2020

Factor Structure And Affective Composition Of The Chills: Replication And Extension

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Factor Structure and Affective Composition of the Chills: Replication and Extension

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A Thesis presented to the Graduate Faculty of The College of William & Mary in Candidacy for the Degree of Master of Science

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College of William & Mary
August 2020

APPROVAL PAGE

This Thesis is submitted in partial fulfillment of
the requirements for the degree of

Master of Science

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COMPLIANCE PAGE

Research approved by

Protection of Human Subjects Committee (PHSC)

Protocol number(s): PHSC-2019-04-04-13581-tmthra

Date(s) of approval: 04/04/2019

ABSTRACT

"The chills" refers to a set of bodily sensations (goosebumps, tingling, coldness, and shivers) that sometimes accompany strong emotion (Maruskin, Thrash & Elliot, 2012). Past factor analyses of the chills identified a multi-factor, hierarchical structure, consisting of four lower-order factors (goosebumps, tingling, coldness, and shivers) and two higher-order factors (goosetingles and coldshivers). Research on the affective nomological nets of particular chills factors provided additional evidence of the discriminant validity of the two higher-order and the four-lower-order factors (Maruskin, Thrash & Elliot, 2012; Wadsworth, 2019). Despite evidence of discriminant validity, most researchers have continued to treat the chills as a unitary construct. The goal of the present study is to replicate and extend evidence that the chills consists of a set of distinguishable sensations with distinct affective correlates. Specifically, I aim to (a) replicate the factor structure of the chills and (b) further test whether the four lower-order sensations show distinct relations to core affect variables. Using the narrative recall method, the present study assessed chills sensations and core affect during recalled chills experience. Results of factor analyses replicated the factor structure of the chills established by Maruskin et al. (2012). Results of circumplex analyses provided additional evidence of the discriminant validity of higher-order and lower-order sensations. Goosetingles tended to accompany pleasant states, whereas coldshivers tended to accompany unpleasant states. Furthermore, relative to goosebumps, tingling accompanied states lower on activation and higher on pleasure. Relative to coldness, shivers accompanied states lower on displeasure and higher on activation. These findings are consistent with but refine the conclusions of Maruskin et al. (2012) and point to the value of incorporating the affect circumplex in understanding the chills.

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ACKNOWLEDGEMENTS

First, I would like to thank my advisor, Professor Todd Thrash, for his patience and guidance throughout this research. Next, I would like to thank Professor Xiaowen Xu and Professor Adrian Bravo for careful reading of the thesis. Finally, I would like to thank my parents for their understanding and support.

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In the first scientific study of the chills, Goldstein (1980) found that there was agreement on what the chills feels like. “It is a chill, shudder, tingling, or tickling. It may be accompanied by a feeling of ‘hair standing on end’ or ‘goose bumps’ on the arms. Thrills are invariably associated with sudden changes in mood or emotion” (p. 127). As Goldstein described, the chills experience tends to be emotionally significant and involves a set of bodily sensations such as shuddering, tingling, and goosebumps.

This peculiar but emotionally significant experience exists as a hierarchical, multi-factor construct (Maruskin, Thrash & Elliot, 2012). Validation studies (Maruskin, Thrash & Elliot, 2012; Wadsworth, 2019) also established the distinct nomological nets of the chills according to affective composition. Despite evidence of discriminant validity, most researchers have continued to treat the chills as a unitary construct and as a result, yielded inconsistent findings regarding the affective composition of the chills. The overarching goal of the present study is to replicate and extend evidence that the chills consists of a set of distinguishable sensations with distinct affective correlates. Specifically, I aim to (a) replicate the factor structure of the chills established by Maruskin et al. (2012) and (b) further test the discriminant validity of the four lower-order sensations according to affective composition.

Inconsistent Conceptualizations of the Chills

Inconsistent Definitions of the Chills

As Goldstein (1980) described, the chills are a set of bodily sensations (e.g., shuddering, tingling, and goosebumps) that accompany emotion. Researchers generally endorse Goldstein’s description but focus on different aspect of it when defining the chills. Sloboda (1991) reported that “shivers down the spine” was a common bodily reaction of musically induced chills. Craig (2005) and Benedek et al. (2011) equated the chills with goosebumps or piloerection. Panksepp (1995) speculated about the existence of two types of the chills, “shivery, gooseflesh type of skin sensations” and “tingly somatosensory feeling”. Bannister (2020) combined common descriptives of the chills and defined the chills as “shivers, gooseflesh, and/or tingling sensations”.

Other researchers relied on laypersons’ understanding of the term “chills” and neglected to specify a definition of the chills for participants. This practice raises questions regarding construct validity because they may have measured other constructs. For example, shivery sensations caused by social isolation and shivers caused by cold weather may fall under the blanket term “chills,” but they are in fact different concepts. Whereas the former is a social regulatory response to social loss, the latter is a thermogenic response to cold (Panksepp, 1995; Kleinebeckel & Klussmann, 1990).

Limited Research on the Factor Structure of the Chills

Due to the lack of clarity in defining the chills, there exists only two factor analyses of the chills within the nascent literature. Results of these factor analyses showed that the chills may exist as a multi-factor construct.

In the first factor analysis of the chills, Maruskin (2010) examined goosebumps, tingling, coldness, and shivers using 1 item each. Results of multilevel principal components showed that tingling and goosebumps loaded on the first component (goosetingles) and coldness and shivers loaded on the second component (coldshivers) at both between-person and within-person levels. These findings suggested that the chills exists as a two-factor construct. However, this study was unable to detect the potential hierarchical structure of the chills due to the limited number of chills items. To identify a hierarchical factor structure, each lower-order factor must have at least 2 indicators (Kline, 2016).

In the second factor analysis of the chills, Nusbaum and Silvia (2012) examined 12 items assessing three types of aesthetic experiences, including aesthetic chills (emotional chills elicited by the arts), feeling touched, and absorption. They found that the three items assessing aesthetic chills ("feel chills down your spine", "get goose bumps", and "feel like your hair is standing on end") converged to yield one factor. These findings suggested that the chills exists as a type of aesthetic experience distinct from absorption and being touch. However, this study was unable to detect multiple factors of the chills due a limited range of chills experiences (overall chills and goosebumps) assessed.

Inconsistent Findings Regarding the Affective Composition of the Chills

Inattention to the factor structure of the chills has led to inconsistent findings regarding the affective composition of the chills. Pioneering studies (Goldstein, 1980; Panksepp, 1995) suggested that the chills are indicators of emotionally significant events, although theories and findings about the specific affective states that accompany the chills have varied.

Operationalizing chills in a way that did not distinguish specific sensations, Goldstein (1980) found that more than 80% of his participants reported the chills to be a pleasurable experience. In a subsequent experiment, Goldstein (1980) also found that chills frequency was significantly attenuated by naloxone, an opiate receptor antagonist. These findings suggest that chills sensations accompany heightened bodily arousal and pleasant affective states.

Also using an undifferentiated measure of the chills, Panksepp (1995) found that the chills accompany unpleasant affect such as feelings of social loss and sadness. In six studies, Panksepp (1995) found that the emotional content and acoustic features of music were responsible for chills generation. Specifically, sad songs with high pitches were more effective at eliciting the chills than happy songs with low pitches. According to Panksepp's separation call hypothesis, the wailing of infants evokes a cold, shivery type of sensations in primary care givers, which provides them the motivational impetus for contact seeking or parent-child reunion. Evolutionarily, this parent-child interaction may have generalized into a neurologically based chills response whenever subjects experience separation or social loss. In sum, the nascent literature has been plagued by inconsistent findings of the chills. Considering the amount of between-person variability in chills experiences, it is possible that the chills exists as a multi-factor construct. A differentiated conception may provide more consistent and precise predictions about the affective composition of the chills.

A Validated Conceptualization of the Chills

In light of inconsistent definition of chills and hints of a multi-factor chills construct, Maruskin and colleagues (2012) conducted two studies to investigate the content universe and factor structure of the chills. They derived an integrated definition of "the chills" that subsumes four lower-order sensations (goosebumps, tingling, coldness, and shivers) and two higher-order sensations (goosetingles and coldshivers). Validation studies also established the distinct nomological nets of the chills according to trait antecedents, elicitors, affective composition, and attachment-related consequences (Marskin, Thrash & Elliot, 2012; Wadsworth, 2019). In the next paragraphs, I introduce the conceptualization of “the chills” validated by Marskin et al. (2012) and Wadsworth (2019).

Content Universe

Maruskin and colleagues (2012) conducted a narrative study (study 1) to explore the content universe of the chills. Maruskin et al. (2012) asked participants to describe the chills they experienced during emotionally significant events. Research assistants extracted all words and phrases that described physical sensations of the chills. Cluster analysis of these words and phrases identified four lower-order clusters (goosebumps, tingling, coldness, and shivers) and two higher-order clusters (goosetingles and coldshivers). These findings indicated that the chills consists of four semantically distinguishable sensations: goosebumps, tingling, coldness, and shivers. These four sensations aligned with descriptive data in extant studies (Goldstein, 1980; Sloboda, 1991; Nusbaum & Silvia, 2011), thus meriting them as the core components of “the chills” construct.

Factor Structure of the Chills

Maruskin et al. (2012) developed the Chills Questionnaire, which assesses all four sensations using 3 items each. In study 2, they administered the trait version of the Chills Questionnaire and measures of four response bias (self-enhancement bias, self-protection bias, impression management, and self-deceptive enhancement). First-order factor analyses identified goosebumps, tingling, coldness, and shivers as the four lower-order factors of the chills. Second-order factor analyses provided support for a two-factor higher-order structure consisting of goosetingles (goosebumps and tingling) and coldshivers (coldness and shivers) factors. Additionally, the higher-order goosetingles and coldshivers factors were found not to be artifacts of response biases. These findings provided evidence that the chills exists as a hierarchical, multi-factor construct.

Discriminant Validity of Higher-order Sensations

In subsequent studies, Maruskin et al. (2012) examined the trait antecedents, elicitors, affective composition, and consequences of goosetingles and coldshivers. They established the distinct nomological nets of goosetingles and coldshivers and showed that approach and avoidance accounted for the higher-order goosetingles-coldshivers distinction.

Trait antecedents. Maruskin et al. (2012) examined the Big-Five traits, approach and avoidance temperament, and positive and negative emotionality as predictors of overall chills, goosetingles, and coldshivers. Analyses indicated that overall chills was predicted by all traits except for conscientiousness. Regression analyses predicting goosetingles or coldshivers, with the other chills factor controlled, indicated that goosetingles was uniquely predicted by extraversion, approach temperament, and positive emotionality, and coldshivers was predicted by neuroticism, avoidance temperament, and negative emotionality. These findings suggested that constructs underlying approach-avoidance provide an explanation for the higher-order goosetingles-coldshivers distinction.

Elicitors. In a 2-week diary study (study 4), Maruskin et al. (2012) asked participants to write narratives each time they experienced at least one of the four chills sensations. Inspection of the chills narratives suggested that the approach-avoidance distinction provided a sensible classification of elicitors. Ten domains of chills elicitors were identified. Of these, seven were approach elicitors (positive stimuli that led to approach-related behavior) and three were avoidance elicitors (negative stimuli that led to avoidance-related behavior). Approach elicitors included aesthetic beauty, sexual attraction/arousal, inspirational act, thrill/adventure, affiliation reward, relaxation, and achievement reward. Avoidance elicitors included physical threat, affiliation threat, and achievement threat. In their follow-up analyses, Maruskin and colleagues (2012) found that goosetingles and coldshivers tended to involve distinct classes of elicitors. Relative to coldshivers, goosetingles was more likely to involve approach elicitors (aesthetic beauty and sexual attraction/arousal in particular); relative to goosetingles, coldshivers was more likely to involve avoidance elicitors (affiliation threat and achievement threat in particular). These findings showed that goosetingles and coldshivers have distinct elicitors relevant to approach or avoidance motivation, respectively.

Affective Composition. In a narrative recall study (study 3), Maruskin and colleagues (2012) asked participants to recall personal experiences and complete questionnaires regarding chills sensations and discrete emotions. Participants in the chills condition were asked to recall an instance during which they experienced at least one of the four chills sensations. Participants in the control condition were asked to recall a typical experience in their daily life. One-way ANOVA showed that goosetingles and coldshivers accompany discrete emotions that differ in valence. Relative to coldshivers, goosetingles involved higher levels of positive emotions (e.g., enjoyment, surprise, and awe) and lower levels of negative emotions (e.g., sadness, disgust, and fear). Similar findings were obtained in a diary study (study 4). Multilevel analyses demonstrated that at between- and within-person levels, goosetingles was uniquely predicted by surprise, positive affect, and energetic arousal; coldshivers was uniquely predicted by fear, negative affect, and tense arousal. These findings indicated that goosetingles and coldshivers differ in valence, consistent with the approach-avoidance findings discussed above.

It should be noted that the approach-avoidance and positive-negative valence are two distinct frameworks. Approach and avoidance often, but not always, correspond to positive and negative affective valence, respectively. Negative emotions elicited during fight or flight promote behaviors that are defensive in function (Darwin, 1872/1965), and anger in humans has been linked to approach rather than avoidance motivational systems (Harmon-Jones, 2003). Given that the chills does not appear to be a common accompaniment of anger in humans, in practice the approach-avoidance and positive-negative valence distinctions tend to be compatible theoretical frameworks.

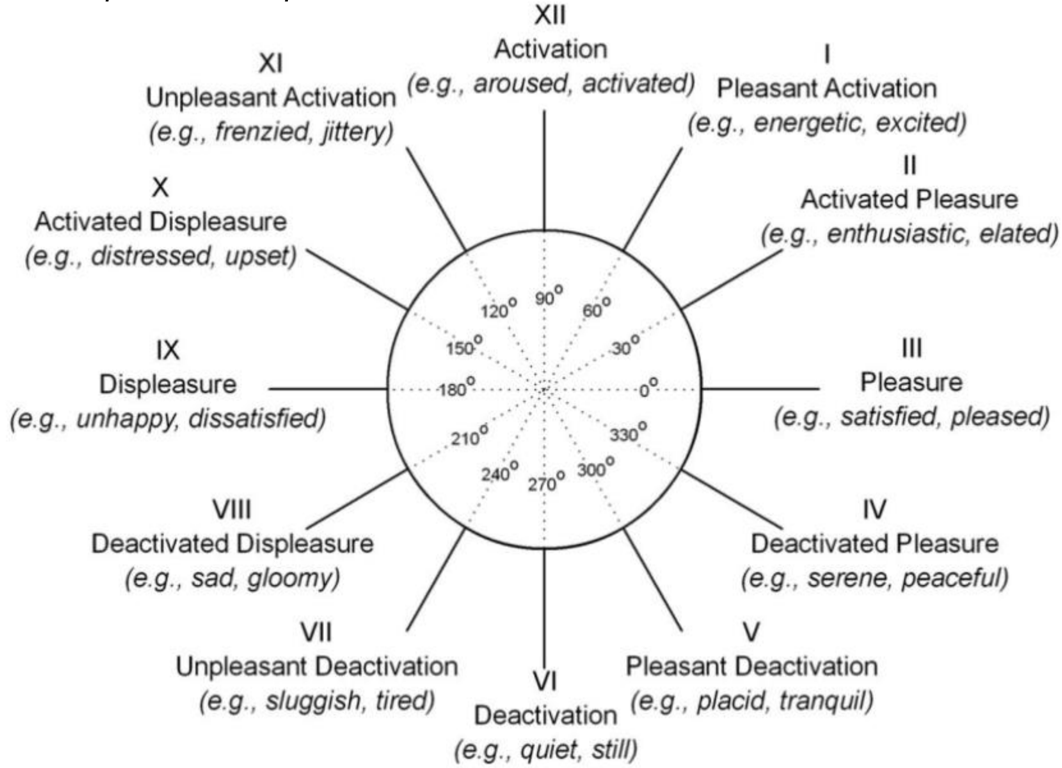
Consequences. In an experiment (study 5), Maruskin and colleagues (2012) investigated the attachment-related consequences of the chills. Participants were randomly assigned to one of the three conditions. In the self-actualization condition, participants watched a video clip (Susan Boyle performing vocals) that served as an approach elicitor. In the self-annihilation condition, participants watched a video clip (Suicide in C sharp) that served as an avoidance elicitor. In the control condition, participants watched a video clip (how to play “Hot Cross Buns” on the piano) that was lacking in approach and avoidance cues. After watching videos, participants completed questionnaires regarding chills sensations and closeness to their mothers or mother figures.

Analyses were conducted using structural equation modeling. Results indicated that participants in the self-actualization and self-annihilation conditions reported higher intensity of goosetingles and coldshivers, respectively. These findings suggest that goosetingles and coldshivers involve distinct classes of approach and avoidance elicitors. Next, Maruskin and colleagues (2012) modeled closeness to mother as the outcome variable. They found that goosetingles positively predicted closeness to mother, and that coldshivers negatively (but marginally; $p < .10$) predicted closeness to mother. Notably, an alternative model that specified a unique effect of coldness, rather than coldshivers, on closeness had better fit. This finding indicated that the effect of coldshivers on closeness to mother was attributable to coldness specifically, thus providing evidence of the discriminant validity of coldness and shivers. Additionally, findings regarding coldness converged with Panksepp's separation call hypothesis. The chills (coldness in particular) signals one's deep-seated fears of losing touch with primary caregivers.

Discriminant Validity of Lower-order Sensations

Wadsworth (2019) established the distinct nomological nets of goosebumps, tingling, coldness, and shivers according to core affect. Core affect refers to one's instantaneous or non-reflective feeling at a moment in time (Yik, Russell & Steiger, 2011). The 12-point circumplex model of core affect (12-PAC; Figure 1) integrates dimensional models of mood and emotion (e.g., Watson 1988's positive and negative affect, Thayer 1986's tense and energetic arousal) and provides a parsimonious but finer differentiation between 12 core affective states. Incorporating the 12-PAC into the chills research therefore provides an opportunity to capture the finer distinction between lower-order sensations.

Figure 1
The 12-point Circumplex Model of Core Affect



Wadsworth (2019) asked participants to watch 14 videos and complete questionnaires regarding chills sensations and core affect each time they watched a video. The cross-classified multilevel design affords three levels of analyses. At the between-person level, variance in a core affect variable is explained by individual differences in experiencing chills sensations. At the between-video level, variance in a core affect variable is explained by differences between videos. The cell or residual level captures residual variance not explained by individual differences or differences between videos.

Results of between-video level analyses revealed that lower-order sensations are distinguishable according to affective valence and arousal. Relative to tingling, goosebumps accompanied core affective states lower on pleasure and higher on arousal. Relative to shivers, coldness accompanied core affective states higher on displeasure and lower on arousal. These results are consistent with previous findings obtained by Maruskin et al. (2012). Averaging valence across goosebumps and tingling, goosetingles accompany pleasant affective states. Averaging valence across coldness and shivers, coldshivers accompany unpleasant affective states. More important for present purposes, Wadsworth’s findings additionally provide preliminary evidence that the lower-order components of goosetingles and coldshivers are distinguishable in terms of affective composition.

Present Study

In spite of the evidence of a multi-factor chills construct, researchers have continued to treat the chills as a unitary construct. Nusbaum and colleagues (2014) equated the chills with goosebumps. Similarly, Wassiliwizky et al. (2015) stated that “we did not differentiate between chills and goose bumps since we did not want to overburden our participants.” Mori and Iwanaga (2017) designed their own chills questionnaire without showing the convergent validity of their items (how frequently do you (1) get goose bumps, (2) feel shivers down your spine,

(3) feel like weeping, and (4) get a lump in your throat?). Bannister (2020) endorsed the goosetingles-coldshivers distinction, yet collapsed across sensations in his analyses. In light of these observations, I speculated that researchers are unaware of the differentiation established by Maruskin et al. (2012), are skeptical of a multi-factor chills construct, or use a restricted range of stimuli not amenable to differentiation. Thus, the overarching goal of the present study is to replicate and extend evidence that the chills consists of a set of distinguishable sensations with distinct affective correlates.

Herein I emphasize the difference between two types of replication - direct and conceptual replication. A direct replication maintains the design, measures, and procedures of the original study, whereas a conceptual replication involves changes in one or more of those dimensions (Earp & Trafimow, 2015). Both types of replication improve the reliability of underlying theories but only conceptual replications (or imprecise replications) have the incremental benefit of extending theories. As Rothenthal (1990) wrote "The more imprecise the replications, the greater the benefit to the external validity of the tested relationship if the results support the relationship" (p. 5).

Using the narrative recall method, the present study involves a conceptual replication of past findings from our laboratory (Maruskin et al., 2012; Wadsworth, 2019). Specifically, I aim to (a) replicate the factor structure of the chills and (b) test whether the four lower-order sensations show distinct relations to core affect variables.

In addition to conceptual replication, the present study also overcomes two limitations of the Wadsworth (2019) study. The first limitation concerns statistics. Due to the lack of significance test for circumplex structured data, Wadsworth (2019) was unable to directly test the discriminant validity of lower-order sensations in terms of valence and arousal. The present study addresses this limitation by supplementing circumplex analyses with factor analyses. I aim to test whether the four lower-order sensations are factorially distinct and whether they differ in core affect.

The second limitation concerns methodology. Although use of video stimuli is rigorous in a number of respects, findings might not generalize beyond the types of elicitors that are depicted in a small number of video stimuli. For example, the particular videos that elicited goosebumps may happen to also elicit sadness, causing goosebumps to bias towards displeasure. Using the narrative recall method, the present study allowed for a broader and more representative range of chills experiences.

Hypotheses

Goosebumps

According to the social hierarchy theory proposed by Keltner and Haidt (2003), humans are biologically wired to respond to awe inducing stimuli (e.g., displays of confidence). Functionally, social awe helps individuals define social roles and social hierarchy. In a diary study, Schurtz and colleagues (2011) confirmed that awe occurs in the context of social comparison, when subjects appreciate the ability, talent, or skills of a superior other. More importantly, it was found that goosebumps positively predicted awe (a positive emotion) and negatively predicted envy and fear (negative emotions). These findings suggested that goosebumps elicited during social processes accompanies pleasant affective states.

Goosebumps has also been found to accompany pleasant affective states within the aesthetic domain. Wassiliwizky and colleagues (2015) asked participants to watch emotional videos and complete questionnaires regarding their emotional response to these videos. Results indicated that participants who experienced goosebumps reported higher intensity of being moved, a mixed emotional state that involves both sadness and happiness. Subsequent analyses revealed that the mixed state of being moved fully mediated the relation between sadness and happiness. That is, the state of being moved does not compensate for sadness but rather transform it into an overall pleasant feeling. Combining an objective measure (a camera that records piloerection on the forearms) and a subjective measure (self-report) of goosebumps, Sumpf and colleagues (2015) obtained similar results. Participants who experienced goosebumps reported an increase in their ability to experience positive feelings and increase in heart rate. In light of these findings, I hypothesized that goosebumps accompany core affective states high on pleasure and activation.

A number of animal studies also linked goosebumps with negative emotions such as anger and fear. Darwin (1872/1965) documented that "gooseflesh" or involuntary erection of dermal appendages occurs under the influence of anger and fear, when animals (e.g., chimpanzees, gorillas, and hyenas) perceive threatening stimuli in their environment. However, findings from these animal studies are less relevant because the present study involves human subjects.

Tingling

Research on the affective composition of tingling is scant. I only found one study that linked tingling with affective states high on pleasure and low on activation. Schmeid and Barclay (1999) interviewed 25 mothers about their motherhood experiences. They found that tingling is a common sensation experienced during breastfeeding. For mothers who succeeded in breastfeeding, tingling was described as "pleasurable, sensual, and intimate" and "calm and relaxed". In explaining their findings, Schmeid and Barclay (1999; also see Schmeid & Lupton, 2001) suggested that tingling and successful breastfeeding embody a mother's intimate connection with her child. This proposal contrasts with Panksepp's separation call hypothesis (Panksepp, 1995), implying that tingling and coldness may represent the opposite ends of the spectrum. Whereas the former signals social reunion and accompanies pleasure and relaxation, the latter signals social loss and accompanies displeasure. Therefore, I hypothesized that tingling accompanies core affective states high on pleasure and low on activation. I also hypothesized that tingling can be distinguished from goosebumps in terms of activation, such that tingling accompanies core affective states lower on activation than goosebumps.

Coldness

Bannister (2019) found that feeling cold was associated with social distress and displeasure. Bannister (2019) distinguished three types of aesthetic chills experiences (e.g., warm, cold, and moving chills) according to elicitors and affective composition. Cold chills accompany negatively valenced feelings and are more likely to be elicited by themes of distress than themes of communion, love, and gratitude. These findings suggested that cold chills underlie an episode of unpleasant experience.

Two other studies also linked feeling cold with social distress and unpleasant states. In an experiment, Zhong and Leonardelli (2008) found that people who felt socially excluded perceived room temperature to be colder than those who did not feel excluded. Similarly, Harlow and Suomi (1970) showed that physical warmth plays an important role in facilitating social processes. They found that monkeys raised by warm surrogate mothers were more affiliative than monkeys raised by cold surrogate mothers. All these findings converge with Panksepp's separation call hypothesis and suggest that coldness accompanies unpleasant affect. In light of these findings, I hypothesized that coldness involves core affective states high on displeasure.

Additionally, the unpleasant states associated with coldness have varying levels of activation. For example, distress and sadness are characterized by activation and deactivation, respectively (Yik, Russell & Steiger, 2011). Therefore, it is likely that coldness accompanies a moderate level of affective activation.

Shivers

Research on the affective composition of shivers is scant. I found one study that linked shiver with fear and disgust. Blake and colleagues (2017) conducted a narrative study to investigate the elicitors and behavioral consequences of fear, disgust, and "heebie jeebies" (a distinct type of disgust elicited by skin-transmitted pathogens). They found that a fair percent of participants reported shiver when describing fear (42.4%), disgust (15.3%), and heebie jeebies (42.4%). According to Blake et al. (2017), these negatively valenced emotions are defensive in function; they promote avoidance-related behaviors that protect humans and animals from contamination and physical threats. In light of these findings, I hypothesized that shivers accompany core affective states high on displeasure and activation. I also hypothesized that shivers can be distinguished from coldness in terms of activation, such that shivers accompanies core affective states higher on activation than coldness.

Method

Participants

The raw data set consisted of 484 submissions from students in a U.S. university. Sixty-five cases were removed because they were not attributable to consenting participants (4 cases were submitted by researchers during pilot testing, 60 were blank, and one was submitted by a student who declined consent and withdrew). An additional 99 cases were removed because they were deemed extraneous (61 respondents could not recall a particular instance of the chills, 32 started the study but did not complete it, and 6 submitted duplicate responses).

To ensure the quality of the data, a data cleaning procedure was carried out to remove 52 cases that met at least one criterion of careless responding: (1) The participant responded incorrectly to an attention check item, (2) the case involved an unusually low amount of variability across items, (3) duration of completion was unusually fast, (4) the participant self-reported that their data were invalid for analyses, or (5) the participant did not follow the instruction of the study. This set of criteria was guided by research by Meade and Craig (2008). In the present study, 15 participants responded incorrectly to the attention check item ("During the experience of the chills that you recalled and wrote about, to what extent did you experience each emotion described below? Choose ‘not at all’ to show that you are paying attention.”), 6 participants demonstrated response invariance across more than 20% of the assessment, 3 participants finished the survey in less than 5 minutes, 27 participants reported on an end-of-study question that their data were invalid for analyses, and 17 participants did not follow the instruction of the study and reported non-emotional chills experiences.

The final sample consisted of 268 students (106 men, 159 women, 3 other) who participated in return for credit toward a research participation requirement. Participants’ mean age was 19.03 (range 18 - 22 years). Ethinic composition was Caucasion (60.8%), Asian (16.4%), African American (9.0%), Hispanic (7.8%), and other (6.0%).

Procedure

Participants completed questionnaires online using Qualtrics. A definition of the chills was provided for participants at the beginning of the study. “The chills” was defined as an experience that (1) involves one or more of the following bodily 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 hair-on-end feeling; and (2) is a reaction to an emotionally significant cause. Participants were then asked to recall a particular chills experience and complete questionnaires regarding chills sensations, core affect, discrete emotions, inspiration, meaning in life, spirituality, and closeness to others. Some of these variables are peripheral to the focus of this thesis and are not discussed further.

Measures

Internal consistencies for each variable are reported in Table 1.

Chills sensations. Chills sensations were assessed using a state version of the 12-item Chills Questionnaire (Maruskin, Thrash & Elliot, 2012). Participants rated the extent to which they experienced goosebumps (e.g., “felt hairs stand-on-end somewhere on my body,” “got goosebumps,” “felt hairs stand on end”), tingling (“felt tingling sensations in my skin,” “felt tickling sensations somewhere in my body,” “felt a tingling sensation spread over me”), coldness (“got a cold feeling,” “got a cold sensation deep inside me,” “got a cold feeling at my core”), and shivers (“felt my muscles quiver or tremble,” “felt myself shudder,” “felt myself shiver or shake”) during recalled experiences. Participants reported their ratings on a scale from 1 (*not at all*) to 7 (*very strongly*).

Core Affect. Affective experience was assessed using the adjective-based 12-Point Affect Circumplex Scale (12-PAC; Yik, Russell & Steiger, 2011). Participants rated the extent to which they felt each affective state during recalled experiences on a scale from 1 (*not at all*) to 5 (*extremely*). The 12 core affect included pleasure (0°; “happy,” “content,” “satisfied,” “pleased”), activated pleasure (30°; “proud,” “enthusiastic,” “euphoric”), pleasant activation (60°; “energetic,” “full of pep,” “excited,” “wakeful,” “attentive,” “wide awake,” “active,” “alert,” “vigorous”), activation (90°; “aroused,” “hyperactivated,” “intense”), unpleasant activation (120°; “anxious,” “frenzied,” “jittery,” “nervous”), activated displeasure (150°; “scared,” “upset,” “shaky,” “fearful,” “clutched up,” “tense,” “ashamed,” “guilty,” “agitated,” “hostile”), displeasure (180°; “troubled,” “miserable,” “unhappy,” “dissatisfied”), deactivated displeasure (210°; “sad,” “down,” “gloomy,” “blue,” “melancholy”), unpleasant deactivation (240°; “droopy,” “drowsy,” “dull,” “bored,” “sluggish,” “tired”), deactivation (270°; “quiet,” “still”), pleasant deactivation (300°; “placid,” “relaxed,” “tranquill,” “at rest,” “calm”), and deactivated pleasure (330°; “serene,” “soothed,” “peaceful,” “at ease,” “secure”).

Table 1
Descriptive Statistics for Chills Sensations

Chills sensation	*M*	*SD*	Range	Cronbach's alpha
Goosebumps	5.06	1.90	1-7	.87
Tingling	4.91	1.69	1-7	.80
Coldness	3.83	2.17	1-7	.92
Shivers	4.65	1.82	1-7	.82
Goosetingles	4.98	1.48	1-7	.81
Coldshivers	4.24	1.71	1-7	.86
Overall Chills	4.61	1.27	1-7	.83

Results

Data Analysis Plan

Data analyses were conducted in four stages. First, a series of confirmatory factor analyses (CFAs) were conducted to examine the factor structure of the chills. Next, circumplex correlation analyses were conducted to examine the affective composition of the chills in terms of core affect. Then, circumplex regression analyses were conducted to examine the distinct affective correlates of particular lower-order sensations. Finally, supplement analyses were carried out to compare patterns of correlations between each lower-order sensation and the 12 core affect variables.

CFAs

Descriptive statistics for the chills sensations are shown in Table 1, and the correlation matrix of the chills sensations is shown in Table 2. My first aim was to replicate the factor structure of the chills using the narrative recall design. The hypothesized structure involves four lower-order factors (goosebumps, tingling, coldness, and shivers) and two higher-order factors (goosetingles and coldshivers). Confirmatory factor analyses were conducted with AMOS 22.0 with maximum likelihood estimation. Fit indexes for the models tested in the first and second-order CFAs are shown in Table 3. Results of second-order CFAs are presented in Figure 2.

Table 2

Correlations Among Study Variables

Variable	1	2	3	4	5	6	7
1. Goosebumps	_						
2. Tingling	.35**	_					
3. Coldness	.18**	.13*	_				
4. Shivers	.21**	.23**	.46**	_			
5. Goosetingles	.84**	.80**	.19**	.26**	_		
6. Coldshivers	.23**	.20**	.88**	.82**	.26**	_	
7. Overall Chills	.64**	.60*	.71**	.71**	.76**	.83**	_

*p < .05. **p<.01.

First-order CFAs. Preliminary CFAs were conducted to test the discriminant validity of the four lower-order chills factors. Model 1 specified four factors corresponding to the four lower-order sensations: goosebumps, tingling, coldness, and shivers. The three relevant items from the Chills Questionnaire served as indicators of these factors. This model demonstrated good fit to the data, as shown in Table 3. The four chills factors were positively intercorrelated (rs = .16-.50, ps < .01).

Model 1 demonstrated better fit to the data than any nested models. Specifically, Model 1 fit better than all six of the possible three-factor models ($\chi^2(3) = 217.68 - 451.91$, ps < .01) in which a particular pair of chills sensations is modeled as indistinguishable. Consistent with this finding, Model 1 also fit better than a two-factor goosetingles-coldshivers model (Model 2; $\chi^2(5) = 451.42$, p < .01) which specifies that goosebumps and tingling are indistinguishable from one another, and that coldness and shivers are indistinguishable. Model 1 also fit better than the one-factor model (Model 3; $\chi^2(6) = 933.81$, $p < .01$) which specifies that all four chills sensations are indistinguishable from all others. These findings establish goosebumps, tingling, coldness, and shivers as four distinguishable chills sensations.

Second-order CFAs. Second-order CFAs were conducted to test higher-order chills factors. Model 4 included two higher-order chills factors (goosetingles and coldshivers) to account for the correlation between goosebumps and tingling, and the correlation between coldness and shivers. Model 4 demonstrated good fit to the data, as shown in Table 3. The two higher-order chills factors were intercorrelated ($r = .45$, $p < .01$). Model 4 fit better than a model with a single higher-order chills factor (Model 5; $\chi^2(1) = 21.78$, $p < .01$). Together, these findings show that the four lower-order chills factors are distinguishable yet they can be converged to form higher-order goosetingles and coldshivers factors for parsimonious reasons.

Table 3

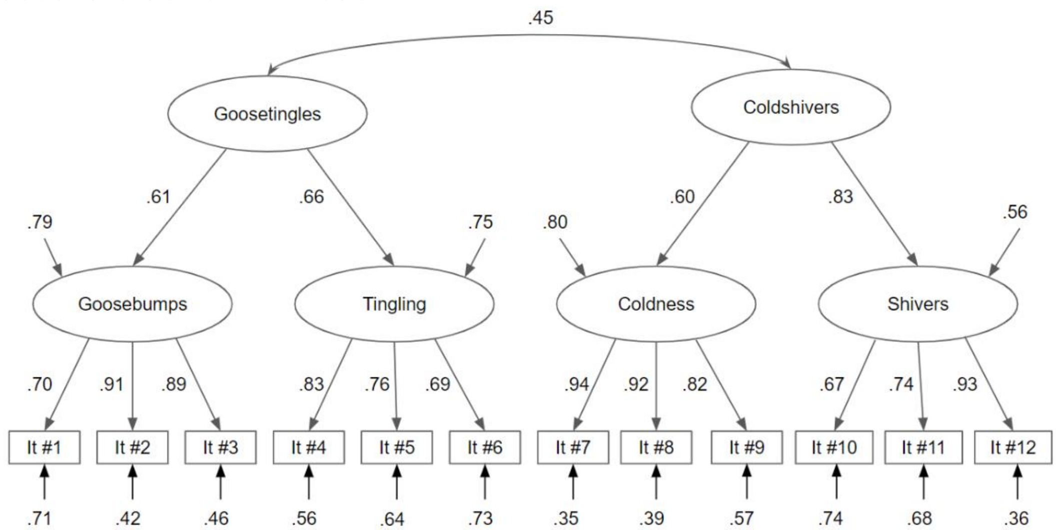
Confirmatory Factor Analyses Fit Indexes

Model	$\chi 2$	*df*	TLI	CFI	RMSEA	AIC
1. Four factors	90.22	48	.97	.98	.057	150.22
2. Two factors	541.64	53	.66	.73	.186	591.64
3. One factor	1024.03	54	.33	.45	.259	1072.03
4. Four FO factors, two SO factors	90.68	49	.97	.98	.056	148.68
5. Four FO factors, one SO factor	112.46	50	.95	.97	.068	168.46

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.

Figure 2

Second-order CFA - Model 4



Circumplex Correlation Analyses

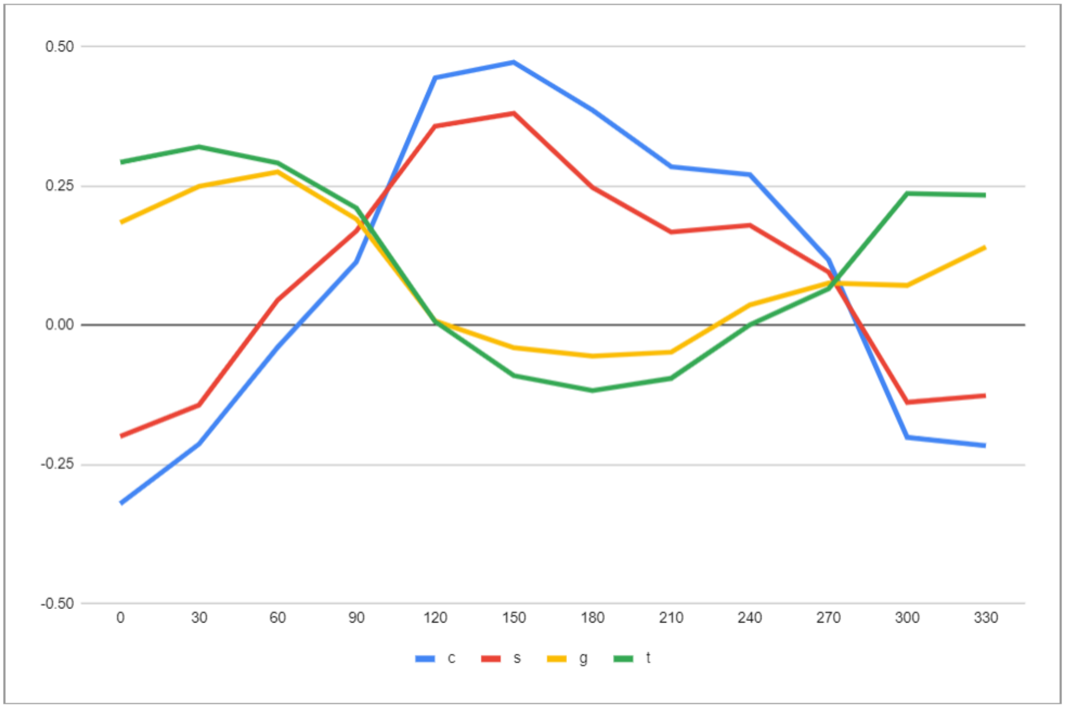
My second aim was to assess the affective composition of the chills in terms of core affect. Not all external variables are correlated with core affect. However, if an external variable is correlated with core affect, the pattern of correlations between that external variable and the 12 core affect variables will form a cosine wave (Yik, Russell & Steiger, 2011). To determine if the chills are correlated with core affect, I assessed whether the patterns of correlations between chills sensations and the 12 core affect variables formed cosine waves. Table 4 shows correlation coefficients of each lower-order sensation. Figure 3 shows the patterns of correlations for lower-order sensations. As shown in Table 4 and Figure 3, the sets of correlations between chills sensations and the 12 core affect variables formed patterns similar to cosine waves, thus providing preliminary evidence that the chills is related to core affect.

Table 4
Correlation Coefficients of Each Lower-order Sensation

	Coldness	Shivers	Goosebumps	Tingling
Pleasure	-.32**	-.20**	.19**	.29**
Activated pleasure	-.21**	-.14*	.25**	.32**
Pleasant activation	-.04	.05	.28**	.29**
Activation	.11	.17**	.19**	.21**
Unpleasant activation	.45**	.36**	.01	.01
Activated displeasure	.47**	.38**	-.04	-.09
Displeasure	.39**	.25**	-.06	-.12
Deactivated displeasure	.29**	.17**	-.05	-.10
Unpleasant deactivation	.27**	.18**	.04	.00
Deactivation	.118	.10	.08	.07
Pleasant Deactivation	-.20**	-.14*	.07	.24**
Deactivated pleasure	-.22**	-.13*	.14*	.23**

*p < .05. **p<.01.

Figure 3
Cosine Waves Formed by Lower-order Sensations



Note. Horizontal axis = angular positions in the 12-PAC; vertical axis = correlation coefficients; c = coldness; s = shivers; g = goosebumps; t = tingling.

Using the cosine wave technique (Yik, Russell & Steiger, 2011), I determined whether each chills sensation has a distinct affective profile. The cosine wave technique relies on the general cosine function Y = a + b*cos(X + d), where X is the angular position (in degrees) within the circumplex space (0 degrees = pleasure, 90 degrees = activation, 180 degrees = displeasure, and 270 degrees = deactivation), and Y is the modeled correlation between the chills sensation and affect at the specified angle. The analysis was run separately for each chills sensation. A nonlinear regression analysis yields three parameter estimates: (1)

Variance accounted for (VAF), which indicates the fit of the cosine wave; (2) â, the estimated angle at which the correlation between the chills sensation and affect is maximized; and (3) r_{max}, the magnitude of the correlation at â. Table 5 shows parameter estimates from circumplex correlation analyses. Figures 5 to 10 show the patterns of correlations for each lower-order sensation. Figure 4 shows the relative locations of chills sensations in the 12-PAC.

T*able 5*

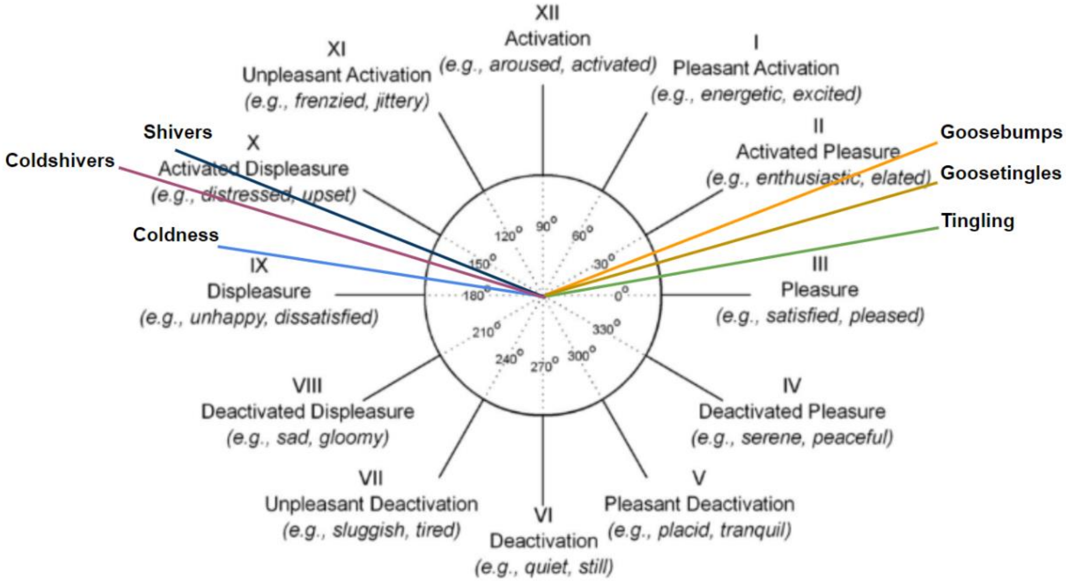
Parameter Estimates from Circumplex Correlation Analyses

	a	b	d	VAF	â (degrees)	rmax
Goosebumps	.09	.15	-.38	.85	22.00	.23
Tingling	.11	.22	-.18	.95	10.54	.34
Coldness	.09	-.37	.17	.95	170.20	.47
Shivers	.09	-.26	.32	.91	161.78	.34
Goosetingles	.12	.22	-.27	.93	15.47	.34
Coldshivers	.11	-.38	.23	.94	166.73	.48

Note. When b > 0, â = -d; when b < 0, â = 3.14 - d; rmax = a + b * cos(â + d).

Figure 4

Relative Locations of Chills Sensations in the 12-PAC



Placing Lower-order Sensations in the 12-PAC

Goosebumps. The pattern of correlations for goosebumps demonstrated good fit with the cosine curve (VAF = 84.5%), indicating that goosebumps was correlated with core affect. Specifically, goosebumps tended to accompany the core affective state located at 22.00° in the 12-PAC. The magnitude of the correlation between goosebumps and this core affective state was .23, as shown in Figure 5. These findings supported the hypothesis; goosebumps tended to accompany core affective states high on pleasure and activation.

Figure 5
Cosine Wave Formed by Goosebumps

Note. X-axis = angular positions in the 12-PAC; Y-axis = correlation coefficients.

Tingling. The pattern of correlations for tingling demonstrated excellent fit with the cosine curve (VAF = 95.4%), indicating that tingling was correlated with core affect. Specifically, tingling tended to accompany the core affective state located at 10.54° in the 12-PAC. The magnitude of the correlation between tingling and this core affective state was .34, as shown in Figure 6. These findings partially supported the hypothesis; tingling tended to accompany core affective states high on pleasure but slightly above moderate in activation. Relative to goosebumps, tingling tended to accompany core affective states higher on pleasure and lower on activation.

Figure 6
Cosine Wave Formed by Tingling

Note. X-axis = angular positions in the 12-PAC; Y-axis = correlation coefficients.

Coldness. The pattern of correlations for coldness demonstrated excellent fit with the cosine curve (VAF = 94.7%), indicating that coldness was correlated with core affect. Specifically, coldness tended to accompany the core affective state located at 170.20° in the 12-PAC. The magnitude of the correlation between tingling and this core affective state was .47, as shown in Figure 7. These findings partially supported the hypothesis; coldness tended to accompany core affective states high on displeasure and slightly above moderate in activation.

Figure 7
Cosine Wave Formed by Coldness

Note. X-axis = angular positions in the 12-PAC; Y-axis = correlation coefficients.

Shivers. The pattern of correlations for shivers demonstrated good fit with the cosine curve (VAF = 90.7%), indicating that shivers was correlated with core affect. Specifically, shivers tended to accompany the core affective state located at 161.78° in the 12-PAC. The magnitude of the correlation between shivers and this core affective state was .34, as shown in Figure 8. These findings supported the hypothesis; shivers tended to core affective states high on displeasure and activation. Relative to coldness, shivers tended to accompany core affective states lower on displeasure and higher on activation.

Figure 8

Cosine Wave Formed by Shivers

Note. X-axis = angular positions in the 12-PAC; Y-axis = correlation coefficients.

Placing Higher-order Sensations in the 12-PAC

Goosetingles. The pattern of correlations for goosetingles demonstrated excellent fit with the cosine curve (VAF = 92.7%), indicating that goosetingles was correlated with core affect. Specifically, goosetingles tended to accompany the core affective state located at 15.47° in the 12-PAC. The magnitude of the correlation between shivers and this core affective state was .34, as shown in Figure 9. These findings show that goosetingles tends to accompany core affective states high on pleasure and above moderate in activation.

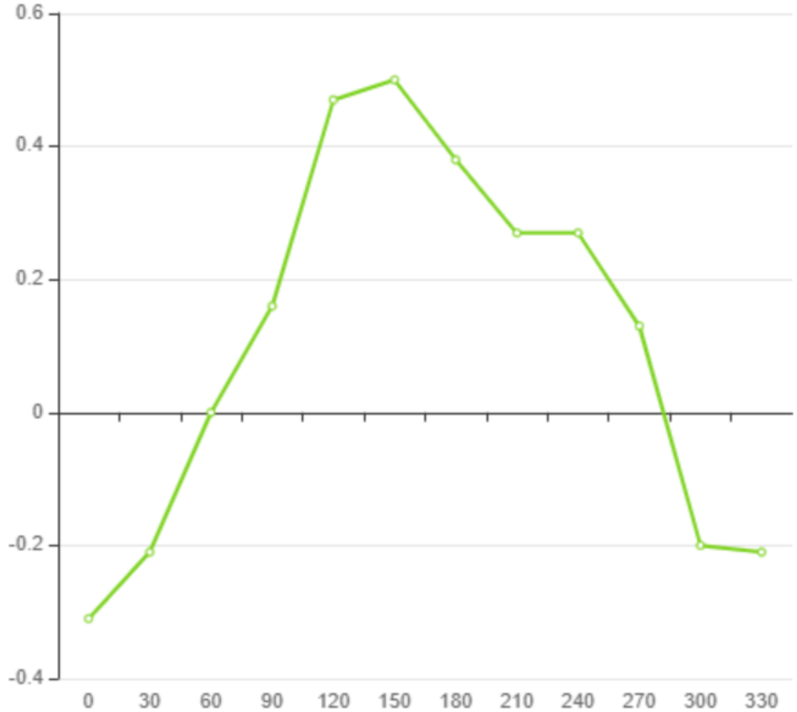
Figure 9
Cosine Wave Formed by Goosetingles

Note. X-axis = angular positions in the 12-PAC; Y-axis = correlation coefficients.

Coldshivers. The pattern of correlations for coldshivers demonstrated excellent fit with the cosine curve (VAF = 93.5%), indicating that coldshivers was correlated with core affect. Specifically, coldshivers tended to accompany the core affective state located at 166.73° in the 12-PAC. The magnitude of the correlation between coldshivers and this core affective state was .48, as shown in Figure 10. These findings show that coldshivers tends to accompany core affective states high on displeasure and above moderate in activation.

Figure 10

Cosine Wave Formed by Coldshivers



Note. X-axis = angular positions in the 12-PAC; Y-axis = correlation coefficients.

Circumplex Regression Analyses

To examine the distinct affective correlates of the four lower-order sensations, I conducted 12 multiple regression analyses each predicting a 12 core affect variable from the four lower-order sensations. Table 6 shows standardized beta weights of each lower-order sensation.

Table 6

Standardized Beta Wights of Each Lower-order Sensation

	Coldness	Shivers	Goosebumps	Tingling
Pleasure	-.32**	-.16**	.17**	.31**
Activated pleasure	-.22**	-.16*	.21**	.31**
Pleasant activation	-.11	.00	.21**	.23**
Activation	.03	.10	.12	.14*
Unpleasant activation	.37**	.22**	-.08	-.06
Activated displeasure	.40**	.26**	-.11	-.16**
Displeasure	.36**	.14*	-.09	-.16**
Deactivated displeasure	.28**	.09	-.07	-.13*
Unpleasant deactivation	.24**	.08	-.01	-.05
Deactivation	.09	.04	.04	.03
Pleasant Deactivation	-.19**	-.12	.03	.28**
Deactivated pleasure	-.22**	-.10	.12	.25**

*p < .05. **p<.01.

Goosebumps. The 12 regression analyses each predicting a 12 core affect variable, with tingling, coldness, and shivers controlled, indicated that goosebumps positively predicted pleasant and activated states (pleasure, β = .17, p < .01; activated pleasure, β = .21, p < .01; pleasant activation, β = .21, p < .01). These findings are consistent with findings from circumplex analyses, suggesting that goosebumps tends to accompany pleasant arousal.

Tingling. The 12 regression analyses each predicting a 12 core affect variable, with goosebumps, coldness, and shivers controlled, indicated that tingling positively predicted pleasant states (pleasure, β = .31, p < .01; activated pleasure, β = .31, p < .01; pleasant activation, β =

.23, $p < .01$; pleasant deactivation, β = .28, $p < .01$; deactivated pleasure, β = .25, $p < .01$) and negatively predicted unpleasant states (activated displeasure, β = -.16, $p < .01$; displeasure, β = -.16, $p < .01$; deactivated displeasure, β = -.13, $p < .05$). Interestingly, tingling also predicted activation (β = .14, $p < .05$), a neutral state characterized by a high level of activation. These findings are consistent with findings from circumplex analyses, suggesting that tingling tends to accompany pleasant states. Additionally, tingling accompanied both activated and deactivated states, suggesting that tingling may be distinguished from goosebumps in terms of arousal.

Coldness. The 12 regression analyses each predicting a core affect variable, with goosebumps, tingling, and shivers controlled, indicated that coldness positively predicted unpleasant states (unpleasant activation, β = .37, $p < .01$; activated displeasure, β = .40, $p < .01$; displeasure, β = .36, $p < .01$; deactivated displeasure, β = .28, $p < .01$; unpleasant activation, β = .24, $p < .01$) and negatively predicted pleasant states (pleasure, β = -.32, $p < .01$; activated pleasure, β = -.22, $p < .01$; pleasant activation, β = -.19, $p < .01$; deactivated pleasure, β = -.22, $p < .01$). These findings are consistent with findings from circumplex analyses, suggesting that coldness tends to accompany unpleasant states. Also consistent with the hypothesis, coldness accompanied both activated and deactivated states.

Shivers. Regression analyses each predicting a 12 core affect variable, with goosebumps, tingling, and coldness controlled, indicated that shivers positively predicted displeasing states (unpleasant activation, β = .22, p < .01; activated displeasure, β = .26, p < .01; displeasure, β = .14, p < .05) and negatively predicted pleasing and activated states (pleasure, β = -.16, p < .01; activated pleasure, β = -.16, p < .05). These findings are consistent with findings from circumplex analyses, suggesting that shivers tends to accompany unpleasant states. Additionally, shivers accompanied only activated states, suggesting that shivers may be distinguished from coldness in terms of arousal.

Comparing the Patterns of Correlations for Lower-order Sensations

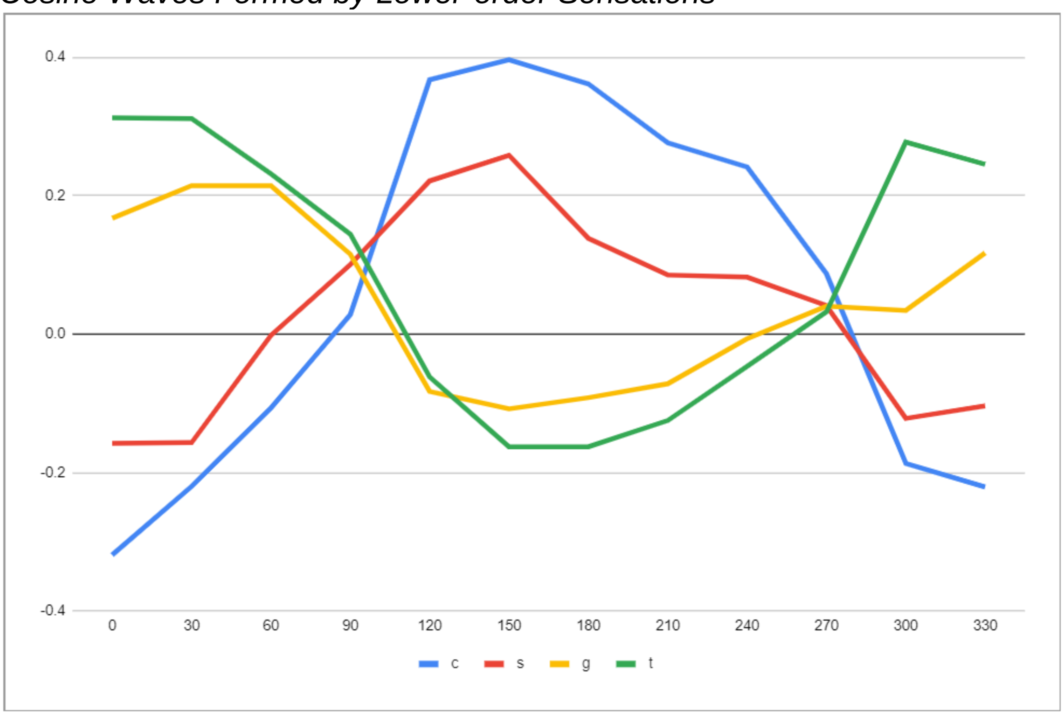
Figure 11 shows the patterns of correlations for lower-order sensations. The vertical axis represents standardized beta coefficients from multiple regression analyses. The horizontal axis represents angular positions of the 12 core affective states in the 12-PAC.

The patterns of correlations for goosebumps and tingling were characterized by peaks at 30° (activation pleasure; $\beta_{goosebumps}$ = .21, p < .01; $\beta_{tingling}$ = .31, p < .01) and troughs at 150° (activated displeasure; $\beta_{goosebumps}$ = -.11, n.s.; $\beta_{tingling}$ = -.16, p < .01). As expected, goosebumps and tingling were characterized by pleasant and activated states. Relative to goosebumps, tingling also accompanied pleasant and deactivated states such as pleasant deactivation ($\beta_{tingling}$ = .28, p < .01) and deactivated pleasure ($\beta_{tingling}$ = .25, p < .01), suggesting that tingling involves an overall lower level of affective activation than goosebumps.

The patterns of correlations for coldness and shivers were characterized by peaks at 150° (activated displeasure; $\beta_{coldness}$ = .40, p < .01; $\beta_{shivers}$ = .26, p < .01) and troughs at 0° (pleasure; $\beta_{coldness}$ = -.32, p < .01; $\beta_{shivers}$ = -.16, p < .01). As expected, coldness and shivers were characterized by unpleasant and activated states. Relative to shivers, coldness also accompanied unpleasant and deactivated states such as deactivated displeasure ($\beta_{coldness}$ = .28, p < .01) and unpleasant deactivation ($\beta_{coldness}$ = .24, p < .01), suggesting that coldness involves an overall lower level of affective activation than shivers.

Figure 11

Cosine Waves Formed by Lower-order Sensations



Note. Horizontal axis = angular positions in the 12-PAC; vertical axis = standardized beta coefficients; c = coldness; s = shivers; g = goosebumps; t = tingling.

Discussion

Factor structure of the Chills

Using the narrative recall method, the present study replicated the factor structure of the chills established by Maruskin et al. (2012). The chills exists as a hierarchical, multi-factor structure, consisting of four lower-order sensations (goosebumps, tingling, coldness, and shivers) and two higher-order sensations (goosetingles and coldshivers). Consistent with the data obtained by Maruskin et al. (2012), goosebumps and tingling and coldness and shivers were moderately correlated (rs = .40 - .50, ps < .01). Therefore, it is unclear whether goosebumps was sufficiently distinct from tingling and whether coldness was sufficiently distinct from shivers to have unique nomological nets. This question was addressed by the subsequent circumplex analyses.

Affective Composition of the Chills

Results of circumplex correlation analyses show that the two higher-order sensations have different affective correlates. Goosetingles was best characterized by the pleasant activated state located at 15.47° in the 12-PAC; and coldshivers was best characterized by the unpleasant activated state located at 166.73° in the 12-PAC (Figure 3). These findings highlight the value of affective valence in establishing the affective nomological nets of higher-order sensations. Additionally, these findings are consistent with findings obtained by Maruskin et al. (study 4), thus providing additional evidence of the discriminant validity of the higher-order goosetingles-coldshivers factors.

Results of circumplex correlation analyses also show that the four lower-order sensations have different affective correlates. Goosebumps, tingling, coldness, and shivers were best characterized by the core affective states located at 22.00°, 10.54°, 170.20°, and 161.78° in the 12-PAC, respectively (Figure 3). Relative to goosebumps, tingling tends to accompany core affective states higher on pleasure and lower on activation. Relative to coldness, shivers tends to accompany core affective states lower on displeasure and higher on activation. These findings highlight the value of affective valence and arousal in establishing the affective nomological nets of lower-order sensations. Although the differences between goosebumps and tingling, and between coldness and shivers, were smaller than those documented by Wadsworth (2019), the present findings replicate the ordering of the sensations within the circumplex that Wadsworth documented. These findings provide additional evidence of the discriminant validity of goosebumps, tingling, coldness, and shivers.

Finally, results of circumplex regression analyses show that the four lower-order sensations have distinct affective correlates. Goosebumps and tingling tend to accompany pleasant states but tingling involves an overall lower level of activation than goosebumps. Similarly, coldness and shivers tend to accompany unpleasant states but coldness involves an overall lower activation than shivers. A similar set of findings were obtained from comparing the patterns of correlations for goosebumps and tingling and coldness and shivers. These findings highlight the value of affective activation in distinguishing goosebumps from tingling and coldness from shivers.

Goosebumps

Consistent with my hypothesis, goosebumps accompanied pleasant activated states. This finding provides support for Keltner and Haidt's social hierarchy theory, but not Darwin's (1872/1965) findings linking goosebumps with unpleasant states during fight or flight.

Inconsistent findings regarding the affective composition of goosebumps are likely caused by the idiosyncrasy of the eliciting situation. Participants of the present study attributed the chills more to the success, victory, and competence of others than physical threat or danger in the external environment ($t(267) = 2.68$, $p < .01$). Therefore, it is likely for the present study to support theory of the chills (or goosebumps) in the context of social comparison.

Findings from the present study provides support for Keltner and Haidt's (2003) social hierarchy theory, which linked goosebumps with pleasant, awe-related emotions. Although the present study did not directly analyze the relation between social awe and goosebumps, the affective correlates of goosebumps (pleasure, activated pleasure, pleasant activation), nevertheless bolster a positive relation between goosebumps and awe. Similar to goosebumps experiences, intense awe experiences were found to also involve affective states high on pleasure (Yaden et al., 2018). In light of these findings, I posit that goosebumps exists as a pleasant experience during social comparisons. It signals one's deep-seated appreciation for others' talent, skills, or competence.

Tingling

Consistent with my hypothesis and the qualitative data obtained by Schmeid and Barclay (1999), tingling accompanied affective states high on pleasure. Schemid and Lupton (2001) suggested that the positive relation between tingling and pleasure is attributable to the intimate relation between the mother and child. Breastfeeding stimulates the release of oxytocin, which results in euphoric feelings in the mother (for a review, see Klaus, 1998). These findings highlight the value of interpersonal closeness in understanding tingling. To better understand the affective composition of tingling, future research may examine the neurological basis of intimate relationship.

Additionally, Bottorff (1990) and Shaw (2003) argued that breastfeeding resembles a reflexive form of gift giving, which contributes to the pleasant feeling in the mother (Schemid & Lupton, 2001). Specifically, breastfeeding contributes to “positive sensory bodily experience” (Shaw, 2003, pp. 64) in the mother and helps establishing meaningful relationships between the mother and the child through the satisfaction of maternal desires. Therefore, it is possible that the pleasure of tingling is also attributable to finding and experiencing meaning in life (Newman, Nezlek & Thrash, 2018).

I hypothesized that tingling accompanies affective states low on activation, but findings suggest that tingling involves affective states slightly above moderate in activation. I speculate that the inconsistency is caused by the idiosyncrasy of the eliciting situation. My hypothesis was derived from extant literature on tingling during breastfeeding, but none of the participants reported the chills in this context.

Coldness

Consistent with my hypothesis, coldness accompanied affective states high on displeasure and moderate in activation. These findings are consistent with extant literature on feeling cold and social distress (Maruskin et al., 2012; Zhong & Leonardelli, 2008; Harlow & Domek, 1970), suggesting that feeling cold serves social signaling functions. Panksepp’s (1995) separation call hypothesis provides an adequate explanation for these findings. Feeling cold signals one’s deep-seated fear for losing contact with attachment figures.

Shivers

Consistent with my hypothesis and findings obtained by Blake and colleagues (2017), shivers accompanied affective states high on displeasure and activation. Studies suggested that the affective correlates of shivers (disgust and fear; Blake et al., 2017) serve adaptive functions. Curtis et al. (2014) and Ohman and Mineka (2001) argued that humans and animals are evolutionarily wired to display disgust in the face of contaminations and fear in the face of danger. These negative emotions trigger bodily reactions of shivers or shaking (Blake et al., 2017) and promote avoidance-related behaviors to protect the self from potential harms. Therefore, it is likely that shivering signals one's deep-seated fear for existential threats.

Limitations

The present study is limited in that it involves analyses at a single level. As Maruskin et al. (2012) suggested, the factor structure of the chills could be different 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." (p. 146). Therefore, researchers may design diary studies and conduct multilevel factor analyses to examine the factor structure of the chills at within-person and between-person levels.

Another advantage of multilevel design is that it controls between-person variability in affective experiences. For example, differences in individuals' tendencies to experience positive and negative affect and activation may bias the results of the present study (Feldman, 1995). A multilevel model that specifies within-person variables at level 1 and between-person variables at level 2 is able to test the unique predictive utility of particular chills sensations controlling individual differences in affective experiences. These analyses may provide additional evidence of the discriminant validity of lower-order sensations.

The present study is also limited in that the narrative recall method introduces recall bias. Hassan (2005) suggested that the data gathered through memory recall are prone to errors and thus, posing threats to internal validity of the study. For example, details of an event could go unnoticed and the retrieval of distant memory may add new information as spurious facts. To address this problem, future studies may consider event-contingent dairy designs.

In sum, the present study replicated the factor structure of the chills established by Maruskin et al. (2012) and provided additional evidence that the chills consists of a set of distinguishable sensations with distinct affective correlates (Wadsworth, 2019). Replication leads to validation. Future studies may extend this line of research to further validate the multi-factor chills construct established by Maruskin et al. (2012).

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