is part of one of the trekking routes of the *Montmell Mountain* range (located in Tarragona, Spain). Following the criteria of SRT (Ulrich, 1983, 1984), the

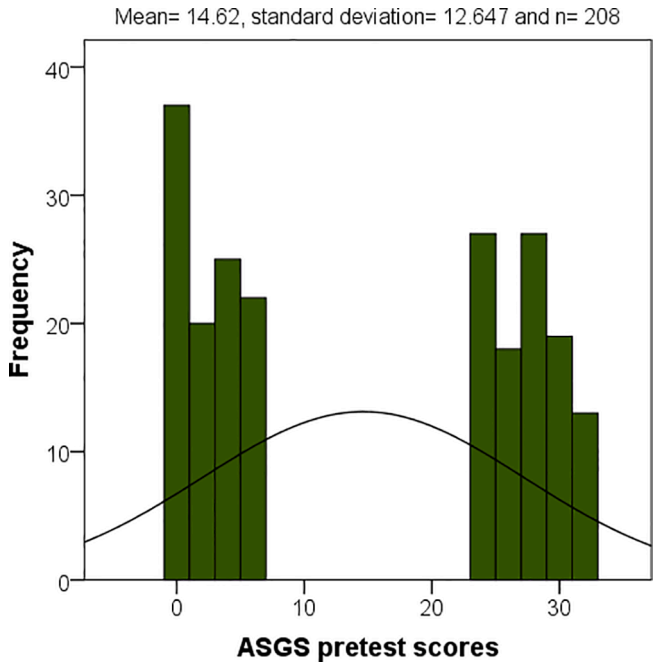

Fig. 2. Frequencies and histogram of pretest ASGS scores. The 50th percentile was used to differentiate between paranormal believers and non-believers.

fact that it is a natural park meets the characteristics of natural environments. The logistical decisions were related to the conditions regarding transportation, the duration of the excursion and the dates when the activities were to take place. Each visit to *Marmellar* lasted for a total of 3 h (from 1:00p.m. to approximately 4:00p.m., including lunch). Each participant was given a free lunch pack containing the following: a sandwich, a piece of fruit, juice, water and a snack. The ingredients of the meals took into account the intolerances and allergies of each participant. In no case could the participant take natural psychostimulants (e.g., coffee and infusions) or central nervous system depressants (e.g., sedative infusions). Twenty-four hours before the excursions, the questionnaires described in subsection 2.2 were sent digitally to the participants to conduct the pretests. Once these questionnaires were completed, the team and the participant traveled to *Marmellar* by car. During the drive, the history of the place was explained to all participants (believers and nonbelievers), taking into account the information provided by LaVanguardia (2020). Notably, no subject had previously visited the abandoned village of *Marmellar*.

Phase 4: Development of the visit to the *Marmellar* village. In each excursion, the participant received the following instructions: *"You must make a 60-minute tour of the village. The tour is free, and you can explore whatever you want about this place. During this time, you can do any leisure activity you wish. Keep in mind that you are in a protected natural environment. Therefore, your actions should not harm the natural and historical characteristics of the place"*. After 60 min, the research team and the participant had 1 h to eat and rest. After lunch, another excursion was made that lasted 60 min. The second excursion had the same characteristics and instructions as the first one. In total, the stay in *Marmellar* would last 3 h. During the two activities or excursions the participant was alone and could not interact with other people or use the phone or any installed applications (e.g., WhatsApp). The leisure activities by the participants included walking, observing, and contemplating the natural environment. Participants did not fall asleep, did not practice sports, and did not engage in any activity that interfered with the purposes of the excursions (e.g., reading a book, drawing, using their mobile devices, taking pictures, etc.).

Phase 5: At the end of the last tour of the place, the participant had to answer the MMSI-2 and STAI questionnaires. They were also asked the following question: *"Please indicate on a scale from 0 to 10 the degree to which you identify with the characteristics of this place (with 0 being 'nothing at all' and 10 being 'completely')"*. This consultation served as an estimator of the sense-of-place.

There were no setbacks in the execution of the excursions and the application of the questionnaires.

2.4. Statistical analysis

The data were processed with JASP and JAMOVI software (see The Jamovi Project, 2020). First, an *analysis of variance* of 2 factors was applied (2x2 ANOVA). One factor differentiated the measures in time (pre- and posttests) and referred to Ulrich's (1983) theory. The other factor had the categories "group of believing subjects" and "group of nonbelieving subjects" and referred to beliefs in the existence of the paranormal. The MMSI-2 scales and the state-trait anxiety index (STAI-E) were the dependent variables.

The 2×2 ANOVA model enables the analysis of 4 types of effects: (a) main effects, (b) main interaction effects, (c) simple effects, and (d) simple interaction effects. The main effects use the means of the dependent variables based on the marginal distributions. In contrast, simple effects use the means observed for each dependent variable and group. In ANOVA models, the means (observed and marginal) are compared with each other to see if the observed variability in each comparison exceeds the expected variability by chance. To better facilitate the understanding and applicability of this model to the hypotheses in Fig. 1, we made a contingency table that shows the means related to the main and simple effects. This information is found in Table 1.

The notations in Table 1 that include the "+" symbol are the marginal means for each dependent variable. According to Pardo & Ruiz (2015), simple effects and especially simple interaction effects are usually not analyzed in 2x2 ANOVA models because simple interaction effects are comparisons that are difficult to understand without a statistical basis. The annotations in Table 1 are used in the results section to explain more easily the comparisons made.

Second, the analysis of the sense-of-place was carried out using *Student's t-tests*, the *Mann-Whitney U tests* and *Cohen's d. Analysis of covariance* (ANCOVA) using the sense-of-place as a covariable was not applied because it did not comply with two previous assumptions of this model (see Keppel & Wickens, 2004). The rest of the previous assumptions were met for both the ANOVA model and *Student's t-test*. These statistical analyses enabled us to contrast the hypotheses raised in Fig. 1 of the introduction.

3. Results

3.1. Descriptive statistics

The descriptive statistics are presented in two tables. Table 2 shows the compilation of the marginal means, and Table 3 presents the observed empirical means.

In the tables below, the comparisons between means follow the

Table 1
Example of a 2x2 contingency table with the location of each cell. The mean corresponding to each dependent variable is found in each cell.

	A- *Pretest*	B- *Posttest*	*Main effects*
A- Believers	*Means* AA	*Means* AB	A+
B- Nonbelievers	*Means* BA	*Means* BB	B+
Main effects	+A	+B	++

Note: The annotations in this table come from the proposals of Pardo & Ruiz (2015). The "+" notation means that the mean of that cells are marginal. The codes in each cell can be used to understand the comparisons of the means in Tables 5, 6 and 7.

Table 2
Descriptive marginal statistics for each variable and group (n = 208).

DV	Nonbelievers(including pre- andposttest scores)		Believers(including pre- andposttest scores)		*Pre*tests(including believersand nonbelievers)		*Post*tests(including believersand nonbelievers)	
	Means	SD*	Means	SD*	Means	SD*	Means	SD*
STAI	9.07	0.534	13.23	0.534	10.3	0.386	12	0.386
Su	12.6	0.437	15.9	0.437	13.8	0.310	14.8	0.310
Nt	26.6	0.680	31.2	0.680	28.2	0.489	29.6	0.489

Note: STAI = state-trait anxiety, Su = suggestibility, Nt = neurasthenia, and SD = standard deviation.
* The SDs were calculated for each variable because the means are marginal (see also Table 3).

Table 3
Descriptive statistics per variable and group (n = 104).

Dependent variables	*Pre*tests				*Post*tests			
	Nonbelievers		Believers		Nonbelievers		Believers	
	Means	SD	Means	SD	Means	SD	Means	SD
STAI	9.087	5.532	11.433	5.180	9.058	5.554	15.019	5.976
Su	12.913	3.632	14.913	5.195	12.567	3.502	16.952	5.244
Nt	26.654	6.947	29.683	7.156	26.558	6.920	32.683	7.156
ASGS	2.24	2.13	27	2.76	–	–	–	–
SP	–	–	–	–	1.89	1.45	4.66	3.29

Note: STAI = state-trait anxiety, Su = suggestibility, Nt = neurasthenia, ASGS = scores regarding paranormal beliefs, SP = sense-of-place, and SD = standard deviation.

mathematical notations in Table 1.

3.2. Two-factor linear model

Table 4 summarizes the main effects observed. Nonparametric versions of *Fisher's F* were included as complementary statistical inferences. The effect size was also estimated using the partial eta squared statistic. This statistic can be interpreted as the explained variance over the dependent variables.

According to the *F-test*, significant results were obtained for all the dependent variables and all the main effects. However, the main interaction effects show the highest explained variances. In the case of stress, the interaction of paranormal beliefs and the characteristics of the environment (pre- and posttests) predicts 39% of the observed changes in stress. Nevertheless, suggestibility is the variable that undergoes the greatest changes. Specifically, the interaction predicts 63.5% of the increase in observed suggestibility. According to these results and according to the marginal means in Table 2, environmental stress, suggestibility and neurasthenia increased significantly after the subjects' exposure to the rural environment of *Marmellar*. The problem is that they are marginal means; and with this first inference, it is not possible to know if these increases only occur in the group of believers or nonbelievers. For this reason, the analyses of the simple effects (see Tables 5 and 6) and the inference based on the simple effects of interaction (see Table 7) are presented.

Table 4
Analysis of variance (ANOVA) and the main effects of the variables.

DV	IV	*F (df = 1)*	[a]χ^2 *(df = 1)*	*Kendall'sW test*	Effect sizeη_p^2
STAI	*Pre-post*	127.652**	62.235** (*Friedman test*)	0.947	0.383 (38.3%)
	Beliefs	30.2**	4.020*(*Durbin test*)	102,155.805	0.128 (12.8%)
	Interaction	131.826**	–	–	0.390 (39%)
Su	*Pre-post*	286.111**	70.127** (*Friedman test*)	0.974	0.581 (58.1%)
	Beliefs	28.705**	1.546(*Durbin test*)	58,600.146	0.122 (12.2%)
	Interaction	358.898**	–	–	0.635 (63.5%)
Nt	*Pre-post*	68.688**	115.614** (*Friedman test*)	0.963	0.250 (25%)
	Beliefs	22.672**	1.830(*Durbin test*)	161,463.754	0.099 (0.9%
	Interaction	78.087**	–	–	0.275 (27.5%)

Note: *p < 0.05, and **p < 0.001. DV = dependent variables, IV = independent variables, df = degrees of freedom,η_p^2 = eta partial squared use to measure the explained variance, STAI = state-trait anxiety, Su = suggestibility, and Nt = neurasthenia. a. Chi square was adapted to each type of main effect per Pardo and Ruiz (2015).

The only difference between simple effects and simple interaction effects is that for the former, the comparison between the respective means is always made by maintaining the one of the factors at the same level. In contrast, for the simple interaction effects, the comparison between the means is carried out at different levels for both factors.

Table 5 shows that only believers in the paranormal reported increases in the three dependent variables (i.e., STAI, Su and Nt). The results of Table 6 indicate that both paranormal believers and nonbelievers) evidenced similar STAI, Su and Nt scores before being exposed to *Marmellar*'s environment for three hours. Finally, the simple interaction effects shown in Table 7 reveal that the means of the nonbelievers in the post-tests were significantly lower than the means of the believers in the pre-tests. This important result supports our interpretations of the results in Tables 5 and 6, i.e., the variation is only significant in the group of paranormal believers. However, the effect sizes in Tables 5-7 are not very strong. The largest effects are observed for the stress and suggestibility variables and then only for the group of paranormal believers.

In general, the ANOVA results reject the null hypotheses and support our hypotheses specified in subsection 1.1. Therefore, we conclude that *natural environments with paranormal attributions generate effects that are seemingly paradoxical to the predictions of stress reduction theory.*

3.3. Do paranormal beliefs influence "sense-of-place"?

In this analysis, we used the *Student's t-test* and its nonparametric tests. Table 8 compares the differences between the observed means regarding the sense-of-place in the paranormal believers versus the nonbelievers.

These results indicate that the sense-of-place was significantly for higher in the paranormal believers than non-believers, which affirms that belief systems can influence people's holistic impressions of physical environments. However, our results do not immediately clarify

Table 5
Simple main effects analysis for the paranormal beliefs variable between the "pre" and "post" test variable.

Dependentvariables	ParanormalBeliefs variable	*Meanscomparison*	*t-test**	*p* values(Bonferroni)	*p* values(Tukey)	*d*
STAI	Believers	AA - AB	16.108	<0.001	<0.001	1.117
	Nonbelievers	BA - BB	−0.130	~1	~1	−0.009
Su	Believers	AA - AB	25.356	<0.001	<0.001	1.758
	Nonbelievers	BA - BB	−1.435	0.916	0.479	−0.1
Nt	Believers	AA - AB	12.109	<0.001	<0.001	0.840
	Nonbelievers	BA - BB	−0388	~1	~1	−0.027

Note: STAI = state-trait anxiety, Su = suggestibility, Nt = neurasthenia, and
d = Cohen's d corrected using Hedges' g. * The *t*-test was corrected for multiple comparisons.

Table 6
Simple main effects analysis for the pre- and posttest variables between "believers" and "nonbelievers".

Dependentvariables	Pre and Posttests	*Meanscomparison*	*t-test**	*p* values(Tukey)	*p* values(Bonferroni)	*d*
STAI	*Pre*test	AA - BA	−3.039	0.016	0.014	−0.211
	*Post*test	AB - BB	−7.721	<0.001	<0.001	−0.535
Su	*Pre*test	AA - BA	−3.598	0.002	0.002	−0.249
	*Post*test	AB - BB	−7.072	<0.001	<0.001	−0.490
Nt	*Pre*test	AA - BA	−3.100	0.013	0.012	−0.215
	*Post*test	AB - BB	−6.269	<0.001	<0.001	−0.435

Note: STAI = state-trait anxiety, Su = suggestibility, Nt = neurasthenia, and d = Cohen's d corrected using Hedges' g. * The *t*-test was corrected for multiple comparisons.

Table 7
Interaction of the simple main effects.

Dependentvariables	*Meanscomparison*	*t-test**	*p* values(Tukey)	*p* values(Bonferroni)	*d*
STAI	AA - BB	−3.076	0.014	0.013	−0.213
	BA - AB	7.684	<0.001	<0.001	0.533
Su	AA - BB	−3.784	0.001	0.001	−0.262
	BA - AB	6.886	<0.001	<0.001	0.477
Nt	AA - BB	−3.198	0.010	0.009	−0.222
	BA - AB	6.170	<0.001	<0.001	0.840

Note: Note: STAI = state-trait anxiety, Su = suggestibility, Nt = neurasthenia, and d = Cohen's d corrected using Hedges' g. * The *t*-test was corrected for multiple comparisons.

Table 8
Means comparison using *t*-test for sense-of-place (dependent variable) and beliefs in paranormal (independent variable).

Dependent variables	Groups	*Welch's t-test*(p-values)	*Mann-Whitney U test*(p-values)	[a]*Cohen's d*according *t-test* size effect
Sense-of-place	Nonbelievers Believers	−7.856<0.001	2,840<0.001	−1.085

Note: [a]Cohen's *d* corrected using Hedges' *g*.

whether sense-of-place affects perceived levels of stress, suggestibility, and neurasthenia. We address this confound in the general Discussion.

4. Discussion

This study examined the moderation effects of people's paranormal beliefs on *Stress Reduction Theory* under real-world conditions by having participants tour a natural environment with relaxing physical characteristics per SRT reasoning but simultaneously imbued with a potentially countervailing "haunted" reputation. In this situation, we found that paranormal believers reported significant increases in their stress levels, suggestibility, and neurasthenia, whereas non-believers showed no such significant variations in their stress levels. Moreover, paranormal believers reported higher levels of a sense-of-place with respect to the non-believers. These patterns indicate that people's belief systems can substantially alter or nullify outcomes predicted by SRT, as well as suggest some practical considerations for the landscape design process.

Particularly, we found that the tenets of Ulrich's (1983, 1984) original model are not unassailable, i.e., despite immersion within a naturally-relaxing environment, expectancy-attribution effects related to paranormal beliefs *increased* (not decreased) the levels of stress, suggestibility, and neurasthenia in participants. This finding conceptually replicates previous research on the role of suggestion in the haunt-type experiences reported by paranormal believers (e.g., Houran et al., 2020; Lange & Houran, 1997, 2001). Future research might find that the apparent exceptions to SRT/ ART can extrapolate to other belief systems like *religious ideology* (e.g., Bilewicz & Klebaniuk, 2013). In fact, people may attribute various meanings to the same natural or built environment due to its perceived *authenticity* (Maitland, 2019), *aesthetics* (Maitland & Smith, 2009), or any other number of *ecological*, *social*, *economic*, *cultural*, *historical*, or other aspects (Adams et al., 2017). This view sides with other research that suggests "enactive" (environment-person) experiences depend more on psychological or situational context than the role of discrete variables in the physical environment (see e.g., Dagnall et al., 2020; Lange & Houran, 2001).

However, it seems to further contradict SRT/ ART principles that the stress levels of the non-believers in our study were likewise not reduced after their immersive experiences. This implies that paranormal legends associated with a location might also somehow impede the positive effects of natural exposure in people who should be immune to expectancy effects. Two explanations come to mind to square this apparent discrepancy. First, per Ulrich's (1984) research on SRT with hospitalized patients, it might be that the effects of natural exposure are *only* or *mostly* evident in individuals who are experiencing a relatively high degree of environmental stress, dissonance, or "dis-ease" (i.e., the natural state of "ease" being disrupted or imbalanced). The paranormal

believers might thus have experienced strong anticipation or physiological arousal at the prospect of visiting a haunted locale (cf. Houran et al., 2020), whereas the non-believers had no such dis-ease that needed leveling. In other words, perhaps the relatively low stress levels of the non-believers were not conducive for SRT/ ART effects. Alternatively, the instruction set in the research proceedings might have fueled the voluntary attention of the non-believers and thereby introduced a confounding factor to the influence of natural exposure.

On a practical level, our results offer a cautionary lesson for designers and managers of natural and built environments. It does seem adequate simply to reduce the types of physical variables or cues that might unwittingly stimulate people's threat detection systems, as discussed in detail by previous authors (see Dagnall et al., 2020; Jawer et al., 2020; McAndrew, 2020). Instead, the more complex and nuanced challenge is to minimize the psychological cues that can stoke paranormal attributions or otherwise negative impressions in visitors. This is likely to be easier said than done for people with strong paranormal beliefs, but our study underscores the need to strategically plan and manage the "brand personality" of a location and this starts with being conscientious about building or designing structures in the vicinity of what might be called "uncanny geographies," i.e., areas or zones with existing reputations that explicitly or implicitly serve as paranormal legends (for an extended discussion, see Houran et al., 2020). Feasibility studies for new landscape designs, built structures, or other environmental projects that aim to leverage SRT, ART, and biophilic designs are advised to include assessments of the religio-cultural perceptions, stories, or histories linked to a specific geography.

4.1. Implications of the moderation effects of paranormal beliefs on SRT

Our findings underscore the importance of psychological influences and belief systems on people's subjective experiences of external environments. Although structural and accidental features of natural or built environments certainly can influence people's psychological well-being, it seems clear that these effects are not independent of prior learnings or schemas of individuals. In fact, belief systems, including the paranormal, can be explained through psychological theories of learning (Irwin, 2009; Irwin et al., 2013). As described in the introduction, numerous investigations have showed that stress levels are reduced when people were more exposed to green or natural environments (Huang et al., 2020; Lin et al., 2019; Thompson et al., 2012). However, the results of this research question the generalizability of some of this evidence for SRT.

We argue that the increased stress levels were an exception to Ulrich's (1983, 1984) original theory, because we only observed these in paranormal believers. In this context, paranormal beliefs were apparently not beneficial (or anxiolytic) when forming an impression of the natural environment. This "antagonistic" effect of belief has been documented in prior studies of paranormal experients who were already highly fearful of the supernatural (Lange & Houran, 1999, 2001; Lange and Houran, 2000), but it contrasts with Bilewicz and Klebaniuk (2013) who studied the psychological effects of religious symbols in university classrooms. Therefore, consistent with the arguments of Houran and colleagues (2020; Hill et al., 2019; Lange & Houran, 2001), we contend that the features of physical environments naturally influence people's sense-of-place (i.e., SRT) but that biological sensations do not consistently outweigh the role of people's own beliefs in immersive or enactive experiences.

Another observable exception to SRT in our study was that the levels of stress, suggestibility, and neurasthenia in non-believers in the paranormal remained stable after the excursion. According to SRT, this group should have reported reductions in their stress levels. The only information given to all participants that might explain the lack of significant differences in the non-believers was that real crimes indeed occurred at *Marmellar* (see LaVanguardia, 2020). Thus, it might be that even this group of participants maintained some level of physiological arousal under these circumstances due to the psychology of paranormal tourism. That is, this activity represents a hybrid of "dark tourism" (places historically associated with death or tragedy) and "heritage tourism" (places where visitors can experience authentic representations of people and stories of the past) (Houran et al., 2020). Overall, the visit to *Marmellar* might have therefore constituted an "immersive experience" for all participants.

An immersive experience is traditionally deemed an illusory environment that completely surrounds you such that you feel that you are inside it and part of it. The term originated with technology environments that were designed to command the senses such as "virtual, augmented, or mixed realities." But Houran et al. (2020) re-defined immersive experiences in terms of psychological absorption — "a disposition for having episodes of 'total' attention that fully engage one's representational (i.e., perceptual, enactive, imaginative, and ideational) resources" (Tellegen & Atkinson, 1974, p. 268). Simply put, this entails the cognitive capacity for involvement in sensory and imaginative experiences in ways that alter a person's perception, memory, and mood with behavioral and biological consequences.

Taken altogether, our findings suggest that SRT is incomplete as a *one-way* model ("biology → beliefs"). Biology and beliefs instead seem to work in tandem via a *two-way* model that defines enactive experiences (Jawer et al., 2020; Jelić et al., 2016). From this perspective, sometimes we observe "belief → biology" effects (cf. Lange & Houran, 1997). Fig. 3 summarizes this hypothetical "interactionist" model, which should be tested in future research.

4.2. Implications of the effect of paranormal beliefs on the sense-of-place

The sense-of-place is a variable related to SRT (see Gatersleben et al., 2020; Grahn & Stigsdotter, 2010; Liu et al., 2020). If sense-of-place fundamentally represents subjective perceptions (e.g., Lengen and Kistemann, 2012), then it is reasonable to expect that people's belief systems can influence it. In fact, a possible explanation for the significant relationship between beliefs and sense-of-place originates with Irwin's (2009) contention that paranormal beliefs can provide people a useful sense of control. Other authors defend this idea (e.g., Andrade et al., 2017), including researchers who specifically examined the psychology of ghostly beliefs and experiences (Lange & Houran, 2001). Therefore, another proposal for future study would be to link the sensation of control as a mediating variable between paranormal beliefs and sense-of-place. It would also be interesting to analyze the relation that this variable has with the moderating effects of paranormal beliefs on SRT. However, this possibility is only being advisable if the sense-of-place covariates with the recorded stress levels.

4.3. Limitations

We note a few methodological shortcomings. *First*, sense-of-place was measured as a subjective feeling or an opinion as opposed to using a previously structured or validated test. This might be the main reason why sense-of-place did not correlate with our dependent variables. However, a literature search for a self-reported questionnaire adapted to Spanish that evaluated this variable was unsuccessful. Still, our approach was based on the self-reported models applied to other environmental psychology research (Quinn et al., 2019; Zia et al., 2014).

Second, we relied on self-reported measures of perceived stress, while other research used direct biological measurements based on cortisol levels in the body (e.g., Huang et al., 2020). Our approach was not inappropriate, but the results from this indirect measure should be conceptually replicated via biological indicators of increased stress levels. Nevertheless, our results reinforce the contrasted hypotheses and can serve as preliminary evidence for further research on possible exceptions or refinements to SRT.

Third, our findings have limited generalizability. Although our sample was sufficiently large for the analyses we conducted, the

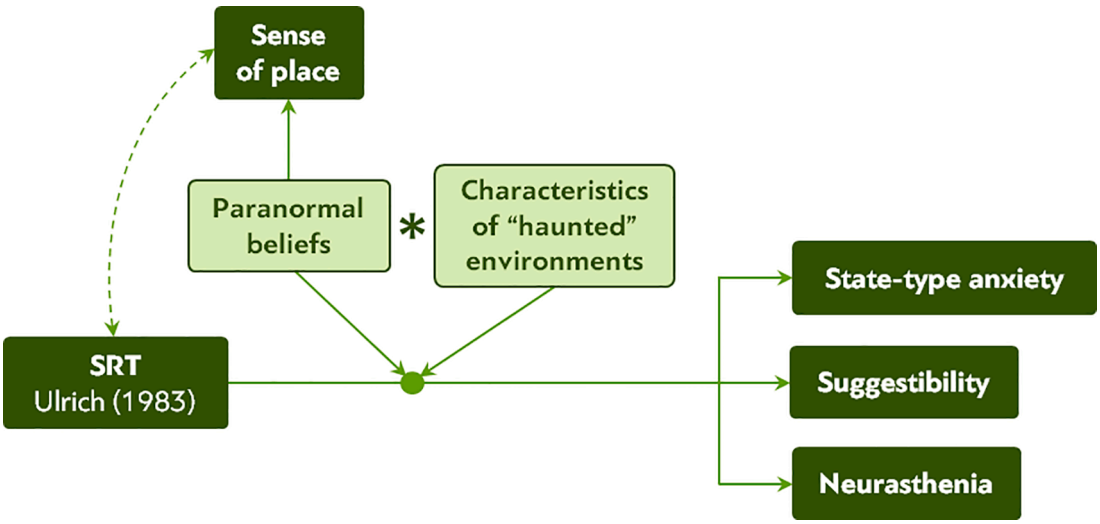

Fig. 3. An Interactionist Model for Sense-of-place at the Marmellar Tourist Site. The asterisk indicates the presence of an interaction between the two variables.

sampling was not probability-based and further restricted to participants in Spain. This could imply that cultural factors are possible "covariates" with the effects observed here. It is important to note that the concept of a "haunted" place may have similar meanings in Western countries, but its psychosocial impact may be different across different cultures or even individual ideologies of participants (Hill et al., 2019). For example, it is possible that, in some Western countries, the reputedly haunted sites generate reactions of comfort and security in the believing for paranormal believers (e.g., Bilewicz & Klebaniuk, 2013). Therefore, future research should explore differences in participants' cultural beliefs and expectancies about "haunted" places.

5. Conclusions

Contrary to basic tenets of SRT, not all "natural" environments automatically reduce stress levels. We found that stress levels can increase when a natural environment has a paranormal reputation and when visitors have an existing belief in the paranormal. Interestingly, the stress levels of non-believers can be sustained under similar conditions, perhaps suggesting that any type of "immersive" experience correlates to physiological arousal. Our collective results imply that belief systems can significantly moderate the effects of SRT. It is possible that the interaction between paranormal beliefs and the effects of natural environments on stress levels is also conditioned by the discrete physical characteristics of the environment, which may facilitate thoughts, feelings, or perceptions that an environment is "haunted" (see Dagnall et al., 2020; Houran et al., 2019b; Jawer et al., 2020).

Furthermore, paranormal believers reported higher levels of sense-of-place than non-believers during visits to a reputedly haunted location. This effect was not unexpected (Jawer et al., 2020) and it may reflect a sense of control that paranormal beliefs can provide individuals (Irwin, 2009). However, the relationship between paranormal beliefs and sense-of-place is not entirely clear-cut, since the paranormal believers showed higher levels of stress as opposed to anxiolytic outcomes. This indicates that the correlation between sense-of-place and stress levels, if any, should be negative. In any case, more research is needed to better understand how belief systems work to shape a person's sense-of-place.

Lastly, our findings support an interactionist model of "haunted" environments (cf. Fig. 3), which agrees with previous work on the psychology of ghostly episodes (Houran et al., 2019a, 2019b; Jawer et al., 2020; Lange & Houran, 2001). This view contends that increased stress, suggestibility, and neurasthenia in paranormal believers reflect the interaction between paranormal beliefs and attributions and the perceived characteristics of physical environments. In particular, paranormal beliefs predicted 12.8% of the variance in stress levels. Given that the explained variance increases by 26.2% (cf. Table 4) when a "haunted" label was attributed to the site (pre-postvariable), it seems likely that the physical features of the site interacted with the beliefs to account for a greater percentage of the variance in people's stress levels.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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