From values to emotions : Cognitive appraisal mediates the impact of core values on emotional experience

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Cognitive appraisal mediates the impact of core values on emotional experience

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Abstract

Emotions and values are fundamentally connected. They both are psychological markers of subjective relevance, and are thought to be deeply functionally intertwined: According to appraisal theories of emotion, emotions arise when value concerns are at stake; according to theories of value, a value that is threatened or supported gets infused with feelings. Surprisingly, while these assumptions are considered well-established by researchers in the respective domains, up to now empirical research has not provided much evidence supporting a link between values and emotions. To fill this gap, here we report results from three experiments demonstrating that values are indeed antecedents of emotions when emotional experiences arise in response to value-relevant stimuli. Individual differences in biospheric values predicted the intensity of emotional responses towards positive and negative information concerning nature and climate change, both when measured via psychophysiology (Experiment 1) and via self-report (Experiments 1-3). Primary appraisal was identified as the key process connecting values and emotions (Experiments 2-3), supporting the notion of appraisal theories that specific mechanisms of relevance detection underlie the elicitation of emotion. These findings may lead to new developments in value and emotion theories, potentially resulting in a stronger integration of the two constructs in a shared theoretical framework.

Keywords: values, emotion, emotional intensity, primary appraisals, secondary appraisals, Skin Conductance Responses, biospheric values, environmental change

1. Introduction

Think for a moment about something that is of high importance in your life. This can be your family, your career, or that charity project into which you have invested time and effort. What do you feel? You may feel happy, excited, frustrated or stressed, but it is highly unlikely that you don′t feel anything: We experience emotions when we are reminded of things we care about. As Lazarus wrote in 1991: "We don't become emotional about unimportant things, but about values and goals to which we have made a strong commitment" (Lazarus, 1991b, page 819). After becoming emotional about something that is important to you, it is also likely that you feel the urge to take action. For example, calling your family to be sure that they are well, checking your emails to see if anything important has come up at work, or working on that problem that got your project stuck for days. These everyday examples point out that our core values and emotions are fundamental drivers of behavior (Brosch & Sander, 2016). But how are they connected? With the present research, we offer a novel perspective on the link between values and emotions in the framework of two major psychological theories: The Theory of Basic Human Values (Schwartz, 1992; Schwartz et al., 2012) and appraisal theories of emotion (for a review see Moors, Ellsworth, Scherer, & Frijda, 2013).

1.1. Values and Emotions

Philosophical theories on the relationship between values and emotions have identified three levels of connection between the two concepts: *explicative, ontological and intentional*. The explicative level indicates that emotions are value: an emotion is of value because it promotes appropriate behavior towards its object. The ontological level indicates that emotions explain the existence of value: something is of value because it is able to elicit an emotion. The intentional level indicates that emotions are evaluations of value: an emotion arises from the appraisal that the object at hand is of value for the individual. Across these three levels, the function of emotions is to obtain information about valuable objects in the environment, allowing to adjust behavior accordingly (Deonna & Teroni, 2015).

Psychological theories have mainly focused on the intentional link between values and emotion. Within this frame of reference, for the present work we follow the definition of values and emotions as proposed by the Theory of Basic Human Values (Schwartz, 1992; Schwartz et al., 2012) and by appraisal theories of emotion (Moors, Ellsworth, Scherer, & Frijda, 2013). On the one hand, the Theory of Basic Human Values defines values as a set of desirable abstract goals that consistently guide one's actions across situations and time (Bardi & Schwartz, 2003; Lee et al., 2019; Schwartz, 1992; Schwartz et al., 2012, 2001). When values are threatened or supported, they become infused with feeling (Schwartz, 2010). For instance, someone who highly values friendship might feel sad when they perceive that this value is threatened by an argument. In response, the person is likely to engage in a series of behaviors aimed to restore the friendship, such as calling the friend to make peace. On the other hand, appraisal theories describe emotions as affective experiences that are elicited by objects or events appraised as relevant to one's personal goals (Ellsworth & Scherer, 2003; Frijda, 1986, 1988, 2009; Lazarus, 1991a, 1991b; Moors et al., 2013; Moors, Boddez, & De Houwer, 2017; Scherer, 2013, 2019; Scherer & Moors, 2019). That is, once an object or event is appraised as relevant to one′s personal goals, an emotional episode takes place involving changes in a number of components of the organism, such as the somatic component, i.e., physiological responses, the motor component, i.e., facial expressions, the feeling component, i.e., the subjective experience of feelings, and the motivational component, i.e., action tendencies and behavioral responses (Frijda, 1986, 1988, 2007; Lazarus, 1991a; Moors, 2020; Moors et al., 2013). For example, someone who highly values being good at school should appraise receiving a bad grade as goal-relevant, feel sad or guilty about it, and engage in a series of response behaviors such as studying harder to avoid another bad grade.

Thus, values and emotions can similarly be regarded as psychological markers of subjective relevance. While values operate at a conceptually high, trans-situational level, by defining what a person generally endorses as guiding principles in their life, emotions operate at a more situational level, by activating the organism in response to something that, within a given situation, touches upon a person's goals and values. Despite the quite explicit theoretical links between values and emotions, researchers have not yet systematically explored their association at the empirical level. Here we investigate this connection empirically across three experiments by testing the hypothesis that an individual's core values will selectively predict the intensity of their emotional responses in the encounter with value-related stimuli, and that this effect should be mediated by cognitive appraisals of relevance.

Values are considered to be consciously accessible constructs. This implies that when you ask someone about their values, their answer corresponds to the value itself (Schwartz et al., 2012). Hence, the most direct and effective way to measure values are self-reports. Various instruments have been developed for this purpose, the most widely used being the Schwartz Value Survey (SVS; Schwartz, 1992). The SVS measures to what extent each of nineteen values represent a guiding principle in a person's life. These values differ with regard to whether they focus on personal versus social outcomes, whether they promote self-expansion versus self-protection, whether they express openness to change versus conservation of the status quo, or whether they promote self-interest versus transcendence of self-interest in the service of others (Schwartz et al., 2012). The distribution of values with respect to these dimensions is represented in the Schwartz Value Wheel (Figure 1).

Figure 1

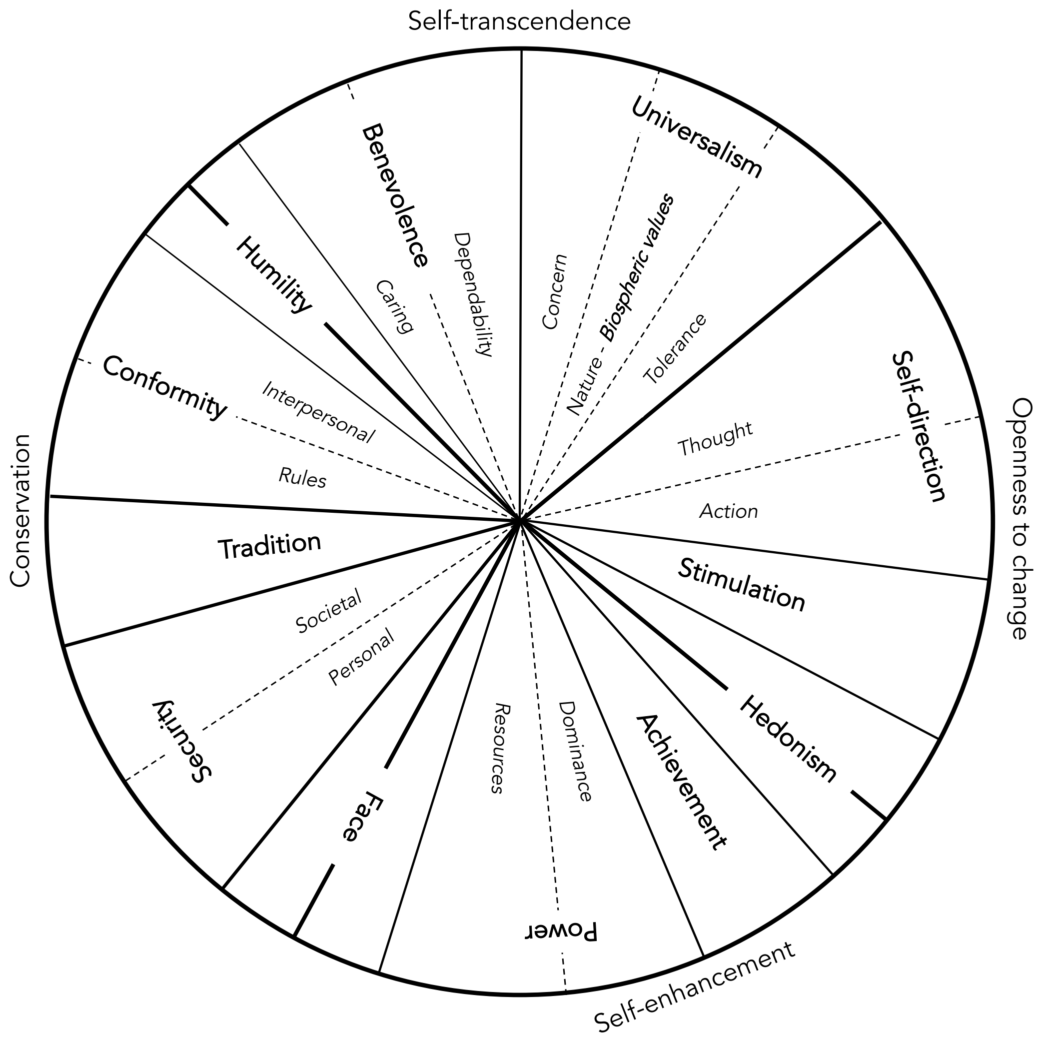

Figure 1. Adapted visualization of the revised Schwartz Value Wheel (from Schwartz, 2012). The main value types are organized along two axes: Self-transcendence (i.e., values that prioritize the well-being of something or someone other than the self) versus self-enhancement (i.e., values that prioritize personal well-being), and openness to change (i.e., values that prioritize following personal intellectual and emotional interests in unpredictable and uncertain directions) versus conservation (i.e., values that prioritize preserving the status quo) (Schwartz, 2012).

Concerning the operationalization and measurement of emotion, research has developed both psychophysiological and self-report ways to assess and quantify the intensity of an emotional experience in relation to a certain object or event. Psychophysiological measures of emotional intensity are measures of the physiological changes driven by the autonomic nervous system that happen in response to an emotional stimulus. One of the most widely used measures is Electrodermal Activity (EDA) (Sander, Grandjean, & Scherer, 2018; Spielhofer et al., 2021). EDA is an indirect measure of the quantity of sweat secreted by the glands located in the hypodermis of palmar and plantar regions of the human body. Changes in EDA are higher in response to emotional stimuli (positive and negative) as compared to neutral stimuli, therefore EDA scores are frequently used as indicators of emotional arousal (Bradley, Miccoli, Escrig, & Lang, 2008; Lang, Greenwald, Bradley, & Hamm, 1993).

The most common self-report measure of emotional intensity is via questionnaires. Measuring emotions via questionnaires allows to obtain a representation of the conscious components of an emotion (i.e., those components that the individual is able and willing to consciously perceive, process, and report), and it is a more widely used method compared to physiological measures because it is faster, cheaper and requires no to very little technological support. Importantly, physiological and self-report measures of emotion provide complementary information, each describing a different component of the emotional response, which in the context of an emotional episode should show some degree of synchronicity (Scherer, 2000). In the present study we investigated the link between values and emotional experiences using both psychophysiological and self-report measurements of emotional intensity.

We tested the link between values and emotion in a domain where understanding the mechanisms that explain emotional responses is important not only from a theoretical, but also from an applied point of view: emotional responses to environmental stimuli such as nature and the effects of climate change. Many people, in fact, do not experience strong emotions towards the natural environment and climate change issues (Leiserowitz, 2005; Wang, Leviston, Hurlstone, Lawrence, & Walker, 2018; Weber, 2006). However, research has shown that stronger emotions towards the environment, and in particular to natural risks and consequences of climate change, are associated with stronger willingness to engage in sustainable actions (Brosch, 2021; Brosch, Patel, & Sander, 2014; Chapman, Lickel, & Markowitz, 2017; Hahnel & Brosch, 2018; Roeser, 2012; Van Linden, Leiserowitz, Feinberg, & Maibach, 2015; Wang et al., 2018). Therefore, understanding the mechanisms of emotional responses in this framework can fundamentally contribute to improve behavioral intervention techniques aimed at motivating people towards a sustainable lifestyle, which is a necessary response to the current environmental crisis (Bouman et al., 2020; Perlaviciute, Steg, Contzen, Roeser, & Huijts, 2018). In this perspective, we focused our research on the relationship of *biospheric* values, i.e., values related to concerns about the well-being of nature and the ecosystem (Steg, 2016; Steg, Perlaviciute, van der Werff, & Lurvink, 2014), and the emotions that people experience towards nature and the consequences of climate change.

Environmental values or *biospheric values* represent the value base for pro-environmental attitudes, beliefs, norms and behavior (Brosch, Patel, & Sander, 2014; de Groot & Steg, 2008; Dietz, Fitzgerald, & Shwom, 2005; Steg, Perlaviciute, van der Werff, & Lurvink, 2014). Within the framework of the Theory of Basic Human Values, biospheric values correspond to the dimension called *nature*, specifically referring to the concern for the welfare of nature and the ecosystem (for a comparative overview of the two terms, see Conte et al., 2021). Their overarching value type is *universalism*, which represents a comprehensive concern for the welfare of all people and nature (Schwartz et al., 2012).

Previous research has shown that biospheric values predict decisions that people make in support of the environment (Conte, Hahnel & Brosch, 2021), their self-reported trait propensity to experience emotions in an environmental context (Hahnel & Brosch, 2018), and their level of worry for the consequences of climate change (Bouman et al., 2020). In the present research, we tested the hypothesis that higher biospheric values should correspond to higher changes in EDA and higher self-reported emotional intensity associated to environmental stimuli relating to nature and to climate change, but not to unrelated stimuli.

1.2. The mediating role of cognitive appraisals

According to appraisal theories of emotion, an emotional episode is generated by the subjective cognitive appraisal of a stimulus or situation, based on a set of criteria (Brosch, 2013; Scherer, 2013). While individual theories differ somewhat in the appraisal criteria they propose, most appraisal theories of emotion recognize the appraisals of relevance (i.e., to what extent something is pertinent to a person's goals and concerns) and control (i.e., whether the stimulus/situation and its consequences can be controlled) as core elements of the elicitation and differentiation of an emotional experience (Blascovich & Tomaka, 1996; Frijda, 1988; Lazarus, 1991a; Moors et al., 2017; Roseman, Antoniou, & Jose, 1996; Scherer, 2009, 2013).

The Cognitive-Motivational-Relational Theory of Emotion (Lazarus, 1991b) builds on these two key appraisals, labeled as *primary* and *secondary* appraisal. Primary appraisal concerns the stakes that one has in the encounter with an object or event. It is primary because without a stake there is simply no potential for emotion. The three sub-types of primary appraisal are *goal relevance*, i.e., whether one's goals are involved or not in the encounter with an object or event; *goal congruence*, i.e., whether the object or event is harmful or beneficial to one's goals; and *goal content*, i.e., to what kind of specific goal the object or event is related. Goal relevance determines the intensity of an emotion, in that more relevant events result in stronger emotions. Goal congruence determines the valence of an emotion, in that value threats result in negative emotions while value benefits result in positive emotions. Goal content differentiates among emotions, even within the same valence category, depending on the type of goal involved, for example self-preservation (anger) versus keeping moral standards (guilt) (Lazarus, 1991b).

Secondary appraisal concerns the options and prospects for coping one has in the encounter with the object or event. The three sub-types of secondary appraisal are *blame or credit*, *coping potential* and *future expectations*. Blame or credit depends on whether there is an attribution of responsibility for the harm, threat or benefit. This accountability can be directed to oneself or to someone else, which influences the type of emotion experienced. Coping potential is related to whether one has the possibility or not to influence the relationship with the appraised target for the better. Future expectations concern anticipations of whether the interaction will work out favorably or not for any reason, including effective or ineffective coping (Lazarus, 1991b).

The Biopsychosocial (BPS) model of challenge and threat provides a theoretical rationale for a causal relationship between primary and secondary appraisals, psychophysiological, and behavioral responses to affective stimuli (Blascovich & Tomaka, 1996). According to the model, in the context of motivated-performance tasks, the psychological processes underlying primary and secondary appraisals mediate the relationship between a stimulus and the physiological response enacted by the organism. That is, in situations where personal goals are activated, primary and secondary appraisals elicit specific physiological changes in the organism. The specificity of these physiological changes, in turn, shape motivational, affective and behavioral responses (Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003; Seery, 2013).

In the specific context of environmental issues such as climate change, primary appraisal reflects the extent to which climate change is perceived as a threat to one's concerns and well-being, while secondary appraisal reflects one's perceived ability to actually be able to contribute to the mitigation of the issue. In line with the BPS model predictions, both appraisals have been shown to be significant determinants of affective and behavioral responses to climate change, even though the psychophysiological component in this context has not been investigated yet (Keller et al., 2012; Klöckner, 2013; Spence, Poortinga, & Pidgeon, 2012).

Coherently, in the present study we hypothesized that both primary and secondary appraisals should predict people's emotional reactions to environmental stimuli. However, we hypothesized that only primary appraisal should mediate the relationship between biospheric values and emotional reactions to environmental stimuli. Primary appraisal, in fact, can be understood as a psychological marker of the subjective relevance of a stimulus to one's concerns, goals, and values. As a psychological marker of relevance, primary appraisal should play a role in the relationship between a value-relevant stimulus, and affective responses when individual differences in values are taken into account as moderators. Conversely, secondary appraisal should not mediate this same relationship, as it is theoretically not related to the subjective relevance attributed to a stimulus.

1.3. The Present Research

In the present research we tested the hypothesis that biospheric values predict the intensity of the emotions that people experience when exposed to environmental stimuli related to nature and the consequences of climate change, but not to unrelated stimuli (H1). Specifically, we predicted that higher self-report measures of biospheric values should be associated with higher emotional responses both to positive environmental affective stimuli (e.g., a beautiful unharmed landscape) and negative environmental affective stimuli (e.g., a polluted beach). We tested this hypothesis across three experiments performed on three independent samples assessing both physiological measures (Experiment 1) and self-report measures of emotional intensity (Experiments 1-3).

We moreover provided first insights into the cognitive processes underlying the relation between values and emotions by testing the hypothesis that primary appraisals of relevance as well as secondary appraisals of control positively predict the intensity of the experienced emotions (H2). We hypothesized that only primary appraisals, but not secondary appraisals, should mediate the association of biospheric values with emotional intensity (H3).

The present research contributes to the understanding of the fundamental relation between values and emotions, for which we provide an empirical investigation in the framework of the Theory of Basic Human Values (Schwartz, 1992; Schwartz et al., 2012) and appraisal theory of emotion (Moors et al., 2013). It also contributes to a stronger integration of emotion research into the timely and important societal topic of climate change.

2. Experiment 1

In Experiment 1, we tested the hypothesis that biospheric values positively predict the intensity of the emotions that people experience when exposed to environmental stimuli, but not to stimuli unrelated to the environment (H1), by assessing both self-report and physiological measures of emotional intensity.

2.1. Method

2.1.1. Participants.

We determined sample size based on previous studies measuring psychophysiological responses to affective stimuli (Lang et al., 1993). We aimed at doubling the size of the sample in order to ensure sufficient statistical power to test our hypotheses after applying exclusion criteria.

A total of 219 undergraduate students at the University of Geneva completed the questionnaire session. Once completed the questionnaire session, they could register to participate in the experimental session by booking one of the 121 time slots available that were assigned on a first-come-first-served basis. Therefore, a final sample of 121 students took part in the experiment in exchange for course credits. Due to technical problems occurring during the experiment, 5 participants were directly excluded from further analyses. This left us with a final sample of $N = 116$ ($M_{age} = 22.98$, range 18-50 years old, 73% female). Artifacfddfts detection and removal procedures were subsequently applied on a trial basis.

2.1.2. Design and procedure.

At the beginning of the semester, participants completed a questionnaire measuring biospheric values, together with demographic information and other psychological variables outside the scope of the present manuscript (for a complete list of the measures collected see the Supplemental Material). For this and the following experiments, participants reported their biospheric values by indicating on a scale from -1 (= opposed to the principles that guide me) to 0 (= not important at all) to 7 (= of supreme importance) the extent to which each these four items represented a guiding principle in their life: a) respecting the Earth; b) unity with nature; c) protecting the environment; d) preventing pollution (Steg et al., 2014). We calculated participants' individual scores of biospheric values by averaging their responses to the four items (for a more detailed description of the questionnaire see the Supplemental Material). After around six weeks, participants came individually to the lab to complete a computer-based experimental session.

The experiment had a within-subjects design. Participants viewed and evaluated a series of pictures that systematically varied on two levels: valence (positive, negative, neutral) and content (environmental, other), resulting in the following experimental conditions or picture categories: *positive environmental* (i.e. positive pictures with high association to natural environment, for example a beautiful landscape), *positive other* (i.e. positive pictures with low association to natural environment, for example a scenic urban skyline), *negative environmental* (i.e. negative pictures with high association to natural environment, for example a polluted beach), *negative other* (i.e. negative pictures with low association to natural environment, for example a dirty room), and *neutral* (i.e. neutral pictures with low association to natural environment, for example a padlock on a door). A previous pre-test of the pictures on an independent sample (N= 63) showed that all images fell into the assigned categories based on participants′ ratings of valence and content. Moreover, categories of pictures were matched for arousal ratings (for pictures pre-testing strategy and results see the Supplemental Material). The experiment was split in two blocks with a five to ten minutes pause in between to allow participants to rest their eyes and to move. Each of the two blocks contained twenty-five trials of one picture each, resulting in a total of fifty trials. The pictures were presented in random order within each session.

In each trial participants first saw a fixation cross on the screen, followed by one of the pictures, followed in turn by a new fixation cross. At the end of each trial, participants rated the intensity of their emotional reaction towards the stimulus (from here onwards, *emotional intensity*) on a Likert scale from 1 = *very relaxing* to 6 = *very exciting*. A schematic summary of the experimental sequence is illustrated in Figure 2. At the end of the second block participants were debriefed, thanked, and could leave the lab. This and all experiments included in the present article were reviewed and approved by the Ethics Commission of the University of Geneva.

Figure 2

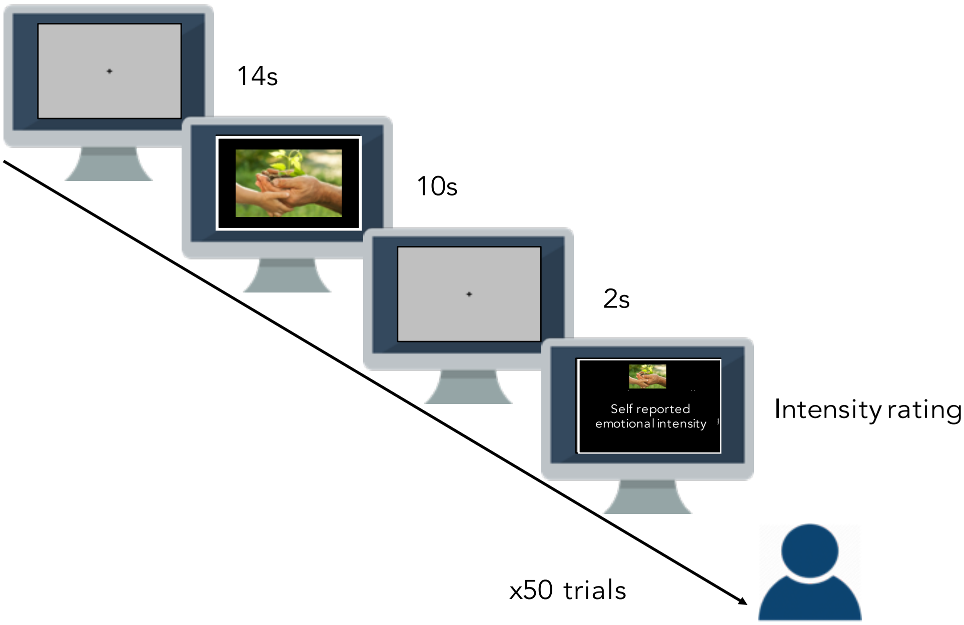

Figure 2. Schematic representation of the experimental sequence in Experiment 1.

2.1.3. Apparatus.

Electrodermal Activity (EDA) was recorded using the Biopac MP150 System (Goleta, CA, USA); sampling rate 1000Hz. Pre-gelled Ag/AgCl electrodes were placed on the medial phalange of index and middle fingers of participants' left hand. Visual stimuli were presented on an LCD 25-inch monitor. Emotional intensity was rated using the numeric keypad of the keyboard. Data collection took place in a booth specifically suitable for physiological measurements at the laboratories of Campus Biotech in Geneva (Switzerland).

2.1.4. Skin Conductance Response definition.

The EDA data was low-pass filtered (Blackman - 92 dB, cutoff frequency 1 Hz) and Skin Conductance Responses (SCR) were detected automatically with AcqKnowledge 4.4 software as well as checked manually for artifacts and response detection (10.53% trials excluded after artifacts detection and exclusion) (for a similar scoring method see Stussi, Brosch & Sander, 2015). SCR were scored for each trial as the peak-to-peak amplitude difference in skin conductance of the largest response starting in the 0.5 to 4.5 s temporal window following the stimulus onset. The minimal response criterion was 0.02μS; responses below this criterion were scored as '0' and remained in the analyses indicating absence of SCR. A log+1 correction was applied to SCR scores to reduce the typically positive skewed distribution.

2.1.5. Data analysis.

Using a multilevel linear regression model, we tested the effect of the interaction of *picture category* and *biospheric values* on each of the two dependent variables of this study, SCR and self-reported emotional intensity. In order to take into account the repeated-measures design and possible systematic differences across stimuli, we allowed random intercepts for *subject* and *picture*. As fixed effects we specified the variables *picture category* and *biospheric values*, together with their two-ways interaction. Measures of emotional intensity and biospheric values were mean centered (z-scores). The variable *picture category* was coded into four ad-hoc contrasts, specified as follows: affective [+] (positive and negative) versus neutral [-] pictures, positive [+] versus negative [-] pictures, positive environmental [+] versus positive other [-] pictures, and negative environmental [+] versus negative other [-] pictures (for the complete numerical coding scheme see the Supplemental Material). Simple slope analysis on the significant interactions was performed on the same statistical model. In this case, however, the variable *picture category* was dummy coded with the category of picture of interest set as baseline. We performed the analysis using the lmerTest R package (version 3.1-3) (Kuznetsova, Brockhoff, & Christensen, 2017). After pre-processing and cleaning, all statistical analyses in this experiment were conducted on a total of 5,189 observations. For the sake of conciseness, in the main manuscript we report results for the interaction of *picture category x biospheric values* for the contrasts of interest to our hypothesis (H1), namely positive environmental versus positive other and negative environmental versus negative other. A comprehensive report of all findings for each experiment reported here is available in the Supplemental Material. All the findings reported in the following sections remained robust when controlling for age and gender as covariates (see Supplemental Material for all main analyses with gender and age as covariates, Tables 34-35).

2.2. Results

Mean, SD and 95% CI of emotional intensity ratings and SCR for each picture category in Experiment 1 are reported in Table 1.

Table 1

Means of standardized values (z-scores), SDs and 95% CIs of experienced emotional intensity ratings and Skin Conductance Responses (SCR) by picture category in Experiment 1. The standardized values of SCR were calculated after applying the log+1 correction to the distribution.

Reported Emotional Intensity

Picture category					
Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	1037	4.20 (.53)	1.27 (.82)	.077 (.05)
	Other	1038	4.66 (.83)	1.07 (.70)	.065 (.04)
Positive	Environmental	1040	2.07 (-.85)	1.29 (.84)	.078 (.05)
	Other	1036	2.98 (-.26)	1.44 (.94)	.088 (.06)
Neutral		1038	3.00 (-.25)	1.01 (.94)	.06 (.04)

Skin Conductance Responses (SCR)

Picture category					
Valence	Content	$N_{obs.}$	Mean (µS, z-log+1)	SD (z)	95% CI (z)
Negative	Environmental	1037	.07 (-.08)	.25 (.81)	.02 (.05)
	Other	1038	.13 (.09)	.43 (1.17)	.03 (.07)
Positive	Environmental	1040	.10 (-.01)	.38 (1.01)	.02 (.06)
	Other	1036	.11 (.06)	.34 (1.04)	.02 (.06)
Neutral		1038	.08 (-.06)	.32 (.93)	.02 (.06)

Reported emotional intensity. In line with our hypothesis (H1), higher biospheric values predicted higher emotional intensity for negative environmental stimuli (B = .09, 95% CI [.03, .15], t(320.56) = 3.09, p = .002), but not for negative other stimuli (B = -.02, 95% CI [-.073, .041], t(318.56) = -.55, p = .583). In the multilevel model, this was reflected as a significant interaction between biospheric values and the contrast negative environmental versus negative other stimuli (B = .05, 95% CI [.023, .083], t(5032) = 3.48, p < .001). The interaction between biospheric values and the contrast positive environmental versus positive other stimuli was however not significant (B = -.002, 95% CI [-.03, .03], t(5032) = -.11, p = .912).

Skin Conductance Responses. In line with our hypothesis (H1), the association between biospheric values and SCR was significantly stronger when participants were exposed to positive environmental stimuli (B = .07, 95% CI [-.009, .156], t(265.60) = 1.75, p = .082) as compared to positive other stimuli (B = -.01, 95% CI [-.096, .068], t(265.99) = -.33, p = .738): Higher biospheric values predicted greater SCR when people were exposed to positive environmental stimuli, but not when they were exposed to positive pictures of other content. In the multilevel model, this was reflected as a significant interaction between biospheric values and the contrast positive environmental versus positive other stimuli (B = .04, 95% CI [.003, .084], $t(5032) = 2.13$, $p = .034$). The interaction between biospheric values and the contrast negative environmental versus negative other stimuli was not significant (B = -.01, 95% CI [-.054, .027], $t(5032) = -.66$, $p = .511$). Both interactions are illustrated in Figure 3.

Figure 3

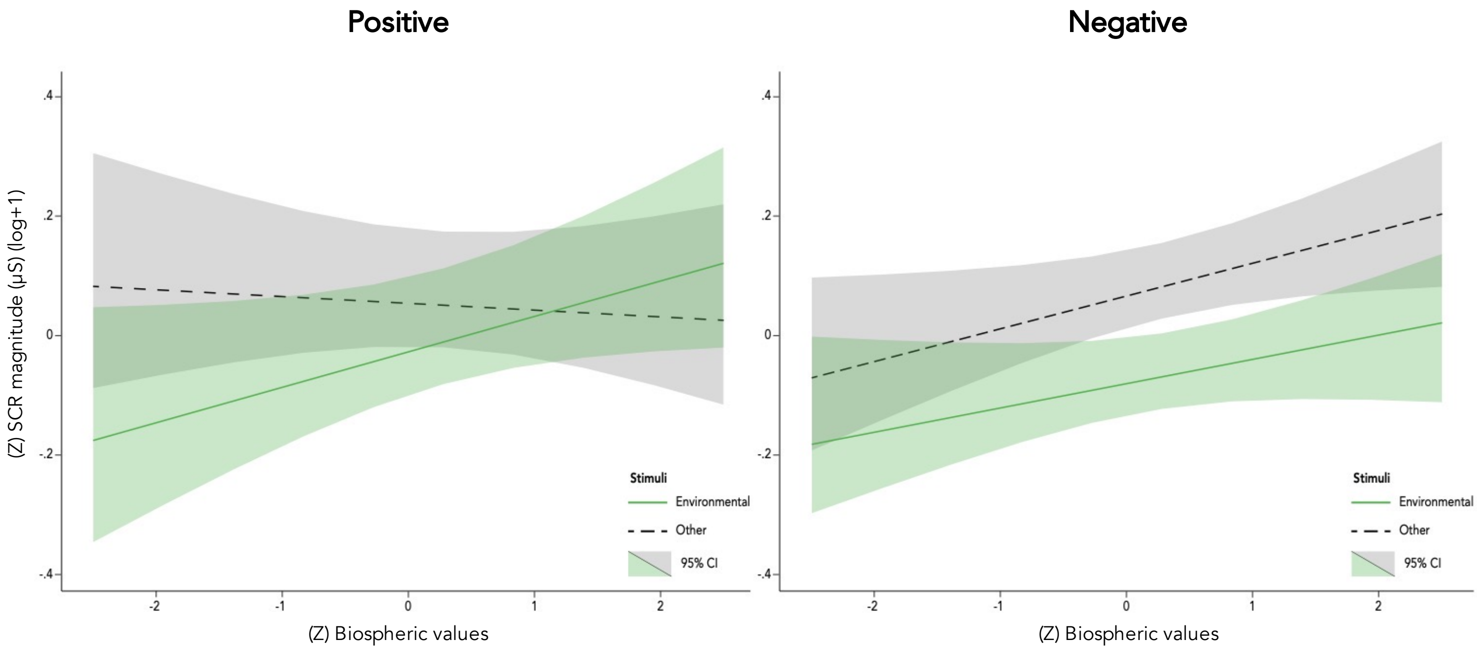

Figure 3. Visualization of the interaction of the contrasts *positive nature versus positive other* and *negative nature versus negative other* with biospheric values for the dependent variable SCR. The interaction between biospheric values and the contrasts positive environmental versus positive other stimuli was significant, in that biospheric values predicted participants' SCR associated to positive environmental stimuli, but not to positive other stimuli. The interaction between biospheric values and the contrasts negative environmental versus negative other stimuli was not significant, as it can be observed that higher biospheric values were associated to higher SCR both for negative environmental and negative other stimuli.

2.3. Discussion

In Experiment 1 we provide first partial evidence in support of the hypothesis that biospheric values selectively explain the intensity of emotions elicited in response to environmental stimuli, but not or only to a lesser extent to stimuli with content unrelated to the natural environment (H1). The hypothesis was supported for positive stimuli when emotional intensity was measured via psychophysiology (SCR), and for negative stimuli when emotional intensity was measured via self-report. While these findings generally support the idea that core values predict the intensity of the subjective emotional experience elicited by value-related stimuli, they revealed a dissociation based on stimulus valence and measurement type. This dissociation is very interesting form a theoretical perspective, as previous literature showed that SCR should not be sensitive to the valence of the stimulus or, in other words, to the quality of the emotion experienced, but only to its intensity (Bradley et al., 2008; Lang et al., 1993). Thus, the results that we present here are novel and surprising. In the context of motivated-performance tasks, the Biopsychosocial (BPS) model suggests the idea that cognitive processes differentiate psychophysiological as well as behavioral responses within an emotional episode. In this perspective, our findings might point out that biospheric values had different influences on the components of the emotional responses that we assessed based on the valence of the stimuli. That is, when emotions were measured as psychophysiological responses, biospheric values might specifically have captured the extent to which environmental positive stimuli were intrinsically rewarding, as a signal of value-congruence. When emotions were measured as self-reported experiences, on the other hand, biospheric values might have specifically captured the extent to which environmental negative stimuli were evaluated as menacing, as a signal of value-threat.

Equally, we did not expect to find valence being a significant moderator of reported emotional intensity ratings. However, the interpretation of these findings must consider the fact that reported emotional intensity was measured using a scale ranging from *very relaxing* to *very exciting. Relaxing* and *exciting* are emotional states that might be interpreted more often as positive rather than negative. This aspect could have qualitatively influenced participants′ responses, in turn influencing the pattern of results that we observed. In order to address this issue, in Experiments 2 and 3 we switched to a unipolar scale ranging from *absence of emotional reaction* to *extremely intense emotional reaction* to measure emotional intensity using self-reports.

3. Experiment 2

In Experiment 2, we aimed to replicate the findings from Experiment 1 on a new sample, testing our core hypothesis that biospheric values selectively explain the intensity of emotions elicited in response to positive and negative environmental stimuli, but not to stimuli with unrelated content (H1). We moreover tested the hypotheses that primary and secondary appraisals predict emotional intensity when individuals are exposed to affective stimuli (H2), but that only primary appraisal mediates the relationship between biospheric core values and emotional responses to affective environmental stimuli (H3). In this study we focused on self-report measures only, introducing a new scale to measure *reported emotional intensity*.

3.1. Method

3.1.1. Participants.

We determined sample size based on the established rule of thumb that a minimum of fifty observations per stimulus category is generally recommended for regression analyses (Van Voorhis & Morgan, 2007), and that online studies are often found to be underpowered compared to laboratory studies, given that they allow for a lesser degree of control of contextual conditions which may influence participants′ performance during the task (Curran, 2016). Therefore, a total of 211 undergraduate students of the University of Geneva took part in the first and second session of the experiment in exchange for credits (M_{age} = 21.44, range 18-46 years old, 82.46% female).

3.1.2. Design and procedure.

At the beginning of the semester, participants completed a questionnaire measuring biospheric values (for a detailed description of the questionnaire see the Supplemental Material) (Steg et al., 2014) together with demographic information and other psychological variables outside the scope of the present manuscript (for a complete list of the measures collected see the Supplemental Material). After around twelve weeks, during the experimental session, participants viewed and evaluated the same fifty pictures used in Experiment 1 in terms of emotional intensity, primary appraisal and secondary appraisal. This resulted in a within-subjects design with five picture categories based on valence and content of the images: *positive environmental*, *positive other*, *negative environmental*, *negative other* and *neutral*. Experiment 2 was conducted online.

Participants saw the pictures in sequence, with each picture displayed individually on the screen in random order. For each picture, participants rated emotional intensity. Addressing the limitations of the emotional intensity scale used in Experiment 1, in order to capture a wider range of emotional states and based on the idea that the intensity of emotions can be defined on a gradual criterion, in Experiment 2 we adapted the self-report measure of emotional intensity switching to a unipolar scale where emotional intensity is represented as a linear function that goes from *0 = absence of emotional reaction* to *7 = extremely intense* *emotional reaction*. Moreover, participants provided measures of primary and secondary appraisals. In the case of primary appraisal, they answered on a scale from 0 = *not at all* to 7 = *totally* the following three items: "To what extent does this picture represent something / a situation…" (i) "that is important for you?", (ii) "…that touches upon your personal goals and concerns?", (iii) "…that can affect your well-being?". In the case of secondary appraisal, they answered on the same scale from 0 to 7 the following three items: (i) "…for which you personally are responsible?", (ii) "…that you personally can influence?", (iii) "…that you personally can change for the better?". The six appraisal questions were presented in random order. In order to avoid attentional fatigue and ensure better response quality, the experiment was split in two sessions of twenty-five pictures each. After completing the two experimental sessions, participants were thanked and debriefed.

3.1.3. Data analysis.

Reported emotional intensity. We tested the effect of the interaction *picture category x biospheric values* (H1) and the main effect of primary and secondary appraisals (H2) on emotional intensity by means of the same multilevel linear regression model used in Experiment 1, adding primary and secondary appraisal as fixed effects. Primary and secondary appraisal scores were computed by averaging responses to the respective the three-items scales. Both scales had high internal reliability with Cronbach's alpha = .87. All variables were standardized for the analysis (z-scores). The same four ad-hoc contrasts specified in Experiment 1 were applied to the variable *picture category* in Experiment 2. Simple slope analysis of the significant interactions was performed as in Experiment 2.

Mediation of primary and secondary appraisal. We tested whether primary and secondary appraisals are mediators of the relationship between the interaction *picture* *category x biospheric values* and emotional intensity (H3) via two independent mediation analyses: one for primary appraisal as mediator (specifying secondary appraisal as covariate), and one for secondary appraisal as mediator (specifying primary appraisal as covariate). Following a model-based approach, we performed these analyses using the mediation R package (version 5.4.0) (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014). For each mediation analysis we specified (i) a mediator model with (primary/secondary) appraisal as DV and the interaction *picture category*[1] *x biospheric values* together with (secondary /primary) appraisal as fixed effects, and (ii) an outcome model with *reported emotional intensity* as DV and the interaction *picture category x biospheric values* together with primary and secondary appraisal as fixed effects. Due to the constraints of the package, all models were limited to random intercepts for subject only. All mediations were tested via the mediate function, function that computed the estimated Average Causal Mediation Effect (ACME) under the models of interest on a quasi-Bayesian Monte Carlo method with 5,000 simulations. A comprehensive report of all findings for each mediation model is available in the Supplemental Material (section *Experiment 2, Model-based mediation analysis*, and section *Experiment 3, Model-based mediation analysis*).

All the findings reported the following sections remained robust when controlling for age and gender as covariates (see Supplemental Material for all main analyses with gender and age as covariates, Tables 36-41).

3.2. Results

Mean, SD and 95% CI of primary appraisal, secondary appraisal and emotional intensity ratings by picture category are reported in Table 2. All statistical analyses in Experiment 2 were conducted on a total of 10,550 observations.

[1] The variable picture category was coded in four contrasts as specified in section 2.1.5.

Table 2

The table reports mean, mean of standardized values (z-scores), SD and 95% CI of emotional intensity, primary and secondary appraisals ratings in Experiment 2.

Reported Emotional Intensity

Picture category

Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	2110	4.45 (.70)	1.76 (.81)	.08 (.03)
	Other	2110	3.91 (.45)	1.85 (.85)	.08 (.04)
Positive	Environmental	2110	3.23 (.14)	1.94 (.89)	.08 (.04)
	Other	2110	2.25 (-.31)	1.86 (.85)	.08 (.04)
Neutral		2110	.77 (-.99)	1.25 (.57)	.05 (.02)

Primary Appraisal

Picture category

Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	2110	4.43 (.85)	1.83 (.02)	.08 (.04)
	Other	2110	2.20 (-.18)	1.86 (.85)	.08 (.04)
Positive	Environmental	2110	3.02 (.20)	2.08 (.02)	.09 (.04)
	Other	2110	2.08 (-.23)	1.97 (.90)	.08 (.04)
Neutral		2110	1.18 (-.64)	1.17 (.78)	.07 (.03)

Secondary Appraisal

Picture category

Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	2110	3.57 (.77)	2.06 (1.00)	.09 (.04)
	Other	2110	1.66 (-.06)	1.80 (.88)	.08 (.04)
Positive	Environmental	2110	2.29 (.14)	2.01 (.97)	.09 (.04)
	Other	2110	1.53 (-.23)	1.83 (.89)	.08 (.04)
Neutral		2110	.93 (-.52)	1.52 (.74)	.06 (.03)

Reported emotional intensity. In line with our first hypothesis (H1), higher biospheric values predicted higher emotional intensity to positive (B = .05, 95% CI [.003,

.10], $t(321.20) = 2.10$, $p = .036$) and negative ($B = .07$, 95% CI [.02, .11], $t(322.70) = 2.70$, $p = .007$) environmental stimuli, but not to positive other ($B = -.02$, 95% CI [-.07, .03], $t(320.40) = -.72$, $p = .472$) and negative other ($B = .03$, 95% CI [-.02, .08], $t(320.50) = 1.16$, $p = .247$) stimuli. In the multilevel model, this was reflected as a significant interaction between biospheric values and the contrast positive environmental versus positive other stimuli ($B = .03$, 95% CI [.02, .05], $t(10280) = 4.06$, $p < .001$), and an interaction between biospheric values and the contrast negative environmental versus negative other stimuli ($B = .02$, 95% CI [.002, .03], $t(10290) = 2.22$, $p = .026$).

Confirming our second hypothesis (H2), the multilevel model revealed a main effect of both primary ($F(1, 10455.7) = 1155.4$, $\eta_p^2 = .10$, $p < .001$) and secondary ($F(1, 10453.1) = 244.15$, $\eta_p^2 = .02$, $p < .001$) appraisals on emotional intensity across stimulus categories, in that higher primary ($B = .32$, 95% CI [.30, .34], $t(10460) = 33.99$, $p < .001$) and secondary ($B = .15$, 95% CI [.13, .16], $t(10450) = 15.63$, $p < .001$) appraisals were related to more intense emotional experience.

Mediation of primary and secondary appraisals. We conducted a model-based mediation analysis to test the hypothesis that the effects of the interactions between biospheric values and picture category described above were driven by primary but not by secondary appraisals (H3) (see section *3.1.3. Data analysis*). In partial support of the hypothesis, the mediation analysis showed that primary appraisals mediated the effect of the interaction for the contrast negative environmental versus negative other stimuli ($B = .02$, 95% CI [.01, .02], $p < .001$, proportion mediated = 49%), but not for the contrast positive environmental versus positive other stimuli ($B = .003$, 95% CI [-.004, .01], $p = .406$). As expected, we did not observe mediation effects of secondary appraisals, neither for the contrast negative environmental versus negative other stimuli ($B = .001$, 95% CI [-.001, 0], p

= .263) nor for the contrast positive environmental versus positive other stimuli (B = .001, 95% CI [-.001, .0], p = .200) pictures.

We additionally tested our mediation hypotheses following the traditional steps recommended by Baron and Kenny (Baron & Kenny, 1986). Notably, all the results of this analysis supported the findings obtained with the model-based approach described above. The additional analysis is available in the Supplemental material (sections *Experiment 2, Baron and Kenny mediation analysis*, page 21)

3.3. Discussion

In Experiment 2 we replicated and extended findings of Experiment 1, showing that biospheric values selectively predicted the intensity of emotions elicited in response to environmental stimuli, but not to stimuli with content unrelated to the natural environment of both positive and negative valence (H1). Interestingly, while in Experiment 1 we found the effect of biospheric values to be significant only for negative stimuli, in this replication we found that the effect was significant both for positive and negative stimuli. This might be due to the fact that we changed the response scale from Experiment 1 and 2. We switched from a bipolar scale where both ends represented high emotional intensity states with a more positive rather than negative connotation (*very relaxing* and *very exciting*) to a unipolar scale where emotional intensity was represented as a linear function, thus leaving the valence (or indeed the entire quality) of the state open to participants' interpretation.

We moreover provided first evidence about the cognitive processes underlying the relationship between biospheric values and emotional intensity. Consistent with appraisal theory of emotion, both primary and secondary appraisals predicted the intensity of the emotional experience, displaying that the more people care (i.e., primary appraisal of relevance) and the more people feel responsible and in control of something (i.e., secondary appraisals of responsibility and control), the more emotional they will feel about it (H2). However, only primary appraisal was a significant mediator of the relationship between biospheric values and the intensity of the emotional experience toward affective stimuli related to the natural environment (H3). Inconsistent with the hypothesis, this effect was observed only for negative, but not for positive stimuli. As this finding may have been due to the restricted range of biospheric values in the investigated population (psychology undergraduate students), we conducted a direct replication of Experiment 2 on a sample from the general population.

4. Experiment 3

In Experiment 3, we aimed to replicate Experiment 2 in a sample representative of the general population, testing the hypotheses that biospheric values selectively explain the intensity of emotions elicited in response to positive and negative environmental stimuli (H1), that primary and secondary appraisals predict emotional intensity when exposed to affective stimuli (H2), and that primary appraisal mediates the relationship between biospheric core values and emotional responses to affective environmental stimuli (H3).

4.1. Method

4.1.1. Participants.

We determined sample size based on a post-hoc analysis of the fit of the multilevel model of Experiment 2 using Akaike Information Criterion (AIC) (Akaike, 1998). The analysis showed that, given the sample size, the model had sufficient power to detect the effect of the interactions of interest in the absence of within-subjects effects (i.e., random slopes). For this reason, we aimed to obtain a final sample size similar to Experiment 2. We included oversampling to ensure a sufficient number of observations even in case of high dropout rates due to the fluctuating reliability of panel participants. Therefore, a total of 270 French citizens recruited via market research institute took part in the experiment in exchange for monetary compensation (M_{age} = 46.14, range 18-76 years old, 45.92% female). Upon our request, the agency invited to participate in our study a nationally representative sample of the general population in terms of age, income and education distribution. In addition, we asked to aim for a gender balanced group. Once invited, people were able to access and complete the questionnaire session and, two weeks later, the second session of the experiment on a first-come-first-served basis until the planned sample size was reached.

4.1.2. Design and procedure.

Participants invited in the first session completed a questionnaire measuring biospheric values (for a detailed description of the questionnaire see the Supplemental Material) (Steg et al., 2014) together with demographic information. Two weeks later, during the experimental session, participants viewed and evaluated the same fifty pictures used in Experiment 1 in terms of emotional intensity, primary appraisal and secondary appraisal replicating the procedure of Experiment 2 (see section *3.1.1. Design and Procedure*).

4.1.3. Data analysis.

Data analysis strategies were identical to Experiment 2 (see section *3.1.3. Data analysis*). Primary and secondary appraisals scales had high internal reliability with primary appraisals Cronbach's alpha = .83 and secondary appraisals Cronbach's alpha = .87.

All the findings reported in the following sections remained robust when controlling for age and gender as covariates (see Supplemental Material for all main analyses with gender and age as covariates, Tables 37-47).

4.2. Results

Mean, SD and 95% CI of primary appraisals, secondary appraisals and emotional intensity ratings for each picture category are reported in Table 3. All statistical analyses in Experiment 3 were conducted on a total of 13,500 observations.

Table 3

The table reports mean, mean of standardized values (z-scores), SD and 95% CI of emotional intensity, primary and secondary appraisals ratings in Experiment 3.

Reported Emotional Intensity

Picture category

Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	2700	5.04 (.47)	1.88 (.84)	.07 (.03)
	Other	2700	4.61 (.28)	2.02 (.90)	.08 (.03)
Positive	Environmental	2700	4.58 (.26)	1.93 (.86)	.07 (.03)
	Other	2700	3.55 (-.20)	2.09 (.93)	.08 (.04)
Neutral		2700	2.16 (-.82)	2.00 (.89)	.07 (.03)

Primary Appraisals

Picture category

Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	2700	4.65 (.56)	1.88 (.88)	.07 (.03)
	Other	2700	3.46 (.00)	2.00 (.93)	.08 (.04)
Positive	Environmental	2700	4.01 (.26)	1.99 (.93)	.07 (.03)

	Other	2700	2.94 (-.24)	2.02 (.94)	.08 (.04)
Neutral		2700	2.19 (-.59)	1.96 (.92)	.07 (.03)

Secondary Appraisals

Picture category

Valence	Content	$N_{obs.}$	Mean (z)	SD (z)	95% CI (z)
Negative	Environmental	2700	4.04 (.47)	2.05 (.97)	.08 (.04)
	Other	2700	3.01 (-.01)	2.07 (.97)	.08 (.04)
Positive	Environmental	2700	3.49 (.21)	2.03 (.96)	.08 (.04)
	Other	2700	2.65 (-.19)	1.98 (.93)	.07 (.04)
Neutral		2700	2.01 (-.48)	1.90 (.89)	.07 (.03)

Reported emotional intensity. In line with our first hypothesis (H1), higher biospheric values predicted higher emotional intensity to positive environmental (B = .08, 95% CI [.04, .12], t(465.40) = 4.03, p < .001) but not to positive other (B = .03, 95% CI [-.01, .07], t(459) = 1.51, p = .133) stimuli. In the multilevel model, this was reflected as a significant interaction between biospheric values and the contrast positive environmental versus positive other stimuli (B = .02, 95% CI [.01, .04], t(13180) = 3.29, p = .001). Biospheric values moreover predicted the emotional intensity that people experienced both when exposed to negative environmental (B = .10, 95% CI [.06, .14], t(470.50) = 5.00, p < .001) and negative other (B = .10, 95% CI [.06, .14], t(461.30) = 5.02, p < .001) stimuli. The interaction between biospheric values and the contrast negative nature versus negative other stimuli was not significant (B = .00, 95% CI [-.01, .01], t(13180) = .01, p = .994).

Confirming our second hypothesis (H2), the multilevel model revealed a main effect of primary (F(1, 13297.8) = 2620.06, η_p^2= .16, p < .001) and secondary (F(1, 13280.9) = 477.06, η_p^2= .03, p < .001) appraisal on emotional intensity across categories of stimuli, in that higher scores of primary (B = .45, 95% CI [.44, .47], t(13300) = 51.19, p < .001) and secondary (*B* = .19, 95% CI [.17, .21], $t(13280) = 21.84$, $p < .001$) appraisals corresponded to the experience of more intense emotion.

Mediation of primary and secondary appraisals. In line with Experiment 2 we conducted a model-based mediation analysis to test the hypothesis that the effects of the interactions between biospheric values and picture category described above were driven by primary but not by secondary appraisals (H3) (see section *3.1.3. Data analysis*). In partial support of the hypothesis, the mediation analysis showed that primary appraisals partially mediated the effect of the interaction between picture category and biospheric values on emotional intensity for the contrast positive environmental versus positive other stimuli (*B* = .02, 95% CI [.01, .03], $p < .001$, proportion mediated = 44%), as well as for the contrast negative environmental versus negative other stimuli (*B* = .02, 95% CI [.01, .02], $p < .001$, proportion mediated= 10%). As expected, we did not find a mediation effect of secondary appraisals for the contrast positive environmental versus positive other stimuli (*B* = .001, 95% CI [-.001, .00], $p = .168$). However, we did find a mediation effect of secondary appraisal for the contrast negative environmental versus negative other stimuli (*B* = .003, 95% CI [.001, .01], $p < .010$, proportion mediated= 28%).

We additionally tested our mediation hypotheses following the traditional steps recommended by Baron and Kenny (Baron & Kenny, 1986). Notably, all the results of this analysis supported the findings obtained with the model-based approach described above. The additional analysis is available in the Supplemental material (sections *Experiment 3, Baron and Kenny mediation analysis*, page 31)

4.3. Discussion

In Experiment 3, we replicated Experiment 2 on a sample representative of the general population. In line with Experiment 2 we found that both primary and secondary appraisals positively predicted emotional intensity experienced in response to affective stimuli (H2), and that primary appraisal mediated the relationship between biospheric values and emotional intensity. However, in contrast to Experiment 2, in Experiment 1 we observed this mediating effect both for positive and for negative environmental stimuli. Moreover, biospheric values selectively predicted the intensity of emotions elicited in response to positive environmental stimuli nature, but not negative environmental stimuli, which is only partially consistent with our hypothesis (H1). Across three experiments, our results were consistent with the theoretically derived hypothesis. However, effects were only partially consistent with regard to stimulus valence. On the one hand, we found that the interaction between biospheric values and picture category was a significant predictor of *reported emotional intensity* towards positive stimuli in Experiments 2 and 3, but not in Experiment 1. On the other hand, we found that the interaction between biospheric values and picture category was a significant predictor of *reported emotional intensity* towards negative stimuli in Experiments 1 and 2, but not in Experiment 3. Some methodological variations across experiments might explain these differences. In particular, we changed the scale to measure *reported emotional intensity* between Experiment 1 and Experiments 2 and 3; we tested a sample of students in Experiments 1 and 2 while we tested a sample representative of the general population in Experiment 3; finally, we collected data in the laboratory in Experiment 1 while we collected data online in Experiments 2 and 3. Nevertheless, the findings reported in this article consistently point towards the existence of a link between values and emotion that will be discussed more in detail in the next section.

6. General Discussion

In the present study we investigated the relationship between core values and the intensity of emotional experiences in the framework of the Theory of Basic Human Values (Schwartz, 1992; Schwartz et al., 2012) and appraisal theories of emotion (Moors et al., 2013), using biospheric values and emotional responses towards environmental stimuli as a field of application with utmost societal relevance. Across three studies, we found evidence showing that biospheric values selectively predicted the intensity of emotional experiences when people were exposed to stimuli that either supported (i.e., positive affective stimuli) or threatened (i.e., negative affective stimuli) the values in question. We observed this effect in association to positive affective stimuli when measuring emotional intensity through psychophysiology (Experiment 1) and in association to both positive (Experiments 2 and 3) and negative (Experiments 1 and 2) affective stimuli when measuring emotional intensity through self-report. We moreover examined the cognitive processes underlying this relation. Findings revealed that both primary and secondary appraisals explained the intensity of the emotions that people experienced when exposed to affective stimuli, and that the effect of values on emotional intensity was mediated more strongly and consistently by primary rather than secondary appraisals (Experiments 2 and 3). We will first critically examine some of the limitations of our study. Then, we will illustrate the theoretical implications of our findings.

Concerning the limitations of this study, we start by pointing out that the evidence in support of our hypothesis, albeit robust, is mainly indirect. This is because we predominantly observed correlations between self-report measurements of emotional states and conscious appraisals, which may not fully reflect the actual emotion process (Frijda, 1988). This is a common problem in emotion research, and we agree that it calls for a collective effort within the community to develop better ways to comprehensively measure emotional experiences (Kuppens, 2019). In the present research we partially overcame this limitation by integrating psychophysiological measurements of emotional intensity, which allowed us to capture more than one component of the emotion process. The SCR findings of Experiment 1 showed that that biospheric values uniquely predicted psychophysiological reactions to positive stimuli related to nature. With respect to previous literature, this dissociation based on valence represents a novel and surprising finding because changes in electrodermal activity should not be sensitive to the quality of the emotion experienced, but only to its intensity (Bradley et al., 2008; Lang et al., 1993). Interestingly, these results were replicated with self-reported measures of emotional intensity in Experiment 3, which was conducted on a sample from the general population. Although the size of the effect observed for SCR was relatively modest, this consistency across experiments encourages future developments of our study that should aim to replicate the psychophysiological results of this study, as well as integrate other components of emotion such as the motor or the expression component.

Second, we performed a mediation analysis to test the effect of appraisals in the relation between values and emotion. Mediation analysis assumes causation; therefore, we based our analysis on the underlying assumption of causality between values, appraisals and emotional intensity. We formulated our hypotheses in these terms because of two reasons: from a methodological point, we measured values independently and before measuring appraisals and emotional intensity; from a theoretical point, values are stable traits while emotions are transitory, situation-based experiences that arise when a value is at stake. In light of this, it follows that values should be considered predictors of emotional experiences, rather than the other way around. Coherently, most previous self-report studies provide support for a causal link between appraisal and emotion (Moors, 2020; Roseman & Evdokas, 2004).

Lastly, an important aspect of our study is that we focused on the relation between biospheric values and the intensity of emotions experienced towards nature and climate change. This particular angle on the more general research question represents, on the one hand, a strength of our research, because it makes our study relevant for the literature that focuses on psychological responses to the global environmental crisis. On the other hand, it necessarily represents a limit to the generalizability of our findings. Theoretically, however, all the values identified by the Theory of Basic Human Values (Schwartz, 1992; Schwartz et al., 2012) should hold similar relations with emotional intensity. Future research should nonetheless look at other values, for example values that lie opposite to biospheric values on the Schwartz Value Wheel (Figure 1), such as power and achievement.

In what concerns the theoretical implications of our findings, both emotion theories and value theories suggest the existence of an intentional link between values and emotion. Appraisal theories suggest that an emotion only arises when a value is at stake, while the Theory of Basic Human Values (Schwartz, 1992; Schwartz et al., 2012) suggests that when values are activated (i.e., are at stake in a certain situation), they get infused with feelings. These basic assumptions are logically complementary, and are generally considered well-established facts by researchers in the respective domains. However, until now the empirical challenge of integrating these theories to systematically investigate the link between values and emotion had not been addressed. The present research aimed at filling this gap.

Our results suggest that core values can be considered antecedents of emotional intensity when an emotional experience arises as a situational response to a value-relevant stimulus. Operationally speaking, this means that values can predict the intensity of the emotion that people experience in response to value-related stimuli. This interplay certainly adds a level of complexity, but at the same time a level of sophistication, to research focused on understanding how values relate to affect, and on the nature and dynamics of value-relevance detection as trigger of an emotional experience. Thus, our findings may contribute to the development of a structural explanation of emotion, i.e., the explanation of the relations between different components of an emotional episode, and to the development of value theory, providing an empirical framework to observe and validate the affective processes inferred by value theory. We moreover provide evidence identifying primary appraisals as the key element connecting values and the intensity of the emotions experienced, supporting the key notion of appraisal theories that specific mechanisms of relevance detection are the cognitive processes behind the relation of value and emotion. Finally, our findings advance theories in environmental psychology. While biospheric values have been investigated widely in the context of climate change responses, emotions have entered the picture only recently (Brosch, 2021). The present study offers a comprehensive theoretical framework to describe the relation between biospheric values and emotions towards nature and climate change.

In conclusion, in this article we present empirical data supporting a strong link between values and emotion by showing that values are reliable predictors of the intensity of the emotion that people experience as a response to value-related stimuli, and that primary appraisals consistently mediate this relationship. These findings pave the way to a new field of investigation focused on understanding the nature of this link as well as its connection to other variables such as, for instance, personality traits, attitudes, beliefs, and behavior. Ultimately, these findings may lead to new developments in theories of values and emotions that should aim at integrating the two constructs into one shared framework.

References

Bardi, A., & Schwartz, S. H. (2003). Values and Behavior: Strength and Structure of Relations. *Personality and Social Psychology Bulletin*, *29*, 1207–1220.

Baron, R. M., & Kenny, D. A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research. Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology*, *51*, 1173–1182.

Bates, D., Kliegl, R., Vasishth, S., & Baayen, H. (2015). Parsimonious Mixed Models. *ArXiv Preprint ArXiv: 1506.04967.*

Bates, D. M., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*, 1–48.

Bechara, A., Damasio, H., Tranel, D., Damasio, A. R., Bushnell, M. C., Matthews, P. M., & Rawlins, J. N. P. (1997). Deciding Advantageously Before Knowing the Advantageous Strategy. *Science*, *275*, 1293–1295.

Benjamin, D. J., Berger, J. O., Johannesson, M., Nosek, B. A., Wagenmakers, E. J., Berk, R., … Johnson, V. E. (2018). Redefine statistical significance. *Nature Human Behaviour*, *2*, 6–10.

Blascovich, J., Mendes, W. B., Tomaka, J., Salomon, K., & Seery, M. (2003). The robust nature of the biopsychosocial model challenge and threat: A reply to Wright and Kirby. *Personality and Social Psychology Review*, *7*234–243.

Blascovich, J., & Tomaka, J. (1996). The Biopsychosocial Model of Arousal Regulation. *Advances in Experimental Social Psychology*, *28*, 1–51.

Bouman, T., Verschoor, M., Albers, C. J., Böhm, G., Fisher, S. D., Poortinga, W., … Steg, L. (2020). When worry about climate change leads to climate action: How values, worry and personal responsibility relate to various climate actions. *Global Environmental*

Change, *62*, 102061.

Bradley, M. M., Miccoli, L., Escrig, M. A., & Lang, P. J. (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology*, *45*(4), 602–607.

Brosch, T. (2021). Affect and emotions as drivers of climate change perception and action: a review. *Current Opinion in Behavioral Sciences*, *42*, 15–21.

Brosch, T., Patel, M. K., & Sander, D. (2014). Affective Influences on Energy-Related Decisions and Behaviors. *Frontiers in Energy Research*, *2*, 1–12.

Brosch, T., & Sander, D. (2016). *Handbook of Value: Perspectives from Economics, Neuroscience, Philosophy, Psychology and Sociology.* New York: Oxford University Press.

Brosch, T. (2013). Comment: On the role of appraisal processes in the construction of emotion. *Emotion Review*, *5*, 369–373.

Chapman, D. A., Lickel, B., & Markowitz, E. M. (2017). Reassessing emotion in climate change communication. *Nature Climate Change*, *7*, 850–852.

Conte, B., Hahnel, U. J. J., & Brosch, T. (2021). The dynamics of humanistic and biospheric altruism in conflicting choice environments. *Personality and Individual Differences*, *173*, 110599.

Curran, P. G. (2016). Methods for the detection of carelessly invalid responses in survey data. *Journal of Experimental Social Psychology*, *66*, 4–19.

Dan-Glauser, E. S., & Scherer, K. R. (2011). The Geneva affective picture database (GAPED): a new 730-picture database focusing on valence and normative significance. *Behavior research methods*, *43*, 468-477.

de Groot, J. I. M., & Steg, L. (2008). Value Orientations to Explain Beliefs related to Enviornmental Significant Behavior. How to measure Egoistic, Altruistic, and Biospheric Value Orientations. *Environment and Behavior*, *40*, 330–354.

Deonna, J., & Teroni, F. (2015). Value and Emotion. In T. Brosch & D. Sander (Eds.), *Handbook of Value*. Oxford: Oxford University Press.

Dietz, T., Fitzgerald, A., & Shwom, R. (2005). Environmental values. *Annual Review of Environment and Resources*, *30*, 335–372.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Series in affective science. Handbook of affective sciences* (pp. 572–595). Orford: Oxford University Press.

Frijda, N. H. (1986). *The Emotions*. New York, NY: Cambridge University Press.

Frijda, N. H. (1988). The Laws of Emotion. *American Psychologist*, *43*, 349–358.

Frijda, N. H. (2007). *The Laws of Emotion*. Mahwah, NJ: Erlbaum.

Frijda, N. H. (2009). Action tendencies. In D. Sander & K. R. Scherer (Eds.), *The Oxford companion to emotion and the affective sciences*. New York, NY: Oxford University Press.

Graham, J., Nosek, B. A., Haidt, J., Iyer, R., Koleva, S., & Ditto, P. H. (2011). Mapping the Moral Domain. *Journal of Personality and Social Psychology*, *101*, 366–385.

Hahnel, U. J. J., & Brosch, T. (2018). Environmental trait affect. *Journal of Environmental Psychology*, *59*, 94–106.

Keller, C., Bostrom, A., Kuttschreuter, M., Savadori, L., Spence, A., & White, M. (2012). Bringing appraisal theory to environmental risk perception: A review of conceptual approaches of the past 40years and suggestions for future research. *Journal of Risk Research*, *15*, 237–256.

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General*, *128*, 78–87.

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour-A meta-analysis. *Global Environmental Change*, *23*, 1028–1038.

Kuppens, P. (2019). Improving theory, measurement, and reality to advance the future of emotion research. *Cognition and Emotion*, *33*, 20–23.

Kuznetsova, A., Brockhoff, P., & Christensen, R. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*, 1–26. Retrieved from https://cran.r-project.org/package=lmerTest

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual* (Report No. A-8). Gainesville, FL: University of Florida, NIMH Center for the Study of Emotion and Attention.

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral and behavioral reactions. *Psychophysiology*, *30*, 261–273.

Lazarus, R. S. (1991a). Cognition and motivation in emotion. *American Psychologist*, *46*, 352–367.

Lazarus, R. S. (1991b). Progress on a cognitive-motivational-relational theory of emotion. *American Psychologist*, *46*, 819–834.

Lee, J. A., Sneddon, J. N., Daly, T. M., Schwartz, S. H., Soutar, G. N., & Louviere, J. J. (2019). Testing and Extending Schwartz Refined Value Theory Using a Best–Worst Scaling Approach. *Assessment*, *26*, 166–180.

Leiserowitz, A. A. (2005). American risk perceptions: Is climate change dangerous? *Risk Analysis*, *25*, 1433–1442.

Lin, M., Lucas, H. C., & Shmueli, G. (2013). Too Big to Fail: Large Samples and the p-Value Problem. *Information Systems Research*, *24*, 906–917.

Marchewka, A., Żurawski, Ł., Jednoróg, K., & Grabowska, A. (2014). The Nencki Affective Picture System (NAPS): Introduction to a novel, standardized, wide-range, high-quality, realistic picture database. *Behavior research methods*, *46*, 596-610.

Matuschek, H., Kliegl, R., Vasishth, S., Baayen, H., & Bates, D. (2017). Balancing Type I error and power in linear mixed models. *Journal of Memory and Language*, *94*, 305–315.

Moors, A. (2020). Comparison of four families of psychological emotion theories. In A. Scarantino (Ed.), *The Routlegde Handbook of Emotion Theory*. New York: Taylor & Francis.

Moors, A., Ellsworth, P. C., Scherer, K. R., & Frijda, N. H. (2013). Appraisal theories of emotion: State of the art and future development. *Emotion Review*, *5*, 119–124.

Moors, Agnes, Boddez, Y., & De Houwer, J. (2017). The power of goal-directed processes in the causation of emotional and other actions. *Emotion Review*, *9*, 310–318.

Murphy, R. O., Ackermann, K. a, & Handgraaf, M. J. J. (2010). Measuring Social Value Orientation. *Judgement and Decision Making*, *6*, 771–781.

Perlaviciute, G., Steg, L., Contzen, N., Roeser, S., & Huijts, N. (2018). Emotional Responses to Energy Projects: Insights for Responsible Decision Making in a Sustainable Energy Transition. *Sustainability*, *10*, 2526.

Poortinga, W., Steg, L., Vlek, C., & Wieserma, G. (2003). Household preferences for energy-saving measures: a conjoint analysis. *Journal of Economic Psychology*, *24*, 49–64.

Poortinga, Wouter, Steg, L., & Vlek, C. (2004). Values, environmental concern, and environmental behavior: A study into household energy use. *Environment and Behavior*, *36*, 70–93.

Roeser, S. (2012). Risk Communication, Public Engagement, and Climate Change: A Role for Emotions. *Risk Analysis*, *32*, 1033–1040.

Roseman, I. J., Antoniou, A. A., & Jose, P. E. (1996). *Appraisal determinants of emotions:*

Constructing a more accurate and comprehensive theory. *Cognition and Emotion* (Vol. 10).

Roseman, I. J., & Evdokas, A. (2004). Appraisals cause experienced emotions: Experimental evidence. *Cognition and Emotion*, *18*, 1–28.

Sander, D., Grandjean, D., & Scherer, K. R. (2018). An Appraisal-Driven Componential Approach to the Emotional Brain. *Emotion Review*, *10*, 219–231.

Sander, David, Grandjean, D., & Scherer, K. R. (2005). A systems approach to appraisal mechanisms in emotion. *Neural Networks*, *18*, 317–352.

Scherer, K. R. (2000). Emotions are episodes of subsystem synchronization driven by nonlinear appraisal processes. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self-organization: Dynamic systems approaches to emotional development* (pp. 70–99). Cambridge, UK: Cambridge Univeristy Press.

Scherer, K. R. (2013). The nature and dynamics of relevance and valence appraisals: Theoretical advances and recent evidence. *Emotion Review*, *5*, 150–162.

Scherer, Klaus R. (2009). The dynamic architecture of emotion: Evidence for the component process model. *Cognition & Emotion*, *23*, 1307–1351.

Scherer, Klaus R. (2019). Studying appraisal-driven emotion processes: taking stock and moving to the future. *Cognition and Emotion*, *33*, 31–40.

Scherer, Klaus R., & Moors, A. (2019). The Emotion Process: Event Appraisal and Component Differentiation. *Annual Review of Psychology*, *70*, 719-745.

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in Experimental Social Psychology*, *25*, 1–65.

Schwartz, S. H. (2010). Basic values: How they motivate and inhibit prosocial behavior. In M. Mikulincer & P. R. Shaver (Eds.), *Prosocial motives, emotions, and behavior: The* *better angels of our nature.* (pp. 221–241). American Psychological Association.

Schwartz, S. H., Cieciuch, J., Vecchione, M., Davidov, E., Fischer, R., Beierlein, C., … Konty, M. (2012). Refining the theory of basic individual values. *Journal of Personality and Social Psychology*, *103*, 663–688.

Schwartz, S. H., Melech, G., Lehmann, A., Burgess, S., Harris, M., & Owens, V. (2001). Extending the cross-cultural validity of the theory of basic human values with a different method of measurement. *Journal of Cross-Cultural Psychology*, *32*, 519–542.

Seery, M. D. (2013). The Biopsychosocial Model of Challenge and Threat: Using the Heart to Measure the Mind. *Social and Personality Psychology Compass*, *7*, 637–653.

Spence, A., Poortinga, W., & Pidgeon, N. (2012). The Psychological Distance of Climate Change. *Risk Analysis*, *32*, 957–972.

Spielberger, C. D. (1988). Manual for the State-Trait Anger Expression Inventory (STAXI). *Odessa, FL: Psychological Assessment Resources*.

Spielhofer, R., Thrash, T., Hayek, U. W., Grêt-Regamey, A., Salak, B., Grübel, J., & Schinazi, V. R. (2021). Physiological and behavioral reactions to renewable energy systems in various landscape types. *Renewable and Sustainable Energy Reviews*, *135*, 21–24.

Steg, L. (2016). Values, Norms, and Intrinsic Motivation to Act Proenvironmentally. *Annual Review of Environment and Resources*, *41*, 277–292.

Steg, L., Perlaviciute, G., van der Werff, E., & Lurvink, J. (2014). The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions. *Environment and Behavior*, *46*, 163–192.

Stussi, Y., Brosch, T., & Sander, D. (2015). Learning to fear depends on emotion and gaze interaction: The role of self-relevance in fear learning. *Biological Psychology*, *109*, 232–238.

Sütterlin, B., Brunner, T. A., & Siegrist, M. (2011). Who puts the most energy into energy conservation? A segmentation of energy consumers based on energy-related behavioral characteristics. *Energy Policy*, *39*, 8137–8152.

Tabi, A., Hille, S. L., & Wüstenhagen, R. (2014). What makes people seal the green power deal? - Customer segmentation based on choice experiment in Germany. *Ecological Economics*, *107*, 206–215.

Tingley, D., Yamamoto, T., Hirose, K., Keele, L., & Imai, K. (2014). mediation: R Package for Causal Mediation Analysis. *Journal of Statistical Software*, *59*, 1–38.

Van der Linden, S., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLoS ONE*, *10*, 2–9.

van Leeuwen, F., & Park, J. H. (2009). Perceptions of social dangers, moral foundations, and political orientation. *Personality and Individual Differences*, *47*, 169–173.

Wang, S., Leviston, Z., Hurlstone, M., Lawrence, C., & Walker, I. (2018). Emotions predict policy support: Why it matters how people feel about climate change. *Global Environmental Change*, *50*, 25–40.

Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change*, *77*, 103–120.

Wilson Van Voorhis, C. R., & Morgan, B. L. (2007). Understanding Power and Rules of Thumb for Determining Sample Sizes. *Tutorials in Quantitative Methods for Psychology*, *3*, 43–50.