The Chills as a Psychological Construct: Content Universe, Factor Structure, Affective Composition, Elicitors, Trait Antecedents, and Consequences

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We examined the content universe, factor structure, affective composition, elicitors, trait antecedents, and consequences of "the chills." In Study 1, participants described what it means to get the chills. A second sample sorted all references to physical sensations based on similarity. Cluster analysis identified 4 lower order clusters (goosebumps, tingling, coldness, shivers) and 2 higher order clusters ("goosetingles," "coldshivers"). In Study 2, factor analysis of questionnaire data supported a model with lower and higher order factors that corresponded to the Study 1 clusters. Goosetingles and coldshivers were predicted by approach-related traits (e.g., extraversion) and avoidance-related traits (e.g., neuroticism), respectively. In Study 3, analysis of narrative data replicated the goosetingles–coldshivers structure. Relative to coldshivers, goosetingles involved greater awe, surprise, and enjoyment and less disgust, fear, and sadness. In Study 4, analysis of diary data extended the goosetingles–coldshivers structure to between- and within-person levels of analysis. Goosetingles involved positive affects and was elicited by approach-related stimuli, whereas coldshivers involved negative affects and was elicited by avoidance-related stimuli. In Study 5, manipulation of exposure to self-actualization and self-annihilation elicited goosetingles and coldshivers, respectively. Goosetingles and coldshivers had positive and negative effects, respectively, on interpersonal closeness. In sum, diverse forms of evidence converge to indicate that the chills encompasses distinct approach- and avoidance-related constructs. Failure to distinguish these constructs explains null and inconsistent findings in the nascent literature. Goosetingles and coldshivers are posited to serve the function of signaling that an event in the environment is pertinent to one's most deep-seated hopes or fears.

Keywords: chills, piloerection, emotion, affect, approach–avoidance motivation

"The chills" refers to a set of bodily sensations, such as goosebumps and shivers, that accompany strong emotion (Goldstein, 1980). The peculiarity of the chills response and its obscurity as a research topic belie the significance of the events that elicit it. The following passage from the Mahābhārata, an epic from ancient India, portrays the hero Arjuna experiencing one aspect of the chills—goosebumps—in response to a divine encounter (italics added):

> Then Krishna revealed his supreme form—Possessing numerous mouths and eyes, glittering with divine ornaments, displaying divine signs, divinely garlanded, divinely scented, all-shaped, all-powerful, transcendent and limitless. Were a thousand suns to explode suddenly in the sky, their brilliance would approximate the glory of the site. And in the body of Krishna, Arjuna saw the separate universes united, and resting. Struck with awe, *his hair on end*, he bent his head, and joined his palms. (Book 6, Section 35)

Chills sensations are elicited by the awful as well as the awesome. In the following, a witness to the horror depicted in Robert Barker's 1799 panoramic painting, *The Battle of the Nile*, recounts feeling a shiver—another aspect of the chills (italics added):

> As soon as you enter a *shiver runs down your spine*. The darkness of night is all around, illuminated only by burning ships and cannon fire. . . . And if the whole scene is terrible, still it is the fate of the Orient that arouses the greatest horror. . . . Clinging to the masts and yardarms in desperate contortions are the poor sailors; some have been torn to pieces and catapulted into the air by the explosion; heads, limbs, cannon mounts, yards, masts, muskets, crates, shreds of ropes

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> and all the other contents of the ship rain down on all sides. (quoted in Griffiths, 2008, p. 59)

We believe that chills experiences deserve greater research attention for several reasons. First, according to peripheralist theories of emotion (James, 1884/1922), embodiment is what makes emotion *felt*. Chills experiences are unmistakable embodiments of emotion (Sloboda, 1991) and provide a vehicle for investigating the rich textures of consciousness and feeling. Second, the nascent literature reveals considerable between-person variability in the chills (Panksepp, 1998), perhaps reflecting something fundamental about personality. Indeed, McCrae (2007) argued that aesthetic chills—chills in response to art or beauty—is the best universal marker of Openness to Experience. Third, Panksepp (1995) argued that a cold chill provides the motivational impetus to reinstate social contact following separation or loss. Thus, what appears to be a mere quirk of human neurophysiology may provide clues about thermoregulatory underpinnings of social motivation. Finally, the weightiness of elicitors of the chills, such as the divine encounter and human annihilation portrayed above, makes the chills an intrinsically important topic of investigation.

The need for research is further indicated by the state of the nascent chills literature. The literature is a jumble of disparate claims and findings, a fact that has not been apparent to date because the literature has never been reviewed thoroughly. The problem of inconsistency may be due to a second problem: Researchers have focused on relating the chills to other constructs without having addressed the more fundamental question (see Anderson & Gerbing, 1988) of whether the chills is a factorially coherent construct. A final problem is that most research has focused on responses to pleasant music, obscuring the relevance of other pleasant stimuli and neglecting aversive stimuli. As a result, the chills literature has been marginalized as a branch of the aesthetics literature and has been largely isolated from general psychological theory and constructs (e.g., approach–avoidance motivation).

We propose that the chills may consist of factorially distinct approach- and avoidance-related constructs that have not been distinguished to date. Approach motivation is focused on moving toward pleasant stimuli, whereas avoidance motivation is focused on moving away from aversive stimuli. This distinction has been fundamental and pervasive in the emotion, motivation, and personality literatures (Elliot, 2008a). Introduction of the approach–avoidance distinction into the chills literature would facilitate theoretical integration with other literatures and would provide a solid foundation for obtaining consistent findings. In the present research, we examined six core issues: the content universe, factor structure, affective composition, elicitors, trait antecedents, and consequences of the chills. We review the literature related to each of these issues below, with particular attention to findings relevant to approach–avoidance.

Literature Related to the Aims of the Present Research

Content Universe

Researchers have allotted little attention to delineation of the chills construct, and extant definitions of the chills are varied. Examples of researchers' definitions are as follows: "a subtle nervous tremor caused by intense emotion" (Grewe, Nagel, Kopiez, & Altenmüller, 2007, p. 297); a "feeling of goose bumps, tingling, and shivers" (Nusbaum & Silvia, 2011, p. 199); and "the tingly somatosensory feeling that can be evoked by certain kinds of music" (Panksepp, 1995, p. 172). Also relevant is the following description based on participants' accounts: "a chill, shudder, tingling, or tickling" that may involve a feeling of "hair standing on end" or goosebumps (Goldstein, 1980, p. 127).

One way in which such definitions differ is that some refer to objective bodily processes, whereas others refer to subjective sensations of bodily processes. We propose that the chills is best defined in terms of subjective bodily sensations. One reason is that most research is focused on understanding the construct that laypersons call getting "the chills"; self-reports of the chills are therefore face valid regardless of what is actually happening in the body. Our approach exemplifies a tradition in which bodily sensations constitute a construct class in its own right, the basis of which may be biological or social (Pennebaker, 1982), although we presume that chills experiences are strongly rooted in biology. A second, more pragmatic reason is that little is known about the biological basis of most chills sensations. Defining the chills in terms of objective bodily processes would bias research arbitrarily toward chills sensations that have a known objective counterpart (e.g., goosebumps).

Definitions of the chills also differ in terms of the particular sensations that are specified. Collectively, definitions appear to encompass four classes of sensations: shiver/shudder, chill/cold, feeling of hair-on-end/goosebumps, and tingling/tickling. We tentatively embrace these sensations as composing the content universe of the chills. Because the chills is more established as a folk concept than as a scientific concept, the best criterion for settling on a set of sensations, we contend, is the testimony of the layperson.

Finally, some definitions are constrained, such that a given set of sensations qualifies as the chills if accompanied by emotion or elicited by stimuli within a specified content domain (e.g., music or aesthetics more generally). We have no reason to restrict the chills to a particular content domain. The presence of emotion, however, is a useful qualifying condition. Implicitly, if not explicitly, all chills researchers distinguish chills that accompany emotional episodes from those that arise from purely physical causes (e.g., illness or cold air). These considerations led us to adopt the following working definition of the chills: a set of bodily sensations—shivers, goosebumps, tingling, and coldness—that accompany emotion. Our first aim in this research was to corroborate or improve this definition based on participants' accounts.

Factor Structure

Much of the chills literature is based on the unstated assumption that the various chills sensations cohere as a unitary construct. For instance, researchers generally assess the chills using a single item or definition (e.g., Grewe, Nagel, Kopiez, & Altenmüller, 2005) or combine data about different sensations into a single index (e.g., Sloboda, 1991).

Evidence justifying the assumption of factorial coherence is scant. In the only factor analysis of the chills to date, Silvia and Nusbaum (2011) examined 12 items concerning aesthetic response. The three chills-relevant items—"feel chills down your spine," "feel like your hair is standing on end," and "feel goose bumps"—loaded on a single factor. However, this study was not designed to detect multiple chills factors if they exist. Use of only

three chills items, inclusion of only two of four chills sensations, and restriction to the aesthetics domain all favor finding a single factor.

In lieu of direct evidence of coherence, we looked for clues in literatures on nonemotional analogues of chills sensations. In the medical literature, both goosebumps and "cold shivers" have been documented as symptoms of epileptic seizures, but, notably, a seizure is more likely to involve one of these symptoms than both (Stefan, Feichtinger, & Black, 2003; Stefan, Pauli, Kerling, Schwarz, & Koebnick, 2002). The thermoregulation literature shows that both piloerection and shivering function as cold-defense responses, but piloerection is mediated by the sympathetic nervous system and shivering is not (Jänig, 2009; Romanovsky, 2007). Moreover, the afferent pathway that stimulates these cold-defense responses is distinct from the pathway responsible for feeling cold (Romanovsky, 2007). It is unclear to what extent chills-like sensations resulting from seizures or a cold environment are homologous to chills sensations that accompany emotion. Nevertheless, these findings suggest the possibility of weak rather than strong coherence of sensations. Our second aim was to examine whether the sensations composing the content universe of "the chills" are factorially coherent.

Affective Composition

Although theorists agree that the chills involves heightened affect, their portrayals of this state have varied. Laski (1961) reported that tingling, shivers, and thrills commonly accompany ecstasy. Goldstein (1980) portrayed the chills as euphoric and found that an opiate receptor antagonist attenuated chills. Blood and Zatorre (2001) found that chills was related to blood flow in brain areas associated with pleasure and reward (e.g., left ventral striatum). Recent studies have linked the chills to wonder and transcendence (Balteş, Avram, Miclea, & Miu, 2011) or admiration (Algoe & Haidt, 2009). Other theorists have posited relations with awe (Konečni, 2008; Pearsall, 2007) or surprise (Huron, 2006; McCrae, 2007). Panksepp (1995) argued that sadness is the emotion most likely to involve the chills, and he reported that sad songs are more effective than happy songs at eliciting the chills. Grewe, Katzur, Kopiez, and Altenmüller (2011) reported that chills from music was related to pleasant affect, whereas chills from pictures or sounds was related to unpleasant affect. In sum, the chills has been associated with a wide range of positive and negative affective states.

One interpretation of these disparate claims and findings is that the chills is an indicator of general emotional arousal and therefore accompanies diverse affective states. Indeed, theorists have proposed that the chills indicates strong emotion (Gabrielsson & Lindström, 1993), sympathetic arousal (Sloboda, 1991), or nonspecific arousal (Grewe et al., 2011). Although Panksepp (1995) emphasized that the chills was associated more with sadness than happiness, perhaps more important was his finding that chills was related to both emotions.

A second interpretation is that the chills is a composite of distinct sensations that are related to different affective states. Because this possibility has never been investigated, we inspected other literatures for clues about the affective character of particular chills sensations. Regarding shivers and shudders, ego psychologists and existentialists have used the term *ego-chill* to describe a shudder caused by the sudden awareness of one's mortality (Erikson, 1958; Leveton, 1965). Early emotion theorists associated shivers with emotional excitement (Darwin, 1872) or fright and sorrow in particular (Lange, 1885/1922). A cold feeling, Darwin (1872) argued, accompanies fear, as a result of vasoconstriction. Lange (1885/1922) linked feeling cold to sorrow as well as fright. Studies of the bodily sensations that accompany emotion have confirmed that feeling cold is characteristic of sadness and fear (Breugelmans et al., 2005; Rimé & Giovannini, 1986; Rimé, Philippot, & Cisamolo, 1990; Scherer, Summerfield, & Wallbott, 1983; Scherer & Wallbott, 1994).

Regarding goosebumps, Darwin (1872) observed that erection of body hair during anger and fear makes an animal appear larger and more threatening, dissuading predators from attacking. Nishida (1997) found that piloerection accompanies appetitive courtship behaviors in chimpanzees. Keltner (2009) suggested that piloerection accompanied adversarial defense in our primate ancestors but accompanies a positive experience of awe in humans. Benedek and Kaernbach (2011) reported that piloerection was related to feeling "moved." We are aware of little theory about the significance of tingling sensations. We note, however, that James (1884/1922) referred in passing to a "tingle at the perfection of the musical form."

These literatures hint at the possibility that shivers and feeling cold tend to be negative in affective tone, whereas goosebumps and tingling tend to be positive in tone. Our third aim was to characterize the affective composition of the chills and to determine whether particular chills factors show differentiated patterns of relations to affective states.

Elicitors

Studies of elicitors of the chills have focused on identifying the full range of elicitors or those specific to music. Regarding the former, Goldstein (1980) asked participants about the stimuli that give them the chills. The category of elicitors with the highest frequency was musical passages. Other categories included movie scenes, moments of inspiration, physical contact, and parades. Although these categories are informative in a descriptive sense, they are not mutually exclusive or closely aligned with psychological processes.

Other researchers have identified musical features as elicitors, including crescendos, textural changes, and unprepared harmonies (Guhn, Hamm, & Zentner, 2007; Panksepp, 1995; Sloboda, 1991). Musical features, like Goldstein's (1980) elicitors, are difficult to map onto psychological processes. A few theorists have ventured to interpret musical and other acoustical features in terms of their psychological significance, such as manageable threat (Huron, 2006) or resemblance to a child's separation call (Panksepp & Bernatzky, 2002) or the primate warning cry (Halpern, Blake, & Hillenbrand, 1986). These proposals have not been tested directly.

In sum, candidate elicitors have lacked theoretical grounding or empirical support. We note that Goldstein (1980) emphasized pleasant elicitors, whereas others have emphasized aversive elicitors. Our fourth aim was to examine whether elicitors may be distinguished in terms of approach–avoidance and whether particular chills factors are differentially associated with approach and avoidance elicitors.

Trait Antecedents

The question of who gets the chills has been examined from the perspective of the trait approach to personality. All studies to date have concerned chills in the aesthetics domain, and hypotheses have concerned Openness to Experience or Agreeableness.

McCrae (2007) argued that aesthetic chills is the best universal marker of Openness to Experience, on the basis of a strong cross-language factor loading of the following Openness to Experience item: "Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement." Nusbaum and Silvia (2011) found that Openness to Experience was the only Big Five trait that predicted self-reports of chills frequency, and Silvia and Nusbaum (2011) reported that the "openness" subscale of an Openness to Experience measure predicted self-reports of chills frequency. Silvia and Nusbaum also found that chills frequency was predicted negatively by the intellect subscale of Openness to Experience, positively by Extraversion and Neuroticism subscales, and negatively by a Conscientiousness subscale.

Emphasizing the importance of emotional responsivity and social-emotional sensitivity, Panksepp (1995; Panksepp & Bernatzky, 2002) proposed that Agreeableness is the Big Five trait most predictive of chills from music. Panksepp and Bernatzky (2002) cited unpublished analyses in which Agreeableness was the only Big Five trait that correlated with the chills. Grewe et al. (2007) found that chills was predicted positively by reward dependence, a trait similar to Agreeableness, and negatively by thrill seeking.

Although Panksepp (1995) singled out Agreeableness as the Big Five trait relevant to the chills, his theorizing about emotional responsivity also implicates other emotion-relevant traits, particularly Extraversion (which involves a proneness to positive affective states) and Neuroticism (which involves a proneness to negative affective states; Larsen & Ketelaar, 1991). Silvia and Nusbaum's (2011) finding that Extraversion and Neuroticism were both positively related to the chills gains theoretical significance in this light. Extraversion also emerged as a significant predictor in exploratory analyses by Rickard (2004).

In sum, all Big Five traits have predicted the chills in at least one study, but none has consistently predicted the chills. In light of our discussion of factor structure, the inconsistent findings may reflect a failure to discriminate distinct chills sensations. We investigated not only the Big Five traits, but also the more explicitly valenced traits of approach–avoidance temperament (sensitivities to reward or punishment) and positive–negative emotionality (dispositions to experience positive or negative emotions). Our fifth aim was to identify trait antecedents of the chills and to determine whether traits differentially predict particular chills factors.

Consequences

On the basis of null effects of the chills on outcomes such as mood and self-concept, Konečni, Wanic, and Brown (2007) concluded that the chills may be of limited psychological significance. However, because their chills measure encompassed shivers, tingling, and goosebumps, the null effects may be symptomatic of a more fundamental problem: combining sensations that have different or opposite effects into a single chills variable.

Most extant theory about the functional significance of the chills focuses on interpersonal consequences. Panksepp (1995) proposed that the chills accompanies separation distress in the parent or child and provides an aversive, thermally based motivation to seek social contact. Whereas Panksepp posited that the chills accompanies separation, Keltner (2009) posited that goosebumps involve feelings of closeness, as if one were able to reach out beyond one's skin.

We propose that the most plausible reconciliation of these hypotheses is that the separation-avoidance function described by Panksepp (1995) is regulated by coldness rather than chills sensations generally; an association between coldness (specifically) and separation could be independent of an association between goosebumps and closeness. Recent research confirms a link between coldness and separation. Separation leads to the experience of coldness (IJzerman & Semin, 2010; Zhong & Leonardelli, 2008), and coldness leads to feeling separated (IJzerman & Semin, 2009; see also Williams & Bargh, 2008).

The premise that the separation-avoidance function is unique to coldness is derived from the thermoregulation literature. Most chills sensations correspond to known cold-defense responses: Shivering produces heat (Kleinebeckel & Klussmann, 1990), goosebumps prevent heat loss by trapping a layer of warm air near the skin (Fujiwara et al., 2011), and feeling cold motivates voluntary behavioral strategies such as seeking shelter (Egan et al., 2005). Feeling cold is therefore unique among cold-defense responses in regulating temperature through voluntary behavior, including social behavior as described by Panksepp (1995). In fact, operation of other cold-defense responses (e.g., goosebumps) may signal that the temperature threat is being managed through other means, possibly ameliorating feelings of coldness and separation. Our final aim was to reconcile Panksepp's and Keltner's (2009) proposals by showing that different components of the chills have opposite effects on closeness to an attachment figure. Coldness and goosebumps were expected to be negative and positive predictors of closeness, respectively.

Integration and Plan of the Present Studies

In light of varied conceptualizations of the chills, hints of a multifactor structure, and inconsistent and null empirical findings, we began our research by investigating two fundamental but neglected issues: the content universe (Study 1) and factor structure (Studies 2–4) of the chills. We then tested the hypothesis that the chills relates to diverse traits (Study 2), affective states (Studies 3, 4), and elicitors (Studies 3, 4) because it consists of distinct sensations that have different nomological networks. The literature on the affective composition of the chills provides preliminary evidence that goosebumps and tingling may converge with approach-related constructs, whereas coldness and shivers may converge with avoidance-related constructs. In our final study (Study 5), we examined whether goosebumps and coldness have opposite effects on closeness to an attachment figure.

Study 1

The aim of Study 1 was to document the core sensations to which individuals refer when they speak of getting "the chills." Participants in Sample A were instructed to describe what it means

to get the chills, and research assistants extracted all references to physical sensations from these descriptions. Participants in Sample B categorized the sensations using a card sort method, and a cluster analysis was conducted to identify discrete classes of sensations. This strategy allowed us to identify the content universe and conceptually distinct components of the chills construct before attempting to operationalize it in our subsequent studies.

Method

Participants. Sample A consisted of 35 introductory psychology students (22 male, 12 female, one unspecified) from a U.S. university who participated in order to fulfill a research participation requirement. Mean age was 19.24 years (range: 18–23). Sample B consisted of 22 undergraduate and graduate students (10 male, 12 female) from a U.S. university who participated in return for pizza and beverages. Mean age was 21.09 years (range: 18–37).

Procedure.

Generation of descriptions of the chills. Participants in Sample A were instructed to describe what it means to get the chills. Participants in this and all subsequent studies were told that we were interested in the meaning of this phrase as it applies to emotionally significant events—excluding, for instance, chills from a cold environment or from physical illness.

Extraction of physical sensations. Two coders blind to the purpose of the study independently extracted from the descriptions all words or phrases that referred to discrete physical sensations of bodily responses or processes. Category agreement, an index of interrater reliability commonly used in text coding (Winter, 1994), was .99. Discrepancies were resolved through discussion. Although the instructions to Sample A participants made no reference to bodily sensations, two thirds of participants (23 of 35) mentioned at least one such sensation. In total, 38 sensations were extracted.

Because all Sample A participants had been asked to describe the same phenomenon, the full set of 38 sensations included some redundancies. Redundancies were retained for the card-sorting task performed by Sample B for two reasons. First, frequently mentioned sensations are more likely to reflect core categories than are idiosyncratic ones. Retaining redundancies therefore preserved important frequency information. Second, because some descriptions are essentially, but not literally, identical (e.g., "hair standing on end" and "hair stands on end"), decisions about which descriptions are redundant and which are not is a matter of subjective judgment. This is the kind of subjectivity that we sought to avoid in having a sample of participants do the sorting task.

Classification of physical sensations. Participants in Sample B categorized the sensations using the card sort method (Coxon, 1999). Each participant received a shuffled set of 38 cards, each of which listed one sensation. Participants were asked to sort the cards into piles, such that sensations that are the same or similar are sorted into the same pile and sensations that are different or dissimilar are sorted into different piles.

Results and Discussion

Hierarchical agglomerative cluster analysis (HACA; Aldenderfer & Blashfield, 1984) was used to analyze the card sort data. In HACA, the two most similar objects are merged to form a cluster. Thereafter, the next two most similar objects, or an object and a cluster or two clusters, are merged. This process is repeated until a single cluster is obtained. HACA yields a tree-like dendogram consisting of n clusters of one object at the leaves and one cluster of n objects at the trunk. In keeping with the majority of cluster analysis studies of card sort data (see Coxon, 1999), we operationalized the similarity of a given pair of sensations as the number (frequency) of participants who sorted them into the same pile. Each element of the 38×38 frequency matrix was subtracted from the maximum frequency, and the resulting dissimilarity matrix was analyzed. Ward's method, which forms clusters based on an error sum of squares function, served as the criterion for creating clusters. Ward's method is widely used and is often recommended as superior to other methods (e.g., Meehl, 1992).

Five sensations (e.g., "a little light-headed," "nauseous") were excluded from our primary analysis because they concern illness (a stated exclusion criterion), have poor face validity, and lack precedent in the chills literature. They were included in a secondary analysis, the results of which are footnoted below.

The HACA dendogram is shown in Figure 1. The analysis yielded two primary clusters, which we labeled "goosetingles" and "coldshivers." Goosetingles subsumed two secondary clusters, which we labeled "goosebumps" and "tingling." Coldshivers likewise subsumed two secondary clusters, "coldness" and "shivers." Distinctions among tertiary clusters were minor; for instance, the goosebumps cluster subsumed one tertiary cluster involving the word *goosebumps* and another involving variants of the phrase *hair standing on end*.

An ideal balance between interpretability and parsimony occurred at the level of the secondary clusters—goosebumps, tingling, coldness, and shivers. Moreover, as noted in the introduction, all four of these components are prominent in theorists' definitions and descriptive data within the existing literature (e.g., Goldstein, 1980). Thus, we embraced these four sensations as composing the content universe of the chills construct, and we operationalized the chills in terms of these components in Studies 2–5. This approach also allowed us to further explore the higher order goosetingles–coldshivers concepts. The term *cold shivers* has been associated with fright (Lange, 1885/1922) and epileptic seizures (Stefan et al., 2002). This fact, together with preliminary evidence reviewed in the introduction, suggests that coldshivers and goosetingles may indicate aversive and appetitive processes, respectively.[1]

[1] Inclusion of the illness-related items yielded a cluster structure very similar to that reported above. As in the main analysis, there were two primary clusters, goosetingles and coldshivers. The coldshivers cluster again subsumed coldness and shivers clusters. The goosetingles cluster subsumed a goosebumps cluster and a tingling–illness cluster. The tingling–illness cluster subsumed tertiary tingling and illness clusters. The tingling cluster consisted of the same sensations as in the main analysis, and the illness cluster consisted of the five sensations that had been dropped from the main analysis. Thus, our conclusion about the structure of the chills is the same whether the illness items are included or excluded.

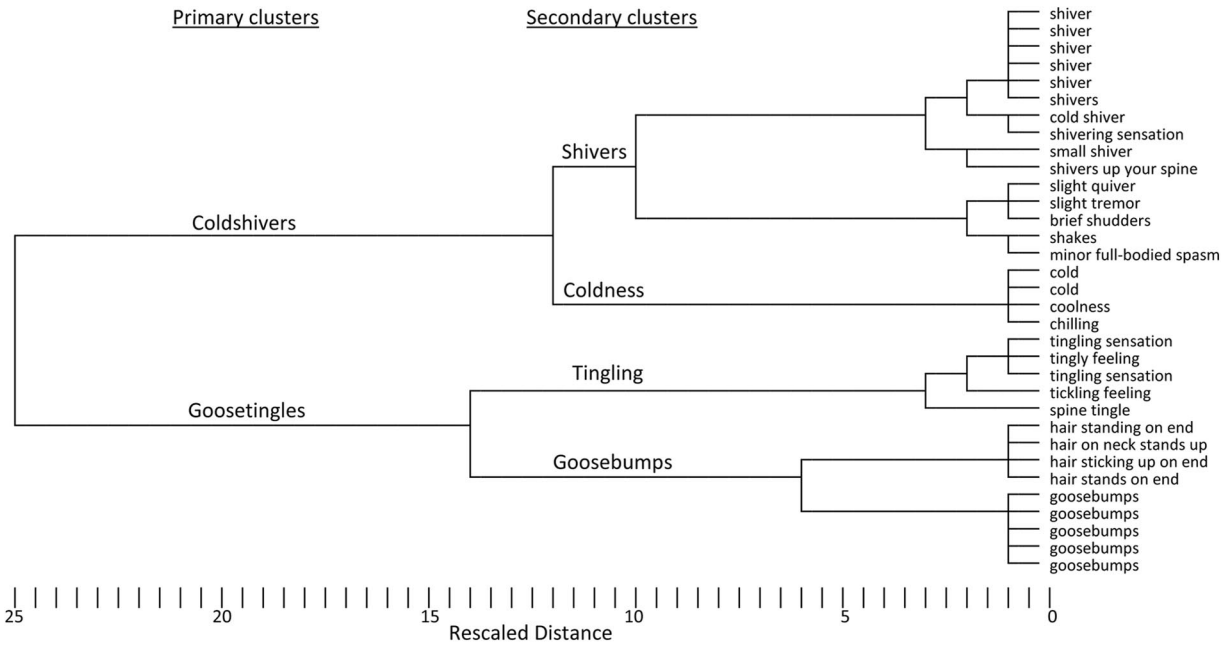

Figure 1. Hierarchical cluster analysis of chills sensations (Study 1).

Study 2

Having established the content universe and cluster structure of the chills construct, we first aimed in Study 2 to establish its factor structure, based on self-reports of the frequency of chills sensations. Whereas the cluster analysis in Study 1 concerned the similarity of sensations (e.g., coldness and shivers were found to be similar), the factor analysis in this study concerned the covariance of sensations across individuals. We expected to identify four distinct lower order factors representing goosebumps, tingling, coldness, and shivers. We also expected these lower order factors to load on two higher order factors representing goosetingles and coldshivers.

If the goosetingles–coldshivers factor structure were to be documented, our second aim was to examine whether this structure is an artifact of response biases. We suspected that goosebumps and tingling are generally regarded as desirable and that coldness and shivers are generally regarded as undesirable. Accordingly, goosebumps and tingling may converge merely because social desirability concerns lead some individuals to endorse both sets of items, and coldness and shivers may converge merely because social desirability concerns lead some individuals to reject both sets of items. To address this possibility, we measured and controlled impression management (IM) and self-deceptive enhancement (SDE), which refer to conscious and unconscious tendencies, respectively, to overstate one's desirable characteristics and to understate one's undesirable characteristics.

The rival hypothesis described above would explain why goosebumps and tingling converge and why coldness and shivers converge; however, it would also imply that goosetingles and coldshivers converge as a single factor, with goosebumps and tingling loading positively and coldness and shivers loading negatively. A second rival hypothesis, which has the virtue of explaining why goosetingles and coldshivers are factorially distinct, is that they are caused by different response biases. We do not have reason to suspect that IM and SDE are themselves differentially relevant to goosetingles and coldshivers. However, a pair of biases orthogonal to the IM–SDE distinction—self-enhancement (SE) bias and self-protection (SP) bias—are differentially relevant. SE refers to the tendency to overstate one's desirable characteristics, whereas SP refers to a tendency to understate one's undesirable characteristics. If SE leads some individuals to overstate their levels of goosebumps and tingling (thus creating a goosetingles factor), and, independently, if SP leads some individuals to understate their levels of coldness and shivers (thus creating an independent coldshivers factor), then these response biases would explain both within-factor convergence and the independence of the factors. To address this second rival hypotheses, we controlled SE and SP biases in a second set of analyses.

Our final aim was to link chills variables to personality traits representing three theoretical frameworks: the Big Five traits, approach–avoidance temperaments, and positive–negative emotionality. The Big Five framework provides a reasonably comprehensive coverage of the personality trait domain and has been the focus of most previous research on trait antecedents of the chills. These studies have yielded inconsistent findings, perhaps because goosetingles and coldshivers have not been distinguished. To provide a more direct test of our ideas about approach–avoidance, we also measured approach–avoidance temperaments and positive–negative emotionality. Approach and avoidance temperaments refer to biologically based sensitivities to reward and punishment, respectively. Approach temperament involves perceptual vigilance for, affective reactivity to, and behavioral predisposition toward reward stimuli; avoidance temperament involves perceptual vigilance for, affective reactivity to, and behavioral predisposition away from punishment stimuli (Elliot & Thrash, 2002). Because approach and avoidance temperaments are broad constructs that concern not only emotion but also perceptual and behavioral processes, we also measured the more specifically

relevant traits of positive and negative emotionality, which are tendencies to experience positive and negative emotional states, respectively. We controlled response biases in these analyses to eliminate possible spurious associations between traits and chills variables.

Method

Participants and procedure. Participants were 362 introductory psychology students (162 men, 200 women) from a U.S. university who participated in order to satisfy a research participation requirement. Mean age was 18.90 years (range: 18–52). Participants completed all measures during one of several questionnaire sessions.

Measures.

Chills sensations. A Chills Questionnaire was developed in pilot research through an iterative process of item writing, data collection, factor analysis, and item revision. Four three-item scales assessed the frequency of goosebumps ("get goosebumps," "feel hairs stand-on-end somewhere on my body," "feel my hairs stand on end"), tingling ("feel tingling sensations in my skin," "feel a tingling sensation spread over me," "feel tickling sensations somewhere in my body"), coldness ("get a cold sensation deep inside me," "get a cold feeling at my core," "get a cold feeling"), and shivers ("feel my muscles quiver or tremble," "feel myself shudder," "feel myself shiver or shake") in response to emotionally significant events. Response options were as follows: 1 = *never or almost never*, 2 = *every few years*, 3 = *about once a year*, 4 = *every few months*, 5 = *about once a month*, 6 = *about once a week*, 7 = *every few days*, 8 = *about once a day*, 9 = *a few times a day*. Cronbach's alphas in the present study were as follows: goosebumps, .86; tingling, .83; coldness, .89; shivers, .86.

Big Five traits. Extraversion, Neuroticism, Openness to Experience, Agreeableness, and Conscientiousness were assessed with the NEO Five-Factor Inventory (Costa & McCrae, 1992), which includes 12 items per trait. Participants responded using a scale from 1 (*if you strongly disagree or the statement is definitely false*) to 5 (*if you strongly agree or the statement is definitely true*). Costa and McCrae (1992) provided evidence of reliability and validity. Cronbach's alphas in this study were as follows: Extraversion, .84; Neuroticism, .87; Openness to Experience, .73; Agreeableness, .81; Conscientiousness, .89.

Approach and avoidance temperaments. Approach temperament and avoidance temperament were assessed with the Approach–Avoidance Temperament Questionnaire (Elliot & Thrash, 2010), which includes six items per temperament. Participants responded using a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Elliot and Thrash (2010) provided evidence of reliability and validity. Cronbach's alphas in this study were .86 for approach temperament and .85 for avoidance temperament.

Positive and negative emotionality. Positive emotionality and negative emotionality were assessed with Version IV-A of the Differential Emotions Scale (Izard, Libero, Putnam, & Haynes, 1993). This measure assesses individual differences in the frequency of positive and negative emotions. The positive emotionality scale concerns the frequency of interest, enjoyment, and surprise, and the negative emotionality scale concerns the frequency of sadness, anger, disgust, contempt, fear, guilt, shame, shyness, and hostility directed inward. Participants responded using a scale from 1 (*rarely or never*) to 5 (*very often*). Izard et al. (1993) provided evidence of reliability and validity. Cronbach's alphas in this study were .83 for positive emotionality and .92 for negative emotionality.

Response biases. IM, SDE, SE, and SP were assessed with the Paulhus Deception Scales (PDS; Paulhus, 1998). The IM and SDE scales consist of 20 items each that were rated from 1 (*not at all true*) to 5 (*very true*). On both scales, 10 items concern qualities that are desirable but uncommon; extreme endorsement of these items is considered indicative of bias. The other 10 items from each scale concern qualities that are undesirable but common; extreme rejection of these items is considered indicative of bias. After recoding reversed items, responses of 5 were assigned a score of 1 and other responses were assigned a score of 0. IM and SDE indexes were computed by summing scores across items. Paulhus (1998) has provided evidence of the reliability and validity of these scales.

Following Elliot and Thrash (2002), SE and SP indexes were computed by rescoring the PDS. A 20-item SE index was derived by summing scores from items that concern the presence of desirable but uncommon characteristics. A 20-item SP index was derived by summing scores from items that concern the absence of undesirable but common characteristics. Cronbach's alphas in this study were as follows: IM, .75; SDE, .75; SE, .67; SP, .72.

Results and Discussion

Descriptive statistics for the chills sensations are shown in Table 1, and correlations among study variables are shown in Table 2. Confirmatory factor analyses (CFAs) were conducted with AMOS 17.0 with maximum likelihood estimation. Covariance matrices served as input. Fit indexes for the models discussed below are presented in Table 3.

CFAs.

First-order CFAs. In an initial CFA model (Model 1), we specified four factors corresponding to the four clusters of sensations documented in Study 1: goosebumps, tingling, coldness, and shivers. As shown in Table 3, Model 1 had a good fit to the data. The four factors were moderately intercorrelated (rs = .41–.68, ps $< .001$). Model 1 fit better than all six nested three-factor models (not shown in Table 3), each of which specifies that a particular pair of sensations cannot be distinguished, $\chi^2(3) = 197.06–587.85$, ps $< .001$. Therefore, it is not surprising that Model 1 also fit better than a two-factor goosetingles–coldshivers model (Model 2), which specifies that goosebumps and tingling cannot be distinguished and that coldness and shivers cannot be distinguished, $\chi^2(5) = 587.85$, $p < .001$. Model 1 also fit better than a one-factor model (Model 3), which specifies that none of the four sensations can be distinguished from any another, $\chi^2(6) = 814.67$, $p < .001$. Whereas the cluster analysis in Study 1 showed

Table 1
Descriptive Statistics for Each Chills Sensation (Study 2)

Chills sensation	*M*	*SD*	Range
Goosebumps	12.29	5.55	3–27
Tingling	12.21	5.83	3–27
Coldness	8.55	5.51	3–24
Shivers	11.57	5.63	3–27

Table 2
Correlations Among Study Variables (Study 2)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Overall chills	—															
2. Goosetingles	.91***	—														
3. Coldshivers	.90***	.65***	—													
4. Extraversion	.13*	.20***	.04	—												
5. Neuroticism	.10	.02	.16**	−.39***	—											
6. Openness	.17**	.14**	.17**	.04	.02	—										
7. Agreeableness	−.10*	−.05	−.14**	.40***	−.27***	.05	—									
8. Conscientiousness	−.02	.03	−.06	.30***	−.29***	−.19***	.22***	—								
9. Approach temperament	.21***	.25***	.14*	.54***	−.23***	.18***	.24***	.41***	—							
10. Avoidance temperament	.15**	.10	.17**	−.27***	.68***	.07	−.13*	−.08	.08	—						
11. Positive emotionality	.22***	.26***	.13*	.51***	−.38***	.09	.25***	.33***	.62***	−.10	—					
12. Negative emotionality	.26***	.15**	.32***	−.41***	.70***	.01	−.37***	−.27***	−.19***	.61***	−.14**	—				
13. Impression management	−.15**	−.14**	−.14*	.10	−.21***	.04	.33***	.22***	.10	−.05	.16**	−.27***	—			
14. Self-deceptive enhancement	−.02	−.02	−.01	.12*	−.25***	.20***	−.02	.11*	.07	−.15**	.13*	−.29***	.36***	—		
15. Self-enhancement	−.07	−.09	−.03	.10	−.23***	.10*	.16**	.23***	.13*	−.06	.25***	−.21***	.76***	.63***	—	
16. Self-protection	−.13*	−.10	−.14**	.12*	−.24***	.11*	.23***	.13*	.05	−.13*	.07	−.36***	.77***	.67***	.49***	—

* $p < .05$. ** $p < .01$. *** $p < .001$.

that goosebumps, tingling, coldness, and shivers are conceptually distinguishable, these findings show that they are also factorially distinguishable.

Second-order CFAs. In second-order CFA, second-order factors are modeled in an effort to account for the correlations among first-order factors (Rindskopf & Rose, 1988). A model with four first-order factors (goosebumps, tingling, coldness, shivers) and two second-order factors (goosetingles, coldshivers) was found to have good fit (Model 4; see Figure 2). The goosetingles and coldshivers second-order factors were strongly correlated ($r = .89$, $p < .001$).[2] A model with a single higher order chills factor also had good fit (Model 5). However, this model fit significantly worse than Model 4, $\chi^2(1) = 7.45$, $p < .01$. Consistent with the hierarchical cluster structure, these findings indicate that the four lower order factors may be modeled parsimoniously in terms of higher order goosetingles and coldshivers factors.

Second-order CFAs with response biases controlled. To address the possibility that the goosetingles and coldshivers factors are artifacts of IM and SDE, we conducted a second set of second-order CFAs. Model 6 was identical to Model 4, except that IM and SDE were controlled with a procedure recommended by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). IM and SDE latent variables were modeled with three random item parcels each as indicators. These method factors were specified to influence not only their indicators, but also all observed chills variables (i.e., responses to particular items). Following Podsakoff et al., these method factors were specified to be correlated with one another but uncorrelated with other latent variables in the model. This model was found to have good fit. As in the original CFAs, the model with two second-order factors fit significantly better than a model with one second-order factor (Model 7), $\chi^2(1) = 7.91$, $p < .01$.

Next we tested a model that was identical to Model 6 except that SE and SP were modeled in place of IM and SDE (Model 8). This model was found to have good fit. As in the other analyses, the model with two second-order factors fit significantly better than a model with one second-order factor (Model 9), $\chi^2(1) = 5.84$, $p < .05$. These analyses show that the goosetingles–coldshivers structure is not an artifact of any of a variety of response biases.

In sum, the second-order CFAs provide preliminary evidence of the discriminant validity of goosetingles and coldshivers. However, it is not clear whether goosetingles and coldshivers are sufficiently distinct to have unique nomological networks, an issue we address in the following section.

Regression analyses of trait antecedents. Next we examined trait antecedents of the chills variables using simultaneous regression analyses. In preliminary analyses, the criterion was an overall chills index based on all 12 chills items. In subsequent analyses, the criterion was a goosetingles or coldshivers index based on the relevant six items.

[2] Although the goosetingles and coldshivers factors were strongly related, we note that over a fifth of their variance was unshared ($1 - r^2 = .21$). Moreover, we note that the reported correlation has been adjusted for attenuation through use of latent variables and therefore is not comparable to the more commonly reported correlations between observed variables. In this study, the correlation between the observed goosetingles and coldshivers variables was .65. A correlation of this size generally would not be regarded as strong enough to preclude distinct patterns of relations to other constructs.

Table 3
Confirmatory Factor Analysis Fit Indexes (Study 2)

Model	χ^2	*df*	TLI	CFI	RMSEA	AIC
1. Four factors	82.24	48	.98	.99	.044	166.24
2. Two factors	670.09	53	.71	.77	.180	744.09
3. One factor	896.91	54	.61	.68	.208	944.91
4. Four FO factors, two SO factors	86.11	49	.98	.99	.046	144.11
5. Four FO factors, one SO factor	93.56	50	.98	.98	.049	149.56
6. Four FO factors, two SO factors, IM and SDE controlled	155.49	105	.98	.98	.036	287.49
7. Four FO factors, one SO factor, IM and SDE controlled	163.40	106	.97	.98	.039	293.40
8. Four FO factors, two SO factors, SE and SP controlled	143.73	105	.98	.99	.032	275.73
9. Four FO factors, one SO factor, SE and SP controlled	149.57	106	.98	.99	.034	279.57

Note. TLI = Tucker–Lewis index; CFI = comparative fit index; RMSEA = root-mean-square error of approximation; AIC = Akaike information criterion; FO = first-order; SO = second-order; IM = impression management; SDE = self-deceptive enhancement; SE = self-enhancement; SP = self-protection.

Overall chills. Results for the prediction of overall chills are shown in Table 4 and are summarized below.

In the first analysis, overall chills was regressed on the Big Five traits. Extraversion, Neuroticism, and Openness to Experience were found to be positive predictors of the chills, and Agreeableness was a negative predictor. In the second analysis, overall chills was regressed on approach and avoidance temperaments. Both temperament variables were found to be positive predictors of the chills. In the third analysis, overall chills was regressed on positive and negative emotionality. Both emotionality variables were found to be positive predictors of the chills.

These findings show that the trait antecedents of overall chills tend to show little differentiation. Four of the Big Five traits predicted the chills. In addition, across analyses, the chills was consistently predicted by approach-related traits (Extraversion, approach temperament, and positive emotionality), as well as by avoidance-related traits (Neuroticism, avoidance temperament, and negative emotionality).

Goosetingles. Next we repeated the three regression analyses, this time predicting goosetingles rather than overall chills. Coldshivers was included as a predictor in these analyses in order to remove shared variance. Results are shown in Table 4 and are summarized below.

In the first analysis, goosetingles was predicted positively by Extraversion. No other Big Five traits were significant predictors. In the second analysis, goosetingles was predicted by approach temperament but not avoidance temperament. In the third analysis, goosetingles was predicted by positive emotionality but not negative emotionality.

These findings show that trait antecedents of goosetingles are more differentiated than those of overall chills. Goosetingles was consistently predicted by approach-related traits but not by avoidance-related traits.

Coldshivers. Next we repeated the three regression analyses, this time predicting coldshivers. Goosetingles was included as a predictor in order to remove shared variance. Results are shown in Table 4 and are summarized below.

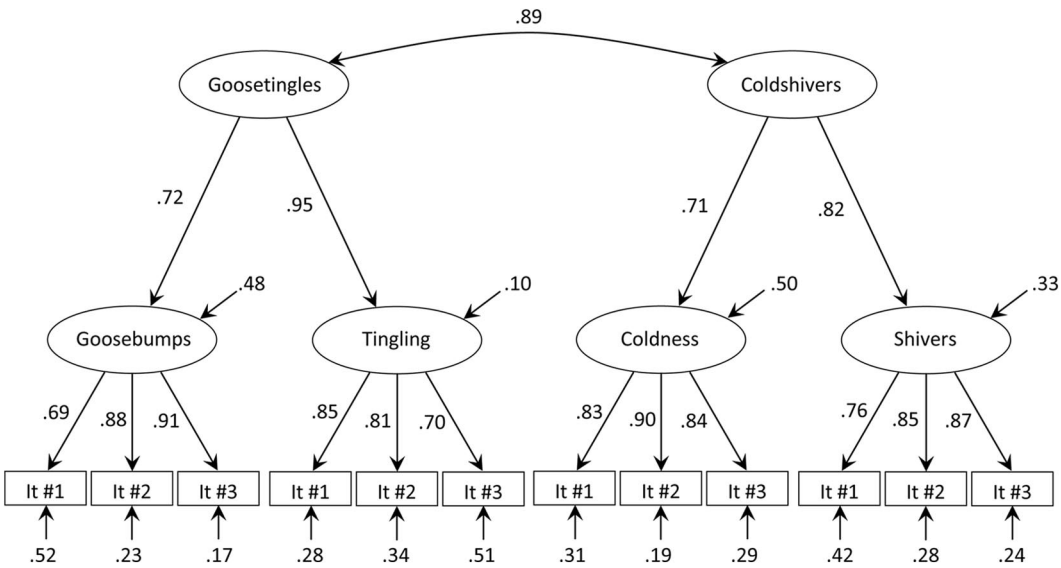

Figure 2. Second-order confirmatory factor analysis (Study 2). Items are numbered in the order presented in the text. All modeled correlations and path coefficients were significant ($p < .05$). It = item.

Table 4
Prediction of Chills Variables From Traits: Standardized Regression Coefficients (Study 2)

Predictor variable	Overall chills	Goosetingles	Coldshivers
Analysis 1			
Extraversion	.25***	.18***	−.02
Neuroticism	.15**	−.01	.12**
Openness to Experience	.17**	.03	.08
Agreeableness	−.18**	−.04	−.07
Conscientiousness	.02	.03	−.01
Goosetingles			.64***
Coldshivers		.64***	
Analysis 2			
Approach temperament	.20***	.17***	−.04
Avoidance temperament	.13*	−.02	.10*
Goosetingles			.65***
Coldshivers		.63***	
Analysis 3			
Positive emotionality	.26***	.17***	.00
Negative emotionality	.29***	−.03	.23***
Goosetingles			.62***
Coldshivers		.64***	

* $p < .05$. ** $p < .01$. *** $p < .001$.

In the first analysis, coldshivers was predicted positively by Neuroticism. No other Big Five traits were significant predictors. In the second analysis, coldshivers was predicted by avoidance temperament but not approach temperament. In the third analysis, coldshivers was predicted by negative emotionality but not positive emotionality.

These findings show that the antecedents of coldshivers are more differentiated than those of overall chills and are complementary to those of goosetingles. Whereas goosetingles was consistently predicted only by approach-related traits, coldshivers was consistently predicted only by avoidance-related traits.

In follow-up analyses, the nine regression analyses reported above were repeated with IM and SDE included as predictors. These analyses yielded a pattern of significant effects identical to that summarized above. In a second set of follow-up analyses, the nine analyses were repeated with SE and SP included as predictors. Again, these analyses yielded a pattern of significant effects identical to that summarized above. These follow-up analyses show that the relations between traits and chills variables are not artifacts of any of a variety of response biases.

This study provides strong evidence of the need to distinguish goosetingles and coldshivers components of the chills. Goosetingles and coldshivers were factorially distinct and uniquely related to different traits. In light of the discriminant relations of goosetingles and coldshivers to approach- and avoidance-related traits, it is not surprising that past studies relating the chills to particular traits or emotions have yielded inconsistent findings. Moreover, the fact that goosetingles and coldshivers were strongly correlated helps explain why laypersons and researchers have tended to conflate them.

Study 3

In Study 3, we used the narrative recall method to examine particular instances of chills experiences. We examined the full range of chills experiences by asking participants to report on an occasion when they experienced at least one of the four chills sensations. Our first aim in this study was to replicate the goosetingles–coldshivers factor structure. Whereas we examined the covariance of chills sensations across individuals in Study 2, in this study we examined the covariance of sensations across particular instances of the chills. Do goosebumps tend to co-occur with tingling, and does a cold feeling tend to co-occur with shivers? Do goosetingles and coldshivers vary independently of one another across occasions?

Our second aim was to document elicitors of the chills in general and of goosetingles and coldshivers in particular, based on the content of participants' narrative accounts. We expected to identify both approach- and avoidance-related elicitors in the full set of chills narratives, and these were expected to be differentially implicated in experiences that involved predominantly goosetingles or coldshivers, respectively.

Our final aim was to characterize the affective composition of the chills overall and of goosetingles and coldshivers in particular. Following Thrash and Elliot (2004), we used a "normal experience" control condition as a baseline for comparison. In line with the trait findings from Study 2, we expected that, overall, chills would show a largely undifferentiated pattern of relations to emotions, whereas goosetingles and coldshivers would be associated with positive and negative emotions, respectively.

Method

Participants. Participants were 130 introductory psychology students from a U.S. university who participated in order to fulfill a research participation requirement. Mean age was 19.05 years (range: 18–24). Participants were randomly assigned to a chills condition ($n = 70$) or a control condition ($n = 60$). Twelve participants in the chills condition were omitted because they could not recall a particular occasion when they experienced the chills. The final sample consisted of 118 participants (47 men, 71 women).

Procedure. Participants in the chills condition were asked to recall an occasion when they experienced the chills. The chills was defined as an experience involving one or more of the following sensations: (a) feeling cold or feeling a chill, (b) feeling a shiver or shudder, (c) having a tingling or ticklish feeling, or (d) having goosebumps or a hair-on-end feeling. The definition of the chills construct was constrained as described in Study 1. Defining the chills as involving one or more of the above sensations, rather than all of them, was critical to our goal of examining the factor structure of the chills. Participants in the control condition were asked to recall a normal experience, which was defined as an experience that is representative of the participant's usual experiences on typical days. Participants in both conditions were asked to relive the recalled experience and to provide a narrative account of the experience. Participants then indicated their levels of the chills sensations and emotions during the recalled experience.

Measures.

Chills sensations. The four chills sensations were assessed with single items that corresponded to the descriptors given to participants in the chills condition. Items are shown in Table 5.

Table 5
Principal Component Analysis: Varimax Loadings (Study 3)

Item	Component 1	Component 2
Felt cold or felt a chill	*.80*	.01
Felt a shiver or shudder	*.79*	.09
Had a tingling or ticklish feeling	.01	*.75*
Had goosebumps or a hair-on-end feeling	.08	*.74*

Note. Primary loadings are shown in italics.

Participants responded using a scale from 1 (*not at all*) to 7 (*very strongly*).

Discrete emotions. The original adjective-based version of the Differential Emotions Scale (Izard, 1977), which is amenable to the assessment of recalled emotional states, was used to assess interest (e.g., *attentive*), enjoyment (e.g., *joyful*), surprise (e.g., *surprised*), sadness (e.g., *sad*), anger (e.g., *angry*), disgust (e.g., *disgusted*), and fear (e.g., *afraid*). Izard (1977) provided evidence of reliability and validity. Following Thrash, Maruskin, Cassidy, Fryer, and Ryan (2010), awe was assessed with the items "full of awe" and "full of wonder." Participants responded using a scale from 1 (*not at all*) to 5 (*extremely*) for all emotions. In this study, Cronbach's alphas were as follows: interest, .83; enjoyment, .94; surprise, .81; sadness, .85; anger, .88; disgust, .90; fear, .95; and awe, .86.

Results and Discussion

Principal component analysis (PCA) of chills items. Means and standard deviations (in parentheses) for each sensation in the chills condition were as follows: goosebumps, 5.48 (1.57); tingling, 4.28 (1.94); coldness, 4.88 (1.75); shivers, 4.83 (1.78). Means and standard deviations in the control condition were as follows: goosebumps, 2.23 (1.71); tingling, 2.03 (1.60); coldness, 2.52 (2.01); shivers, 2.08 (1.70).

We conducted a PCA of the four chills sensations using data from the chills condition. Eigenvalues were 1.35, 1.04, .90, and .71, indicating a two-component solution. As shown in Table 5, coldness and shivers loaded on the first component, and tingling and goosebumps loaded on the second component. Within the chills condition, unit-weighted indexes of goosetingles and coldshivers were largely unrelated ($r = .11$, *ns*). These findings replicate the goosetingles–coldshivers structure from Study 2 with a different research design, measure, and analytic technique. The fact that goosetingles and coldshivers were more distinct in this study than in Study 2 may reflect the greater sensitivity afforded by examining particular instances of chills experiences. This issue is discussed in more detail in the General Discussion.

On the basis of the PCA findings, in the following analyses of elicitors and affective composition, we examined not only the full set of chills narratives, but also subsets in which the chills experience involved predominantly goosetingles or predominantly coldshivers.

Elicitors.

Overall chills. Inspection of the full set of chills narratives revealed a diverse set of elicitors. Examples of elicitors were physical danger, affiliation threat, achievement threat, aesthetic beauty, inspirational acts, and romantic intimacy. Our reading of the narratives led us to conclude that the approach–avoidance distinction offers the most natural and useful means of distinguishing the elicitors; most narratives could be classified readily as involving either a positive stimulus evaluation that led to an approach tendency or a negative stimulus evaluation that led to an avoidance tendency. Accordingly, we asked two graduate students to independently code the narratives for approach versus avoidance. Coding instructions were adapted from Elliot and Friedman (2007). Cohen's kappa was .90. Discrepancies were resolved through discussion. The final coding indicated that 27 chills narratives involved approach elicitors, whereas 31 involved avoidance elicitors. There were not enough narratives that we could confidently make further distinctions among elicitors. We therefore postponed the issue of further differentiation until Study 4, in which considerably more narratives were available.

Goosetingles and coldshivers. Next we examined whether approach and avoidance elicitors were differentially implicated in goosetingles and coldshivers experiences. To identify sets of narratives in which the chills experience involved predominantly goosetingles or coldshivers, we standardized the goosetingles and coldshivers indexes within the chills condition and subtracted the standardized coldshivers score from the standardized goosetingles score. Narratives in the top quartile ($n = 14$) were identified as involving predominantly goosetingles (goosetingles, $M = 12.00$; coldshivers, $M = 7.36$), and narratives in the bottom quartile ($n = 15$) were identified as involving predominantly coldshivers (goosetingles, $M = 7.47$; coldshivers, $M = 11.80$).

Avoidance elicitors were more frequent for coldshivers narratives ($n = 12$) than goosetingles narratives ($n = 5$), whereas approach elicitors were more frequent for goosetingles narratives ($n = 9$) than coldshivers narratives ($n = 3$). The difference in these distributions was significant, $\chi^2(1) = 5.86$ $p < .05$. These results indicate that goosetingles and coldshivers tend to have different elicitors, supplementing the factor-analytic evidence of discriminant validity. Moreover, the fact that goosetingles and coldshivers tended to involve approach and avoidance elicitors, respectively, is consistent with the temperament findings from Study 2.

Affective composition of the chills.

Overall chills. In preliminary analyses of affective composition, we contrasted the full set of chills narratives with the control narratives. Means of the affect variables in the chills and control conditions are shown in Table 6. Differences were tested with *t* tests. As shown in Table 6, overall chills involved high levels of surprise, awe, disgust, and fear. Disgust and fear are avoidance-related emotions, whereas surprise and awe are cognitively complex emotions that are not strongly valenced but that are often considered positive emotions (e.g., regarding surprise, see Izard et al., 1993; regarding awe, see Keltner, 2009). The finding that overall chills was related to both positive and negative emotions is consistent with the emotionality findings from Study 2.

Goosetingles and coldshivers. Next, we conducted a one-way analysis of variance with planned comparisons of the goosetingles and coldshivers narratives with the control condition narratives. The results are reported in Table 6. Relative to the control condition, goosetingles was found to involve high levels of surprise and awe, whereas coldshivers was found to involve high levels of surprise, sadness, disgust, and fear and a low level of enjoyment. These findings show that goosetingles and coldshivers differ in

Table 6
Means, t Tests, and Planned Comparisons (Study 3)

	M				*t*			
Variable	Control	Chills	Goosetingles	Coldshivers	Chills vs. control[a]	Goosetingles vs. control[b]	Coldshivers vs. control[b]	Goosetingles vs. coldshivers[b]
Interest	7.58	8.71	7.93	8.20	1.80	0.32	0.59	−0.20
Enjoyment	7.82	6.88	8.36	4.80	−1.21	0.47	−2.70**	2.47*
Surprise	4.67	8.24	9.50	7.13	6.39***	5.81***	3.05**	2.27*
Awe	3.10	5.16	5.79	4.20	4.65***	4.12***	1.74	1.94†
Sadness	4.60	5.43	4.07	6.20	1.61	−0.71	2.21*	−2.29*
Anger	4.30	4.17	3.36	3.87	−0.30	−1.56	−0.74	−0.67
Disgust	4.05	5.59	4.64	6.73	2.73**	0.73	3.38**	−2.05*
Fear	3.87	7.21	4.64	9.40	5.57***	0.99	7.28***	−4.86***

[a] $df = 116$. [b] $df = 86$.
† $p < .06$. * $p < .05$. ** $p < .01$. *** $p < .001$.

affective composition. Goosetingles involved heightened levels of positive emotions—at least those that are more cognitively complex—whereas coldshivers tended to involve heightened levels of negative emotions.

To provide a more direct test of discriminant validity, we also conducted contrasts between the sets of goosetingles and coldshivers narratives (see Table 6). Relative to coldshivers, goosetingles involved higher levels of enjoyment, surprise, and awe and lower levels of sadness, disgust, and fear. The association of goosetingles and coldshivers with positive and negative emotions, respectively, is consistent with the elicitor findings from this study and with the emotionality findings from Study 2.

Study 4

In Study 4, we employed an event-contingent diary design (Reis & Gable, 2000), in which participants submitted an online questionnaire each time they experienced the chills over a 2-week period. As in Study 3, we examined the full range of chills experiences—experiences involving at least one of the four sensations. A benefit of the event-contingent diary method is that it preserves the multilevel structure of real-world events—instances of the chills are nested within persons. Accordingly, variance in chills sensations may be decomposed into between-person variance (i.e., variance between individuals' means) and within-person variance (i.e., individuals' variance around their own means).

Our first goal was to test the generalizability of the goosetingles–coldshivers factor structure. In the context of multilevel diary data, there may be different factor structures at the between-person and within-person levels. For example, if the same individuals tended to experience both goosetingles and coldshivers, but goosetingles and coldshivers did not necessarily occur on the same occasions, the chills would consist of one factor at the between-person level and two factors at the within-person level. Replication of the two-factor structure at two statistically independent levels of analysis would increase confidence that the structure reflects something intrinsic about the chills construct.

Our second aim was to extend the elicitor findings from Study 3. We aimed to replicate the finding that goosetingles experiences are more likely to involve approach elicitors and that coldshivers experiences are more likely to involve avoidance elicitors. We also sought to identify particular categories of approach and avoidance elicitors and to test which are most often implicated in goosetingles and coldshivers experiences.

Our third aim was to extend the affective composition findings from Study 3 by examining the relations of goosetingles and coldshivers with affect at both between-person and within-person levels of analysis. In this study, we measured several key discrete emotions from Study 2, as well as affect variables representing two two-dimensional frameworks: activated positive affect (PA) and negative affect (NA; Watson, Clark, & Tellegen, 1988) and energetic arousal and tense arousal (Thayer, 1986). We expected goosetingles to be related to cognitively complex positive discrete emotions, as well as the more general approach-relevant variables of PA and energetic arousal. We expected coldshivers to be related to negative discrete emotions, NA, and tense arousal.

Method

Participants. Participants were 192 introductory psychology students (89 men, 103 women) from a U.S. university who participated in return for extra course credit. Mean age was 18.68 years (range: 18–22).

Procedure. Participants were asked to complete an online questionnaire each time they experienced the chills during the 14-day period. The chills was defined as in Study 3. The questionnaire included an open-ended question about the elicitor of the experience, as well as measures of discrete emotions, activated affects, and arousal variables. Participants were also asked to indicate the amount of time that had elapsed between the chills experience and diary submission.

We also asked participants to complete a brief online questionnaire each evening. This questionnaire served two purposes: It helped keep participants engaged in the study, even if they experienced chills infrequently, and it provided a daily reminder of the definition of the chills (which was provided upon submission of the questionnaire). Measures on the evening questionnaire (e.g.,

positive and negative daily events) are not relevant to the present study and are not discussed further.

Measures.

Chills sensations. Chills sensations were assessed with the same items as in Study 3. Based on past research suggesting the possibility of meaningful differences between chills sensations on the left and right sides of the body (Langley & Sherrington, 1891), items were rated separately for the left and right sides. Participants responded using a scale from 0 (*not applicable*) to 5 (*very intense*). In preliminary analyses, we examined left–right differences but did not find patterns that were definitive enough to warrant further discussion. Accordingly, for our primary analyses, intensity of each sensation was operationalized as the maximum of the left and right scores.

Discrete emotions. Surprise, awe, and fear were assessed with the same measures as in Study 3. For these measures and those below, participants responded using a scale from 1 (*not at all*) to 5 (*extremely*). Cronbach's alphas were as follows: surprise, .71; awe, .90; fear, .94.

PA and NA. PA and NA were assessed with a short version of the Positive and Negative Affect Schedule (Watson et al., 1988) that has five items per scale (Kercher, 1992). Evidence of reliability and validity was provided by Mackinnon et al. (1999). In this study, Cronbach's alphas were .73 for PA and .88 for NA.

Energetic and tense arousal. Energetic and tense arousal were assessed with shortened versions of the energy and tension scales of the Activation–Deactivation Adjective Checklist (Thayer, 1986). The original scales consist of five adjectives each. Three items from each scale were used based on PCAs of several sets of pilot data (energetic arousal: *energetic*, *lively*, *full of pep*; tense arousal: *clutched up*, *tense*, *fearful*). Evidence of the reliability and validity of the original scales was summarized by Thayer (1986, 1989). In this study, Cronbach's alphas for energetic and tense arousal were .89 and .78, respectively.

Results and Discussion

Descriptive analyses. In total, 574 chills diaries were submitted by participants. Of these, 58 were omitted because the chills was caused by cold temperature or illness (i.e., the stated exclusion criteria) or by other similar causes that were insignificant from a psychological standpoint (e.g., urination).

The number of valid chills diaries submitted per person ranged from 0 to 15 over the 14-day period. The mean number of diaries was 2.69, and the mode was 2. Of the original 192 participants, 163 submitted at least one valid diary. Diaries that were missing data or that were submitted more than 12 hr after the chills experience were omitted, resulting in a final data set of 428 diaries from 144 participants.

Means, within-person standard deviations (SD_w), and between-person standard deviations (SD_b) for the chills sensations, as estimated in an unconditional multilevel model with HLM 6.08 (Raudenbush, Bryk, & Congdon, 2009), were as follows: goosebumps, $M = 2.56$, $SD_w = 1.27$, $SD_b = 1.01$; tingling, $M = 2.67$, $SD_w = 1.25$, $SD_b = 0.98$; coldness, $M = 2.46$, $SD_w = 1.25$, $SD_b = 1.04$; shivers, $M = 2.78$, $SD_w = 1.33$, $SD_b = 0.88$. Intraclass correlations (ICCs) were as follows: goosebumps, .44; tingling, .44; coldness, .45; shivers, .40. These ICCs indicate that nearly half (40%–45%) of the variance in chills sensations was at the between-person (vs. within-person) level.

Between-person and within-person PCAs of chills items. We conducted PCAs of between-person and within-person covariance matrices using an approach developed by Muthén (1994) and adapted by Reise, Ventura, Nuechterlein, and Kim (2005). A pooled within-person covariance matrix and an estimated population between-person covariance matrix were generated with Mplus (Muthén & Muthén, 2004; for programming details, see Dyer, Hanges, & Hall, 2005). Both matrices provide unbiased and consistent estimates of population covariances (Muthén, 1994). PCAs of these matrices were conducted with SPSS.

The between-person analysis yielded eigenvalues of 1.42, 1.11, .83, and .63, indicating a two-component solution. Varimax loadings are presented in Table 7. Coldness and shivers loaded on the first component. Tingling and goosebumps loaded on the second component. Unit-weighted indexes of individuals' mean coldshivers and mean goosetingles were modestly correlated ($r = .18$, $p < .05$).

The within-person analysis yielded eigenvalues of 1.39, 1.09, .79, and .73, indicating a two-component solution. Varimax loadings are presented in Table 7. Again, coldness and shivers loaded on the first component, and tingling and goosebumps loaded on the second component. An analysis of random variance components (see Thrash, Maruskin, et al., 2010, Study 2, for details on this computation procedure) indicated that the average within-person correlation between unit-weighted indexes of goosetingles and coldshivers was .36 (*ns*). These analyses show that the goosetingles–coldshivers factor structure is replicable at two statistically independent levels of analysis.

Elicitors.

Overall chills. Participants' open-ended descriptions revealed a diverse set of elicitors. Our inspection of the narratives again suggested the importance of the approach–avoidance distinction. To further differentiate the elicitors, we perused the narratives with the aim of identifying natural subcategories. This process resulted in the identification of eight domains of approach elicitors (including an "other approach" category) and four domains of avoidance elicitors (including an "other avoidance" category). Two graduate students coded the elicitors for approach–avoidance (Cohen's $\kappa = .83$) and for specific domains (Cohen's $\kappa = .78$). Discrepancies were resolved through discussion. The final coding revealed that

Table 7
Between-Person and Within-Person Principal Component Analyses: Varimax Loadings (Study 4)

	Components at between-person level		Components at within-person level	
Item	1	2	1	2
Felt cold or felt a chill	*.79*	.19	*.68*	.34
Felt a shiver or shudder	*.75*	−.12	*.80*	−.22
Had a tingling or ticklish feeling	−.20	*.80*	−.18	*.82*
Had goosebumps or a hair-on-end feeling	.34	*.71*	.38	*.61*

Note. Primary loadings are shown in italics.

294 of the chills narratives involved approach elicitors, whereas 134 involved avoidance elicitors. The distribution across domains is shown in Table 8. The most frequent elicitor domains were aesthetic beauty, physical threat, sexual attraction/arousal, and inspirational acts.

Goosetingles and coldshivers. In light of the PCA findings, we examined whether approach and avoidance elicitors were differentially implicated in goosetingles and coldshivers experiences. Narratives that involved predominantly goosetingles ($n = 116$; goosetingles, $M = 5.17$; coldshivers, $M = 0.82$) or coldshivers ($n = 106$; goosetingles, $M = 0.89$; coldshivers, $M = 4.72$) were identified with the same procedure as in Study 3.

Avoidance elicitors were found to be more frequent for coldshivers narratives ($n = 39$) than goosetingles narratives ($n = 24$), whereas approach elicitors were more frequent for goosetingles narratives ($n = 92$) than coldshivers narratives ($n = 67$). The difference in these distributions was significant, $\chi^2(1) = 7.07$ $p < .01$.

The distributions of goosetingles and coldshivers across specific elicitor domains are shown in Table 8. Overall, the frequencies of particular elicitors differed for goosetingles and coldshivers, $\chi^2(11) = 41.84$, $p < .001$. Adjusted standardized residuals, which provide targeted significance tests for individual categories (Agresti & Finlay, 1986), are also shown in Table 8. Aesthetic beauty and sexual attraction/arousal more often elicited goosetingles than coldshivers, whereas affiliation threat and achievement threat more often elicited coldshivers than goosetingles.

In sum, approach elicitors in general, and aesthetic beauty and sexual attraction/arousal in particular, were found to distinctively elicit goosetingles. Avoidance elicitors in general, and affiliation threat and achievement threat in particular, were found to distinctively elicit coldshivers.

Affective composition. Analyses of the relations of goosetingles and coldshivers with affect were conducted with HLM. The following multilevel model was tested:

Level 1:

$$AF_w = \beta_{0j} + \beta_{1j}(GT_w) + \beta_{2j}(CS_w) + r_{ij}$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{02}(GT_b) + \gamma_{03}(CS_b) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

The Level 1 and Level 2 units were occasions and persons, respectively. Variables at Level 1 are subscripted with a *w* because they varied *within* persons; variables at Level 2 are subscripted with a *b* because they varied *between* persons. AF_w refers to a given affect variable on particular occasions; GT_w and CS_w refer to goosetingles and coldshivers, respectively, on particular occasions; and GT_b and CS_b refer to individuals' mean levels of goosetingles and coldshivers across occasions. GT_w and CS_w were centered around individuals' means (i.e., group-mean centered), and GT_b and CS_b were centered around the means of all observations (i.e., grand-mean centered). With group-mean centering at Level 1, Level 1 effects are purely within-person effects and are statistically independent of between-person effects (Nezlek, 2007).

The parameters γ_{02} and γ_{03} refer to the unique between-person effects of goosetingles and coldshivers, respectively. For instance, the significance test for γ_{02} addresses the question of whether individuals' mean levels of goosetingles uniquely predict mean levels of the affect variable. The parameters γ_{10} and γ_{20} refer to the unique within-person effects of goosetingles and coldshivers,

Table 8
Frequencies of Elicitor Categories and Differences in Frequencies Between Goosetingles and Coldshivers Diaries (Study 4)

Elicitor category	Frequency			Adjusted standardized residual (*z*)
	Total	Goosetingles	Coldshivers	
Approach				
Aesthetic beauty	84	*35*	10	3.84***
Sexual attraction/arousal	54	*24*	10	2.33*
Inspirational act	52	11	16	1.28
Thrill/adventure	35	8	11	0.93
Affiliation reward	28	8	9	0.45
Relaxation	9	2	2	0.09
Achievement reward	8	1	3	1.10
Other approach	24	3	6	1.16
Avoidance				
Physical threat	66	18	13	0.70
Affiliation threat	45	2	*16*	3.65***
Achievement threat	17	1	*9*	2.74**
Other avoidance	6	3	1	0.92

Note. "Goosetingles" refers to the set of 116 diaries that involved predominantly goosetingles (as defined in the text), and "coldshivers" refers to the set of 106 diaries that involved predominantly coldshivers. Adjusted standardized residuals provide targeted comparisons of the frequencies of goosetingles and coldshivers within particular elicitor categories. Distinctive elicitors are shown in italics.
* $p < .05$. ** $p < .01$. *** $p < .001$.

respectively. For instance, the significance test for γ_{10} addresses the question of whether individuals' deviations from their mean levels of goosetingles uniquely predict fluctuations in affect.

Results are shown in Table 9. At one or both levels of analysis, goosetingles was uniquely positively related to surprise, awe, PA, and energetic arousal. At both levels of analysis, coldshivers was uniquely positively related to fear, NA, and tense arousal. In sum, goosetingles was related to cognitively complex positive emotions and approach-related affective states, whereas coldshivers was related to negative emotions and avoidance-related affective states. These results are consistent with the elicitor findings and extend the affective composition findings from Study 3. Moreover, the fact that most of the effects were documented at two statistically independent levels of analysis attests to the robustness and generalizability of our conclusions.

Study 5

Having used descriptive (Study 1) and correlational (Studies 2-4) designs, we turned to the experimental method in our final study. Our first aim was to demonstrate that goosetingles and coldshivers may be differentially elicited by experimentally manipulated stimuli. Because chills experiences are responses to eliciting stimuli, it is the elicitors, and not chills variables per se, that are amenable to experimental manipulation (see Thrash, Elliot, Maruskin, & Cassidy, 2010, for a discussion of this issue regarding the elicitation of experiential states more generally).

Our criteria for choosing elicitors of goosetingles and coldshivers were that they (a) differ in terms of approach–avoidance, (b) be similar in thematic content, and (c) be potent.[3] Use of potent manipulations is standard practice in experimental research and is likely necessary to effectively elicit the chills. These considerations led us to choose video clips representing the following pair of existentially potent themes: *self-actualization*, as exemplified by Susan Boyle's vocal performance on Britain's *Got Talent*, and *self-annihilation*, as exemplified by a performance in which two men create the illusion of mutilating their arms with knives. We predicted that self-actualization and self-annihilation, relative to a control condition, would elicit goosetingles and coldshivers, respectively.

Table 9
Multilevel Model Predicting Affect Variables From Goosetingles and Coldshivers: Unstandardized Coefficients (Study 4)

	Goosetingles		Coldshivers	
Criterion variable	Between (γ_{02})	Within (γ_{10})	Between (γ_{03})	Within (γ_{20})
Discrete emotions				
Surprise	0.43*	0.13†	0.26	0.00
Awe	0.35*	0.07	−0.12	0.01
Fear	0.02	0.10	1.13***	0.16*
Activated affects				
Positive affect	0.73*	0.31**	0.04	−0.10
Negative affect	0.03	0.10	1.92***	0.31*
Arousal states				
Energetic arousal	0.31†	0.20*	0.14	−0.08
Tense arousal	0.10	0.13	1.12***	0.14*

† $p < .07$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Our second aim was to document the interpersonal consequences of chills experiences. In light of our reconciliation of Panksepp's (1995) and Keltner's (2005) proposals (see introduction), we expected coldshivers and goosetingles to have opposite effects (negative and positive, respectively) on closeness to an attachment figure. We further expected the negative influence of coldshivers to be driven by the coldness component and not by shivers, because only the former is posited to regulate voluntary social behavior. Because Keltner had theorized about goosebumps and not goosetingles, we also explored whether the influence of goosetingles is driven by the goosebumps component and not by tingling. However, we had no a priori basis for expecting this type of differentiation. Our final aim was to establish incremental predictive validity by showing that the chills variables predict closeness even when the discrete emotions of awe and fear are controlled.

Method

Participants. Participants were 100 introductory psychology students (48 men, 52 women) from a U.S. university who participated in order to satisfy a research participation requirement. Mean age was 19.45 years (range: 18–46).

Procedure. Participants attended individual sessions in the laboratory. They were randomly assigned to one of three conditions: self-actualization ($n = 34$), self-annihilation ($n = 33$), or control ($n = 33$). Participants in the self-actualization condition watched a video clip from the show Britain's *Got Talent* (2:58). In this clip, Susan Boyle offers a moving vocal performance that exceeds the expectations of the judges and audience. Participants in the self-annihilation condition watched Suicide-in-C-Sharp, an illusion act from the show *Dirty Tricks* (1:47). Accompanied by violin, two men create the illusion of mutilating their arms with large knives, while behaving as if they are stroking violins with a bow. Participants in the control condition watched a tutorial about how to play "Hot Cross Buns" on the piano (2:05). Like the other two videos, this video involves music and maintains the participant's attention, but it is devoid of emotional content. After watching the video, participants completed questionnaires regarding chills sensations, awe, and fear experienced during the video, and then completed a measure of closeness to their mother.

Measures.

Chills sensations. Chills sensations were assessed with a state version of the Chills Questionnaire used in Study 2. Items were phrased in past rather than present tense, and participants rated intensity (1 = *not at all* to 7 = *very strongly*) rather than frequency. Cronbach's alphas were as follows: goosebumps, .88; tingling, .92; coldness, .92; shivers, .91.

[3] On the basis of Criteria b and c, we opted not to manipulate the elicitors documented in Study 4. Study 4, a short-term study of experiences in everyday life, had not been designed to identify potent elicitors. Moreover, the elicitors of goosetingles and coldshivers that emerged in Study 4 (e.g., aesthetic beauty and affiliation threat, respectively) differed not only in valence but also in thematic content. In Study 5, we selected elicitors that differed in valence but were similar in thematic content (i.e., actualizing vs. annihilating the self).

Emotions. Awe and fear were assessed with the same measures as in Studies 2 and 3. Cronbach's alpha was .94 for awe and .97 for fear.

Closeness to mother. Closeness to mother was assessed with the Inclusion of Other in the Self (IOS) scale (Aron, Aron, & Smollan, 1992). This measure consists of seven pairs of circles—one circle representing the self and one representing the other—that vary in their degree of overlap. Participants were asked to indicate which pair of circles best represents their relationship with their mother or mother figure. Responses were assigned values from 1 to 7, with larger values indicating greater closeness. Aron et al. (1992) provided evidence of the reliability and validity of the IOS as a measure of closeness.

Results and Discussion

Means and standard deviations of the observed chills variables in each condition are shown in Table 10. Fit indexes for the structural equation models discussed below are presented in Table 11.

Elicitors. To test relations between the elicitors and the chills variables, we modeled dummy-coded variables representing self-actualization and self-annihilation as correlated exogenous variables. Goosebumps and tingling were modeled as indicators of a goosetingles latent variable, and coldness and shivers were modeled as indicators of a coldshivers latent variable. Both elicitor variables were specified to predict both chills variables, and residual error terms of the latent variables were allowed to correlate. This model (Model 1) was found to have good fit.

As expected, self-actualization had a strong effect on goosetingles ($\beta = .84$, $p < .001$), and self-annihilation had a strong effect on coldshivers ($\beta = .73$, $p < .001$). Weaker cross-effects were also documented, such that self-actualization influenced coldshivers ($\beta = .39$, $p < .01$) and self-annihilation influenced goosetingles ($\beta = .31$, $p < .01$). Both hypothesized effects were significantly stronger than both cross-effects, $\chi^2(1) \geq 7.29$, $ps < .01$, and the hypothesized effects accounted for considerably more variance (53%–71%) than did the cross-effects (10%–15%). These results indicate that self-actualization and self-annihilation differentially elicited goosetingles and coldshivers, respectively.[4]

Consequences. Next we included the candidate consequence variable, closeness to mother, in Model 1. Closeness was specified to be influenced by both goosetingles and coldshivers. This model was found to have good fit (Model 2). Closeness was predicted positively by goosetingles ($\beta = .34$, $p < .05$) and negatively (but marginally) by coldshivers ($\beta = -.23$, $p < .10$).

Table 10
Means and Standard Deviations of Chills Sensations by Condition (Study 5)

	Control		Self-actualization		Self-annihilation	
Chills sensation	*M*	*SD*	*M*	*SD*	*M*	*SD*
Goosebumps	3.15	0.57	9.91	4.99	5.24	3.78
Tingling	3.61	2.16	11.32	4.93	7.15	5.73
Coldness	3.12	0.42	6.12	4.06	7.61	4.64
Shivers	3.36	1.19	6.62	4.17	10.52	6.55

We then tested the separate, unique effects of coldness and shivers. Model 3 was identical to Model 2, except that the path from coldshivers to closeness was replaced by separate paths from coldness and shivers. As predicted, closeness was found to be uniquely predicted by coldness ($\beta = -.29$, $p < .05$), but not by shivers ($\beta = .04$, *ns*). Trimming the path from shivers produced a model (Model 4) that fit better (e.g., lower chi-square and Akaike information criterion) than Model 2. (These models are not nested and therefore cannot be compared using a chi-square difference test.) These findings indicate that the negative effect of coldshivers on closeness is specifically attributable to the coldness component.

Likewise, we tested the separate, unique effects of goosebumps and tingling. Model 5 was identical to Model 4, except that the path from goosetingles to closeness was replaced by separate paths from goosebumps and tingling. Neither goosebumps ($\beta = .15$, *ns*) nor tingling ($\beta = .19$, *ns*) was found to uniquely predict closeness. This finding indicates that the positive effect of goosetingles on closeness is not attributable to one component in particular.

In light of these results, Model 4 was accepted as the final model of predictive validity (see Figure 3). The finding that goosetingles and coldness had opposite effects on closeness to an attachment figure establishes predictive validity and provides further evidence of the need to distinguish components of the chills.[5]

Incremental predictive validity. To test the incremental predictive validity of the chills variables above and beyond discrete emotions, we added awe and fear observed variables to Model 4. The elicitor variables were specified to influence both emotions, and both emotions were specified to influence closeness. Residuals of the goosetingles, coldshivers, awe, and fear variables were specified to be intercorrelated. This model was found to have good fit (Model 6). Awe was found to be predicted by self-actualization ($\beta = .88$, $p < .001$) but not self-annihilation ($\beta = .13$, *ns*), whereas fear was found to be predicted by self-annihilation ($\beta = .67$, $p < .001$) but not self-actualization ($\beta = -.02$, *ns*). The relations between the elicitors and the chills variables were the same as in Model 4. Most important, closeness was predicted by goosetingles ($\beta = .51$, $p < .05$) and coldness ($\beta = -.31$, $p < .05$) but not by awe ($\beta = -.15$, *ns*) or fear ($\beta = -.04$, *ns*). These findings indicate that the influence of the chills variables on closeness were not due to variance that the chills variables share with awe or fear.

[4] The presence of weak cross-effects in this study resembles the finding from Studies 3 and 4 that a minority of goosetingles experiences involve avoidance elicitors and that a minority of coldshivers experiences involve approach elicitors. Additional research is needed to determine whether mismatches between chills variables and their elicitors are due to a degree of ambivalence in the complex situations that elicit chills responses, an inherent secondary activation of goosetingles or coldshivers when the other is aroused, difficulty that some or all participants have in fully distinguishing these states, or some other factor.

[5] Although our primary interest was in the elicitors and consequences of chills variables, we also conducted tests of indirect effects. AMOS was used to bootstrap bias-corrected confidence intervals with 1,000 bootstrap samples (Cheung & Lau, 2008). AMOS does not accommodate bootstrapping for specific indirect effects in the case of multiple mediators. We circumvented this limitation using the phantom model approach (Macho & Ledermann, 2011), in which each specific indirect effect is rerepresented in the form of a total effect by means of phantom latent variables. As

Table 11
Structural Equation Model Fit Indexes (Study 5)

Model	χ^2	*df*	TLI	CFI	RMSEA	AIC
1. Elicitors model	4.99	5	1.00	1.00	.000	36.99
2. Predictive validity of goosetingles and coldshivers	8.12	9	1.01	1.00	.000	46.12
3. Predictive validity of goosetingles, coldness, and shivers	5.62	8	1.02	1.00	.000	45.62
4. Predictive validity of goosetingles and coldness	5.70	9	1.03	1.00	.000	43.70
5. Predictive validity of goosebumps, tingling, and coldness	6.07	8	1.02	1.00	.000	46.07
6. Incremental predictive validity	7.92	16	1.04	1.00	.000	65.93

Note. TLI = Tucker–Lewis index; CFI = comparative fit index; RMSEA = root-mean-square error of approximation; AIC = Akaike information criterion.

General Discussion

The nascent chills literature has been plagued by null and inconsistent findings. Anticipating that these problems may reflect researchers' lack of attention to fundamental issues, such as the content universe of the chills and its factor structure, we began our research with the following two-step strategy: We identified the universe of conceptually distinct sensations subsumed by the phrase *the chills*, and then documented the factor structure of these sensations. Whereas past authors have treated the chills as a unitary construct, we found that the chills consists of distinct "goosetingles" and "coldshivers" factors. We then examined the kinds of substantive issues that have yielded inconsistent findings in past research—namely, affective composition, elicitors, and trait antecedents—and found that goosetingles and coldshivers consistently align with approach- and avoidance-related constructs, respectively. Finally, we showed that goosetingles and coldshivers have opposite (positive, negative) effects on closeness to an attachment figure. In light of the discriminant validity of goosetingles and coldshivers, it is not surprising that an undifferentiated chills construct has yielded inconsistent and null findings in past research. In the following, we discuss our findings and their implications in more detail.

Content Universe of the Chills

In Study 1, we used the following strategy to delineate the content universe of the chills: We solicited participants' narrative accounts of the chills, extracted references to physical sensations, asked a second sample to sort the sensations based on similarity, and used cluster analysis to generate a model of the conceptual structure of the chills. The chills was found to consist of four conceptually distinct sensations: goosebumps, tingling, coldness, and shivers. For the first time, researchers have an objective basis for defining the chills and for evaluating the content validity of their operationalizations.

Our cluster analysis also identified higher order goosetingles and coldshivers clusters. This higher order structure is noteworthy because the sensations that compose goosetingles (goosebumps, tingling) have previously been associated with positive affective states, whereas the sensations that compose coldshivers (coldness, shivers) have previously been associated with negative affective states. Moreover, a distinction between two higher order components offers conceptual parsimony and a potential parallel to approach–avoidance processes. For these reasons, we focused primarily on the goosetingles–coldshivers distinction in our subsequent studies (Studies 2–4). A benefit of conceptualizing the chills in terms of a hierarchical structure is that the four lower order components may be examined when theory calls for fidelity rather than bandwidth, as in our investigation of interpersonal consequences (Study 5).

Factor Structure

Informed by the results of Study 1, we developed a Chills Questionnaire in Study 2. A factor analysis yielded four distinct factors corresponding to the lower order clusters from Study 1. We also documented a higher order goosetingles–coldshivers factor structure that corresponds to the higher order cluster structure. The goosetingles–coldshivers factor structure was robust across subsequent studies, which included a narrative recall study (Study 3) and an event-contingent diary study (Study 4). This structure emerged regardless of whether the units of analysis were individuals (Studies 2, 4) or occasions (Studies 3, 4) and regardless of whether analyses were conducted at the between-person (Studies 2–4) or within-person (Study 4) level of analysis. These findings

expected, self-actualization had a positive indirect effect on closeness via goosetingles (unstandardized effect = 0.90, 95% CI [0.21, 1.54]), whereas self-annihilation had a negative indirect effect via coldshivers and its coldness indicator (unstandardized effect = −0.46, 95% CI [−1.01, −0.05]; see Figure 3). Weaker indirect effects involving the cross-effects from elicitors to chills variables were also present. Self-actualization had a negative indirect effect via coldshivers and its coldness indicator (unstandardized effect = −0.25, 95% CI [−0.62, −0.04]), and self-annihilation had a positive indirect effect via goosetingles (unstandardized effect = 0.33, 95% CI [0.12, 0.76]). Thus, both self-actualization and self-annihilation had positive and negative indirect effects on closeness, indicating *inconsistent mediation* in both cases (McFatter, 1979).

The phantom model approach was also used to compare the magnitudes of the expected indirect effects and those involving cross-effects. The expected positive indirect effect of self-actualization via goosetingles was stronger than the negative indirect effect via coldshivers and coldness (unstandardized effect = 0.65, 95% CI [0.15, 1.14]), thus resulting in a positive total effect of self-actualization on closeness (unstandardized effect = 0.58, 95% CI [0.08, 1.05]). The expected negative indirect effect of self-annihilation via coldshivers and coldness was nonsignificantly stronger than the positive indirect effect via goosetingles (unstandardized effect = 0.13, 95% CI [−0.18, 0.57]), thus resulting in a nonsignificant negative total effect of self-annihilation on closeness (unstandardized effect = −0.19, 95% CI [−0.82, 0.18]).

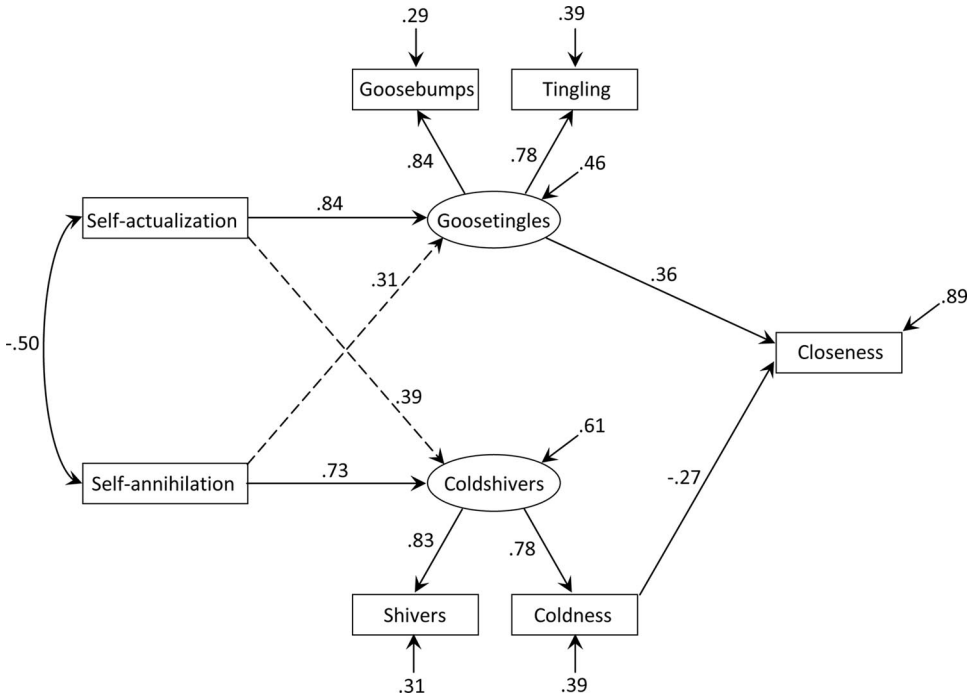

Figure 3. Structural equation model of predictive validity (Study 5). The solid paths from elicitors to chills variables were significantly stronger than the dashed paths. For presentation clarity, the correlation ($r = .79$) between the residuals of the goosetingles and coldshivers latent variables is not shown. All modeled correlations and path coefficients were significant ($p < .05$).

indicate that the chills encompasses factorially distinct goosetingles and coldshivers constructs.

The correlation between goosetingles and coldshivers varied considerably across studies, ranging from .11 (*ns*; Study 3) to .89 ($p < .001$; Study 2). Disattenuation through use of latent variables partially explains why the correlation was so strong in Study 2. Also, Study 2 was the only study to use a trait questionnaire, which requires that individuals draw generalizations about past experiences. Individuals may have more difficulty distinguishing chills sensations under these conditions than when they are recalling a particular instance of the chills (Study 3) or when neither recollection nor generalization is required (Study 4). The fact that goosetingles and coldshivers were strongly correlated based on trait data helps explain why laypersons and researchers alike have not distinguished them. It may be difficult to distinguish goosetingles and coldshivers when one thinks or theorizes about these constructs in the abstract.

Affective Composition

In Study 2, our trait measure of overall chills was positively related to both positive and negative emotionality. In contrast, goosetingles was uniquely related only to positive emotionality, and coldshivers was uniquely related only to negative emotionality. In Study 3, overall chills was characterized by high levels of diverse emotions: awe, surprise, disgust, and fear. Goosetingles was characterized by high levels of awe and surprise, whereas coldshivers was characterized by high levels of disgust, fear, sadness, and surprise and a low level of enjoyment. Relative to coldshivers, goosetingles involved higher levels of awe, surprise, and enjoyment and lower levels of disgust, fear, and sadness. In Study 4, goosetingles covaried with awe, surprise, PA, and energetic arousal, whereas coldshivers covaried with fear, NA, and tense arousal.

Several conclusions follow from these findings. First, goosetingles is distinctively related to positive affective states, whereas coldshivers is distinctively related to negative affective states. This conclusion, in conjunction with evidence that goosetingles and coldshivers are factorially distinct, provides strong evidence of discriminant validity. Second, the reason that the chills may appear to be a general indicator of emotion is that it confounds distinct constructs that relate to different emotions. Finally, failure to distinguish goosetingles and coldshivers may explain inconsistencies in the nascent literature. For instance, researchers who have linked the chills to positive emotions (e.g., Blood & Zatorre, 2001) have likely used the term *chills* to refer to a construct similar to what we have called goosetingles, whereas researchers who have linked the chills to negative emotions (e.g., Panksepp, 1995) have likely used this term to refer to a construct similar to what we have called coldshivers.

Positive emotions unrelated to goosetingles and negative emotions unrelated to coldshivers deserve comment. In Study 3, goosetingles was related to awe and surprise but not interest or enjoyment, and coldshivers was related to sadness, disgust, and fear but not anger. Goosetingles apparently does not involve generic pleasures (i.e., interest, enjoyment); instead, goosetingles involves emotions that are cognitively complex and that imply the

occurrence of something extraordinary (i.e., awe, surprise). The lack of relation between coldshivers and anger likely reflects the fact that anger is not purely avoidance related. Although anger is elicited by an aversive stimulus, it may lead the individual either to avoid the aversive stimulus or to approach it (e.g., attack it), depending on contextual factors (Aarts et al., 2010; see also Carver & Harmon-Jones, 2009). The negative emotions that were most strongly related to coldshivers were fear and disgust, which are prototypical of avoidance-related emotions.

Elicitors

In Studies 3 and 4, narrative accounts of elicitors were coded for approach–avoidance. Percentages of chills experiences involving approach (vs. avoidance) elicitors were 47% (27 of 58) in Study 3 and 69% (294 of 428) in Study 4. These values indicate substantial proportions of both approach and avoidance elicitors, a finding that contrasts with the preponderance of pleasant elicitors documented by Goldstein (1980). Goldstein appears to have asked his participants about *thrills*, a term that is roughly synonymous with *chills* (Panksepp, 1995) but that connotes positive emotion (Hupka, Lenton, & Hutchison, 1999), perhaps skewing Goldstein's findings in an appetitive direction.

In Studies 3 and 4, approach and avoidance elicitors were found to be differentially associated with goosetingles and coldshivers, respectively. In Study 5, we manipulated exposure to two existentially potent elicitors that differ in valence, self-actualization and self-annihilation, and found that they differentially elicit goosetingles and coldshivers, respectively. These findings provide additional evidence of the discriminant validity of goosetingles and coldshivers and of their differential relations to approach and avoidance processes.

In our diary study (Study 4), differentiation of approach and avoidance elicitor categories revealed a wide variety of elicitor domains (see Table 8). This finding indicates that chills experiences are more broadly relevant than has been apparent from the nascent literature, which has focused on chills in the aesthetics domain. In the context of everyday life experiences, aesthetic beauty and sexual attraction/arousal were the elicitors most uniquely associated with goosetingles, and affiliation threat and achievement threat were the elicitors most uniquely associated with coldshivers.

Trait Antecedents

In Study 2, we found that overall chills was predicted by diverse traits. Regarding the Big Five traits, overall chills was predicted positively by Openness to Experience, Extraversion, and Neuroticism and negatively by Agreeableness. We also found that overall chills was predicted positively by both approach temperament and avoidance temperament, and positively by both positive emotionality and negative emotionality.

The positive effect of Openness to Experience is consistent with theorizing by McCrae (2007) and Nusbaum and Silvia (2011). These theorists focused on chills in the aesthetics domain, whereas we examined chills experiences more generally. Additional research is needed to determine whether Openness to Experience predicts scores on our domain-general chills measure because aesthetics is a domain in which chills often occurs, or because being open is conducive to the chills across content domains. Additional research is also needed to reconcile our finding that Agreeableness is a negative predictor of the chills with Panksepp and Bernatzky's (2002) conclusion that Agreeableness predisposes individuals to the chills. We emphasize that Panksepp had theorized about aesthetic chills rather than chills experiences more generally, perhaps accounting for the difference in our conclusions.

Whereas overall chills was predicted by diverse traits, goosetingles was distinctively predicted by approach-related traits (Extraversion, approach temperament, and positive emotionality), and coldshivers was distinctively predicted by avoidance-related traits (Neuroticism, avoidance temperament, and negative emotionality). These findings provide additional evidence of discriminant validity and of differential relations to approach and avoidance. The fact that the chills encompasses approach- and avoidance-related constructs explains why Extraversion and Neuroticism predicted overall chills in our data and in previous research (e.g., Silvia & Nusbaum, 2011). Inconsistencies in the extant literature on trait antecedents are likely due to neglect of the goosetingles–coldshivers distinction.

Consequences

Most prior theory about the function of the chills has focused on interpersonal consequences, but theorists' predictions have been difficult to reconcile. For instance, Panksepp (1995) proposed that the chills is associated with attachment threat, whereas Keltner (2009) proposed that goosebumps, a component of the chills, is associated with closeness. We reconciled these proposals in Study 5 by showing that coldshivers and goosetingles function in the ways described by Panksepp and Keltner, respectively; coldshivers was a negative predictor of closeness to an attachment figure, whereas goosetingles was a positive predictor. Moreover, as expected, we found that the negative influence of coldshivers was attributable specifically to its coldness component and not to shivers. This finding is consistent with the thermoregulation literature, in which feeling cold is conceptualized as motivating voluntary thermoregulatory behavior (e.g., seeking proximity to others), whereas other cold-defense responses, such as piloerection and shivering, are conceptualized as regulating temperature through involuntary, nonsocial processes. Perhaps most striking, the effects of the chills variables were not diminished when the discrete emotions of awe and fear were controlled, bolstering the argument that it is chills-related sensations per se that have important interpersonal consequences. Additional research into the interface between the chills and social behavior may shed light on both the thermal basis of social behavior and the social basis of thermoregulation.

Given that goosetingles and coldshivers had opposite effects on closeness, it is not surprising that a unitary chills variable has demonstrated poor predictive validity in past research (Konečni et al., 2007). We caution researchers that demonstrating the predictive validity of the chills may sometimes require not only discriminating specific chills components, but also overcoming the effects of statistical suppression. In our data, for instance, goosetingles and coldshivers were positively correlated but had opposite unique effects on closeness—a classic suppression scenario (MacKinnon, Krull, & Lockwood, 2000). The bivariate correlation between

goosetingles and closeness necessarily underestimates the positive relation between them, because goosetingles covaries with a negative predictor (coldshivers). Likewise, the bivariate correlation between coldshivers and closeness necessarily underestimates the negative relation between them, because coldshivers covaries with a positive predictor (goosetingles). More generally, across our studies, goosetingles and coldshivers were consistently positively related (although not always significantly related) but nevertheless converged with opposite-valenced constructs (e.g., PA and NA, respectively); we therefore suspect that suppression effects may be the rule rather than the exception. We encourage researchers to be vigilant for suppression effects and to harness the explanatory power of suppression (see Paulhus, Robins, Trzesniewski, & Tracy, 2004) in future theory development.

Biological Basis of the Chills

In the introduction, we offered conceptual and pragmatic arguments for using self-report measures rather than objective neurophysiological variables as indicators of the chills. However, identifying neurophysiological underpinnings of chills experiences is an important avenue for research, particularly now that fundamental questions about the content universe and factor structure of the chills have been answered. We have noted that three chills sensations (goosebumps, coldness, shivers) correspond to cold-defense responses, but little is known about the extent to which chills sensations covary with objective indicators of cold-defense responses. In addition, the biological basis of tingling sensations is an open question. In line with the convergence of goosebumps and tingling as part of the goosetingles construct, we suspect that tingling is a subjective accompaniment of pilomotor activity. Another possibility is that tingling indicates vasoconstriction, a fourth cold-defense response that, like piloerection, and unlike shivering and feeling cold, is mediated by the sympathetic nervous system (Jänig, 2009; Romanovsky, 2007).

Our findings call for research into the biological basis of the convergence of goosetingles with approach and of coldshivers with avoidance. Chills researchers have focused to date on indicators of general (e.g., sympathetic) physiological arousal, but our findings suggest that it would be profitable to incorporate insights from the rapidly developing literatures on the neurological and physiological bases of approach and avoidance processes (for overviews, see Elliot, 2008b). We note also that shivering and voluntary behavior are employed to deal with severe temperature threats (Hemingway, 1963; Romanovsky, 2007), consistent with a role of coldshivers in avoidance; other cold-defense responses (e.g., piloerection) are employed to adjust for modest deviations in temperature, which are often pleasurable (McClelland, Atkinson, Clark, & Lowell, 1953), consistent with a role of goosetingles in approach.

Functional Utility

Another important direction for future research concerns identification of the core function served by chills experiences. In light of our finding that goosetingles and coldshivers have opposite effects on closeness to an attachment figure, it is possible that the core function of chills experiences is regulation of attachment relations or social relations more generally. However, our focus on a social outcome was motivated primarily by the aim of reconciling conflicting proposals about social implications of the chills. Because chills experiences may have a variety of nonsocial implications as well, and because social regulation often does not involve instances of goosetingles or coldshivers (but see IJzerman & Semin, 2009, regarding coldness), it is not clear that regulation of social relations warrants privileged consideration. In light of our finding that goosetingles and coldshivers align with approach and avoidance processes, respectively, a second candidate function is that goosetingles and coldshivers play a role in approach and avoidance more generally. However, because many pairs of constructs (e.g., activated PA and NA) align with approach and avoidance processes, and because approach and avoidance often do not involve chills experiences, positing a general approach–avoidance function does not capture what is distinctive about chills experiences.

We propose that chills experiences contribute in a very specific way to approach and avoidance across a variety of life domains (e.g., social, achievement). Specifically, chills experiences are posited to signal that an event in the environment is pertinent to one's most deep-seated hopes or fears. Given that the cognitive flexibility afforded by humans' highly evolved cortex has brought with it problems of poor congruence between implicit and explicit motivations (Thrash, Elliot, & Schultheiss, 2007) and between physiological and experiential components of emotion (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005), the proposed signaling function would provide a critical corrective in orienting the conscious mind, when the situation demands it, toward the primordial concerns of the subcortical brain.

Our proposal that chills experiences serve an intrapersonal signaling function is derived from a consideration of a unique constellation of four characteristics of these experiences. First, chills experiences appear to be grounded in primordial bodily responses. As embodied vestiges of thermoregulatory and social display adaptations (Darwin, 1872; Huron, 2006), chills responses are likely to be informative about deep-seated concerns of long-standing evolutionary significance. Second, chills experiences are conspicuous and unmistakable (Sloboda, 1991) to the individual in whom they occur. In bringing deep-seated concerns to consciousness, chills experiences may promote integration of primordial implicit motivations and action tendencies with conscious goal adoption and deliberative information processing. The plausibility of the argument that chills responses serve an intrapersonal signaling function is bolstered when one considers that one chills response—piloerection—served a social signaling function earlier in evolution (Darwin, 1872). Third, chills experiences are intentional or object-focused—that is, the individual associates the chills with an elicitor in the social environment. The fact that chills experiences are so brief and discrete lends precision in marking a particular event as the source of one's arousal. Finally, chills experiences involve activated, valenced arousal. The fact that chills experiences are differentiated, such that goosetingles and coldshivers are pleasant and unpleasant, respectively, facilitates veridical inference about the nature of the eliciting situation. Particularly in combination, these four features set the chills apart from other bodily sensations, which tend to be dimly perceived, loosely coupled to events in the environment, and poorly differentiated (Pennebaker, 1982; Schachter & Singer, 1962). They also set the chills apart from the conscious experience of emotions,

which, although differentiated, are loosely related to bodily processes and lack the temporal resolution of chills experiences.

The proposed signaling function helps explain our finding that goosetingles and coldshivers tend to be positively related despite being implicated in approach and avoidance. We suspect that the set of cold-defense responses, which have overlapping neuroanatomy (Nagashima, Nakai, Tanaka, & Kanosue, 2000), were recruited through natural selection primarily for their capacity to provide conspicuous signals about precise events in the environment and only secondarily for their capacity to distinctively convey reward and threat information. If the sight of human annihilation produces coldshivers, for instance, some concomitant arousal of goosetingles may be inconsequential, given that the precisely tagged elicitor provides unambiguous evidence of threat. Additional theory and research are needed to determine whether the signaling function that we have described is indeed an adaptation—specifically, an "exaptation" (Buss, Haselton, Shackelford, Bleske, & Wakefield, 1998; Gould, 1991) of older thermoregulatory and social display adaptations—or whether it is simply a by-product of earlier adaptations. Regardless, the posited signaling function is likely to have current utility in individuals' lives.

Limitations and Closing Comments

Two limitations of this research should be noted. First, we established the generalizability of most of our findings across research designs, levels of analysis, and chills measures, but we have not established generalizability beyond the population of undergraduate and graduate students. Second, we assessed the chills through self-report, which is susceptible to a variety of response biases. However, our goosetingles and coldshivers measures were found to be virtually unrelated to social desirability biases (see Table 2), and research participants appear not to have preconceptions about, or even awareness of, the goosetingles–coldshivers distinction.

In closing, we have shown that the chills consists of distinct goosetingles and coldshivers constructs. Goosetingles and coldshivers converge, respectively, with approach- and avoidance-related traits, affective states, and elicitors, and they have opposite implications for interpersonal closeness. Our bifurcation of the previously amorphous chills construct into distinct goosetingles and coldshivers constructs is likely to produce a more consistent body of findings in future research, and it will facilitate much-needed integration with other literatures (e.g., the neurophysiology of approach–avoidance). Future research on the posited signaling function of the chills may shed new light on our evolutionary past. Feeling one's hair stand on end or feeling a shiver after witnessing an event in the social environment is a strange and special occurrence, likely indicating a resonance of the event with our most primordial desires or fears.

References

Aarts, H., Ruys, K. I., Veling, H., Renes, R. A., de Groot, J. H. B., van Nunen, A. M., & Geertjes, S. (2010). The art of anger: Reward context turns avoidance responses to anger-related objects into approach. *Psychological Science, 21,* 1406–1410. doi:10.1177/0956797610384152

Agresti, A., & Finlay, B. (1986). *Statistical methods for the social sciences* (2nd ed.). San Francisco, CA: Dellen.

Aldenderfer, M. S., & Blashfield, R. K. (1984). *Cluster analysis.* Newbury Park, CA: Sage.

Algoe, S. B., & Haidt, J. (2009). Witnessing excellence in action: The "other-praising" emotions of elevation, gratitude, and admiration. *Journal of Positive Psychology, 4,* 105–127. doi:10.1080/17439760802650519

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103,* 411–423. doi:10.1037/0033-2909.103.3.411

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of Other in the Self Scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63,* 596–612. doi:10.1037/0022-3514.63.4.596

Balteş, F. R., Avram, J., Miclea, M., & Miu, A. C. (2011). Emotions induced by operatic music: Psychophysiological effects of music, plot, and acting: A scientist's tribute to Maria Callas. *Brain and Cognition, 76,* 146–157. doi:10.1016/j.bandc.2011.01.012

Benedek, M., & Kaernbach, C. (2011). Physiological correlates and emotional specificity of human piloerection. *Biological Psychology, 86,* 320–329. doi:10.1016/j.biopsycho.2010.12.012

Blood, A. J., & Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences of the United States, 98,* 11818–11823. doi:10.1073/pnas.191355898

Breugelmans, S. M., Poortinga, Y. H., Ambadar, Z., Setiadi, B., Vaca, J. B., Widiyanto, P., & Philippot, P. (2005). Body sensations associated with emotions in Rarámuri Indians, rural Javanese, and three student samples. *Emotion, 5,* 166–174. doi:10.1037/1528-3542.5.2.166

Buss, D. M., Haselton, M. G., Shackelford, T. K., Bleske, A. L., & Wakefield, J. C. (1998). Adaptations, exaptations, and spandrels. *American Psychologist, 53,* 533–548. doi:10.1037/0003-066X.53.5.533

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135,* 183–204. doi:10.1037/a0013965

Cheung, G. W., & Lau, R. S. (2008). Testing mediation and suppression effects of latent variables: Bootstrapping with structural equation models. *Organizational Research Methods, 11,* 296–325. doi:10.1177/1094428107300343

Costa, P. T., & McCrae, R. R. (1992). The Revised NEO Personality Inventory (NEO-PI–R) and NEO Five-Factor Inventory (NEO-FFI) professional manual. Odessa, FL: Psychological Assessment Resources.

Coxon, A. P. M. (1999). *Sorting data: Collection and analysis.* Thousand Oaks, CA: Sage.

Darwin, C. R. (1872). *The expression of emotions in man and animals.* London, England: Murray. doi:10.1037/10001-000

Dyer, N. G., Hanges, P. J., & Hall, R. J. (2005). Applying multilevel confirmatory factor analysis techniques to the study of leadership. *Leadership Quarterly, 16,* 149–167. doi:10.1016/j.leaqua.2004.09.009

Egan, G. F., Johnson, J., Farrell, M., McAllen, R., Zamarripa, F., McKinley, M. J., . . . Fox, P. T. (2005). Cortical, thalamic, and hypothalamic responses to cooling and warming the skin in awake humans: A positron-emission tomography study. *Proceedings of the National Academy of Sciences of the United States, 102,* 5262–5267. doi:10.1073/pnas.0409753102

Elliot, A. J. (2008a). Approach and avoidance motivation. In A. J. Elliot (Ed.), *Handbook of approach and avoidance motivation* (pp. 3–14). New York, NY: Psychology Press.

Elliot, A. J. (Ed.). (2008b). *Handbook of approach and avoidance motivation.* New York, NY: Psychology Press.

Elliot, A. J., & Friedman, R. (2007). Approach–avoidance: A central characteristic of personal goals. In B. R. Little, K. Salmela-Aro, & S. D. Phillips (Eds.), *Personal project pursuit: Goals, action, and human flourishing* (pp. 97–118). Mahwah, NJ: Erlbaum.

Elliot, A. J., & Thrash, T. M. (2002). Approach–avoidance motivation in personality: Approach and avoidance temperaments and goals. *Journal*

of Personality and Social Psychology, 82, 804–818. doi:10.1037/0022-3514.82.5.804

Elliot, A. J., & Thrash, T. M. (2010). Approach and avoidance temperament as basic dimensions of personality. *Journal of Personality, 78,* 865–906. doi:10.1111/j.1467-6494.2010.00636.x

Erikson, E. H. (1958). *Young man Luther.* London, NY: Faber and Faber.

Fujiwara, H., Ferreira, M., Donati, G., Marciano, D. K., Linton, J. M., Sato, Y., . . . Watt, F. M. (2011). The basement membrane of hair follicle stem cells is a muscle cell niche. *Cell, 144,* 577–589. doi:10.1016/j.cell.2011.01.014

Gabrielsson, A., & Lindström, S. (1993). On strong experiences of music. *Musik Psychologie, 10,* 118–139.

Goldstein, A. (1980). Thrills in response to music and other stimuli. *Physiological Psychology, 8,* 126–129.

Gould, S. J. (1991). Exaptation: A crucial tool for evolutionary psychology. *Journal of Social Issues, 47,* 43–65. doi:10.1111/j.1540-4560.1991.tb01822.x

Grewe, O., Katzur, B., Kopiez, R., & Altenmüller, E. (2011). Chills in different sensory domains: Frisson elicited by acoustical, visual, tactile and gustatory stimuli. *Psychology of Music, 39,* 220–239. doi:10.1177/0305735610362950

Grewe, O., Nagel, F., Kopiez, R., & Altenmüller, E. (2005). How does music arouse "chills"?: Investigating strong emotions, combining psychological, physiological, and psychoacoustical methods. *Annals of the New York Academy of Sciences, 1060,* 446–449. doi:10.1196/annals.1360.041

Grewe, O., Nagel, F., Kopiez, R., & Altenmüller, E. (2007). Listening to music as a re-creative process: Physiological, psychological, and psychoacoustical correlates of chills and strong emotions. *Music Perception, 24,* 297–314. doi:10.1525/mp.2007.24.3.297

Griffiths, A. (2008). *Shivers down your spine: Cinemas, museums, and the immersive view.* New York, NY: Columbia University Press.

Guhn, M., Hamm, A., & Zentner, M. (2007). Physiological and musicoacoustic correlates of the chill response. *Music Perception, 24,* 473–484. doi:10.1525/mp.2007.24.5.473

Halpern, D. L., Blake, R., & Hillenbrand, J. (1986). Psychoacoustics of a chilling sound. *Perception & Psychophysics, 39,* 77–80. doi:10.3758/BF03211488

Hemingway, A. (1963). Shivering. *Physiology Reviews, 43,* 397–422.

Hupka, R. B., Lenton, A. P., & Hutchison, K. A. (1999). Universal development of emotion categories in natural language. *Journal of Personality and Social Psychology, 77,* 247–278. doi:10.1037/0022-3514.77.2.247

Huron, D. (2006). *Sweet anticipation: Music and the psychology of expectation.* Cambridge, MA: MIT Press.

IJzerman, H., & Semin, G. R. (2009). The thermometer of social relations: Mapping social proximity on temperature. *Psychological Science, 20,* 1214–1220. doi:10.1111/j.1467-9280.2009.02434.x

IJzerman, H., & Semin, G. R. (2010). Temperature perceptions as a ground for social proximity. *Journal of Experimental Social Psychology, 46,* 867–873. doi:10.1016/j.jesp.2010.07.015

Izard, C. E. (1977). *Human emotions.* New York, NY: Plenum Press.

Izard, C. E., Libero, D. Z., Putnam, P., & Haynes, O. M. (1993). Stability of emotion experiences and their relations to traits of personality. *Journal of Personality and Social Psychology, 64,* 847–860. doi:10.1037/0022-3514.64.5.847

James. W. (1922). What is an emotion? In C. G. Lange & W. James (Eds.), *The emotions: Vol. 1. A series of reprints and translations* (pp. 11–30). Baltimore, MD: Williams & Wilkins. (Original work published 1884) doi:10.1037/10735-001

Jänig, W. (2009). The autonomic nervous system and its coordination by the brain. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 135–186). New York, NY: Oxford University Press.

Keltner, D. (2009). *Born to be good: The science of a meaningful life.* New York, NY: Norton.

Kercher, K. (1992). Assessing subjective well-being in the old-old: The PANAS as a measure of orthogonal dimensions of positive and negative affect. *Research on Aging, 14,* 131–168. doi:10.1177/0164027592142001

Kleinebeckel, D., & Klussmann, F. W. (1990). Shivering. In E. Schönbaum & P. Lomax (Eds.), *Thermoregulation: Physiology and biochemistry* (pp. 235–253). New York, NY: Pergamon Press.

Konečni, V. J. (2008). Does music induce emotion? A theoretical and methodological analysis. *Psychology of Aesthetics, Creativity, and the Arts, 2,* 115–129. doi:10.1037/1931-3896.2.2.115

Konečni, V. J., Wanic, R. A., & Brown, A. (2007). Emotional and aesthetic antecedents and consequences of music-induced thrills. *American Journal of Psychology, 120,* 619–643. doi:10.2307/20445428

Lange, C. G. (1922). The emotions. In C. G. Lange & W. James (Eds.), *The emotions: Vol. 1. A series of reprints and translations* (pp. 33–90). Baltimore, MD: Williams & Wilkins. (Original work published 1885) doi:10.1037/10735-002

Langley, J. N., & Sherrington, C. S. (1891). On pilomotor nerves. *Journal of Physiology, 12,* 278–291.

Larsen, R. J., & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology, 61,* 132–140. doi:10.1037/0022-3514.61.1.132

Laski, M. (1961). *Ecstasy in secular and religious experiences.* Los Angeles, CA: Tarcher.

Leveton, A. (1965). Time, death and the ego-chill. *Journal of Existentialism, 6,* 69–80.

Macho, S., & Ledermann, T. (2011). Estimating, testing, and comparing specific effects in structural equation models: The phantom model approach. *Psychological Methods, 16,* 34–43. doi:10.1037/a0021763

Mackinnon, A., Jorm, A. F., Christensen, H., Korten, A. E., Jacomb, P. A., & Rodgers, B. (1999). A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences, 27,* 405–416. doi:10.1016/S0191-8869(98)00251-7

MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effect. *Prevention Science, 1,* 173–181. doi:10.1023/A:1026595011371

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds? Coherence among emotion experience, behavior, and physiology. *Emotion, 5,* 175–190. doi:10.1037/1528-3542.5.2.175

McClelland, D. C., Atkinson, J. W., Clark, R. A., & Lowell, E. L. (1953). *The achievement motive.* New York, NY: Appleton-Century-Crofts. doi:10.1037/11144-000

McCrae, R. R. (2007). Aesthetic chills as a universal marker of openness to experience. *Motivation and Emotion, 31,* 5–11. doi:10.1007/s11031-007-9053-1

McFatter, R. M. (1979). The use of structural equation models in interpreting regression equations including suppressor and enhancer variables. *Applied Psychological Measurement, 3,* 123–135. doi:10.1177/014662167900300113

Meehl, P. E. (1992). Factors and taxa, traits and types, differences of degree and differences in kind. *Journal of Personality, 60,* 117–174. doi:10.1111/j.1467-6494.1992.tb00269.x

Muthén, B. O. (1994). Multilevel covariance structure analysis. *Sociological Methods and Research, 22,* 376–398. doi:10.1177/0049124194022003006

Muthén, B. O., & Muthén, L. K. (2004). Mplus (Version 3.11) [Computer software]. Los Angeles, CA: Muthén & Muthén.

Nagashima, K., Nakai, S., Tanaka, M., & Kanosue, K. (2000). Neuronal circuitries involved in thermoregulation. *Autonomic Neuroscience: Basic and Clinical, 85,* 18–25. doi:10.1016/S1566-0702(00)00216-2

Nezlek, J. B. (2007). Multilevel modeling in personality research. In R. W. Robins, R. C. Fraley, & R. F. Krueger (Eds.), *Handbook of research methods in personality psychology* (pp. 502–522). New York, NY: Guilford Press.

Nishida, T. (1997). Sexual behavior of adult male chimpanzees of the Mahale Mountains National Park, Tanzania. *Primates, 38,* 379–398. doi:10.1007/BF02381879

Nusbaum, E. C., & Silvia, P. J. (2011). Shivers and timbres: Personality and the experience of chills from music. *Social Psychological and Personality Science, 2,* 199–204. doi:10.1177/1948550610386810

Panksepp, J. (1995). The emotional sources of "chills" induced by music. *Music Perception, 13,* 171–207.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions.* New York, NY: Oxford University Press.

Panksepp, J., & Bernatzky, G. (2002). Emotional sounds and the brain: The neuro-affective foundations of musical appreciation. *Behavioural Processes, 60,* 133–155. doi:10.1016/S0376-6357(02)00080-3

Paulhus, D. L. (1998). *Paulhus Deception Scales (PDS): The Balanced Inventory of Desirable Responding–7: User's manual.* North Tonawanda, NY: Multi-Health Systems.

Paulhus, D. L., Robins, R. W., Trzesniewski, K. H., & Tracy, J. L. (2004). Two replicable suppressor situations in personality research. *Multivariate Behavioral Research, 39,* 303–328. doi:10.1207/s15327906mbr3902_7

Pearsall, P. (2007). *Awe: The delights and dangers of our eleventh emotion.* Deerfield Beach, FL: Health Communications.

Pennebaker, J. W. (1982). *The psychology of physical symptoms.* New York, NY: Springer-Verlag.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88,* 879–903. doi:10.1037/0021-9010.88.5.879

Raudenbush, S., Bryk, A., & Congdon, R. (2009). HLM for Windows 6.08 [Computer software]. Lincolnwood, IL: Scientific Software International.

Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 190–222). New York, NY: Cambridge University Press.

Reise, S. P., Ventura, J., Nuechterlein, K. H., & Kim, K. H. (2005). An illustration of multilevel factor analysis. *Journal of Personality Assessment, 84,* 126–136. doi:10.1207/s15327752jpa8402_02

Rickard, N. S. (2004). Intense emotional responses to music: A test of the physiological arousal hypothesis. *Psychology of Music, 32,* 371–388. doi:10.1177/0305735604046096

Rimé, B., & Giovannini, D. (1986). The physiological patterns of reported emotional states. In K. R. Scherer, H. G. Wallbott, & A. B. Summerfield (Eds.), *Experiencing emotion: A cross-cultural study* (pp. 84–97). New York, NY: Cambridge University Press.

Rimé, B., Philippot, P., & Cisamolo, D. (1990). Social schemata of peripheral changes in emotion. *Journal of Personality and Social Psychology, 59,* 38–49. doi:10.1037/0022-3514.59.1.38

Rindskopf, D., & Rose, T. (1988). Some theory and applications of confirmatory second-order factor analysis. *Multivariate Behavioral Research, 23,* 51–67. doi:10.1207/s15327906mbr2301_3

Romanovsky, A. A. (2007). Thermoregulation: Some concepts have changed. Functional architecture of the thermoregulatory system. *American Journal of Physiology: Regulatory, Integrative and Comparative Physiology, 292,* R37–R46. doi:10.1152/ajpregu.00668.2006

Schachter, S., & Singer, J. R. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review, 69,* 379–399. doi:10.1037/h0046234

Scherer, K. R., Summerfield, A. B., & Wallbott, H. G. (1983). Cross-national research on antecedents and components of emotion: A progress report. *Social Science Information, 22,* 355–385. doi:10.1177/053901883022003002

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. *Journal of Personality and Social Psychology, 66,* 310–328. doi:10.1037/0022-3514.66.2.310

Silvia, P. J., & Nusbaum, E. C. (2011). On personality and piloerection: Individual differences in aesthetic chills and other unusual aesthetic experiences. *Psychology of Aesthetics, Creativity, and the Arts, 5,* 208–214. doi:10.1037/a0021914

Sloboda, J. A. (1991). Music structure and emotional response: Some empirical findings. *Psychology of Music, 19,* 110–120. doi:10.1177/0305735691192002

Stefan, H., Feichtinger, M., & Black, A. (2003). Autonomic phenomena of temperature regulation in temporal lobe epilepsy. *Epilepsy & Behavior, 4,* 65–69. doi:10.1016/S1525-5050(02)00644-3

Stefan, H., Pauli, E., Kerling, F., Schwarz, A., & Koebnick, C. (2002). Autonomic auras: Left hemispheric predominance of epileptic generators of cold shivers and goose bumps? *Epilepsia, 43,* 41–45. doi:10.1046/j.1528-1157.2002.21001.x

Thayer, R. E. (1986). Activation–Deactivation Adjective Check List: Current overview and structural analysis. *Psychological Reports, 58,* 607–614. doi:10.2466/pr0.1986.58.2.607

Thayer, R. E. (1989). *The biopsychology of mood and arousal.* New York, NY: Oxford University Press.

Thrash, T. M., & Elliot, A. J. (2004). Inspiration: Core characteristics, component processes, antecedents, and function. *Journal of Personality and Social Psychology, 87,* 957–973. doi:10.1037/0022-3514.87.6.957

Thrash, T. M., Elliot, A. J., Maruskin, L. A., & Cassidy, S. E. (2010). Inspiration and the promotion of well-being: Tests of causality and mediation. *Journal of Personality and Social Psychology, 98,* 488–506. doi:10.1037/a0017906

Thrash, T. M., Elliot, A. J., & Schultheiss, O. C. (2007). Methodological and dispositional predictors of congruence between implicit and explicit need for achievement. *Personality and Social Psychology Bulletin, 33,* 961–974. doi:10.1177/0146167207301018

Thrash, T. M., Maruskin, L. A., Cassidy, S. E., Fryer, J. W., & Ryan, R. M. (2010). Mediating between the muse and the masses: Inspiration and the actualization of creative ideas. *Journal of Personality and Social Psychology, 98,* 469–487. doi:10.1037/a0017907

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063–1070. doi:10.1037/0022-3514.54.6.1063

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science, 322,* 606–607. doi:10.1126/science.1162548

Winter, D. G. (1994). *Manual for scoring motive imagery in running text* (*Version 4.2*). Unpublished manuscript, Department of Psychology, University of Michigan, Ann Arbor.

Zhong, C.-B., & Leonardelli, G. J. (2008). Cold and lonely: Does social exclusion literally feel cold? *Psychological Science, 19,* 838–842. doi:10.1111/j.1467-9280.2008.02165.x

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