

Fear versus fascination: An exploration of emotional responses to natural threats

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Abstract

This article describes two studies that examined people's emotional responses to threatening encounters with nature. In Study 1, participants from The Netherlands were asked to describe a fearful experience with nature in their home country. We identified four broad categories of fear-relevant situations, named Close Encounters, Forceful Situations, Overwhelming Situations, and Disorienting Situations. Each of these situations evoked negative as well as positive emotions. Study 2 investigated the role of sensation seeking and gender in emotional responses to standardized descriptions of threatening encounters with nature. High sensation seekers and men, as compared to low sensation seekers and women, responded less often with negative emotion and avoidance tendencies, and more often with positive emotion and approach tendencies.

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1. Introduction

Nature has many good things to offer. At a very basic level, nature provides people with elementary necessities such as food, medicine, and clean air. In addition, at a more psychological level, nature offers a wide variety of positive experiences, such as aesthetic pleasure (Parsons & Daniel, 2002), possibilities for discovery and learning (Kahn, 1999), and restoration from stress and mental fatigue (Van den Berg, Koole, & Van der Wulp, 2003). Taken together, there are strong grounds for assuming that contact with nature is frequently beneficial to people.

But there is also a dark side to contact with nature. Natural environments contain many dangers, such as predators, venomous animals, and lightning, that can strike quickly and without warning (Tooby & Cosmides, 1990). People's reactions to these natural threats show considerable variation. On the one hand, encounters with these threatening aspects of nature may evoke strong fears and other negative emotions (Ulrich, 1993). On the other hand, researchers have observed that some people derive highly positive and meaningful experiences from encoun-

ters with natural threats (Kaplan & Kaplan, 1989). To date, the determinants of this variation in emotional responses to natural threats remain largely unknown.

Our central aim in the present research was to gain more insight into people's emotional responses to natural threats. In the following paragraphs, we first review previous research on fear of nature. Next, we discuss the evidence for positive reactions to natural threats, and consider the potential relevance of gender and sensation seeking to understanding individual differences in negative versus positive responses to natural threats. Finally, we present two empirical studies that examined people's emotional responses to natural threats in The Netherlands.

1.1. Fear of nature

Much of the current knowledge on fear of nature derives from laboratory research on fear conditioning within clinical psychology and neuroscience. This research started with the observation that fears and phobias do not occur to an arbitrary group of objects and situations, but rather are directed at natural objects and situations such as snakes, spiders, deep water, heights, depths, darkness and blood (Agras, Sylvester, & Oliveau, 1969). These objects and situations have in common that they represented survival

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threats to pre-modern humans. Accordingly, Seligman (1971) has proposed that modern humans remain “biologically prepared” through natural selection to learn fears of natural objects and situations that threatened the survival of the human species during the course of evolution.

The “biological preparedness hypothesis” has been supported by a large number of well-controlled laboratory studies (see for reviews Ulrich, 1993; Öhman & Mineka, 2001). Most of this research has focused on images of snakes as a prototypical example of evolutionary relevant threats (Öhman & Mineka, 2003). This research has demonstrated that fear of snakes is more easily learned, and harder to unlearn, than fear of other stimuli, including equally or more dangerous man-made stimuli such as guns and electricity outlets (e.g. Hugdahl & Johnsen, 1989). Furthermore, this research has shown that fear of snakes can be activated and learned even when people are not consciously aware of the presence of these animals (e.g. Öhman & Soares, 1993). Finally, this research has found that people’s attention is automatically captured by pictures of snakes in complex visual arrays (Öhman, Flykt, & Esteves, 2001). Together, these findings provide strong evidence that fear of nature is driven by deeply rooted, evolved mechanisms (Öhman & Mineka, 2001).

Biophobia research has focused almost exclusively on fear of animals. As Ulrich (1993) has pointed out, one may wonder to what extent the insights from this research are relevant to people’s reactions to physical properties of natural environments. In recent years, a second line of research has emerged that has studied predictors of negative reactions to visual representations of forest and field settings (Herzog & Kutzli, 2002; Herzog & Kropscott, 2004). Most notably, this research has shown that access, visual or locomotor, is significantly related to both self-reported fear and perceived danger. Forest and field settings that lacked visual or locomotor access were perceived as more dangerous and evoked more self-reported fear than accessible settings. For our ancestors who had to survive in natural environments, access constituted a vital necessity for surveillance, exploration, and escape (Appleton, 1975). Thus, research on fearful reactions to natural environments appears to be largely consistent with an evolutionary account of fear of nature.

Finally, a third line of research has studied people’s fearful experiences during actual visits to wilderness areas. This research has revealed that a stay in the wilderness may evoke strong fears and other negative emotions. For example Kaplan & Talbot (1983; see also Kaplan, 1984; Talbot & Kaplan, 1986; Kaplan & Kaplan, 1989) reported that 92% of a total number of 176 participants of American Outward Challenge Programs expressed fearful emotions (afraid, worried, want to go home) in their journals. These fears dealt with social concerns and physical challenges, but also with aspects of the natural environment itself, such as animals, bugs, the weather, and getting lost. Other studies have reported more detailed lists of fear-evoking aspects of wilderness settings (Ewert, 1986;

Bixler, Carlisle, Hammitt, & Floyd, 1994; Bixler & Floyd, 1997). For example, based on research among school children, Bixler & Floyd (1997) have distinguished nine typical fear-evoking situations: Seeing a snake or stepping on it, getting a spider bite, being chased by a swarm of bees, being caught in a windstorm, being caught in thunder and lightning, getting lost, getting separated from friends, and not getting back before dark. Since most of these fear-evoking situations seem to have some evolutionary significance, these findings once again speak to the relevance of evolutionary theories to understanding fearful reactions to nature.

1.2. *Positive responses to natural threats*

In addition to fears and other negative reactions, evaluations of wilderness programs have also documented numerous positive responses to wilderness, including an increase in psychological energy, a greater self-confidence, and a sense of awe and wonder (Ewert, 1986; Kaplan & Kaplan, 1989; Holyfield & Fine, 1997; Fredrickson & Anderson, 1999). These positive reactions tend to become stronger during the course of the trip, and may persist even after reentry into ‘civilization’. According to Kaplan & Kaplan (1989) confrontations with physical challenges and natural threats constitute a critical factor in these positive changes. By conquering their fear of the potential dangers that ‘lurk in the woods’ (Kaplan & Kaplan, 1989, p. 146), participants of wilderness programs may discover a new sense of competence and fresh energy. Consistent with this notion, participants’ journal entries often expressed personal difficulties and intense positive emotions at the same time (Kaplan & Talbot, 1983). Despite their fears and worries, participants felt oddly refreshed and invigorated, “feeling better than I have in a long time”, laughing all the time, “having a blast” (Kaplan & Talbot, 1983, p. 178).

Experimental research on outdoor adventure activities provides further support for the idea that confrontations with natural threats, in particular depths and heights, can be a direct source of positive emotions. For example, a study by Hennig, Laschefski, & Opper (1994) among novice bungee jumpers showed that ratings on euphoria increased markedly after performing the jump and were accompanied by an increase of more than 200% in beta-endorphin immunoreactivity. This increase in beta-endorphin was significantly correlated with ratings on euphoria obtained at subsequent measurements, indicating a relationship between beta-endorphins and euphoria. Euphoric effects of beta-endorphins and other brain chemicals have also been found in women in labor (Brinsmead, Smith, Singh, Lewin, & Owens, 1985) and marathon runners (Harber & Sutton, 1984) and have been interpreted as an adaptive mechanism that helps individuals tolerate and survive periods of extreme pain and stress.

Researchers of wilderness experience have paid little attention to the possibility that positive responses to natural threats may reflect automatic effects of biochemical

processes. Instead, they have emphasized that people are self-conscious beings, who can be aware of their own fear of nature (Scherl, 1989). This self-awareness may promote existential fears of death and nonexistence because it can remind people of the fact that they themselves are part of nature too, and eventually will have to die like all other living creatures (Koole & Van den Berg, 2004, 2005). But self-awareness may also enable people to control their own fears and transform it into a positive and meaningful experience. Notably, this cognitive explanation of emotional responses to natural threats is not necessarily incompatible with biological explanations. There is growing consensus among emotion researchers that there are multiple levels of processing that contribute to emotional experience (Robinson, 1998). In particular when individuals are confronted with urgent or threatening information, cognitive and physiological processes may operate in combination to generate consciously experienced, negative and/or positive, emotions.

1.3. Individual differences in emotional responses to natural threats

Wilderness programs provide people with opportunities to physically and cognitively master the threats and challenges posed by the physical environment. Consequently, pre-existing individual differences in coping skills and personality might give rise to considerable variation in outcomes of wilderness experience (cf. Weber, 2001). In particular, some individuals may find it more difficult to turn their fear of nature into a positive experience than others. Because wilderness programs attract mostly individuals with a favorable attitude towards engaging in risky activities, empirical evidence of negative outcomes of such programs is scarce. However, evaluations of school field trips and other mandatory nature programs confirms that a small but substantial number of individuals tend to react fearfully to wilderness environments even after spending prolonged periods of time in these environments (see Bixler et al., 1994, for an overview). For example, in a study by Wendling & Wuench (1985) one out of five students reported that they did not like a compulsory wilderness trip and would have rather stayed in the classroom. These results suggest that there exist important individual differences in emotional responses to natural threats.

One important variable that may account for individual differences in emotional responses to natural threats is the personality trait ‘sensation seeking’. Sensation seeking can be defined as an individual’s genetically and socially determined tendency to seek varied, novel, complex, and intense sensations and experiences (Zuckerman, 1994, p. 27). Research on the behavioral correlates of sensation seeking has shown that high sensation seekers typically view risky activities, such as use of alcohol, gambling, and high-risk sports, as less threatening than low sensation seekers (see Roberti, 2004, for an overview). High

sensation seekers often even enjoy such activities, because these provide them with their desired level of stimulation and challenge. As yet, there is no direct evidence for a relationship between sensation seeking and emotional responses to natural threats. However, it has been found that high sensation seekers like ‘gloomy’ nature paintings with a high level of tension more than low sensation seekers (Zuckerman, Ulrich, & McLaughlin, 1993). Furthermore, a recent study on the relationship between sensation seeking and holiday preferences has shown that high sensation seekers have greater preference for adventurous holidays such as trekking in nature (Eachus, 2004). These findings suggest that high sensation seekers may experience threatening encounters with nature as less frightening and more pleasurable than low sensation seekers.

Another person variable that might be relevant to individual differences in emotional responses to natural threats is gender. Outcomes of a representative survey in Sweden (Fredrikson, Annas, Fischer, & Wik, 1996) suggest that phobic fear of nature is more common in women than in men. Animal phobia (snakes, spiders) had a prevalence of 12.1% in women and 3.3% in men. Prevalence of situational phobia (lightning, darkness and heights) was 17.4% in women and 8.5% in men. No gender differences were observed for other types of phobia such as fear of dentists and injections. These findings suggest that women are more likely to respond fearfully to natural threats than men. As yet, there is no direct evidence that women are also less likely than men to respond positively to confrontations with natural threats. However, a study by Hoff & Maple (1982) showed that female visitors were more likely to refuse to enter a reptile house, and if they did enter it, female visitors tended to stay a shorter period of time. The latter observation suggests that women derive less positive emotions from actual confrontations with feared objects than men.

1.4. Overview of the present research

We conducted the present research to learn more about people’s emotional responses to natural threats. Based on evolutionary accounts of human-nature relations we assumed that nature represents a potent and deeply rooted source of fear. Consequently, we predicted that threatening encounters with nature would evoke fear even in a highly cultivated country such as The Netherlands. Based on insights from research on wilderness experience and outdoor adventure activities, we further expected that people might offset their fearful responses to natural threats with highly positive emotions. Finally, we expected that encounters with similar natural threats would elicit different types of emotional responses in different individuals. More specifically we predicted that these individual differences would vary systematically as a function of personality characteristics, in particular sensation seeking and gender.

To test the aforementioned hypotheses, we employed a mixture of methodological approaches that combined both qualitative and quantitative techniques (cf. Creswell, 2003). This multi-method approach enabled us to detect broad patterns in people's interactions with threatening aspects of nature, along with the meanings people attach to these interactions. In Study 1, we investigated people's open-ended descriptions of their emotional reactions to natural threats and explored the potential existence of individual differences in these reactions. In Study 2, we conducted a more focused investigation of individual differences in emotional responses using standardized scenarios of encounters with natural threats.

2. Study 1

In Study 1, we conducted an initial exploration of people's emotional responses to natural threats. Participants in Study 1 were asked to describe in their own words how they were affected by their own threatening encounters with nature. We subsequently coded these descriptions for their emotional contents. Based on the foregoing theoretical discussion, we anticipated that encounters with natural threats would be associated with both negative and positive emotions. A further purpose of Study 1 was to develop a classification scheme of situational characteristics that are salient in people's personal narratives of their encounters with natural threats. Using this preliminary classification scheme, we explored whether similar situations might be associated with different emotional responses among different participants.

2.1. Method

2.1.1. Participants and procedure

Participants consisted of employees of a large environmental research organization, and personal acquaintances of the researchers. All participants were contacted via e-mail. We received 27 reactions, in which 35 episodes were described. Five episodes were excluded from the analysis, because (despite our explicit instructions), these were situated outside The Netherlands. Another three episodes were excluded because these concerned reactions to other people in nature, and not to nature itself. The remaining data set consisted of 27 episodes described by 23 participants (9 men and 14 women).

2.1.2. Instructions

The e-mail survey asked recipients to describe one or more fearful encounters with nature in their home country. To allow for the possibility that these encounters were experienced in a positive way, the e-mail emphasized that the encounter might have been 'both fearful and fascinating at the same time'. Recipients were asked to describe, in about half a page, their emotions and sensations during the encounter(s), as well as the natural objects and situations that caused these emotions and sensations.

2.1.3. Content analysis

To analyse the emotional and situational content of the episodes, the two researchers first underlined all references to emotions and emotion-evoking objects and situations in the episodes. References to emotions could be unambiguously classified as "negative" or "positive". To develop a coding scheme for the situational content, the two researchers independently identified a limited set of abstract situational characteristics that captured the range and variety of the natural objects and circumstances described by the participants. Discrepancies were reconciled through discussion and line-by-line review of coded episodes. After having reached consensus, the two researchers independently scored each episode on each characteristic in the coding scheme. These scores were then submitted to cluster analysis to classify the episodes into similar groups of situations. As a final step in the content analysis, we computed the frequencies of positive and/or negative emotional responses within each cluster of situations.

2.2. Results

2.2.1. Environments

The experiences were situated in various types of natural environments. Five experiences took place in forests or wooded areas, four experiences occurred on the water (seas, rivers, lakes), four experiences happened at the beach or in the dunes, two experiences were situated in swamp-like areas, one experience was located on the moors, one in a meadow, one in a backyard, and one inside a house (which was invaded by bats). In eight episodes the environment was not specified, these episodes focused on natural elements, such as thunder, darkness, or animals. Thus, participants' experiences occurred relatively often (59%) in wooded areas and on or near the water.

2.2.2. Emotions

In eleven episodes (41%) participants reported only negative emotions and sensations. In another eleven (41%) episodes participants described a nature experience that had evoked both negative and positive emotions. Unexpectedly, in five stories (19%) participants described only positive emotions. Because the situational descriptions of these participants indicated that they had clearly been in a threatening situation, it is unlikely that these participants misunderstood our instructions and described a different kind of nature experience. Possibly, these participants may have suppressed their negative feelings so well that they did not reach consciousness. Alternatively, they may have forgotten their negative emotions, or they may have felt embarrassed to write down their negative emotions.

Participants who experienced negative emotions mostly described feelings of fear and lack of control. These feelings were sometimes accompanied by unpleasant bodily sensations, such as 'goose bumps', 'raised hackles' and 'cold

sweat under my arms'. Participants who experienced positive emotions described various types of feelings, such as euphoric feelings of happiness and excitement, feelings of fascination, elevated levels of awareness and perception, and feelings of awe and respect. These latter feelings were often accompanied by feelings of insignificance, described as 'vulnerable', 'diminutive', and 'the feeling that one is all alone in the world'.

2.2.3. Situational characteristics

Table 1 provides an overview of the 10 emotion-evoking characteristics that were identified in the content analysis. The two researchers independently scored the episodes on the 10 characteristics. As can be seen in the first column of Table 1, sufficient inter-rater reliability ($\kappa > 0.65$) was obtained for all characteristics.

We conducted a cluster analysis with the added scores of the two researchers as an outcome variable. These scores took a value of '0' if neither of the two researchers rated the characteristic applicable to an episode, a value of '1' if one of the two researchers rated the characteristic applicable, and a value of '2' if both researchers rated the characteristic applicable.

The cluster analysis was carried out using a two-stage procedure whereby a hierarchical procedure determines the number of clusters and starting means, and then a nonhierarchical method is used for final clustering (Ketchen & Shook, 1996). Inspection of the dendrogram and the agglomeration schedule coefficients provided by the hierarchical cluster analysis suggested that a clustering into four clusters of episodes was appropriate to the data (Aldenderfer & Blashfield, 1984). The adequacy of the final four-cluster solution was confirmed by a one-way MANOVA which revealed a significant multivariate effect of Cluster Membership (1–4) on the situational characteristics, $F(30, 48) = 10.9, p < .001$. Univariate analyses demonstrated significant differences among the four clusters on nine out of 10 characteristics (see Table 1). In addition,

there was a marginally significant difference between the clusters on 'repulsiveness'.

The first cluster was labeled "Close Encounters". It consisted of 10 episodes with high (≥ 1.5) scores on proximity and suddenness, and moderately high (≥ 1) scores on novelty. Compared to the other clusters, this cluster also scored relatively high on repulsiveness. Most episodes in this cluster involved close encounters with animals, such as a deer, wild cows, snakes, bats, or insects. The second cluster was labeled "Forceful Situations". It contained seven episodes with high scores on danger, dependence, and fierceness, and moderately high scores on suddenness and immensity. In five of these forceful episodes people were hit by thunderstorms, mostly in combination with sailing on open water. Two forceful episodes involved people who were swimming in rivers with strong currents. The third cluster was labeled "Overwhelming Situations". It represented five episodes with high scores on immensity, and moderately high scores on absence of others. In these episodes people were overwhelmed by the greatness of a forest, the immensity of the sea, or the impressiveness of a vast plain. The fourth cluster was labeled "Disorienting Situations". It contained five episodes with high scores on invisibility and moderately high scores on novelty. All episodes in this cluster were about people getting lost in nature, mostly in dark forests.

2.2.4. Emotions within clusters

Table 2 provides an overview of frequencies of emotional reactions in each cluster. The results indicate that similar situations evoked different emotional reactions in different individuals. For example, while most participants experienced a mixture of fear and fascination when they were confronted with the powers of nature in a Forceful Situation, some of them were unable to see the bright side of this kind of situation and experienced only negative emotions. Similar variations in the range of emotional

Table 1
Situational characteristics and final cluster means (Study 1)

Characteristic	Definition	Cluster				F
		1	2	3	4	
Danger ($\kappa = 1.00$)	Possibility of death or severe injuries	0.00	1.71	0.00	0.00	34.07**
Dependence ($\kappa = 0.82$)	A situation in which one cannot afford to make mistakes	0.20	1.57	0.00	0.40	7.40**
Fierceness ($\kappa = 0.91$)	Confrontation with the powers of the elements	0.00	1.86	0.40	0.00	31.39**
Immensity ($\kappa = 0.82$)	The presence of vast elements, such as heights and tall trees	0.00	1.00	2.00	0.20	17.14**
Suddenness ($\kappa = 0.78$)	Caught unprepared by an unexpected event	1.60	1.14	0.00	0.20	7.50**
Proximity ($\kappa = 0.85$)	Being at a close distance of something	2.00	0.29	0.40	0.00	33.19**
Novelty ($\kappa = 0.85$)	Being in an unfamiliar area, or being confronted with unknown things	1.20	0.00	0.60	1.20	3.47*
Invisibility ($\kappa = 0.91$)	Being surrounded by darkness, hearing or touching something invisible	0.70	0.00	0.00	2.00	13.44**
Repulsiveness ($\kappa = 1.00$)	The presence of disgusting animals, smells, or materials	0.80	0.00	0.00	0.20	2.65
Absence of others ($\kappa = 1.00$)	Being alone in nature	0.20	0.00	1.20	0.40	9.99*

Note: Scores range from 0 (not applicable) to 2 (applicable). See text for description of how scores were computed.

** $p < .01$; * $p < .05$.

Table 2
Distribution of negative and positive emotions across clusters of threatening situations (Study 1)

	Cluster 1: Close Encounters	Cluster 2: Forceful Situations	Cluster 3: Overwhelming Situations	Cluster 4: Disorienting Situations
Only negative emotions	6 (60%)	2 (29%)	—	3 (60%)
Negative and positive emotions	2 (20%)	5 (71%)	2 (40%)	2 (40%)
Only positive emotions	2 (20%)	—	3 (60%)	—
Total	10 (100%)	7 (100%)	5 (100%)	5 (100%)

reactions were found in the other clusters. These findings are consistent with our hypothesis that there exist important individual differences in emotional responses to threatening situations in nature.

Inspection of Table 2 also suggests that there were differences in emotional reactions between the clusters. In particular, it seems that Close Encounters and Disorienting Situations more often evoked only fear than the other two clusters, while Overwhelming Situations more often evoked only positive emotions. However, because of the small sample size, we could not perform a statistical test to confirm this observation.

2.3. Discussion

Study 1 consisted of an initial exploration of Dutch people's descriptions of threatening encounters with nature in their home country. As predicted, such encounters did not only evoke fear, but also positive emotions. Positive emotions included intense happiness, fascination, and awe and amazement. Each of these emotions has previously been identified as characteristic of so-called 'transcendent' or 'spiritual' nature experiences (Fredrickson & Anderson, 1999; Williams & Harvey, 2001). The result of the present study provides further support for the notion that such deeply meaningful experiences can be elicited by challenging or threatening situations (Kaplan & Kaplan, 1989).

More than half of the experiences were situated in forests and on or near the water. This finding is consistent with historical analyses, which have revealed that forests and waters have been considered as places of fear and terror across different times and cultures (Schama, 1995). Nevertheless, the mere fact that one is in a forest or on or near the water only rarely aroused fear or fascination in our participants. More perilous circumstances, such as being lost, darkness, thunderstorms, or the presence of dangerous animals, were usually required to transform a walk in the forest or a boat trip into a terrifying experience. We summarized these circumstances into 10 characteristics, labeled danger, dependence, fierceness, immensity, suddenness, proximity, novelty, invisibility, repulsiveness, and absence of others. Each of these characteristics appears to have had immediate survival relevance in early evolution-

ary environments. Thus, our findings are consistent with the notion that fear of nature is rooted in our evolutionary history.

The 10 characteristics were used to subdivide the episodes into four 'prototypical' threatening situations, labeled Close Encounters, Forceful Situations, Overwhelming Situations, and Disorienting Situations. In each cluster, some individuals reacted with a combination of positive and negative emotions, while others reacted only with positive or only with negative emotions. This finding provides some preliminary support for the existence of important individual differences in emotional reactions to natural threats. These individual differences were further pursued in Study 2.

3. Study 2

In Study 2 we examined people's emotional responses to standardized descriptions of threatening situations in nature. These scenarios were constructed on the base of situational dimensions identified in Study 1. In particular, we investigated the influence of sensation seeking and gender on people's emotional responses to the scenarios. Based on previous research (Hoff & Maple, 1982; Zuckerman et al., 1993), we expected that men and individuals high in sensation seeking, would be more likely to respond positively to the threatening situations, while women and individuals low in sensation seeking would be more likely to respond negatively to these situations. In a more exploratory vein, Study 2 also examined the potential influence of phobic fears and other variables that have been found relevant to environmental preferences in previous research, including membership of nature protection organizations and frequency of nature visits, and phobic fears of nature (cf. Van den Berg, Vlek, & Coeterier, 1998).

3.1. Method

3.1.1. Participants and procedure

Fifty paid volunteers at Wageningen University (32 women and 18 men, average age 23) participated in the study. Upon arrival in the laboratory, participants were seated at separate desks, where they filled out a written questionnaire. The first part of this questionnaire

contained questions about six scenarios describing threatening situations in nature. The scenarios were printed in the upper half of each page, with the questions printed directly below. The second part of the questionnaire consisted of the 13 items of the sensation-seeking scale, followed by some background questions about participants' age, gender, membership of nature protection organizations, and frequency of visits to nature. Participants were also asked to indicate whether they suffered from one or more phobic fears, and if yes, to indicate what type of object(s) or situation(s) they were afraid of. Finally, participants were paid and dismissed.

3.1.2. Scenarios

The stimulus set consisted of six scenarios describing threatening situations in nature (See the Appendix). Each scenario was described in an objective manner, and did not contain any references to emotions or feelings. The six scenarios were selected from a larger set of 12 scenarios, which were pilot-tested in a postal survey within the general Dutch population ($N = 60$). This larger set of scenarios was constructed on the base of the results of Study 1, and included four Forceful Encounters, four Close Encounters, and four Disorienting Situations. The initial set of scenarios did not include any Overwhelming Situations, because it appeared too difficult to describe these situations as threatening without explicit reference to emotional states.

Results of the pilot study showed that reactions to six scenarios (three Close Encounters and three Disorienting Situations) showed little or no variation. Reactions to the other six scenarios (four Forceful Encounters, one Close Encounter, and one Disorienting Situation) were highly varied. Some participants indicated that they would react "primarily with fear" to these situations, while others indicated that they would react "primarily with fascination". These latter six scenarios were used in the present study.

3.1.3. Assessment of emotional responses

Three questions were asked about each scenario. The first question asked participants to indicate how they would feel if they were in the situation described. They could choose between "primarily afraid" or "primarily fascinated". Participants' answers to this question were aggregated across the six scenarios into a single index (labeled 'Fear/Fascination'). This index represents the number of times a participant selected the alternative "primarily fascinated" (minimum = 0, maximum = 6).

The second question consisted of a list of eight items that described negative and positive emotions. Participants were asked to indicate on a 5-point scale to which degree they would feel the emotion if they were in the situation described. Factor analysis yielded two factors (Table 3). One factor contained the four negative emotions ("afraid", "insecure", "tense", "sad"), while the other factor con-

Table 3
Factor analysis of emotions (Study 2)

Factor	Factor 1 Negative emotions	Factor 2 Positive emotions
Afraid	.86	
Insecure	.83	
Sad	.81	
Tense	.67	-.36
Happy		.86
Impressed		.84
Curious	-.36	.79
Fascinated	-.47	.71
Variance explained	36.2%	35.3%
Alpha	.84	.86

Note: Only factor loadings $> |.30|$ are displayed.

tained the four positive emotions ("happy", "fascinated", "impressed", "curious"). We combined the four negative emotions into one new variable, Negative Emotions, that consisted of the simple average of the four separate indices (range 1–5). In a similar vein, we created a new aggregate variable for Positive Emotions.

The third question consisted of two statements about the participant's tendency to approach or avoid the situation in the future. The first statement was "I would try to avoid this situation in the future", the second statement read "I would want to experience this more often". Participants were asked to indicate how much they agreed with each statement on a 5-point scale.

3.1.4. Assessment of individual differences

To assess individual differences in sensation seeking, we used a Dutch translation of a shortened version of the original Sensation Seeking Scale (SSS-V; Zuckerman, Eysenck, & Eysenck, 1978). This brief version was published by Zuckerman (1978) as a quick self-test. It consists of 13 items that tap into various dimensions of the original scale. Each of the items consists of two alternatives, A or B, that describe a preference or a feeling towards a particular action or situation. One of these alternatives refers to a preference or feeling that expresses a high desire for sensation-seeking, for example "I would like a job that requires a lot of traveling". The other alternative refers to a preference or feeling that expresses a low desire for sensation-seeking, for example "I would prefer a job in one location". All items of the brief measure of the SSS-V referred to actions or situations that were unrelated to nature or natural environments. For each item, participants were asked to choose which of two alternative responses would best describe their preference or feeling. High sensation-seeking choices were coded as '1', whereas low sensation-seeking choices were coded as '0' (Cronbach's $\alpha = .63$).

Table 4
Correlations between sensation seeking and reactions to threatening scenarios (Study 2)

	Fear/fascination	Positive emotions	Negative emotions	Approach in future	Avoid in future
Sensation seeking	.56	.53	-.57	.69	-.55

Note: All correlations are significant at $p < .001$ (2-tailed). Descriptions of the emotion measures are provided in the methods section of Study 2.

3.2. Results and discussion

3.2.1. Fear versus fascination

The scenarios elicited different emotional responses. For five out of six scenarios, about half of the participants indicated that they would feel “primarily afraid” if they were in the situation described. The other half of the participants indicated that they would feel “primarily fascinated” in the situation described. Situation# 5 evoked more fearful reactions than the other situations. Because situational characteristics were not systematically varied across the scenarios, the precise cause of the greater fear-evoking capacity of this scenario is difficult to determine. Speculatively, it could be that the description of a “holiday home” in this scenario lead some participants to imagine that it was situated abroad in a more unfamiliar and uncontrolled setting.

3.2.2. Influence of sensation seeking

Sensation seeking was significantly correlated (all $ps < .001$) with each of the emotional response measures, as well as with future approach/avoidance tendencies (Table 4). High sensation seekers, as compared to low sensation seekers, more often indicated that they would be “primarily fascinated” by a threatening situation. To illustrate the strength of this effect, we divided the participants in a group of 28 low sensation seekers and 22 high sensation seekers on the base of a median split. On average, the low sensation seekers reacted primarily with fear to four out of six situations, while the high sensation seekers reacted primarily with fear to only two situations. High sensation seekers also displayed more positive emotions, and they displayed less negative emotions. Finally, high sensation seekers were more likely to agree with the statement that they would want to experience the situation again in the future, while they were less likely to agree with the statement that they would try to avoid the situation in the future. These results confirm our hypothesis that sensation seeking is an important trait that underlies individual differences in reactions to threatening situations in nature.

3.2.3. Influence of gender

A one-way MANOVA revealed a significant multivariate effect of gender on the five emotional response measures, $F(5, 44) = 4.71$, $p < .01$. As can be seen in Table 5, men were more often primarily fascinated by threatening situations than women. Men also displayed

Table 5
Means of reactions to threatening scenarios by men and women (Study 2)

	Men ($N = 18$)		Women ($N = 32$)		F
	M	S.D.	M	S.D.	
Fear/fascination	3.78	1.48	1.97	1.69	14.35**
Positive emotions	3.07	0.48	2.82	0.63	2.18
Negative emotions	2.60	0.32	3.18	0.57	15.29**
Approach in future	2.64	0.60	2.07	0.72	7.80**
Avoid in future	3.19	0.72	3.74	0.69	7.10*

** $p < .01$; * $p < .05$.

significantly less negative emotions. Furthermore, men were more likely to agree with the statement that they would want to experience the situation again in the future, while they were less likely to agree with the statement that they would try to avoid the situation in the future. Men did not display significantly more positive emotions than women.

Men did not differ significantly from women with respect to sensation seeking, $M = 7.76$ vs. $M = 7.00$, $F(1, 48) = 1.06$, $p = 0.31$. Thus, the gender differences in reactions to threatening situations in nature could not be explained by differences in sensation seeking between men and women. Indeed, additional analyses of the combined effects of sensation seeking and gender yielded parallel, significant effects on emotional reactions.

3.2.4. Influence of other personal variables

There was a small but significant positive correlation between frequency of nature visits and positive emotions, $r = .31$, $p < .05$. However, additional analyses revealed that this relationship could be explained by the fact that participants who frequently visited nature scored higher on sensation seeking. When sensation seeking was controlled for, the significance disappeared, $r = .14$, $p > .36$, suggesting that sensation seeking was responsible for this spurious relationship.

The sample contained 12 participants who were members of nature protection organizations, and 13 participants who suffered from phobic fears (mostly heights). However, one-way MANOVAs did not reveal any multivariate or univariate effects of membership of nature organizations and phobic fears on participants' emotional reactions to the scenarios, all $ps > .11$.

4. General discussion

In the present research, we sought to gain more insight into people's responses to natural threats. As expected, encounters with natural threats were strongly associated with fearful emotions. Indeed, Study 1 showed that even inhabitants of a highly developed country such as The Netherlands were able to recall one or more fearful encounters with nature in their home country. Study 2 confirmed that interactions with nature can be a source of fear, even if these interactions are situated in relatively cultivated settings. For each of the threatening scenarios used in this study, including a scenario about an encounter with cows in agricultural fields, about half or more of the respondents indicated that they would react primarily with fear if they were in this situation. These results suggest that fear of nature is not tied to the spatial context of wilderness settings, which have been focal in previous work on this topic (Kaplan & Kaplan, 1989; Bixler & Floyd, 1997). Instead, the findings of the present research suggest that fear of nature can occur in any type of environment and is evoked by relatively common and unexceptional circumstances, such as the presence of animals, darkness, being alone, or the forces of nature.

Consistent with observations from research on wilderness experience and outdoor adventure activities (Kaplan & Kaplan, 1989; Hennig et al., 1994), encounters with natural threats were also associated with highly positive emotions. In Study 1, we found that fear of nature was often accompanied by profound and meaningful positive emotions, such as extreme happiness, fascination, and awe. In Study 2, participants reported similar positive emotions in response to threatening scenarios using pre-structured rating scales. As yet, few studies have considered the possibility that deeply meaningful and positive experiences with nature may be closely related to fear and other negative emotions. Thus, the results of the present study suggest that research on positive nature experiences may benefit from considering these experiences in conjunction with negative experiences.

Finally, both studies supported the existence of meaningful individual differences in emotional responses to natural threats. Similar situations (e.g. sailing a boat during a heavy storm) were experienced as purely frightening by some people, while others were able to derive enjoyment and positive meaning from them. Study 2 demonstrated that these differences were systematically related to gender and sensation seeking. Men and high sensation seekers, as compared to women and low sensation seekers, more often indicated that they would be primarily fascinated by a threatening encounter with nature. Both gender and sensation seeking constitute basic aspects of people's personality and functioning that are shaped by genetic and social processes (Zuckerman, 1994; Jang, Stein, Taylor, & Livesley, 1999). Therefore, the finding that individual differences in responses to natural threats are related to these variables suggests that these

differences are relatively stable, and cannot easily be influenced or changed. As such, programming activities aimed at modifying negative perceptions of wildlands or natural threats might do well to match individual needs for challenge and threat (Weber, 2001).

5. Limitations and future perspectives

The present research is only an initial exploration of what is clearly an intricate domain of nature experiences. Therefore, there remain many important issues that need to be addressed in future research. A first issue concerns the prevalence and frequency of threatening encounters with nature. How many people have had one or more threatening encounters with nature? How often are people frightened and/or fascinated by nature? And how do emotional responses vary across different types of settings, and different types of encounters with nature? These questions cannot be answered by the present research, because the samples of participants were small and not representative of the general population. Moreover, the research was restricted to threatening encounters with nature in The Netherlands, a country with a highly cultivated landscape that is not representative of the types of natural settings in most parts of the world. By conducting large-scale survey studies among more representative samples in different countries across the world, future research may provide a better understanding of the pervasiveness of fear of nature in modern people's interactions with nature.

Future research may also take a closer look at the influence of sensation seeking on emotional responses to natural threats. In the present research, sensation seeking was measured using an early, brief version of the sensation seeking scale (Zuckerman, 1978). Therefore, it was not possible to reliably determine the separate influences of the four subscales of the full scale (Thrill and Adventure Seeking, Experience Seeking, Disinhibition, and Boredom Susceptibility). Findings of recent research on preferences for adventurous holiday (Eachus, 2004) suggest that in particular the subscales of Experience Seeking and Thrill and Adventure Seeking may be important to the prediction of emotional responses to natural threats. Future research may examine this hypothesis by employing the extended 40-items SSS-V (Zuckerman et al., 1978), or the more recently developed Brief Sensation Seeking Scale (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002).

A more fundamental issue that warrants scrutiny in future research concerns the processes underlying people's overt responses to natural threats. In the introduction, we have argued that emotional responses to natural threats may reflect automatic physiological processes that prepare the body for appropriate defensive behaviors (Öhman & Mineka, 2001), as well as deliberate processes that serve to interpret the situation in a symbolically meaningful way (Koole & Van den Berg, 2004, 2005). The present research

relied on descriptive methods that are unsuitable for studying the operation of these underlying processes. By employing more sophisticated methods, such as experimental designs and neuro-imaging techniques, future research may yield more insight into the interplay between physiological and cognitive processes in the generation of emotional responses to natural threats. Future research might also investigate developmental aspects of emotional responses to natural threats or conduct cross-cultural studies to learn more about the relative importance of genetic versus cultural influences.

Finally, we wish to draw attention to the practical implications of this research. By showing that fear of nature is implied in some of people's most positive and meaningful experiences with nature, the results of the present study strengthen the rationale for the active use of fear in outdoor activity programming for youth and adults. Fearful experiences with nature may not only teach people more about themselves, but these experiences may also help to create a bond with nature. It has been argued that such a bond with nature constitutes a critical antecedent of environmental awareness and concern (Chawla, 1988). Thus, fear-provoking activities can be a valuable tool for therapeutic as well as educational purposes. However, in applying this tool, instructors and interpreters should be aware that some individuals have more difficulties in overcoming their fear of nature than others. For these individuals, fear may pose a barrier to enjoying and learning about nature. However, protecting these individuals against the threatening aspects of nature may also be ineffective because it can hinder the development of a personal bond with nature. Coping with this dilemma is a major task for nature education, and more insight into the nature and determinants of fear of nature may help to enhance the efficacy of nature education programs.

6. Concluding remarks

The present findings suggest that fear plays an important, but ambivalent role in modern human's interactions with nature. There is a bright side to the dark side of nature, but not everybody is able to see it. Some people, in particular women and those low on sensation seeking, may be unable to transform their deeply rooted fears into meaningful positive experiences. An important implication of these findings is that modern society's struggle against the dark side of nature is ultimately psychological, and as such is unlikely to be solved by further scientific or technological developments (cf. Koole & Van den Berg, 2004, 2005). This means that we need psychological wisdom to resolve our battle against the threats of nature, and accept that eliminating the dangers will not eliminate the fear. Instead of going to extremes to control nature, we better find ways to control our fear and transform it into a positive experience.

Appendix. Scenarios used in study 2 (translated from Dutch)

Scenario 1 (Forceful Situation)

You have decided to go to the beach. When you arrive, there is a strong wind, and big clouds are chasing the sky. You start to walk against the wind. On bare feet, you cross a little stream, and then you continue your walk over the deserted beach. The clouds keep racing and the wind turns into a storm. You decide to return. But when you arrive at the stream, it has turned into a real river. The tide is pushing the water on the beach and has created a strong current. You realize that the only way back is through the water.

Scenario 2 (Forceful Situation)

The weather forecasting station has predicted a heavy storm. But in the afternoon, nothing has happened yet, and you decide to take a walk in the forest. You are unaware of the fact that the storm has already reached The Netherlands earlier that day. In the middle of the forest you are startled by the first blasts of wind. Big branches are sweeping hence and forth, and acorns and chestnuts are falling out of the trees. Then you hear a loud noise and an enormous branch falls down just a few meters front of you.

Scenario 3 (Close Encounter)

Together with a friend you have decided to take an early morning walk. The mist is still hanging over the fields when you walk along old farms and hedges. After half an hour, two large animals suddenly step out of the mist. When you have approached them at a close distance, you see that the animals are two large wild cows with sharp horns and long red hairs, a mother and her young. You hold your steps. The big mother animal looks at you watchfully. You become keenly aware of the short distance between you and her.

Scenario 4 (Forceful Situation)

You have decided to take a walk in the forest. The weather is warm and the birds are singing. Lost in thoughts, you walk along the path deeper and deeper into the forest. Suddenly the sun disappears. You look up at the sky and see that big clouds are developing. You decide to walk back in order to get out of the forest before the thunder starts. But the clouds are growing so fast, that you cannot get out of the forest in time. You hear the first strikes of thunder in the distance. Soon the sky is pitch black. You see a flash of lightning directly followed by a loud bang. Then it starts to rain.

Scenario 5 (Forceful Situation)

There is an old rowing boat in the lake near your holiday home. You remember that, as a child, you loved to row in

such a thing. You decide to go out on the lake. Soon, you are on the middle of the lake with the shores far out of sight. Then the wind starts blowing. Big waves start lashing the boat. You decide to return immediately. You have to row hard against the wind to get ahead. An unexpected gust makes the boat rock and blows your sunglasses away. The wind is beating your back.

Scenario 6 (Disorienting Situation)

You are on a guided nature tour. The guide explains how the landscape in the area has evolved and which animals and plants can be found. It has rained a lot the past few weeks, and the ground is wet and boggy. You sink into the soil for a couple of times, and you are lagging behind the group. A small trail leads between prickly bushes and right through a fringe of reeds. Then you sink into the mud a few times more. A cold trickle of water enters your shoes. The group is disappearing out of sight. A wet branch brushes against your face.

References

- Agras, W. S., Sylvester, D., & Oliveau, D. (1969). The epidemiology of common fears and phobias. *Comprehensive Psychiatry*, *10*, 151–156.
- Aldenderfer, M. S., & Blashfield, R. K. (1984). *Cluster analysis*. Sage University paper series on quantitative applications in the social sciences (Series no. 07-044). Beverly Hills, CA: Sage.
- Appleton, J. (1975). *The experience of landscape*. London: Wiley.
- Bixler, R. D., Carlisle, C. L., Hammitt, W. E., & Floyd, M. F. (1994). Observed fears and discomforts among urban students on school field trips to wildland areas. *Journal of Environmental Education*, *26*, 24–33.
- Bixler, R. D., & Floyd, M. F. (1997). Nature is scary, disgusting, and uncomfortable. *Environment and Behavior*, *29*, 443–467.
- Brinsmead, M., Smith, R., Singh, B., Lewin, T., & Owens, P. (1985). Peripartum concentrations of beta-endorphin and cortisol and maternal mood states. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, *25*, 194–197.
- Chawla, L. (1988). Children's concern for the natural environment. *Children's Environments Quarterly*, *5*, 13–20.
- Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed method approaches*. Thousand Oaks, CA: Sage.
- Eachus, P. (2004). Using the Brief Sensation Seeking Scale (BSSS) to predict holiday preferences. *Personality and Individual Differences*, *36*, 141–153.
- Ewert, A. (1986). Fear and anxiety in environmental education programs. *Journal of Environmental Education*, *18*, 33–39.
- Fredrickson, L. M., & Anderson, D. H. (1999). A qualitative exploration of the wilderness experience as a source of spiritual inspiration. *Journal of Environmental Psychology*, *19*, 21–39.
- Fredrikson, M., Annas, P., Fischer, H., & Wik, G. (1996). Gender and age differences in the prevalence of specific fears and phobias. *Behavioral Research and Therapy*, *34*, 33–39.
- Harber, V. J., & Sutton, J. R. (1984). Endorphins and exercise. *Sports Medicine*, *1*, 154–174.
- Hennig, J., Laschewski, U., & Opper, C. (1994). Biopsychological changes after bungee jumping: Beta-endorphin: Immunoreactivity as a mediator of euphoria? *Neuropsychobiology*, *29*, 28–32.
- Herzog, T. R., & Kropscott, L. S. (2004). Legibility, mystery, and visual access as predictors of preference and perceived danger in forest settings without pathways. *Environment and Behavior*, *36*, 659–677.
- Herzog, T. R., & Kutzli, G. E. (2002). Preference and perceived danger in field/forest settings. *Environment and Behavior*, *34*, 819–835.
- Hoff, M. P., & Maple, T. L. (1982). Sex and age differences in the avoidance of reptile exhibits by zoo visitors. *Zoo Biology*, *1*, 263–269.
- Holyfield, L., & Fine, G. A. (1997). Adventure as character work: The collective taming of fear. *Symbolic Interaction*, *20*, 343–363.
- Hoyle, R. H., Stephenson, M. T., Palmgreen, P., Lorch, E. P., & Donohew, R. L. (2002). Reliability and validity of a brief measure of sensation seeking. *Personality and Individual Differences*, *32*(3), 401–414.
- Hugdahl, K., & Johnsen, B. H. (1989). Preparedness and electrodermal fear-conditioning: Ontogenetic vs. phylogenetic explanations. *Behavioral Research & Therapy*, *27*, 269–278.
- Jang, K. L., Stein, M. B., Taylor, S., & Livesley, W. J. (1999). Gender differences in the etiology of anxiety sensitivity: A twin study. *Journal of Gender Specific Medicine*.
- Kahn, P. H., Jr. (1999). *The human relationship with nature: Development and culture*. Cambridge, MA: MIT Press.
- Kaplan, R. (1984). Wilderness perception and psychological benefits: An analysis of a continuing program. *Leisure Sciences*, *6*, 271–290.
- Kaplan, S., & Kaplan, R. (1989). *The experience of nature: A psychological perspective*. New York: Cambridge University Press.
- Kaplan, S., & Talbot, J. F. (1983). Psychological benefits of a wilderness experience. In I. Altman, & J. F. Wohlwill (Eds.), *Human behavior and environment: Advances in theory and research*, Vol. 6 (pp. 163–203). New York: Plenum Press.
- Ketchen, D. J., & Shook, C. L. (1996). The application of cluster analysis in strategic management research: An analysis and critique. *Strategic Management Journal*, *17*, 441–458.
- Koole, S. L., & Van den Berg, A. E. (2004). Paradise lost and reclaimed: A motivational analysis of human-nature relations. In J. Greenberg, S. L. Koole, & T. Pyszczynski (Eds.), *Handbook of experimental existential psychology*. New York: Guilford.
- Koole, S. L., & Van den Berg, A. E. (2005). Lost in the wilderness: Terror management, action control, and evaluations of nature. *Journal of Personality and Social Psychology*, *88*(6), 1014–1028.
- Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, *131*, 466–478.
- Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and learning. *Psychological Review*, *108*, 483–522.
- Öhman, A., & Mineka, S. (2003). The malicious serpent: Snakes as a prototypical stimulus for an evolved module of fear. *Current Directions in Psychological Science*, *12*, 5–9.
- Öhman, A., & Soares, J. J. F. (1993). On the automatic nature of phobic fear: Conditioned electrodermal responses to masked fear-relevant stimuli. *Journal of Abnormal Psychology*, *102*, 1132–1221.
- Parsons, R., & Daniel, T. C. (2002). Good looking: In defense of scenic landscape aesthetics. *Landscape and Urban Planning*, *60*, 43–56.
- Roberti, J. W. (2004). A review of behavioral and biological correlates of sensation seeking. *Journal of Research in Personality*, *38*, 256–279.
- Robinson, M. D. (1998). Running from William James' bear: A review of preattentive mechanisms and their contributions to emotional experience. *Cognition and Emotion*, *12*, 667–696.
- Schama, S. (1995). *Landscape and memory*. London: Harper Collins.
- Scherl, L. M. (1989). Self in wilderness: Understanding the psychological benefits of individual-wilderness interaction through self-control. *Leisure Sciences*, *11*, 123–135.
- Seligman, M. E. P. (1971). Phobias and preparedness. *Behavioral Therapy*, *2*, 307–320.
- Talbot, J. F., & Kaplan, S. (1986). Perspectives on wilderness: Re-examining the value of extended wilderness experiences. *Journal of Environmental Psychology*, *6*, 177–188.
- Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of ancestral environment. *Ethology and Sociobiology*, *11*, 375–424.
- Ulrich, S. R. (1993). Biophilia, biophobia and natural landscapes. In S. R. Kellert, & E. O. Wilson (Eds.), *The biophilia hypothesis*. Washington, DC: Island press.

- Van den Berg, A. E., Koole, S. L., & Van der Wulp, N. Y. (2003). Environmental preference and restoration: (How) are they related? *Journal of Environmental Psychology*, *23*, 135–146.
- Van den Berg, A. E., Vlek, C. A. J., & Coeterier, J. F. (1998). Group differences in the aesthetic evaluation of nature development plans: A multilevel approach. *Journal of Environmental Psychology*, *18*, 141–157.
- Weber, K. (2001). Outdoor adventure tourism: A review of research approaches. *Annals of Tourism Research*, *28*, 360–377.
- Wendling, R. C., & Wuench, K. L. (1985). A fifth-grade outdoor education program: Expectations and effects. *Journal of Interpretation*, *10*, 13–20.
- Williams, K., & Harvey, D. (2001). Transcendent experience in forest environments. *Journal of Environmental Psychology*, *21*, 249–260.
- Zuckerman, M. (1978). The search for high sensation. *Psychology Today*, February, pp. 38–44, continued on pp. 98–99.
- Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking*. New York: Cambridge Press.
- Zuckerman, M., Eysenck, S., & Eysenck, H. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology*, *46*, 139–149.
- Zuckerman, M., Ulrich, R. S., & McLaughlin, J. (1993). Sensation seeking and reactions to nature paintings. *Personality and Individual Differences*, *15*, 563–576.