"The Chills" as a Psychological Response: Affective Composition, Trait Antecedents, and Factor Structure

Laura Anne Maruskin

College of William & Mary - Arts & Sciences

Follow this and additional works at: https://scholarworks.wm.edu/etd

Part of the Behavioral Neurobiology Commons, and the Biological Psychology Commons

Recommended Citation

https://dx.doi.org/doi:10.21220/s2-7g6h-1n76

This Thesis is brought to you for free and open access by the Theses, Dissertations, & Master Projects at W&M ScholarWorks. It has been accepted for inclusion in Dissertations, Theses, and Masters Projects by an authorized administrator of W&M ScholarWorks. For more information, please contact scholarworks@wm.edu.
"The Chills" as a Psychological Response:  
Affective Composition, Trait Antecedents, and Factor Structure

Laura Anne Maruskin  
Weston, Massachusetts

BA, University of Rochester, 2006

A Thesis presented to the Graduate Faculty  
of the College of William and Mary in Candidacy for the Degree of  
Master of Arts

Department of Psychology

The College of William and Mary  
May 2010
This Thesis is submitted in partial fulfillment of the requirements for the degree of

Master of Arts

Laura Anne Maruskin

Approved by the Committee, May 2010

Committee Chair
Assistant Professor Todd Thrash, Psychology
The College of William & Mary

Associate Professor Lee Kirkpatrick, Psychology
The College of William & Mary

Assistant Professor Paul Kieffaber, Psychology
The College of William & Mary
COMPLIANCE PAGE

Research approved by:

Protection of Human Subjects Committee (PHSC)

Protocol number(s):  PHSC-2009-10-24-6281-tmthra
                   PHSC-2009-11-02-6301-tmthra

Date(s) of approval:  10/30/2009
                    11/06/2009
"The chills" refers to a set of bodily reactions—such as goosebumps, tingling, a shiver-down-the-spine, and feeling cold—that are often associated with strong emotion. This is a well-known experience but the topic of little psychological research. The goals of this research were to examine (1) the affective composition of chills experiences, (2) trait antecedents of the chills, and (3) the factor structure of the chills construct. Study 1, a narrative study, indicated that chills experiences are characterized by heightened levels of affects characterized by high arousal and negative valence (e.g., fear). Study 2, an event-contingent diary study, indicated that the traits of Neuroticism and self-transcendence predict overall chills. In addition, Study 2 indicated that the chills construct has a two-factor structure, comprised of “goosetingles” and “coldshivers.” Goosetingles and coldshivers were predicted by self-transcendence and Neuroticism, respectively.
Acknowledgements

First, I would like to thank my advisor, Todd Thrash, for his invaluable guidance and support at all stages of this research. In addition, I would like to thank Lee Kirkpatrick and Paul Kieffaber for their thoughtful input. I would also like to thank my parents, John and Lynn Maruskin, and my sister, Katie Maruskin, for their love and support. Finally, I would like to thank Sugarfree Red Bull and Diet Coke for caffeinating me throughout the research process.
The fascinating chill that music leaves
Is Earth's corroboration
Of Ecstasy's impediment—
'Tis Rapture's germination
In timid and tumultuous soil
A fine—estranging creature—
To something upper wooing us
But not to our Creator—
-Emily Dickinson, #1480

“The chills” refers to a set of bodily reactions, such as goosebumps and a shiver-down-the-spine, that are often associated with strong emotion. As Emily Dickenson noted, experiences of the chills tend to be poignant, and the elicitors of the chills tend to be regarded as important. Despite this, the chills has received little research attention. Further, within the nascent literature, there is a considerable diversity of opinion among researchers regarding fundamental theoretical issues, such as the affective tone of chills experiences and trait antecedents of the chills. Other fundamental issues, such as the factor structure of the chills construct, have been overlooked entirely. The purpose of the present research was to address these problems. Specifically, I aimed to (1) document the affective composition of chills experiences, (2) identify trait antecedents of the chills, and (3) determine the factor structure of the chills as a psychological construct.

Lack of Research Attention

As noted, the chills has received little attention within the psychology literature. Sloboda (1991) argued that chills experiences have not received the experimental attention they deserve. McCrae (2007) identified the chills as a “neglected emotional phenomenon” (p. 5). Panksepp (1995) suggested that this lack of attention may be due to a lack of clarity in the conceptualization of the chills, the inherent subjectivity of chills
experiences, and the potentially idiosyncratic nature of these experiences. Despite these complications, the consensus among researchers is that the chills response may be an important indicator of underlying emotional, physiological, and neurological processes (e.g., Blood & Zatorre, 2001; Goldstein, 1980; Panksepp, 1995; Panksepp & Bernatzky, 2002).

**Definitions of the Chills**

Researchers use the term “chills” interchangeably with a number of other terms and phrases, including thrills, hair-standing-on-end feeling, frisson, and skin orgasm. Panksepp (1995) defined the chills as a “bodily ‘rush’ [that] is commonly described as a spreading gooseflesh, hair-on-end feeling ... common on the back of the neck and head and often moves down the spine, at times spreading across much of the rest of the body” (p. 173). Goldstein (1980) found that participants described a typical experience of the chills as “a slight shudder, chill, or tingling sensation, usually localized at the back of the neck, and fleeting” (p. 128). In sum, the chills involves a set of physiological responses and sensations that are typically presumed to co-occur, such as goosebumps, shiver-down-the-spine, tingling sensations, and feeling cold.

**Prevalence of the Chills**

Several researchers have examined the prevalence of the chills. Goldstein (1980) studied the chills in three target populations: employees at an addiction research institute, medical students, and university music students. The percentage of individuals that reported having experienced the chills at some point in their lives were 53%, 80%, and 90%, respectively. Panksepp (1995) found that 86% of introductory psychology students
experienced the chills with “some regularity” in response to music. Sloboda (1991) found that within the past five years, 90% of British adults had experienced a “shiver down the spine” and 62% had experienced “goose pimples” in response to music. These findings suggest that the chills is a common experience in a variety of populations. In addition, Sloboda’s findings suggest that there may be meaningful distinctions between chills sensations.

*Problems in the Existing Literature*

There are several noteworthy problems in the nascent literature. In the following, I identify three fundamental problems and describe how they are addressed in the present research.

*Inconsistencies in Conceptualization of the Affective Composition of the Chills.* A problem in the existing literature is that there is considerable diversity in conceptualizations of the affective composition of the chills. Although theorists agree that chills experiences involve heightened affect, there is disagreement about the particular affective states that are associated with the chills.

Darwin (1872) linked piloerection to fear and anger. Piloerection refers to the contraction of the pilomotor muscles that results in goosebumps and the erection of hairs. Darwin discussed the evolutionary purpose of the erection of hairs on the face as a mechanism through which an animal could appear larger and more threatening to a predator, thus dissuading the predator from attacking. Darwin also noted that piloerection is one of the most common expressions of emotion in humans.
Huron (2006), who referred to the chills response as “frisson,” defined the experience as the feeling of chills running up and down one’s spine and hair standing up on the back of one’s neck. Huron linked the chills response to surprise and fear. Huron conceptualized surprise as a reaction to a violation of expectation for an outcome. He further argued that surprise inherently involves some degree of fear because of the uncertainty created by the failure of prediction. When this initial fear is tempered by a secondary appraisal of the situation as manageable, the “fight” response (rather than “flight” or “freeze”) is activated. Consistent with Darwin (1874), Huron argued that piloerection is a component of this fight response and makes the animal look bigger and more threatening to predators. Huron further posited that we identify piloerection in response to surprising threats as “chills” because piloerection also plays a role in thermoregulation (i.e., heat retention). Huron’s theory suggests that music is particularly effective in eliciting chills because musical structures often involve manageable surprises, such as sudden changes in loudness or abrupt changes in tempo.

Panksepp (1995) linked chills experiences to social loss and sadness. Panksepp focused primarily on chills in response to music and attributed chills experiences to bittersweet sadness in music, especially when vocals focus on “the drama of lost love” (p.192). In a series of studies, Panksepp found that sad/melancholy songs were more effective than happy songs at eliciting the chills. Based on the observation that a high-pitched voice was particularly effective at eliciting the chills, Panksepp suggested that the chills may have evolved from a mother’s response to separation calls from her young (Panksepp, 1995; Panksepp & Bernatzky, 2002). The chills response in the mother—
involving feelings of coldness and a strong emotional reaction—may motivate social reunion. As noted by Panksepp (1995), "the separation call may have been designed, during the evolutionary construction of the brain’s emotional systems, to acoustically activate a thermally based need for social contact, most especially in parents who suddenly hear the wail of their own lost infant" (p. 199).

Goldstein (1980), who referred to the chills as “thrills,” found that these experiences were associated with a high level of emotional arousal and tend to be experienced as pleasurable. Consistent with these findings, most of the elicitors identified by Goldstein were positive in affective tone (e.g., 87% of participants had experienced the chills in response to “great beauty in nature or art”). Other elicitors were ambiguous regarding affective tone (e.g., 96% of participants had experienced the chills in response to music). Although these findings suggest that the chills is characterized by positive affect, they should be interpreted with caution because it is unclear exactly how chills experiences were defined for participants (e.g., if the pleasurable nature of the stimulus was implied by the definition).

Blood and Zatorre (2001) linked the chills response to pleasure and reward. Using positron emission tomography (PET), they found that self-reported chills intensity was related to regional cerebral blood flow (rCBF) in brain areas associated with pleasure and reward sensitivity. Specifically, they found that chills intensity was positively related to rCBF in left ventral striatum and dorsomedial midbrain, and negatively related to rCBF in right and left amygdala, left hippocampus, and ventro-medial prefrontal cortex. These findings seem to suggest that the chills involves pleasant affect. However, the stimuli
used to elicit the chills were pieces of music that participants had identified as reliably eliciting euphoric chills and pleasant responses. The pleasant quality of the stimuli may have driven the association between chills and blood flow in pleasure/reward centers.

Keltner (2006) linked piloerection to awe, which he characterized as a self-transcendent positive emotion. He claimed that the current elicitors of piloerection are fundamentally different than those early in our evolutionary history. Keltner argued that “piloerection shifted from an association with adversarial defense to connection to the collective” (p.263). Thus, Keltner links piloerection to a self-transcendent form of positive affect, although he does so without citation or supportive evidence.

In conclusion, there is considerable diversity in opinions about the affective tone and composition of the chills. Darwin (1874), Huron (2006), and Panksepp (1995) linked chills experiences to negative affective states—surprise, fear, and sadness/social loss. In contrast, Goldstein (1980), Blood and Zatorre (2001), and Keltner (2006) linked chills experiences to positive affective states—pleasure, reward, and awe. Researchers that linked the chills to negative affect have been more theoretically grounded, although there is a lack of clarity about which particular negative affects are associated with the chills. Studies that have linked the chills to positive affective states have not given the possibility of an association with negative affect ample attention.

As such, the first goal of the present research was to characterize the affective composition of the chills. In order to obtain a comprehensive description of the affective tone of chills experiences, I incorporated measures that represent three theoretical conceptualizations of affect: (1) the two-dimensional (valence and arousal) circumplex
framework, (2) a non-dimensional discrete emotion approach, and (3) Thayer’s (1989) two-dimensional (tension and energy) model of arousal.

Inconsistencies Regarding Trait Antecedents. A second problem in the existing literature on the chills is that there are inconsistencies regarding presumed trait antecedents of chills experiences. Further, only a few empirical studies have examined the relationships between traits and chills experiences.

McCrae (2007) argued that the experience of “aesthetic chills” is characteristic of individuals high in the Big Five trait of Openness to Experience. Aesthetic chills refers to chills experiences in response to art or beauty. Individuals high in Openness tend to be particularly sensitive to art and beauty, and they tend to experience a wide range of feelings and emotions (Terracciano, McCrae, Hagemann, & Costa, 2003). In addition, these individuals tend to be tolerant of ambiguity and have loose mental boundaries (McCrae & Costa, 1997). McCrae noted that the following Openness item, which refers explicitly to the chills, is the best single marker of Openness: “Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement” (NEO-PI-R; Costa & McCrae, 1992a). Because the item retained its meaning and remained an indicator of Openness when translated into diverse languages, McCrae argued that aesthetic chills is a universal marker of Openness. These findings, however, should be interpreted with caution because they are based on a single item that confounds chills experiences with behavior inherently associated with Openness (i.e., reading poetry and viewing art). In other words, because the item that was the basis of his argument refers to both chills and aesthetic objects, he built his conclusion into his argument.
Panksepp and Bernatzky (2002) argued that Agreeableness is the Big Five trait most relevant to the chills. Individuals high in Agreeableness tend to be trusting, sympathetic, and cooperative (Costa & McCrae, 1002b). Panksepp and Bernatzky found that the frequency of chills experiences in response to music was correlated positively with Agreeableness and unrelated to the other Big Five traits (Openness, Extraversion, Neuroticism, and Conscientiousness). The researchers noted, however, that these findings were based only on preliminary analyses. The notion that Agreeableness is relevant to chills experiences is consistent with Panksepp's (1995) claim that the chills may be linked to social loss. However, Neuroticism may be even more relevant because Neuroticism involves a proneness to negative affective states.

Grewe, Nagel, Koiez, and Altenmüller (2007) linked chills experiences to trait reward dependence in exploratory analyses (Cloninger, Przybeck, Svrakic, & Wetzel, 1994). Individuals high in reward dependence tend to readily form warm social bonds, respond to sentimental appeals, and seek positive emotional input in their environment (Cloninger et al., 1994). Grewe and colleagues found that participants high in reward dependence were more likely to get the chills in response to music than those low in reward dependence.

In sum, there is inconsistency in the literature regarding which traits are most relevant to the experience of chills. McCrae identified the chills as a universal marker of Openness. Panksepp and Bernatzky (2002) suggested that Agreeableness may be most relevant. Finally, Grewe and colleagues (2007) identified reward dependence as an important predictor of the chills.
Addressing this inconsistency, the second goal of the present research is to identify the trait antecedents of the chills. In order to do this, I assessed the Big Five traits and supplemented them with self-transcendence. Self-transcendence represents a capacity to become fascinated by and focused on one thing (Cloninger, Svrakic, & Przybeck, 1993). To the extent that self-transcendent states, such as perceiving something to be meaningful or experiencing awe, are relevant to the chills, the trait of self-transcendence may predict chills experiences.

Inattention to Factor Structure. A third problem in the existing literature is that the factor structure of the chills has not been examined. The term “chills” tends to subsume multiple sensations (e.g., goosebumps, tingling, feeling cold, shiver-down-the-spine) and it is assumed that these sensations form a single construct. However, researchers have neither tested this assumption empirically, nor have they discussed the possibility that the chills is a multifactor construct.

There have been only two studies in which chills components have been assessed separately. Sloboda (1991) differentiated between shiver-down-the-spine and goosebumps when assessing chills experiences, but he collapsed these variables in his primary analyses. Grewe and colleagues (2007) assessed shivers and goosebumps, but they did little to exploit the information gained with these separate assessments. Compounding the problem of inattention to factor structure, many researchers have neglected to specify exactly how the chills was defined to participants. The inconsistency in the literature regarding the affective composition and trait antecedents of the chills
may in part reflect inconsistencies in the chills components that have been identified and assessed.

Because the issue of factor structure has been ignored in the chills literature, it is necessary to incorporate other literatures to address this issue. Literature on thermoregulation is particularly relevant, because thermoregulation was perhaps the original function of piloerection, prior to its role in aggressive display (Huron, 2006). Moreover, the particular components of chills experiences (e.g., goosebumps, a shiver-down-the-spine, tingling) resemble mechanisms of thermoregulation. Specifically, piloerection results in a layer of warm air being trapped near the skin; shivering results in heat production; and tingling sensations may be caused by skin vasoconstriction, which helps keep blood from cooling by reducing blood flow to the skin (Benarroch, 2007; Nagashima, Nakai, Tanaka, & Kanosue, 2000; Romanovsky, 2007). These mechanisms have related but distinct neurophysiological substrates, perhaps resulting in a multi-factor structure of the chills. In the present research, I test the factorial coherence of the four sensations that are most frequently discussed in the chills literature: goosebumps, shiver-down-the-spine, tingling sensations, and feeling cold.

Overview of the Present Studies

In Study 1, I implemented a narrative design in order to identify the affective composition of the chills. In Study 2, I conducted an event-contingent diary study in order to identify trait antecedents of chills experiences and to determine the factor structure of the chills construct.
The purpose of Study 1 was to characterize chills experiences in terms of affect and arousal.

Method

Participants

Participants were 136 undergraduates enrolled in an introductory psychology course. Participants were assigned to either a chills condition or a control condition. Seven participants were dropped because they failed to follow instructions, and 31 participants were dropped because they could not recall an instance of the specified experience for their assigned condition (see below). The final sample consisted of 50 participants (18 men and 32 women) in the chills condition and 48 participants (12 men and 36 women) in the control condition.

Procedure

Questionnaires were completed online. Participants recalled an instance of the target experience and described it in a written narrative. Participants also completed questionnaires regarding their affect and arousal during the recalled experience.

Narrative Recall

Chills Condition. Participants in the chills condition were asked to recall a time when they had experienced the chills. The chills was defined for participants as follows: "the experience of a tingling sensation on your skin, a hair-standing-on end feeling, or a shiver running down your spine in response to a psychologically significant situation or cause. These sensations may be accompanied by goosebumps or other bodily responses. (Experiences caused only by a cold temperature do not qualify.)" In narrative form,
participants were asked to describe (1) what caused or elicited the chills, (2) the emotions they felt during their chills experience, (3) any physical bodily sensations that they experienced, and (4) anything their chills experience made them want to do.

**Control Condition.** Participants in the control condition were asked to describe a representative daily experience. A representative daily experience was defined as follows: “an experience that is a good example of the kinds of experiences you have in your everyday life.” In a format parallel to the chills condition, participants were asked to describe (1) what happened during the representative experience, (2) the emotions they experienced, (3) any physical bodily sensations that they experienced, and (4) anything their representative experience made them want to do.

**Dependent Measures**

The internal consistency of each variable is reported in Table 1.

**Circumplex Affect.** Circumplex affect was assessed using the adjective-based measure of affect developed by Feldman Barrett and Russell (1998). Participants rated the degree to which they had experienced eight affective states on a scale of 1 (*not at all*) to 5 (*extremely*). The eight affective states included in the circumplex measure (pleasant, unpleasant, activated, deactivated, pleasant activated, unpleasant deactivated, unpleasant activated, and pleasant deactivated) represent a two-dimensional structure of affect that consists of activation/deactivation and pleasant/unpleasant dimensions.

**Arousal.** Arousal was assessed using the Activation-Deactivation Adjective Checklist (AD ACL; Thayer, 1989). The AD ACL provides a two-dimensional assessment of transitory arousal states, including energetic and tense arousal. Participants
rated the degree to which they experienced a particular feeling or mood (e.g., "tired," "tense") during the experience described in the narrative on a scale of 1 (definitely did not feel) to 5 (definitely felt).

Discrete Emotions. Interest, enjoyment, surprise, sadness, anger, and disgust were assessed using the Differential Emotions Scale (Izard, Libero, Putman, & Haynes, 1993). Participants rated the degree to which they had experienced each emotion on a scale of 1 (not at all) to 5 (extremely). Awe was assessed using three items: “full of awe,” “full of wonder,” and “awestruck.” The first two items were used by Thrash, Maruskin, Cassidy, Fryer, and Ryan (2010) and the third item was added in order to improve internal consistency. Participants rated the degree to which they experienced each on a scale of 1 (not at all) to 5 (extremely).

Results

Descriptive statistics are presented in Table 1. Independent sample t-tests were performed in order to determine the difference between the chills condition and the control condition on the dependent measures.

Regarding circumplex affect, chills experiences were found to involve high levels of unpleasant affect, $t(96) = 2.41, p < .01$, activated affect, $t(96) = 3.29, p < .01$, and unpleasant activated affect $t(96) = 3.54, p < .01$. Chills experiences were found to involve low levels of pleasant affect, $t(96) = -2.82, p < .01$, pleasant deactivated affect, $t(96) = -4.64, p < .001$, and unpleasant deactivated affect, $t(96) = -3.71, p < .001$.

Regarding arousal, chills experiences were found to involve high levels of tense arousal, $t(96) = 6.60, p < .001$. 
Regarding discrete emotions, chills experiences were found to involve high levels of surprise, $t(96) = 4.37, p < .001$, disgust, $t(96) = 2.47, p < .05$, fear, $t(96) = 4.79, p < .001$, and awe, $t(96) = 3.53, p < .01$.

Discussion

These findings indicate that chills experiences tend to involve heightened levels of affective states involving negative valence and high arousal, such as unpleasant activated affect, tense arousal, and fear. It is also noteworthy that surprise and awe were elevated during chills experiences—these two emotions are complex and are often considered to have both positive and negative components. There was no evidence of elevation of any purely positively valenced variables (e.g., enjoyment) or low arousal negatively valenced variables (e.g., sadness).

Study 2

A limitation of Study 1 was that the chills experiences were recalled and may have been influenced by memory errors or biases. To address this limitation, in Study 2 an event-contingent diary design was used in order to collect data about chills experiences immediately after they occurred. The first aim of Study 2 was to identify the factor structure of the chills construct—whether it is a unitary construct or has a multi-factor structure. The second aim was to determine which personality traits predict chills experiences. Participants reported their personality traits and the sensations associated with their chills experiences.

Method

Participants and Procedure
Participants were 192 undergraduates (89 men and 103 women) enrolled in an introductory psychology course. Participants completed individual difference measures and then completed a 14-day diary study. Individual difference measures included the Big Five traits and self-transcendence. Participants completed online questionnaires each time they experienced the chills.

Measures

The internal consistency of each variable is reported in Table 2.

Chills. Four sensations commonly associated with the chills—goosebumps, tingling sensations, feeling cold, and a shiver down the spine sensation—were each assessed with a single item. Participants rated the intensity with which they experienced each sensation from 1 (not at all) to 5 (extremely).

Big Five Traits. Big Five personality traits were assessed using the NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992a). Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness were assessed with 60 items (e.g., Neuroticism, “I often feel tense and jittery”). Participants rated their level of agreement with each item on a scale of 1 (strongly disagree) to 5 (strongly agree).

Self-transcendence. Self-transcendence refers to the ability to become fascinated by and focused on one thing. Self-transcendence was assessed using the self-transcendence scale from the Temperament and Character Inventory (Cloninger, Svrakic, & Przybeck, 1993). Items were rated from 1 (not at all) to 5 (extremely).

Results

Descriptive Statistics
A total of 538 chills diaries were submitted. The number of chills diaries submitted per person ranged from 0 to 15 over the 14-day period. The mean number of chills diary submissions was 2.80 and the median and mode were 2. Descriptive statistics for each variable are reported in Table 2.

**Intraclass Correlations**

The variance of the chills variables 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). In order to estimate the proportion of total variance that was between persons (rather than within persons), intraclass correlations (ICCs) based on random effects were computed using Mplus (Muthén & Muthén, 2004). The ICCs for the chills variables were as follows: goosebumps, ICC = .36; tingles, ICC = .35; cold, ICC = .41; shivers, ICC = .33. These values indicate that roughly one-third of the variance was between persons and two-thirds of the variance was within persons. The presence of variance at both between-person and within-person levels suggests a need for a multilevel analytic strategy.

**Multilevel Principal Components Analysis**

The factor structure of a construct is not necessarily the same at between-person and within-person levels. For example, at the between-person level, a construct may appear to consist of a single factor. However, at the within-person level, the construct may have a multifactor structure. This particular case can be illustrated in the context of laughing and crying as affective responses. Imagine a dataset that contains scores for the frequency of laughing and crying for three individuals. At the between-person level, an
individual may have a high mean for both laughing and crying relative to the other two individuals, who are low in both. At this level of analysis, we would likely conclude that the variables cohere as a single construct, because they are perfectly positively correlated across persons. However, at the within-person level, it is likely that when one variable is high, the other is low (relative to the level of the other variable within that individual). That is, when a particular individual is laughing, they are not concurrently crying. The variables are negatively correlated within each person. So, at the within-person level of analysis, we would likely conclude that laughing and crying represent two separable factors. This example highlights the necessity of considering multiple levels of analysis when determining the factor structure of constructs.

A multilevel principal components analysis was performed in order to determine the factor structure of the chills at both between-person and within-person levels. As recommended by Muthén (1994), an estimated population between-person covariance matrix and a pooled within-person covariance matrix were generated using Mplus (Muthén & Muthén, 2004). The covariance matrices were analyzed using principal components analysis.

The between-person analysis yielded two components with eigenvalues greater than 1 (eigenvalues were 1.50, 1.05, .77, .68). Varimax loadings are presented in Table 3. Tingling and goosebumps loaded on the first component. Shiver-down-the-spine and feeling cold loaded on the second component. These findings indicate that individuals who tend to experience tingling also tend to experience goosebumps. Likewise, those who tend to experience shiver-down-the-spine also tend to experience feeling cold.
The within-person analysis also yielded two components with eigenvalues greater than 1 (eigenvalues were 1.38, 1.06, .85, .72). Varimax loadings are presented in Table 3. Feeling cold and shiver-down-the-spine loaded on the first component. Tingling loaded on the second component. Goosebumps loaded on both components. These findings indicate that within individuals, particular instances of the chills involve feeling cold and shiver-down-the-spine or involve tingling. Goosebumps tends to occur during both types of chills experiences.

In sum, a two-factor structure emerged at both between-person and within-person levels of analysis. At both levels, feeling cold and shiver-down-the-spine loaded on one component, and tingles and goosebumps loaded on the other component. The only noteworthy difference between factor structures was that goosebumps crossloaded on the first component at the within-person level. These findings are at odds with traditional portrayals of the chills as a unitary construct.

Trait Antecedents of Chills Experiences

In order to examine trait antecedents of the chills, average levels of the four chills components were computed. In addition, on the basis of the factor analysis, a composite variable consisting of goosebumps and shiver-down-the-spine (hereafter referred to as “goosetingles”) was computed. A second composite variable consisting of feeling cold and shivers (hereafter referred to as “coldshivers”) was also computed. Goosetingles and coldshivers were modestly positively correlated, \( r = .18, p < .05 \). Finally, because past research has focused on a unitary chills construct, an overall chills variable was
computed. However, because the chills has a multi-factor structure, results based on the overall chills variable must be interpreted with caution.

Correlations between traits and chills variables are presented in Table 4. Neuroticism and self-transcendence were the only traits that predicted chills variables. To test which traits uniquely predicted chills variables, each chills variable was regressed on the set of trait variables. Overall chills was predicted by Neuroticism, $\beta = .18, p < .05$, and self-transcendence, $\beta = .26, p < .01$. Goosetingles was predicted only by self-transcendence, $\beta = .23, p < .01$, and coldshivers was predicted only by Neuroticism, $\beta = .26, p < .01$. Regarding the four chills components, goosebumps were predicted only by self-transcendence, $\beta = .23, p < .01$; feeling cold was predicted only by self-transcendence, $\beta = .29, p < .01$; shiver-down-the-spine was predicted only by Neuroticism; and tingling was not uniquely predicted by any traits. The most noteworthy aspect of these findings is that goosetingles and coldshivers are predicted by different personality traits—self-transcendence and Neuroticism, respectively.

Discussion

The findings of Study 2 provide strong evidence that the chills is a multi-faceted construct. A two-factor structure emerged at both between-person and within-person levels of analysis. Moreover, at the between-person level, goosetingles and coldshivers were predicted by different traits. Individuals high in the trait of self-transcendence were particularly prone to experiencing goosetingles; in contrast, individuals high in Neuroticism were particularly prone to experiencing coldshivers.

General Discussion
Overall, these studies yielded three core findings. First, chills experiences were associated with high arousal, negatively valenced affective states (e.g., fear). Second, Neuroticism and self-transcendence predicted overall chills. Third, the chills had a two-factor structure, comprised of “goosetingles” and “coldshivers.” At the between-person level, these components were predicted by self-transcendence and Neuroticism, respectively. In the following, these finding are discussed in more detail.

The Affective Composition of the Chills

In Study 1, the affective composition of the chills was examined using a narrative method. Regarding circumplex affect, chills experiences were found to involve high levels of unpleasant affect, activated affect, and unpleasant activated affect. Chills experiences involved low levels of pleasant affect, pleasant deactivated affect, and unpleasant deactivated affect. Regarding Thayer’s model of arousal, chills experiences involved high levels of tense arousal, but not energetic arousal. Finally, regarding discrete emotions, chills experiences involved high levels of surprise, disgust, fear, and awe; chills experiences did not involve high levels of sadness, anger, interest, or enjoyment.

The most noteworthy of these findings is that chills experiences are characterized by affective states with negative valence and high arousal. These findings are consistent with the evolutionary theories of Darwin (1867) and Huron (2006). Earlier in our evolutionary history, piloerection may have functioned to make animals look bigger in the presence of predators, thus dissuading predators from attacking. Piloerection associated with chills experiences no longer functions to dissuade predators from
attacking, but may be a vestige of this adaptive function. In light of the association of piloerection with activated negative affect, it appears that chills experiences continue to be elicited by actual threat, or when a surprising event has the potential to be threatening.

The fact that positive emotions were not elevated is at odds with some characterizations of the chills as intensely pleasurable (e.g., Blood & Zatorre, 2001). Notably, past research linking chills experiences to positive states was not theoretically grounded, and the conclusions may have been artifacts of poor study design (see Introduction). Awe, identified by Keltner (2006) as a positive emotion, was found to be elevated during chills experiences. However, most theorists consider awe to be a complex blend of positive and negative emotions (e.g., admiration and fear; McDougall, 1921). The negative components of awe may have driven the relationship between chills and awe.

**Factor Structure of the Chills**

In Study 2, the factor structure of the chills was examined for the first time using an event-contingent diary design. A two-factor structure emerged at both between-person and within-person levels. With only minor differences across levels of analysis, goosebumps and tingling sensations cohered as a single factor (“goosetingles”) and feeling cold and shiver-down-the-spine cohered as a separate factor (“coldshivers”). These findings are at odds with the traditional assumption that the chills is a unitary construct. Because this particular factor structure was not predicted, confirmatory analyses in a second sample must be conducted before strong conclusions are warranted. Nevertheless, a multi-factor structure is consistent with the differentiated
neurophysiology of thermoregulation. Further research is needed to determine whether the factors obtained herein correspond to distinct neurophysiological processes.

The presence of a multi-factor structure of the chills may help to explain inconsistencies in conclusions about the affective composition and trait antecedents of the chills in past research. If chills is operationalized as goosetings in some studies and as coldshivers in others, inconsistencies in findings may reflect the different correlates of these components.

**Trait Antecedents of the Chills**

Trait antecedents of the chills were examined in Study 2. Traits were used to predict individuals’ mean levels of chills variables. Overall chills was predicted by Neuroticism and self-transcendence. Goosetings was uniquely predicted by self-transcendence, whereas coldshivers was uniquely predicted by Neuroticism.

The fact that overall chills and coldshivers were predicted by Neuroticism is consistent with the above finding that chills involved high levels of activated negative affects. The association of chills with Neuroticism and activated negative affect suggests that chills experiences involve arousal of the avoidance temperament system (Elliot & Thrash, 2002). The fact that overall chills and goosetings were predicted by self-transcendence is consistent with the above finding that chills involved high levels of awe, a self-transcendent emotion. The association of chills with Openness and Agreeableness was not replicated.

*Limitations and Future Research*
Several limitation of this research should be noted. First, all variables were measured using self-report. I am currently planning a study that will address this shortcoming and test the convergence of self-reported chills variables with physiological indicators (e.g., skin conductance). Second, the elicitors of overall chills and goosetings/coldshivers components have not been identified. Additional analyses of the present data will be conducted to address this limitation. Third, person-situation interactions were not examined. I am currently collecting data that will indicate whether particular elicitors are more effective in eliciting chills in particular individuals. Finally, participants were undergraduate students. Findings may or may not generalize to other populations.
References


Table 1. Descriptive statistics, internal consistencies, and t-tests (Study 1)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Condition</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>t (96)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Chills</td>
<td></td>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>α</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circumplex affect</td>
<td>Pleasant</td>
<td>.91</td>
<td>6.82</td>
<td>4.46</td>
<td>9.17</td>
<td>3.72</td>
</tr>
<tr>
<td></td>
<td>Unpleasant</td>
<td>.90</td>
<td>7.14</td>
<td>4.04</td>
<td>5.40</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>Activated</td>
<td>.66</td>
<td>9.58</td>
<td>3.38</td>
<td>7.54</td>
<td>2.71</td>
</tr>
<tr>
<td></td>
<td>Deactivated</td>
<td>.51</td>
<td>5.48</td>
<td>2.82</td>
<td>6.40</td>
<td>2.41</td>
</tr>
<tr>
<td></td>
<td>Pleasant act.</td>
<td>.90</td>
<td>24.38</td>
<td>9.77</td>
<td>26.15</td>
<td>9.49</td>
</tr>
<tr>
<td></td>
<td>Unpleasant deact.</td>
<td>.87</td>
<td>7.50</td>
<td>3.06</td>
<td>10.60</td>
<td>5.03</td>
</tr>
<tr>
<td></td>
<td>Unpleasant act.</td>
<td>.88</td>
<td>25.06</td>
<td>10.00</td>
<td>18.75</td>
<td>7.43</td>
</tr>
<tr>
<td></td>
<td>Pleasant deact.</td>
<td>.92</td>
<td>7.06</td>
<td>4.15</td>
<td>12.73</td>
<td>5.69</td>
</tr>
<tr>
<td>Arousal</td>
<td>Energetic</td>
<td>.91</td>
<td>14.54</td>
<td>6.54</td>
<td>12.75</td>
<td>5.56</td>
</tr>
<tr>
<td></td>
<td>Tense</td>
<td>.85</td>
<td>16.34</td>
<td>5.11</td>
<td>9.96</td>
<td>4.42</td>
</tr>
<tr>
<td>Discrete emotions</td>
<td>Interest</td>
<td>.74</td>
<td>10.60</td>
<td>3.38</td>
<td>9.79</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>Enjoyment</td>
<td>.96</td>
<td>7.08</td>
<td>5.01</td>
<td>8.81</td>
<td>4.24</td>
</tr>
<tr>
<td></td>
<td>Surprise</td>
<td>.76</td>
<td>9.10</td>
<td>3.68</td>
<td>6.17</td>
<td>2.91</td>
</tr>
<tr>
<td></td>
<td>Sadness</td>
<td>.90</td>
<td>6.16</td>
<td>3.73</td>
<td>5.23</td>
<td>2.79</td>
</tr>
<tr>
<td></td>
<td>Anger</td>
<td>.93</td>
<td>5.68</td>
<td>3.76</td>
<td>4.44</td>
<td>2.38</td>
</tr>
<tr>
<td></td>
<td>Disgust</td>
<td>.89</td>
<td>6.22</td>
<td>3.73</td>
<td>4.58</td>
<td>2.74</td>
</tr>
<tr>
<td></td>
<td>Fear</td>
<td>.98</td>
<td>8.90</td>
<td>4.78</td>
<td>5.02</td>
<td>3.01</td>
</tr>
<tr>
<td></td>
<td>Awe</td>
<td>.86</td>
<td>5.74</td>
<td>2.95</td>
<td>3.88</td>
<td>2.21</td>
</tr>
</tbody>
</table>

Note. * p < .05. ** p < .01. *** p < .001. α = Cronbach’s alpha.
Table 2. Descriptive Statistics and internal consistencies (Study 2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>41.90</td>
<td>6.49</td>
<td>20</td>
<td>57</td>
<td>.80</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>33.07</td>
<td>9.28</td>
<td>12</td>
<td>57</td>
<td>.90</td>
</tr>
<tr>
<td>Openness</td>
<td>42.36</td>
<td>6.15</td>
<td>24</td>
<td>56</td>
<td>.73</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>43.81</td>
<td>6.59</td>
<td>24</td>
<td>58</td>
<td>.80</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>42.13</td>
<td>7.08</td>
<td>19</td>
<td>57</td>
<td>.87</td>
</tr>
<tr>
<td>Self-transcendence</td>
<td>15.95</td>
<td>6.93</td>
<td>2</td>
<td>32</td>
<td>.87</td>
</tr>
<tr>
<td><strong>Diary variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall chills</td>
<td>6.29</td>
<td>3.72</td>
<td>0</td>
<td>5</td>
<td>.35</td>
</tr>
<tr>
<td>Goosebumps</td>
<td>1.49</td>
<td>1.62</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Tingling</td>
<td>1.71</td>
<td>1.62</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Feeling cold</td>
<td>1.49</td>
<td>1.61</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Shiver-down-the-spine</td>
<td>1.59</td>
<td>1.57</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Note. α = Cronbach’s alpha. For trait variables, N = 192. For diary variables, N = 538.
Table 3. *Principal Components Analysis: Varimax loadings (Study 2)*

<table>
<thead>
<tr>
<th></th>
<th>Between-person</th>
<th></th>
<th>Within-person</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Component 1</td>
<td>Component 2</td>
<td>Component 1</td>
<td>Component 2</td>
</tr>
<tr>
<td>Goosebumps</td>
<td>.76</td>
<td>.18</td>
<td>.61</td>
<td>.45</td>
</tr>
<tr>
<td>Tingles</td>
<td>.81</td>
<td>-.05</td>
<td>-.07</td>
<td>.88</td>
</tr>
<tr>
<td>Feeling cold</td>
<td>.34</td>
<td>.65</td>
<td>.77</td>
<td>.03</td>
</tr>
<tr>
<td>Shiver-down-the-spine</td>
<td>-.13</td>
<td>.85</td>
<td>.64</td>
<td>-.31</td>
</tr>
</tbody>
</table>

*Note.* Loadings greater than .40 are shown in boldface.
### Table 4. Correlations between traits and individuals' mean levels of chills variables

*(Study 2)*

<table>
<thead>
<tr>
<th>Trait</th>
<th>Overall</th>
<th>GT</th>
<th>CS</th>
<th>Goose</th>
<th>Tingle</th>
<th>Cold</th>
<th>Shiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td>-.11</td>
<td>-.12</td>
<td>-.05</td>
<td>-.06</td>
<td>-.13</td>
<td>.00</td>
<td>-.08</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.25**</td>
<td>.14</td>
<td>.25**</td>
<td>.07</td>
<td>.14</td>
<td>.15</td>
<td>.24**</td>
</tr>
<tr>
<td>Openness</td>
<td>.05</td>
<td>.03</td>
<td>.05</td>
<td>-.04</td>
<td>.09</td>
<td>.01</td>
<td>.07</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-.08</td>
<td>-.08</td>
<td>-.04</td>
<td>-.04</td>
<td>-.08</td>
<td>-.02</td>
<td>-.05</td>
</tr>
<tr>
<td>Conscien.</td>
<td>-.13</td>
<td>-.15</td>
<td>-.05</td>
<td>-.08</td>
<td>-.15</td>
<td>-.09</td>
<td>.01</td>
</tr>
<tr>
<td>Self-trans.</td>
<td>.29***</td>
<td>.23**</td>
<td>.21**</td>
<td>.20*</td>
<td>.15</td>
<td>.29</td>
<td>.02</td>
</tr>
</tbody>
</table>

*Note.* *p* < .05. **p** < .01. ***p*** < .001. GT = goosetingles. CS = coldshivers.
Table 5. *Regressions of chills variables on traits: Standardized regression coefficients*  

(Study 2)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Chills variable (individuals’ mean levels)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.00</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.18*</td>
</tr>
<tr>
<td>Openness</td>
<td>-.03</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-.05</td>
</tr>
<tr>
<td>Conscien.</td>
<td>-.04</td>
</tr>
<tr>
<td>Self-trans.</td>
<td>.26**</td>
</tr>
</tbody>
</table>

*Note.* *p* < .05. **p** < .01. GT = goosetingles. CS = coldshivers.