# A Three-Dimensional Taxonomy of Achievement Emotions

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We present a three-dimensional taxonomy of achievement emotions that considers valence, arousal, and object focus as core features of these emotions. By distinguishing between positive and negative emotions (valence), activating and deactivating emotions (arousal), and activity emotions, prospective outcome emotions, and retrospective outcome emotions (object focus), the taxonomy has a 2 × 2 × 3 structure representing 12 groups of achievement emotions. In four studies across different countries ($N$ = 330, 235, 323, and 269 participants in Canada, the United States, Germany, and the U.K., respectively), we investigated the empirical robustness of the taxonomy in educational (Studies 1–3) and work settings (Study 4). An expanded version of the Achievement Emotions Questionnaire was used to assess 12 key emotions representing the taxonomy. Consistently across the four studies, findings from multilevel facet analysis and structural equation modeling documented the importance of the three dimensions for explaining achievement emotions. In addition, based on hypotheses about relations with external variables, the findings show clear links of the emotions with important antecedents and outcomes. The Big Five personality traits, appraisals of control and value, and context perceptions were predictors of the emotions. The 12 emotions, in turn, were related to participants' use of strategies, cognitive performance, and self-reported health problems. Taken together, the findings provide robust evidence for the unique positions of different achievement emotions in the proposed taxonomy, as well as unique patterns of relations with external variables. Directions for future research and implications for policy and practice are discussed.

*Keywords:* achievement emotions, control-value theory, test anxiety, cognitive performance, health

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The authors have no conflicts of interest to disclose. The research was supported by a Research Professorship Grant from the University of Munich awarded to Reinhard Pekrun, a German Academic Exchange Services grant awarded to Reinhard Pekrun and Kristina Stockinger (No. 57389797), and research grants to Raymond P. Perry from the Social Sciences and Humanities Research Council of Canada (Insight No. 435-2017-0804) and the Royal Society of Canada. The authors thank Judith G. Chipperfield, Jeremy M. Hamm, and Steve Hladkyj for their support in providing classroom time for our data collection at the University of Manitoba. The data used for this research and the findings have not previously been disseminated.

Reinhard Pekrun played lead role in conceptualization, formal analysis, investigation, methodology, project administration, validation, writing of original draft and writing of review and editing and equal role in data curation and resources. Herbert W. Marsh played supporting role in conceptualization, investigation, methodology, validation, writing of original draft and writing of review and editing and equal role in formal analysis. Andrew J. Elliot played supporting role in conceptualization, data curation, investigation, methodology, project administration, resources, validation, writing of original draft and writing of review and editing. Kristina Stockinger played supporting role in methodology, project administration, validation, writing of original draft and writing of review and editing. Raymond P. Perry played supporting role in investigation, methodology, project administration, validation, writing of original draft and writing of review and editing. Elisabeth Vogl played supporting role in methodology, project administration, writing of original draft and writing of review and editing. Thomas Goetz played supporting role in conceptualization, writing of original draft and writing of review

Over the past 25 years, there has been an exponential increase in the number of studies on achievement emotions (see Barroso et al., 2021; Camacho-Morles et al., 2021; Cheng & McCarthy, 2018; Ford et al., 2011; Loderer et al., 2020; Loukidou et al., 2009). The findings demonstrate that achievement emotions can profoundly impact thought, action, and performance in achievement settings as well as aspirations, career decisions, dropout rates, wellbeing, and mental health. As a consequence, the importance of these emotions has been recognized both by personality researchers and scientists in applied disciplines, to the extent that authors have noted an "affective turn" in their respective fields (e.g., management science, Barsade et al., 2003; educational psychology, Pekrun & Linnenbrink-Garcia, 2014a).

Research on achievement emotions dates back to inaugural studies on test anxiety in the 1930s (e.g., Brown, 1938). Subsequent research confirmed the importance of anxiety for understanding human performance (von der Embse et al., 2018; Zeidner, 1998, 2014). Starting in the late 1960s, attributional research broadened the perspective by considering the cognitive antecedents of emotions following success and failure, such as pride and shame (Weiner, 1985; Weiner & Kukla, 1970). Since the end of the 20th century, researchers have further expanded the scope of inquiry by exploring emotions related to achievement activities themselves, such as enjoyment or boredom. However, to date, most studies have focused on a small set of select emotions. In addition to anxiety, researchers have most commonly considered enjoyment, anger, and boredom in achievement settings (Camacho-Morles et al., 2021). Studies integrating more than two or three single emotions are largely lacking, with few exceptions (Pekrun et al., 2011).

We propose to expand upon Pekrun's (2006) taxonomy of achievement emotions to conceptualize a broader range of these emotions. The taxonomy considers valence, arousal, and object focus as distinguishing features of the emotions occurring in achievement settings. We further develop this framework and explain how it captures the conceptual space of emotions related to achievement. We detail the locations of important achievement emotions in this space, explain their origins and consequences, and use the framework to conceptualize achievement emotions that have not been considered in the preliminary work by Pekrun et al. (2011), including relaxation, assurance, and disappointment. These emotions have been neglected in existing research.

We first define achievement emotions and present the taxonomy. We then report four empirical studies that tested key properties of this framework. Focusing on prototypical emotions representing the taxonomy, the studies examined the occurrence, interrelations, and dimensions of these emotions in educational and work settings, thus testing the structural validity of the taxonomy. In addition, based on control-value theory (Pekrun, 2006, 2018, 2021), we investigated the relations of the achievement emotions with personality traits, appraisals, context perceptions, achievement behavior, performance, and health problems (Figure 1). As such, the present research provides a substantially broader analysis of the nomological network of achievement emotions than previous research, both in terms of internal structures and relations with external variables.

## Construct of Achievement Emotion

### Definition of Emotion

In line with current definitions (e.g., Scherer & Moors, 2019), we view emotions as multicomponent changes in an organism's psychophysical system that occur in response to events or situations important to the organism. These changes can comprise affective, cognitive, physiological, motivational, and expressive-behavioral components. For example, anxiety before an exam typically includes nervous, uneasy feelings (affective), worries about possible failure (cognitive), physiological arousal (physiological), impulses to avoid taking the exam (motivation), and anxious facial expressions (expressive behavior). Each of these components can involve multiple processes, such as physiological arousal comprising processes triggered in the sympathetic and parasympathetic nervous systems. Following "critical" emotion theories that question classic conceptions of emotions as hard-wired affect programs (Moors, 2017), we contend that these processes are coupled in probabilistic ways and can vary between and within persons. For example, behavioral expressions of emotion vary more across persons and cultures than previously thought (Barrett et al., 2019).

As such, emotions are best viewed as affective episodes that include multiple, loosely connected changes in a multidimensional space of component processes. However, the patterns of these changes are not arbitrary. Instead, some patterns are more likely to occur in response to specific events. These prototypical patterns make it possible to distinguish between different emotions, semantically represent them in language, and use verbal self-report to assess them (Fontaine et al., 2013). Given the flexibility of the multicomponent patterns that we call emotions, we believe it is best not to view them as categories defined by clear-cut boundaries, but rather as prototypes representing families of similar patterns (see Russell & Barrett, 1999, for a similar view). We assume that this view is also valid for achievement emotions. They are best viewed as multicomponent processes, with components loosely coupled, boundaries between emotions gradual rather than categorical, and different emotions described as prototypes representing groups of achievement-related emotional episodes that share core properties.

### Achievement Emotions

Following Pekrun (2006), we define achievement emotions as emotions that occur in response to events and actions that are judged according to competence-based standards of quality. This definition is congruent with classic definitions of related concepts,

and editing. Wijnand A. P. van Tilburg played supporting role in investigation, methodology, project administration, writing of original draft and writing of review and editing. Oliver Lüdtke played supporting role in formal analysis, methodology and writing of review and editing. Walter P. Vispoel played supporting role in methodology and writing of review and editing.

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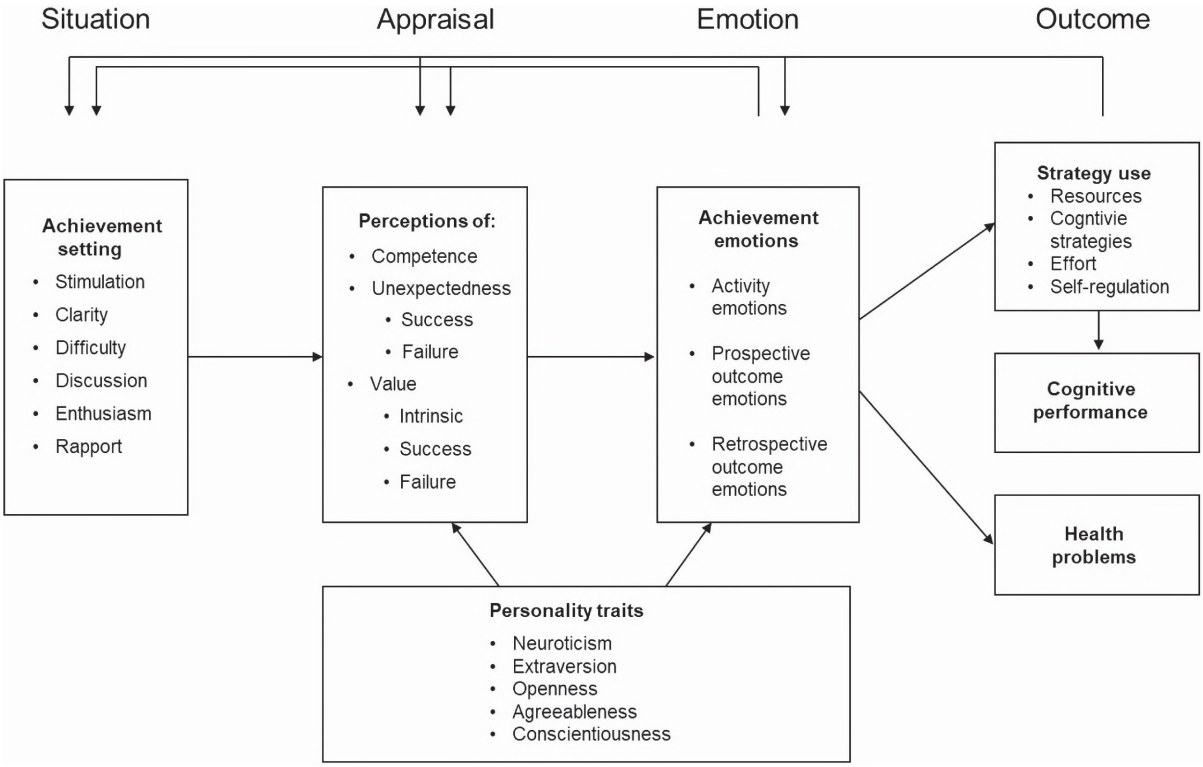
**Figure 1**

*Antecedents and Outcomes of Achievement Emotions: Theoretical Framework*




such as goals and motivation in the literature on achievement motivation. For example, achievement goals are viewed as the aims of competence-relevant behavior (Elliot, 2005; Elliot et al., 2011). Across authors, competence is viewed as central to constructs of achievement motivation and achievement behavior (see Elliot et al., 2017). Similarly, competence is at the conceptual core of the achievement emotion construct.

Traditionally, achievement emotions have been viewed as emotional responses to success and failure, with success and failure defined as discrete events in time. In classic studies, achievement emotions were assessed in response to imagined or real instances of performance feedback implying success or failure, such as receiving a good or bad grade in school (e.g., Folkman & Lazarus, 1985; Weiner, 1985, 2018). Our current definition expands this view by also considering emotions related to ongoing activities that are evaluated based on competence. These activities, while leading to success and failure, can also be judged as more or less competently performed. It is the distinction between outcome-related and activity-related achievement emotions that is at the heart of our taxonomy.

Conceptually, achievement emotions are closely related to achievement motivation, similar to the close relation between emotion and motivation more generally (Pekrun, in press). According to the above definition, achievement emotions can comprise motivational impulses. Conversely, if we define achievement motivation as psychological factors that shape goal direction and intensity of achievement behavior, then emotions can be part of achievement motivation. Based on such a definition, pride, fear, and shame related to success and failure have traditionally been considered as part of achievement motives (McClelland et al., 1953). However, despite the overlap, it is useful to distinguish between the two constructs. Achievement emotion and motivation can be combined in emotional–motivational episodes, but this is not always the case. For example, joy about success does not need to include any specific motivational impulses. Conversely, motivation to invest time in a project can result from calculating costs and benefits, without involving any strong emotions.

## Taxonomy of Achievement Emotions

### Three Fundamental Dimensions

We propose that achievement emotions can be classified along three dimensions: valence, arousal, and object focus. The first two are seen as common to all emotions and their affective basis ("core affect"; Petrolini & Viola, 2020; Russell & Barrett, 1999). The third dimension remains implicit in many conceptions but is equally relevant for distinguishing between emotions that differ in contents, origins, and functions. We contend that these three dimensions fully capture the conceptual space of achievement emotions. In combination, they are considered both necessary and sufficient to represent this space.

#### *Valence*

In terms of valence (or pleasantness), positive (or pleasant) achievement emotions can be distinguished from negative (or unpleasant) achievement emotions. Examples of positive achievement emotions are enjoyment of competently performing one's work, pride about success, or gratitude for help from one's teacher. Anxiety before a pending job interview, anger about unreasonable task demands, and

hopelessness that success cannot be attained are examples of negative achievement emotions. Valence ranges from extremely pleasant to extremely unpleasant and can take any values in between.

### *Arousal*

In terms of arousal, physiologically activating emotions (high arousal) differ from deactivating emotions (low arousal). Arousal refers to the activation of physiological systems as indicated by parameters such as heart rate, respiration rate, and electrodermal activity, and is reflected in feelings of energy and mobilization (Fontaine et al., 2013; Roos et al., 2021; Russell & Barrett, 1999). Excitement about a new project and panic before a job interview are examples of activating achievement emotions. Relief about not having failed an exam and boredom during work are examples of deactivating emotions. Arousal can vary from extremely activating to extremely deactivating.

### *Object Focus*

Different groups of emotions can be distinguished by their objects. We use the term "object" to denote any real or imagined event, situation, action, or physical object to which an emotion can refer (see related discussion of the "intentionality" of emotions in philosophy; Montague, 2009; Scarantino & de Sousa, 2018). Achievement emotions share positions on the valence and arousal dimensions with other emotions, but they differ from other emotions in terms of their object. For example, social emotions refer to other people, epistemic emotions to the generation of knowledge, self-conscious emotions to one's own attributes, and moral emotions to the normative appropriateness of actions (Haidt, 2003; Morton, 2010; Tracy et al., 2007; Vogl et al., 2020). Achievement emotions refer to achievement activities and their success and failure outcomes.

Object focus can also be used to understand the internal structure of the domain of achievement emotions. We propose that the object focus of achievement emotions comprises two different aspects: The *type of object*, and the *temporal relation* between the person and the object at the time of the emotional experience. In terms of type of object, emotions related to achievement activities (activity achievement emotions) can be distinguished from emotions related to achievement outcomes (outcome achievement emotions). In terms of temporal relation, any object of emotion can be located in the present, future, or past. As such, it is possible to distinguish between concurrent emotions that occur parallel to an ongoing action or event, prospective (i.e., anticipatory) emotions related to future actions and events, and retrospective emotions related to past actions and events.

Achievement activities and their outcomes can be seen from these different temporal perspectives. Both can occur in the present, future, or past. By implication, both activity emotions and outcome emotions can involve concurrent, prospective, or retrospective temporal relations. However, all six of the resulting combinations may not be equally important. Activity emotions may be most relevant in relation to an ongoing achievement activity, whereas outcome emotions may typically occur in relation to past or future outcomes. Achievement outcomes usually occur as discrete events, such as the announcement of a grade, implying that emotions either occur before the outcome or afterward, making them either prospective or retrospective. As such, and in the interest of parsimony, we focus on distinguishing between concurrent activity emotions, prospective outcome emotions, and retrospective outcome emotions in the present research. It is a possible avenue for future studies to additionally explore pro- and retrospective activity emotions, as well as concurrent outcome emotions related to outcome events that show sufficient temporal extension to let achievement emotions unfold in parallel rather than retrospectively.

## Functional Relevance of the Three Dimensions

All three dimensions are important for explaining the origins of achievement emotions and their functions for thought and action, as we describe in more detail below (see Studies 2 and 3). *Valence* can trigger different modes of thinking, with positive emotions typically facilitating holistic, flexible, and creative styles of thought, and negative emotions promoting analytic, rigid, and convergent thinking (Clore & Huntsinger, 2007; da Costa et al., 2015; Huntsinger et al., 2014). Valence also shapes motivational consequences, as emotions typically motivate like-valenced actions. Pleasant emotions facilitate approach motivation, like studying for an exam. Unpleasant emotions trigger avoidance or withdrawal, such as skipping an exam; an exception is anger which can trigger aggression.

*Physiological activation* prepares the organism for action and sustains action, such as flight–fight responses in anxiety and anger, respectively. Activation leads to cognitive alertness and facilitates mental effort underpinning cognitive and behavioral action. Deactivation facilitates withdrawal from action. For example, activating excitement supports effort in project work, whereas deactivating boredom undermines effort. In addition, physiological activation can influence health through various pathways, including the hypopituitary-adrenal axis and its influence on the immune system (Pressman et al., 2019).

*Object focus* defines the antecedents of achievement emotions and their cognitive contents. For example, negative outcome emotions such as anxiety are triggered by negative expectations and include thoughts about possible failure. As such, whereas valence and arousal determine effects of achievement emotions, object focus is of prime relevance for understanding their origins. However, due to defining contents, object focus can also contribute to shaping subsequent cognitive and motivational processes. For instance, if the focus is on possible failure, worries about failure may reduce working memory capacity, thus undermining performance on difficult tasks (Mikels & Reuter-Lorenz, 2019).

## Combining the Dimensions: Groups of Achievement Emotions

We posit valence, arousal, and object focus to be conceptually independent dimensions (for possible empirical relations between these dimensions, see, e.g., Petrolini & Viola, 2020). As such, the proposed taxonomy has a $2 \times 2 \times 3$-dimensional structure, which makes it possible to distinguish between 12 groups of achievement emotions. We describe these groups by depicting prototypical exemplars from each group (Table 1). Most of these exemplars can be denoted by emotion terms commonly used in everyday language, and most of them can be represented by terms that are specific to single cells of the taxonomy (e.g., hope, pride, anxiety, and shame). However, some of the terms available in common language are broader and cover emotions from different cells, making it necessary to add qualifiers for semantic clarification. For example, "joy" can

**Table 1**
*Three-Dimensional Taxonomy of Achievement Emotions*

| Object focus | Positive | | Negative | |
|---|---|---|---|---|
| | Activating | Deactivating | Activating | Deactivating |
| Activity | **Enjoyment**<br>Excitement | **Relaxation** | **Anger**<br>Frustration | **Boredom** |
| Outcome–prospective | **Hope**<br>Anticipatory joy | **Assurance** | **Anxiety** | **Hopelessness** |
| Outcome–retrospective | **Pride**<br>Retrospective joy<br>Gratitude | **Relief**<br>Contentment | **Shame/Guilt**<br>Anger | **Disappointment**<br>Sadness |

*Note*. Bold entries = emotions included in the empirical studies.

relate to a current achievement activity (concurrent enjoyment), the anticipation of future success (anticipatory joy), or the recall of past success (retrospective joy). The construction of the taxonomy revealed one emotion that has not been considered to date (the prospective outcome emotion of assurance defined below), possibly due to lack of representation in everyday language.

### *Activity Emotions*

Positive activating members of this group include enjoyment and excitement about achievement activities; a positive deactivating exemplar is pleasant relaxation. These three emotions focus on the pleasure of ongoing competent performance, such as competently dealing with a project at work. Negative activating emotions in this category are anger and frustration about obstacles that hinder competent performance, such as task demands that are viewed as unfair, unexpected impasses when trying to solve a problem, or one's own lack of effort. The negative deactivating counterpart is boredom. Boredom can involve perceptions of inability to act competently due to lack of competence (overchallenge), but it can also deprive us of experiences of competence when tasks are too easy (underchallenge; Pekrun, 2006; Westgate & Wilson, 2018).

### *Prospective Outcome Emotions*

Prospective outcome emotions relate to future success and failure, respectively. In positive prospective emotions, the focus is on possible success, and in negative prospective emotions the focus is on possible failure. Prospective outcome emotions differ in terms of subjective certainty of success and failure. The activating emotions hope and anxiety involve uncertainty about the outcome. Given uncertainty, the affective state can oscillate between these two emotions, depending on the current focus of attention on either success or failure. In contrast, the deactivating emotions assurance and hopelessness involve subjective certainty about outcomes. Assurance relates to subjectively certain attainment of success and hopelessness to certain failure.

To our knowledge, no specific term has been used in prior research to depict a pleasant, relaxed emotional state involving subjective certainty about upcoming success. We propose using the term assurance to denote this state. Importantly, as conceived in our taxonomy, assurance is different from mere certainty (or confidence) itself. In the psychological and neuroscientific literature, the terms certainty and confidence refer to (meta-)cognitive judgments of likelihood and correctness (e.g., Boldt et al., 2019; Mazancieux et al., 2020; Vogl et al., 2020). In contrast, as an emotion, assurance is affective in nature, which adds noncognitive components and makes it different, much like anxiety is more than just an expectancy of negative events. As we conceive it, assurance includes pleasant affective experience, physiological deactivation, and relaxed expressive behavior, in addition to appraisals of subjective certainty.

### *Retrospective Outcome Emotions*

These emotions pertain to past success and failure. We use the term "past" to denote any outcome event that already occurred, regardless of the temporal distance from the event. For example, pride aroused after the announcement of an award is considered a retrospective emotion because it refers to an event that has occurred, even if only a few seconds ago. Given that past outcomes are certain (provided that one is informed about them), these emotions are less characterized by level of certainty and oscillations between positive and negative emotions, as compared with prospective outcome emotions. Activating emotions in this group include pride, joy, gratitude, shame, guilt, and anger. While success and failure are the object focus in all of these emotions, pride, shame, and guilt additionally comprise recognition of self-responsibility, and gratitude and anger recognition of other-responsibility. Deactivating retrospective emotions are relief, disappointment, and sadness. Relief relates to success that occurs although failure had been expected, and disappointment relates to failure when success had been expected.

## Testing the Taxonomy

In four empirical studies with samples from different countries (Canada, the United States, Germany, and the U.K.), we examined the empirical robustness of the proposed taxonomy. We used one prototypical emotion from each category of the taxonomy (12 emotions overall; see Table 1). We first investigated whether participants in a typical achievement setting experience these emotions. Undergraduate courses at university were the setting in Studies 1–3. The undergraduate classroom seems ideal for examining achievement emotions given the emphasis on achievement in undergraduate education (Pekrun et al., 2002). In Study 4, we considered achievement emotions at work, thus testing the generalizability of findings across contexts.

Second, we examined the structural validity of the proposed taxonomy. Specifically, we analyzed whether the 12 emotions

are sufficiently distinct to justify separating the respective cells in the taxonomy. We examined the intercorrelations among these emotions, used a facet-analytic approach to examine the relevance of the three dimensions to explain variance in the emotion scores, and tested multiple-emotion factor models representing the taxonomy against alternative models containing fewer dimensions. We examined these fundamental issues across all four studies, including a comparison of between-person and within-person relations among the emotions in Study 4.

The three dimensions in our taxonomy are crossed, not nested (as in hierarchical models like the Big Five model of personality). The taxonomy implies that all three dimensions and their interactions contribute to each emotion. Because the dimensions are crossed, a unique contribution of our facet approach is the interactions between the dimensions. Achievement emotions cannot be adequately explained in terms of first-order effects of the three dimensions alone; we also need to consider their interplay. Similarly, for explaining relations between emotions and external variables, it is important to not only consider the three dimensions but also their combinations.

This perspective extends the typical two-dimensional (Valence × Arousal) approach to the study of emotions. Our facet approach also provides an alternative way to construct taxonomies that is rarely considered in personality psychology, except for taxonomies of ability in which multiple dimensions are crossed rather than nested (such as Guilford's, 1967, classic taxonomy of intelligence; for facet approaches more generally, see Guttman & Greenbaum, 1998; Hjørland, 2013). Consistent with these considerations, our subsequent analyses of relations with other variables focus on emotion scores representing the different cells of our $2 \times 2 \times 3$ model (i.e., the unique combinations of the three dimensions) rather than a smaller number of summary scores.

Third, we assessed the relations of the emotions with proposed antecedents, including appraisals, perceptions of the classroom context, and personality traits including the Big Five factors. Finally, we examined links between the emotions and important outcomes including learning strategies, academic performance, and reported health problems. Studies 2–4 served to examine the links with antecedents and outcomes. We analyzed relations with personality, strategies, and performance in Study 2, and relations with appraisals, context perceptions, and health problems in Study 3. In Study 4, we added a within-person analysis of the links between achievement emotions and appraisals.

For the analysis of relations with antecedents and outcomes, we used an integrative theoretical framework that is based on Pekrun's (2006, 2018, 2021) control-value theory of achievement emotions (see Figure 1). In line with this theory, we expected achievement emotions to be instigated by achievement-related appraisals of control and value, implying that these appraisals are proximal antecedents. Personality traits and contextual conditions are thought to be more distal antecedents. Achievement emotions, in turn, were expected to impact motivation to achieve, use of strategies, self-regulation of achievement activities, and resulting performance. For the link between achievement emotions and health problems, we developed hypotheses based on theories of stress, emotion, and health. Our hypotheses on these relations with antecedents and outcomes are detailed in Studies 2–4.

The present research is the first to conceptualize and examine the full nomological network of the achievement emotions representing the taxonomy. It is also the first to systematically compare between-person and within-person perspectives on achievement emotions (Study 4). We cover new ground by analyzing achievement emotions that have not been considered to date, including relaxation, assurance, and disappointment, or have been rarely addressed, such as relief. In terms of relations with external variables, previous research has focused on links between achievement emotions and performance. Relations with important domain-general variables, such as personality traits and physical health, have been neglected. In the present research, we examined these relations for all 12 focal emotions.

## Study 1

In Study 1, we tested the taxonomy by probing the occurrence and structure of the emotions representing it. The study included all 12 emotions except for assurance; the scale for assurance was developed in Study 2. Participants were undergraduate university students. We used participants' endorsement of items assessing the emotions to examine their occurrence in the undergraduate studies context. Next, we employed confirmatory factor analysis (CFA) to test the quality of the emotion scales. We then tested the structure of the achievement emotions domain using correlational analysis, our facet-analytic approach, and structural equation modeling (SEM).

Correlational analysis was used to examine the relations between the emotions. We hypothesized that the correlations would be sufficiently low to consider the emotions as separate constructs. The facet approach and SEM were used to more fully test the proposed three-dimensional structure of the taxonomy. In using these two complementary strategies, we considered the nature of the three dimensions. Valence and arousal can be conceptualized either as continuous dimensions (e.g., as bipolar dimensions as in circumplex models) or in terms of categories that bifurcate these dimensions (positive vs. negative; activating vs. deactivating). In contrast, object focus comprises qualitatively different categories (activity vs. outcome; prospective vs. retrospective) that do not constitute a continuous dimension. As such, to fully represent the structure of the taxonomy, a facet-analytic approach is needed. In addition, SEM using quantitative dimensional analysis can provide partial tests of the taxonomy.

Based on these considerations, we used the facet analysis approach to examine whether all three dimensions of the taxonomy contribute to explaining the emotion scores. We hypothesized that all three dimensions and their interactions significantly contribute to explaining variance of these scores. SEM was used to test whether multifactor models representing the emotions as separate constructs fit the data better than plausible simpler models, including one-factor and two-factor models. To limit the number of parameters, we estimated the models separately for positive and negative emotions. Each of the one-factor models comprised one factor representing positive or negative affect, respectively. The two-factor models included two factors differentiating between high-arousal and low-arousal emotions. Compared with our proposed multiple-emotions approach, one- and two-factor models are more concise. However, they may fail to represent differences between the emotions that share locations in the quadrants of the Valence × Arousal space (e.g., enjoyment, hope, and pride in the positive valence–high arousal quadrant; Table 1). As such, we hypothesized that multifactor models would fit the data better.

## Method

### Sample and Procedure

The sample consisted of 330 students (69.7% female; $M_{age}$ = 20.95 years, $SD$ = 1.34) enrolled in an introductory psychological methods course at a large mid-Western Canadian Research–1 university. Most participants were native English speakers (74.2%). Ethics approval was obtained from the institution's ethics committee (Protocol No. P2015:164). Participation in the study was voluntary, and students received course credit for participation. We assessed achievement emotions using an online questionnaire.

### Measures

We developed a revised version of the Achievement Emotions Questionnaire (AEQ; Pekrun et al., 2011) to measure the emotions represented in the taxonomy (henceforth labeled the Achievement Emotions Questionnaire–Revised, AEQ-R). We used the following strategy to construct the scales for the instrument. First, we selected items from the original version of the AEQ considering item statistics (score distributions, factor loadings) and a balanced representation of emotion components. Second, we revised the items to be applicable across achievement contexts. Third, we wrote new items measuring relaxation and disappointment. The AEQ-R (79 items) is shorter than the original AEQ (232 items) and better suited to assess a broad range of achievement emotions when administration time is limited, while preserving psychometric quality as detailed below.

In the present study, instructions for the AEQ-R required participants to indicate how they typically feel about achievement situations at university, such as attending class, studying, or taking a test. To represent distinctions between prospective, concurrent, and retrospective emotions, items were organized in three blocks pertaining to emotional experiences before, during, and after these situations.

The AEQ-R comprises 12 scales measuring enjoyment (eight items; e.g., "I enjoy doing my assignments"), hope (four items; e.g., "I am hopeful that I will perform well at my work"), pride (four items; e.g., "I am proud of my accomplishments"), relaxation (four items; e.g., "I feel relaxed when doing my work"), assurance (five items; e.g., "I feel relaxed because I know I will be successful"; again, this scale was not included in this first study), relief (five items; e.g., "I feel relief because I succeeded on my assignments"), anger (eight items; e.g., "Doing my work makes me irritated"), anxiety (12 items; e.g., "I worry I might fail"), shame (six items; e.g., "My poor performance embarrasses me"), boredom (eight items; e.g., "My work bores me to death"), hopelessness (nine items; e.g., "I feel hopeless"), and disappointment (four items; e.g., "I am disappointed that I did not perform well"). Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (α range .79–.93; see Supplemental Table S1).

### Transparency and Openness

We report all procedures, measures, and data analytic methods used in this study and in Studies 2–4, and we follow the APA journal article reporting standards (Kazak, 2018). We did not exclude any data in any of the studies. In all four studies, all data were collected before any analyses were conducted, and all variables analyzed are reported. The data, materials, and program codes used in this study and in Studies 2–4 are available at the Open Science Framework and can be accessed at https://osf.io/rkgdh/. The AEQ-R and sample Mplus and MLwiN syntax are also available in the Supplemental Materials, Sections 5 and 6.

## Results and Discussion

### Distributions of Emotion Scores

For most of the emotion scales, the mean scores were close to the midpoint, with higher means for pride and relief, and lower means for some of the negative emotions (Supplemental Table S1). However, even for hopelessness, arguably one of the more extreme negative emotions, the mean value was above two on the 5-point response scale, with substantial variation of scores around the mean. As such, the findings suggest that all of the emotions represented in the taxonomy commonly occur in the undergraduate classroom.

### Confirmatory Factor Analysis

We employed CFA with Mplus 8.6 (Muthén & Muthén, 2017) to test the dimensionality of each of the emotion scales. In each of these analyses, we followed recommendations by Pekrun et al. (2011) and used a correlated uniqueness approach by including correlations between residuals for items representing the same emotion component (e.g., cognitive, physiological; see Supplementary Materials for a sample Mplus syntax; we included the same correlations between residuals across studies). The components are unique for each emotion rather than generalized across emotions. For example, whereas the affective component of anxiety includes feelings of nervousness, the affective component of anger comprises feelings of irritation. Similarly, the cognitive component of anxiety comprises thoughts about uncertain failure, whereas the cognitive component of anger includes thoughts about obstacles that hinder one's performance. As such, a correlated uniqueness approach may be more adequate than a multitrait–multimethod approach to represent the components (similar to the unique facets of personality traits being represented by correlated residuals in work on the dimensional structure of traits; see, e.g., Marsh et al., 2010).

We employed the robust maximum likelihood estimator (MLR) which is robust to nonnormality of the observed variables. To deal with missing data, we used the full information maximum likelihood method (FIML). FIML has been found to result in trustworthy, unbiased estimates for missing values (Enders, 2010; Jeličić et al., 2009). To evaluate model fit, we employed the comparative fit index (CFI), the Tucker–Lewis index (TLI), the root-mean-square error of approximation (RMSEA), and the standardized root mean residual (SRMR). As RMSEA may be biased in models with small degrees of freedom (Kenny et al., 2015), we used this index for models with three or more degrees of freedom only. Traditionally, values of CFI and TLI higher than .90 and close to .95, values of RMSEA lower than .06, and values of SRMR lower than .08 have been interpreted as indicating good fit (Browne & Cudeck, 1993; Hu & Bentler, 1998). However, these recommended cutoff values were derived from simulated data and are often not met with more complex datasets, suggesting that they should be used with caution (Marsh et al., 2004).

The CFAs for the emotion scales fit the data well. For most scales, the $\chi^2$ statistic was not significant. Fit indexes were CFI > .97, TLI > .92, RMSEA < .07 (where applicable), and SRMR < .04 for all scales (see Supplemental Table S2). These findings indicate that each of the 11 emotion constructs included in the study can be modeled well using CFA.

### *Correlations Between Emotions*

Factor scores derived from the CFAs were used to estimate the correlations between the emotions. The factor determinacy indexes for these scores (see Supplemental Table S3) suggest that the loss of precision due to using factor scores was acceptable (Rigdon et al., 2019). The findings demonstrate that the emotion constructs were sufficiently independent (Supplemental Table S1). To avoid underestimation of the size of the relations, we disattenuated the correlations using McDonald's ω derived from the CFAs (Supplemental Table S3). All 55 disattenuated correlations were below $r = .72$, and 43 were below .50, documenting that the emotions represented in the taxonomy can be considered separate empirical constructs. Within the domains of positive and negative emotions, correlations were positive; the correlations between positive and negative emotions were moderately negative. An interesting exception is relief, which correlated negatively with relaxation and positively with anxiety. Relief occurs when a stressful and anxiety-provoking situation comes to a positive end (Sweeny & Vohs, 2012), such as receiving a good grade after having anticipated failure. This contingency in occurrence may explain correlational links of relief with tension and anxiety. Overall, the results align with previous findings on relations between achievement emotions (Pekrun et al., 2011), and they extend them to a broader range of emotions.

### *Facet Analysis*

We used a two-level facet analysis approach. The factor scores derived from the emotion CFAs were used to represent the emotions. The emotion scores and orthogonal contrasts representing the facets were located at Level 1 and persons at Level 2 (i.e., emotions were nested under persons in the analysis). We constructed four contrasts representing the dimensions: (a) Valence (positive vs. negative, coded +1 and −1, respectively); (b) Arousal (activating vs. deactivating; coded +1 and −1, respectively); (c) Object Focus 1 (activity vs. outcome; coded +1 and −1, respectively); and (d) Object Focus 2 (prospective vs. retrospective; prospective outcome emotions, retrospective outcome emotions, and activity emotions coded +1, −1, and 0, respectively).

We used MLwiN (Version 2.36; Rasbash et al., 2016) to examine how these contrasts and their interactions explain variation in the participants' scores across the emotions (see Supplemental Materials, section on sample MLwiN syntax for the specification of the model). The emotion scores were person-mean centered in the analysis. At Level 1, the model estimated the within-person effects of the facets on participants' emotion scores. These effects show the degree to which a person's answers depend on the assignments of the emotions to the facets. At Level 2, the model estimates the variances and covariances of these within-person effects. The variances imply that there are between-person differences in the "sensitivity" of the emotion scores to the respective facet. Table 2 depicts the variances and the percentages of the total variation explained by the facets and their interactions. The findings show that all three dimensions (valence, arousal, object focus) contributed significantly to explaining the variation of the within-person effects.

### *Multiple-Emotion Factor Models Versus One- and Two-Factor Models*

We examined whether separate factors for each emotion are needed to represent the data, or if more parsimonious models combining different emotions into integrative factors show equal fit. To avoid convergence problems, we performed these analyses separately for positive and negative emotions. For each of these two groups of emotions, we used exploratory structural equation modeling (ESEM) to test multifactor models against one- and two-factor models. In contrast to CFA, ESEM allows testing cross-loadings of items on multiple factors, which is consistent with our view of emotions as nondiscrete categories. In addition, ESEM typically leads to a more realistic discrimination of constructs (e.g., Marsh et al., 2010).

In the multifactor models, we estimated separate factors for the different emotions within each emotion group. The one-factor models included one single bipolar factor (high vs. low arousal), and the two-factor models included two separate factors representing high- and low-arousal emotions. We included the same correlations between residuals as in the single-emotion CFAs. To estimate the model parameters, we used target rotation. To make it possible to compare the present ESEM findings with results from CFA, we conducted a supplemental analysis testing the same models using CFA (see Supplemental Table S4).

For the positive emotions, the multiple-emotion model fit the data well (CFI = .971, TLI = .952, RMSEA = .039, SRMR = .024; Table 3). In contrast, the one-factor model was clearly not acceptable. The two-factor model showed a slightly better but still unacceptable fit. Similarly, for the negative emotions, the multiple-emotion model showed a good fit to the data (CFI = .957; TLI = .935; RMSEA = .042; SRMR = .025). The one-factor and two-factor models showed poor fit relative to the fit of the multiple-emotion model. In the multiple-emotion models, all items showed strong loadings on their target factors (λs = .47–.96). In contrast, cross-loadings on other emotion factors were generally low (λs < .27). This finding further underscores the discriminant validity of the emotion scores.

In sum, these results indicate that all of the emotions considered in this study occur in achievement settings as represented by the undergraduate classroom. Furthermore, the findings support the structural validity of the proposed taxonomy. Specifically, the results document the separability of the emotion constructs and the importance of all three dimensions in accounting for the structure of the achievement emotions domain. To adequately conceptualize the diverse emotional experiences occurring in achievement settings, the findings suggest that we should distinguish between the emotions represented in the taxonomy, rather than reduce these emotions to just one or two factors.

## Study 2

Study 2 aimed to replicate and extend Study 1. First, we sought to replicate the Study 1 findings on the internal structure of the domain of achievement emotions and extended the analysis by including assurance. Second, we investigated relations of these emotions with

**Table 2**
*Facet Analysis of the Achievement Emotion Taxonomy*

| | Study | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | 2 | | | 3–Time 1 | | | 3–Time 2 | | | 3–Time 3 | | | 4 | | |
| Predictor | Est | *SE* | % | Est | *SE* | % | Est | *SE* | % | Est | *SE* | % | Est | *SE* | % | Est | *SE* | % |
| Valence (V) | **.175** | .014 | 42.7 | **.204** | .007 | 42.5 | **.195** | .008 | 37.9 | **.279** | .008 | 47.2 | **.267** | .008 | 48.0 | **.253** | .025 | 59.9 |
| Arousal (A) | **.020** | .002 | 4.8 | **.025** | .007 | 5.3 | **.023** | .008 | 4.4 | **.022** | .008 | 3.7 | **.019** | .008 | 3.4 | **.020** | .003 | 4.7 |
| Object Focus 1 (OF1) | **.017** | .001 | 4.1 | **.016** | .003 | 3.4 | **.023** | .004 | 4.4 | **.024** | .004 | 4.0 | **.025** | .004 | 4.5 | **.012** | .001 | 2.8 |
| Object Focus 2 (OF2) | **.037** | .003 | 9.0 | **.065** | .011 | 13.5 | **.063** | .012 | 12.2 | **.056** | .013 | 9.4 | **.050** | .012 | 9.0 | **.022** | .003 | 5.2 |
| V × A | **.014** | .001 | 3.4 | **.016** | .007 | 3.4 | **.015** | .008 | 2.9 | **.018** | .008 | 3.0 | **.018** | .008 | 3.2 | **.010** | .002 | 2.4 |
| V × OF1 | **.022** | .002 | 5.3 | **.020** | .003 | 4.2 | **.038** | .004 | 7.3 | **.041** | .004 | 6.9 | **.040** | .004 | 7.2 | **.010** | .001 | 2.4 |
| V × OF2 | **.046** | .004 | 11.2 | **.045** | .011 | 9.5 | **.045** | .012 | 8.7 | **.042** | .013 | 7.1 | **.045** | .012 | 8.1 | **.027** | .003 | 6.4 |
| A × OF1 | **.010** | .001 | 2.4 | **.010** | .003 | 2.1 | **.014** | .004 | 2.7 | **.018** | .004 | 3.0 | **.016** | .004 | 2.9 | **.009** | .001 | 2.1 |
| A × OF2 | **.024** | .002 | 5.8 | **.031** | .011 | 6.5 | **.057** | .012 | 11.0 | **.048** | .013 | 8.1 | **.045** | .012 | 8.1 | **.018** | .003 | 4.3 |
| V × A × OF1 | **.009** | .001 | 2.2 | **.009** | .003 | 1.8 | **.008** | .004 | 1.5 | **.008** | .004 | 1.3 | **.009** | .004 | 1.6 | **.021** | .003 | 5.0 |
| V × A × OF2 | **.035** | .003 | 8.5 | **.034** | .011 | 7.2 | **.033** | .012 | 6.4 | **.034** | .013 | 5.7 | .022 | .012 | 4.0 | **.020** | .003 | 4.7 |
| Total | .409 | | 100.0 | .475 | | 100.0 | .514 | | 100.0 | .590 | | 100.0 | .556 | | 100.0 | .422 | | 100.0 |

*Note*. Est = estimate of variance (absolute values); % = percentage of total variation; *SE* = standard error. The total variation was obtained by summing the variance components for the effects of the facets and their interactions. V × A, V × OF1, V × OF2, A × OF1, and A × OF2 are two-way interactions. V × A × OF1 and V × A × OF2 are three-way interactions. Bold coefficients: $p < .05$.

three groups of antecedents and outcomes: personality traits, use of learning strategies, and cognitive performance. In a supplemental analysis, we examined the discriminant validity of the emotion scores relative to motivation variables (fear of failure and achievement goals; see Supplemental Materials).[1] To contextualize the assessments, we embedded them in a university course and measured emotions, strategies, and performance related to this course. The course was presented face-to-face in lecture format, and evaluation was based on a normative grading structure. To ensure that any observed relations were not mere artifacts of other plausible variables, we controlled for gender, age, and academic ability in the analysis. We based the study on the following theoretical considerations.

## Structure of Achievement Emotions

We expected to replicate the Study 1 results on the discriminant validity of the emotion scales representing the taxonomy, and on the relevance of all three dimensions of the taxonomy to explain the emotion scores. We extended the analysis by including assurance, thus considering the full set of 12 emotions. We expected the assurance scale to show similar discriminant validity as the other emotion scales. Due to differences in object focus, we hypothesized that assurance would differ even from relaxation and relief, the other two emotions that share the same position on the valence and arousal dimensions (i.e., positive and deactivating).

## Personality Antecedents

We hypothesized that achievement emotions are grounded in personality traits. We used the Big Five factor model to consider traits, as this model currently represents the best-validated framework to conceptualize personality (e.g., Ludeke et al., 2019). Evidence for relations between achievement emotions and the Big Five traits is lacking, except for a few studies showing that test anxiety is linked to neuroticism (Hoferichter et al., 2014; Thomas & Cassady, 2019). However, there is broad evidence documenting relations between traits and general propensities to experience emotions (reviews in Hughes et al., 2020; Komulainen et al., 2014; Steel et al., 2008) as well as momentary emotional reactions (see, e.g., Wrzus et al., 2021).

Extant studies suggest that neuroticism sensitizes individuals to negative stimuli and to experiencing negative emotions, and that it is negatively related to pleasant deactivating states such as relaxation and calmness. In contrast, although related findings are less consistent, extraversion is thought to sensitize people to positive stimuli and to experiencing positive emotions (Komulainen et al., 2014). Based on this evidence, we expected negative achievement emotions to be linked to neuroticism, and positive achievement emotions to be linked to extraversion. Positive links with positive emotions were also reported for openness, agreeableness, and conscientiousness (see the meta-analysis in Steel et al., 2008). These links were relatively weak in the available studies. However, given that both achievement emotions and core facets of conscientiousness are embedded in the achievement context, we hypothesized positive achievement emotions would be clearly positively related to conscientiousness.

## Learning Strategies

Achievement emotions are prime drivers of cognitive and behavioral processes underlying performance. As such, we expected achievement emotions to relate to cognitive and motivational facets of strategy use. We focused on the availability of cognitive resources in terms of working memory capacity, use of cognitive learning strategies, effort investment, and self- versus external regulation of learning. Based on the cognitive-motivational model of emotion effects that is part of control-value theory (Pekrun, 2006, 2018), we expected positive activating emotions such as task enjoyment to preserve cognitive resources, facilitate flexible strategies like elaboration of learning material and critical thinking, and promote the

[1] The correlations between the achievement emotions, on the one hand, and fear and failure and achievement goals, on the other, were small to moderate in size, thus further attesting to the discriminant validity of the achievement emotion scores (range of latent correlations ρ = .013–.605; see Supplementary Materials, section Study 2 Materials).

**Table 3**

*Multiple-Emotion Models, One-Factor Models, and Two-Factor Models for Achievement Emotions*

| | Multiple-emotion model | | | | | One-factor model | | | | | Two-factor model | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Study | $\chi^2$ (*df*) | CFI | TLI | RMSEA/ SRMR | | $\chi^2$ (*df*) | CFI | TLI | RMSEA/ SRMR | | $\chi^2$ (*df*) | CFI | TLI | RMSEA/ SRMR | |
| | | | | | | Positive emotions | | | | | | | | | |
| 1 | 345.14 (230) | .971 | .952 | .039 | .024 | 1666.97 (332) | .660 | .613 | .111 | .134 | 1202.18 (305) | .809 | .764 | .087 | .085 |
| 2 | 464.16 (301) | .962 | .937 | .048 | .023 | 1713.47 (446) | .703 | .670 | .110 | .114 | 1338.95 (415) | .783 | .741 | .098 | .080 |
| 3–T1 | 446.48 (301) | .973 | .956 | .042 | .021 | 2586.17 (446) | .610 | .566 | .132 | .164 | 1729.56 (415) | .754 | .707 | .115 | .097 |
| 3–T2 | 386.85 (301) | .983 | .972 | .034 | .019 | 2187.22 (446) | .653 | .614 | .125 | .155 | 1638.08 (415) | .756 | .709 | .108 | .086 |
| 3–T3 | 474.78 (301) | .968 | .947 | .049 | .020 | 2382.51 (446) | .638 | .598 | .135 | .163 | 1729.56 (415) | .739 | .688 | .112 | .091 |
| | | | | | | Negative emotions | | | | | | | | | |
| 1 | 1144.55 (726) | .957 | .935 | .042 | .025 | 2746.17 (946) | .813 | .786 | .076 | .098 | 2072.60 (900) | .878 | .854 | .063 | .060 |
| 2 | 1053.67 (726) | .954 | .932 | .044 | .027 | 2387.36 (946) | .798 | .769 | .081 | .103 | 1872.00 (900) | .864 | .836 | .068 | .075 |
| 3–T1 | 1115.63 (726) | .961 | .941 | .044 | .022 | 3281.07 (946) | .765 | .731 | .094 | .158 | 2154.24 (900) | .874 | .848 | .071 | .053 |
| 3–T2 | 1151.24 (726) | .957 | .935 | .048 | .023 | 3115.76 (946) | .778 | .747 | .096 | .142 | 2196.60 (900) | .868 | .841 | .076 | .054 |
| 3–T3 | 1239.33 (726) | .944 | .917 | .055 | .024 | 2890.65 (946) | .789 | .759 | .093 | .146 | 1951.51 (900) | .886 | .863 | .070 | .052 |

*Note.* T1, T2, T3 = Time 1, Time 2, Time 3, respectively. CFI = confirmatory fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root mean residual.

investment of effort. In addition, we expected these emotions to facilitate self-regulation, as self-regulation requires flexible goal setting, planning, strategy deployment, and monitoring of progress. We expected the opposite pattern of relations for negative deactivating emotions, such as boredom and hopelessness. These emotions can deplete cognitive resources through task-irrelevant thinking and mind wandering, undermine task motivation, and reduce systematic use of strategies, leading to shallow information processing.

For positive deactivating and negative activating emotions, we posit that relations with strategy use will be more variable (see also Cheng & McCarthy, 2018). Positive deactivating emotions, such as relaxation, assurance, and relief, may undermine immediate motivation to invest effort, but may also reinforce motivation to reengage with achievement activities later. This leaves it open to question whether the overall relations with effort are positive or negative. Negative activating emotions like anxiety and shame trigger task-irrelevant thinking, such as worries about possible failure in anxiety. Furthermore, they can undermine interest, intrinsic motivation, use of flexible strategies, and self-regulation. On the other hand, these emotions may promote extrinsic motivation to avoid failure, facilitate use of more rigid strategies such as rehearsal of learning material, and promote external regulation in terms of relying on task assignments and directions by others.

These propositions align with existing evidence for several major achievement emotions including enjoyment, anxiety, and boredom (Cheng & McCarthy, 2018; Kleine et al., 2019; Loukidou et al., 2009; Pekrun & Linnenbrink-Garcia, 2014b). Specifically, in academic contexts, enjoyment was related negatively to task-irrelevant thinking and positively to use of flexible strategies, effort, and self-regulation. Conversely, anxiety and boredom were related positively to irrelevant thinking and negatively to flexible learning, effort, and self-regulation. There is also preliminary, albeit weak evidence for a positive link between anxiety and the use of rehearsal (Pekrun et al., 2011). However, evidence for positive deactivating emotions is largely lacking. Especially for relaxation and assurance, the present study breaks new ground by examining links with strategy use.

## Performance Outcomes

Due to their impact on cognitive and motivational processes, achievement emotions should also influence resulting achievement outcomes. Positive activating emotions should exert positive effects, and negative deactivating emotions negative effects. The effects of negative activating emotions may be more variable. However, for most individuals, relations with performance as indicated by academic grades in school or supervisor ratings at work may be negative as well. We left as an exploratory question how positive deactivating emotions relate to performance.

Relations with performance have been a prime focus of prior research on achievement emotions. Systematic reviews and meta-analyses have confirmed the proposed links for enjoyment, anger, anxiety, and boredom in educational settings (Barroso et al., 2021; Camacho-Morles et al., 2021; Hembree, 1988; Loderer et al., 2020), the workplace (Cheng & McCarthy, 2018; Ford et al., 2011; Loukidou et al., 2009), and sports (Kleine, 1990). Furthermore, a few longitudinal studies suggest that these relations are, in fact, due to effects of emotions on performance, in addition to reverse effects of performance success and failure on the development of emotions (see Pekrun, Lichtenfeld, et al., 2017). However, evidence for other emotions is scarce, and completely lacking for relaxation and assurance.

To examine the link between emotions and performance, we considered two approaches used in the literature. Constructs for different emotions are distinct, yet share commonalities from both theoretical and statistical perspectives. Given this duality of emotions, one approach is to conceptualize different emotions as discrete constructs. The second approach focuses on common dimensions of emotions, most notably positive versus negative valence, and examines emotions using these dimensions (while disregarding differences between single emotions). Most often, based on the valence dimension, different emotions have been combined into constructs of positive and negative affect.

Both approaches are commonly used in research on the performance outcomes of emotions. For example, many studies on the effects of emotion on memory have induced positive or negative

affective states without distinguishing between discrete emotions. Others have focused on the effects of single emotions such as anxiety (see Mikels & Reuter-Lorenz, 2019). We regard the two approaches as complementary and use both in our analysis of achievement emotions and performance.

## Method

The data set for this study is part of a larger project that used a prospective design to analyze personality and motivation in a sample of university students (see Wallace et al., 2022; Weissman et al., 2022). The present study used the data on achievement emotions, personality traits, learning strategies, and course performance.

### *Sample and Procedure*

Participants were 235 undergraduate students (55.7% female; mean age = 19.36 years, *SD* = 1.35) in a social–personality psychology course at a large Northeastern University in the United States. Ethnic background was 48.5% Caucasian, 30.2% Asian, 8.1% Hispanic, 6.4% African American, and 6.8% other. Ethics approval was obtained from the institution's ethics committee (Protocol No. 1176). Participation in the study was voluntary, and students received course credit for their participation. Students completed the self-report measures in two different online assessments. Personality and demographic variables were assessed in the second week of the semester; achievement emotions and learning strategies were assessed 8 weeks later. Exam performance data were obtained from the course professor at the end of the semester.

### *Measures*

**Achievement Emotions.** We used the same AEQ-R as in Study 1 to assess achievement emotions. All 12 scales of the instrument were included. To contextualize the assessment, instructions asked participants to report their emotions in the current social–personality psychology course. Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (α range .82−.94; Supplemental Table S1).

**Personality.** The Big Five personality traits were assessed with the NEO-Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992). The instrument includes five 12-item scales measuring neuroticism (e.g., "I often feel tense and jittery"), extraversion (e.g., "I like to have a lot of people around me"), openness (e.g., "I have a lot of intellectual curiosity"), agreeableness (e.g., "I try to be courteous to everyone I meet"), and conscientiousness (e.g., "I work hard to accomplish my goals"). Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (α range = .75–.87; Supplemental Table S7).

**Learning Strategies.** We included measures of cognitive resources as indicated by task-irrelevant thinking; cognitive learning strategies; effort; self-regulation of learning; and external regulation of learning. Task-irrelevant thinking was assessed with Sarason's (1984) Task-Irrelevant Thinking Scale (10 items; e.g., "My mind wanders during tests"). Cognitive learning strategies and effort were measured with scales from Pintrich et al.'s (1991) Motivated Strategies for Learning Questionnaire (MSLQ), including elaboration (six items; e.g., "I try to relate ideas in the subject to those in other courses whenever possible"), critical thinking (five items; e.g., "I often find myself questioning things I hear or read in this course to decide if I find them convincing"), rehearsal (four items; e.g., "When I study for this course, I practice saying the material to myself over and over"), and effort (four items; e.g., "I work hard to do well in this course even if I don't like what we are doing"). Behavioral regulation was assessed with Goetz's (2004; Pekrun et al., 2011) Self-Regulation of Learning Scale (four items; e.g., "When studying for this course, I set my own goals that I want to achieve") and External Regulation of Learning Scale (three items; e.g., "The way I study in this course largely depends on the professor's recommendations"). Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (α range = .64–.95; Supplemental Table S9).

**Performance.** We used participants' scores on their three course exams as a measure of performance (α = .89 for the sum score of the three measures). The exams had a multiple-choice, fill-in-the-blank, and essay format.

**Demographic Variables.** Gender, age, and academic ability were used as covariates in the analysis. Gender was coded 1 = male, 2 = female. Scores from the Critical Reading, Writing, and Math subscales of the scholastic aptitude test (SAT) were used as indexes of academic ability (α = .76 for the sum score of the three indexes).

## Results and Discussion

### *Distributions of Emotion Scores*

Replicating the Study 1 findings, mean values and variances indicate that students reported all 12 emotions representing the taxonomy (Supplemental Table S1). Importantly, the mean value for the new assurance construct was near the midpoint of the 5-point scale (*M* = 3.12), with substantial variation around the mean (*SD* = 1.12), showing that participants endorsed this emotion while displaying sizable interindividual differences.

### *Testing the Structure of the Taxonomy*

**Confirmatory Factor Analysis for Emotion Scales.** We used the same SEM procedures as in Study 1. The CFAs for the emotion scales fit the data well (Supplemental Table S2), replicating the Study 1 results. Despite the sample size, the $\chi^2$ statistic was not significant for most of the scales. Fit indexes were CFI > .98, TLI > .91, RMSEA < .08 (where applicable), and SRMR < .03 for all CFAs. RMSEA for the anxiety model was an exception, although still in the acceptable range (.095). The CFA results for assurance were especially promising, with CFI = .989, TLI = .966, SRMR = 0.20, and factor loadings ranging from .77 to .92, attesting to the factorial robustness of this new construct.

**Correlations Between Emotions.** Again, the disattenuated correlations between factor scores (Supplemental Table S1) demonstrate that the emotions are sufficiently independent. All of the correlations were below *r* = .78, and most were below .50, supporting discriminant validity of the emotion scores. The pattern of correlations replicated the Study 1 findings, with positive relations between positive emotions, positive relations between negative emotions, and negative relations between the two groups of emotions. Again, relief was an exception, displaying positive relations with both positive emotions and anxiety.

The findings also indicate discriminant validity for the assurance scale. As expected, this prospective, deactivating positive emotion

was most closely related to emotions in adjacent cells of the taxonomy with which it shared positions on two of the three dimensions of the taxonomy, most notably hope (positive, prospective) and relaxation (positive, deactivating). Nevertheless, assurance was clearly distinct from these emotions (*r*s < .65). Similarly, correlations of assurance with anxiety and shame were moderate (*r*s < .37), indicating that assurance is not simply the opposite of these activating negative emotions.

**Facet Analysis.** We used the same facet-analytic approach as in Study 1. The results almost exactly replicated the Study 1 findings (Table 2). Again, all three dimensions and their interactions explained substantial parts of the variance.

**Multiple-Emotion Models Versus One- and Two-Factor Models.** We used the same ESEM procedures as in Study 1 (Table 3; for results from CFA, see Supplemental Table S4). Relative to the multiple-emotion models, the one-factor and two-factor models did not fit the data well. In contrast, fit for the multiple-emotion models was excellent, with CFI > .95, TLI > .93, RMSEA < .05, and SRMR < .03. As such, replicating the Study 1 results, the findings confirm that it is appropriate to draw the distinctions between the emotions in our proposed taxonomy.

### *Personality Antecedents*

To examine the power of the Big Five traits to predict the emotions, we conducted latent regression analyses controlling for students' gender, age, and SAT scores (Table 4; for bivariate correlations derived from these analyses, see Supplemental Table S7). Personality traits and emotions were evaluated as latent variables. Supporting our hypotheses, the results showed that three of the five traits were especially predictive of the achievement emotions even when controlling for the other traits and demographic variables (Table 4).

Neuroticism positively predicted all negative emotions as well as relief. As noted earlier, relief may be contingent on a preceding stress experience, thus explaining why relief shows similar relations to antecedent variables as negative emotions. In addition, neuroticism negatively predicted hope, relaxation, and assurance. Extraversion was a positive predictor of both positive and negative achievement emotions. Specifically, extraversion positively predicted both pride and shame, suggesting that extraverts may be prone to experiencing self-conscious emotions in an achievement context. Conscientiousness positively predicted most of the positive emotions, and negatively predicted hopelessness and disappointment. It is plausible that individual propensities to strive for excellence and get jobs done in a timely manner facilitate the experience of positive emotions in achievement settings. Finally, a negative link between openness and anxiety emerged, indicating that being open to intellectual challenges may reduce anxiety in an achievement context.

Overall, personality traits were significant predictors of 11 of the 12 achievement emotions. All five traits contributed to the prediction, and jointly these traits explained significant portions of the variance in the emotion scores. Most of the predictive relations were modest ($|\beta| \leq .31$), suggesting discriminant validity of the emotion scores. An exception was the strong positive links between neuroticism and the negative achievement emotions (up to $\beta = .67$). These links are in line with the existing evidence on relations between neuroticism and test anxiety cited earlier (Hoferichter et al., 2014; Thomas & Cassady, 2019). Their size is in the same range as correlations between personality scales measuring the same trait (Pace & Brannick, 2010). As such, these links suggest that negative achievement emotions could be considered domain-specific variants of a proneness to experience negative emotions more generally.

The Big Five traits represent dispositions that are generalized across situational contexts. In contrast, achievement emotions relate to a specific type of settings. Given different specificity, general traits and context-specific emotions such as achievement emotions are not conceptually symmetric, which may explain the modest size of their links (see Kretzschmar et al., 2018; Kretzschmar & Nebe, 2021, for the importance of construct symmetry in explaining relations between personality and other variables). An exception is conscientiousness. At least two facets of this trait (i.e., competence, achievement striving) relate to achievement, suggesting (partial) contextual symmetry.

The asymmetry between achievement emotions and general traits begs the question: How would these emotions relate to achievement-specific variants of the Big Five factors? The present data yield answers for fear of failure, which can be interpreted as an achievement-related variant of the anxiety facet of neuroticism. As detailed in the Supplemental Materials (section Study 2 Materials), latent correlations between fear of failure and the achievement emotions ranged from $\rho = .17$–$.60$, with the highest correlation observed for fear of failure and achievement anxiety. These correlations support the discriminant validity of the achievement emotion scales. However, they also suggest that there may be substantial links between achievement emotions and achievement-related lower-level personality traits. It would be an interesting avenue for future research to more broadly explore relations between achievement emotions, on the one hand, and achievement-related variants of the Big Five traits and their facets, on the other.

### *Learning Strategies*

To analyze links between the emotions and learning, we estimated latent correlation models. Each model included one emotion variable and the seven learning variables, estimated as latent constructs. In line with our hypothesis that positive activating emotions preserve cognitive resources, enjoyment, hope, and pride related negatively to task-irrelevant thinking (Supplemental Table S9). Similarly, correlations were negative for relaxation and assurance, suggesting that these deactivating emotions do not detract attention from task performance. In contrast, and as expected, all negative emotions showed substantial positive associations with irrelevant thinking, indicating that these emotions undermine task attention. Relief did not correlate with irrelevant thinking, likely due to its co-occurrence with negative emotions.

Also in line with our hypotheses, there were positive correlations between positive activating emotions (enjoyment, hope, pride) and use of flexible strategies (elaboration and critical thinking). Anger and boredom related negatively to these strategies. In addition, all of the positive emotions related positively to rehearsal. Counter to our expectations, anxiety did not correlate with rehearsal, suggesting that anxiety did not promote more rigid forms of learning in the present context. Furthermore, all of the positive emotions related positively to effort. To the extent that effort can be considered an indicator of motivation, this finding suggests that positive achievement emotions promote students' overall motivation to learn. In contrast, the correlations of anxiety and shame with effort were

**Table 4**

*Personality Traits as Predictors of Achievement Emotions: Latent Multiple Regression Analysis (Study 2)*

| Predictor | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Enjoyment | | Hope | | Pride | | Relaxation | | Assurance | | Relief | |
| Neuroticism | –.143 | .094 | **–.216** | .092 | –.045 | .097 | **–.310** | .086 | **–.242** | .084 | **.260** | .112 |
| Extraversion | .133 | .109 | .042 | .090 | **.211** | .106 | .014 | .102 | **.186** | .089 | .156 | .123 |
| Openness | .001 | .117 | .107 | .085 | .006 | .087 | .091 | .087 | .093 | .086 | .056 | .114 |
| Agreeableness | –.003 | .105 | **.189** | .096 | .109 | .104 | –.008 | .101 | .033 | .086 | **.224** | .109 |
| Conscientiousness | .177 | .091 | **.193** | .088 | **.252** | .084 | **.215** | .083 | **.246** | .077 | .107 | .093 |
| Gender | –.008 | .092 | –.070 | .079 | –.099 | .082 | –.091 | .077 | **–.223** | .071 | –.045 | .084 |
| Age | –.072 | .074 | .048 | .085 | –.023 | .060 | .065 | .065 | –.003 | .060 | –.105 | .083 |
| SAT | **.244** | .077 | .093 | .072 | .116 | .075 | .140 | .074 | **.238** | .074 | .057 | .106 |
| $R^2$ | **.135** | .049 | **.178** | .051 | **.154** | .055 | **.204** | .059 | **.298** | .062 | **.147** | .062 |
| | Anger | | Anxiety | | Shame | | Boredom | | Hopelessness | | Disappointment | |
| Neuroticism | **.411** | .080 | **.672** | .078 | **.570** | .076 | **.353** | .092 | **.580** | .063 | **.337** | .084 |
| Extraversion | .139 | .095 | **.220** | .090 | **.273** | .086 | .058 | .101 | .112 | .076 | **.223** | .082 |
| Openness | –.137 | .078 | **–.186** | .092 | –.113 | .078 | .000 | .104 | –.102 | .077 | –.054 | .085 |
| Agreeableness | –.144 | .101 | .169 | .098 | –.080 | .084 | **–.207** | .102 | –.007 | .081 | –.126 | .093 |
| Conscientiousness | –.152 | .086 | –.091 | .095 | –.092 | .073 | .039 | .087 | **–.147** | .072 | **–.153** | .077 |
| Gender | –.133 | .083 | .087 | .079 | .096 | .073 | –.109 | .086 | –.035 | .066 | .127 | .076 |
| Age | .079 | .076 | –.040 | .067 | –.035 | .070 | –.001 | .065 | **.148** | .072 | –.003 | .064 |
| SAT | .016 | .076 | .027 | .087 | .020 | .094 | –.071 | .091 | –.094 | .065 | –.057 | .084 |
| $R^2$ | **.253** | .064 | **.493** | .084 | **.240** | .050 | **.183** | .063 | **.356** | .059 | **.188** | .058 |

*Note*. Gender is coded 1 = male, 2 = female. SAT = scholastic aptitude test; *SE* = standard error. $p < .05$, .01, and .001 for $|\beta| > 1.96$, 2.58, and 3.29 *SE*, respectively. Bold coefficients: $p < .05$.

near zero, possibly due to variable effects of these emotions on intrinsic versus extrinsic motivation to learn, as argued earlier.

Finally, as expected, the positive emotions related positively to self-regulation, whereas relations were negative for the negative emotions. These associations were especially strong for the future-oriented, prospective emotions hope and assurance (ρs = .73 and .59, respectively; *p*s < .001). In contrast, relations with external regulation were weaker. As hypothesized, anxiety related positively to external regulation, suggesting that anxiety motivates individuals to rely on external guidance.

In interpreting these associations, it should be noted that reciprocal effects may have contributed to the observed correlations. It seems likely that achievement emotions influence the use of learning strategies, but that strategy use reciprocally influences emotions. For example, task enjoyment is likely to facilitate flexible self-regulation, but self-regulated task performance may be more enjoyable than externally directed performance. Future research needs to examine these possible reciprocal effects.

### *Performance Outcomes*

We used SEM to examine how achievement emotions related to students' course performance, controlling for gender, age, and SAT scores. Emotions, performance, and SAT scores were modeled as latent variables. Although the emotion constructs were empirically distinct, there was multicollinearity between them in the data set (Supplemental Table S1). As such, separate models were estimated for the different emotions. In addition, following the procedure recommended by Pekrun, Lichtenfeld, et al. (2017), we estimated an integrative model combining all emotions into two higher order positive and negative affect factors. As such, the present analysis combines two strategies to deal with multicollinearity: using single variables (single-emotion models), and combining them by constructing summary variables (integrative affect model). In each model, we included effects of the covariates on both emotion and achievement (Figure 2).

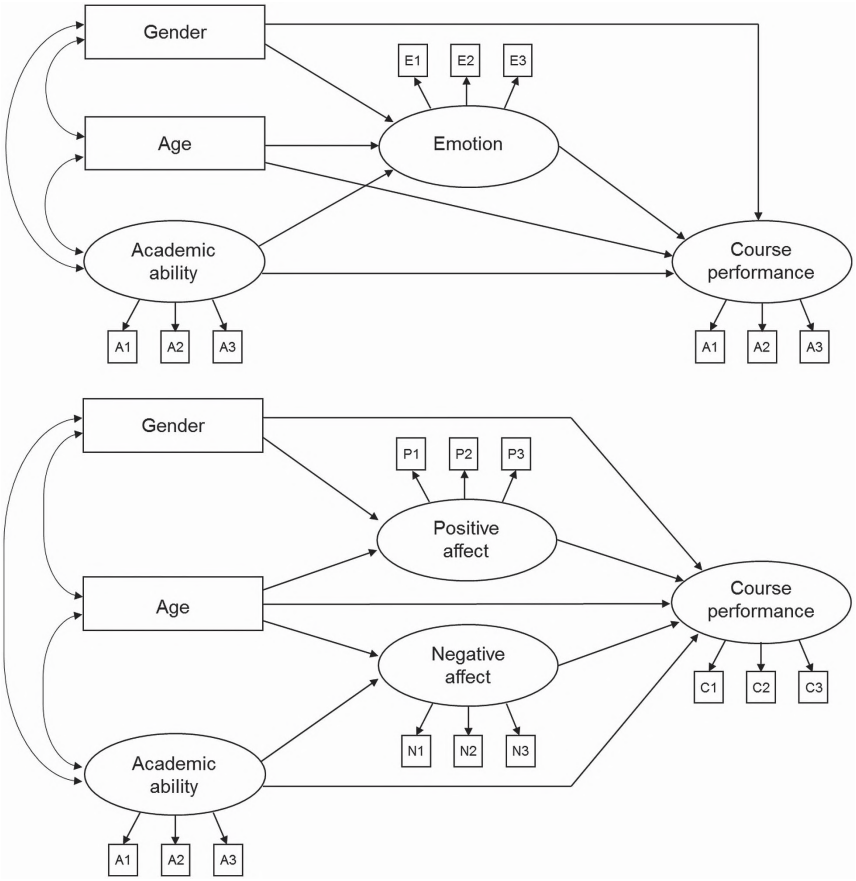
The single-emotion models fit the data well, with CFI > .95, TLI > .93, RMSEA < .06, and SRMR < .07 for all models (Supplemental Table S8). SAT scores had positive effects on course performance in each of the models. Above and beyond these effects, all emotions were significant predictors of performance, except for relief and boredom (Table 5). These effects were positive for the positive emotions and negative for the negative emotions. They were especially strong for the prospective emotions hope, assurance, and hopelessness (βs = .45, .34, and –.33, respectively; *p*s < .001). Specifically, hope was the strongest single predictor of performance. The latent correlation between hope and performance (ρ = .48, Supplemental Table S8) derived from SEM was significantly higher than the performance correlations for any other emotion (*p*s < .01 for all pairwise comparisons of correlations).

In the positive and negative affect model, we estimated the effects of positive and negative emotions combined while controlling for the covariates. ESEM with target rotation was used to estimate the positive and negative affect factors. To limit the number of estimated parameters, we used factor scores derived from the emotion CFAs as indicators of the two affect factors. As in Study 1, the factor determinacy indexes for the emotion factor scores (Supplemental Table S3) suggest that the loss of precision due to using factor scores was acceptable (Rigdon et al., 2019). Course performance and SAT scores were evaluated as latent variables.

The model fit the data well (Supplemental Tables S8 and S10). All positive emotions showed positive loadings on the positive affect factor (range .40–.79), and all negative emotions showed positive loadings on the negative affect factor (range .40–.91). There were no substantial cross-loadings except for relief (.40 on positive affect, .31 on negative affect), in line with the distinct position of relief in the achievement emotions domain as discussed earlier. The positive and negative affect factors showed a negative correlation (ρ = –.45; $p < .001$), consistent

**Figure 2**

*Models for Achievement Emotion and Course Performance*




*Note*. Upper panel: single emotion model. Lower panel: integrated affect model.

with the negative correlations between the single positive and negative emotions (Supplemental Table S1).

Positive affect was a positive predictor of performance, $\beta = .290$, and negative affect was a negative predictor, $\beta = -.265$, controlling for the covariates ($ps < .01$; Supplemental Table S10). This analysis is not suited to demonstrate the unique effects of single emotions on performance. However, the findings imply that positive emotions positively contribute to performance over and above the effects of negative emotions, and that negative emotions contribute over and above the effects of positive emotions, while controlling for gender, age, and academic ability.

In a supplemental analysis, we additionally included the Big Five personality traits as predictors in the single-emotion models (see Supplemental Materials, section Study 2 Materials). Traits, emotions, SAT scores, and course performance were estimated as latent variables. The traits contributed to the prediction of course performance. Among the traits, conscientiousness had the strongest and most consistent predictive effects (Supplemental Table S11). On average across models, the effect was $\beta = .23$, which corresponds exactly to the average true relation (corrected for measurement error) between conscientiousness and university students' academic performance in the meta-analysis by Richardson et al. (2012; $\rho = .23$). Importantly, emotions continued to have significant and substantial predictive effects when including the traits. For example, the predictive effect of hope was $\beta = .41$ ($p < .001$), which is only marginally lower than the effect not including the traits ($\beta = .45$). In conclusion, achievement emotions contributed to predicting achievement over and above the predictive effects of personality traits, and were, in fact, stronger predictors than the traits.

In sum, the findings suggest that achievement emotions are strong predictors of cognitive performance. They extend prior research that has focused on links between anxiety and performance, and confirm that various other positive and negative achievement emotions also predict achievement. Our results show that hope, assurance, and hopelessness may be even stronger predictors than anxiety. It is sensible that these prospective emotions influence achievement, as they are likely to direct motivation to attain success, investment of effort, and deployment of strategies. Supporting this interpretation, hope, and assurance showed substantial positive relations with effort and self-regulation (Supplemental Table S9), which may explain why they were the strongest predictors of resulting course performance.

## Study 3

In Study 3, we again tested the internal structure of the domain of achievement emotions. In addition, we expanded the scope of

**Table 5**

*Structural Equation Models for Achievement Emotions and Performance (Study 2): Factor Loadings, Path Coefficients, and Residual Variances*

| Coefficient | Enjoyment model | | Hope model | | Pride model | | Relaxation model | | Assurance model | | Relief model | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Factor loadings | | | | | | | | | | | | |
| Emotion | .47–.85 | | .60–.92 | | .71–.90 | | .70–.83 | | .78–.91 | | .55–.79 | |
| Ach | .78–.99 | | .78–.95 | | .74–.99 | | .78–.95 | | .78–.91 | | .83–.90 | |
| SAT | .54–.97 | | .54–.96 | | .54–.96 | | .54–.96 | | .55–.96 | | .54–.97 | |
| Paths | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
| Emo → Ach | **.153** | .070 | **.459** | .062 | **.248** | .069 | **.286** | .069 | **.340** | .074 | .020 | .084 |
| Gender → Ach | .089 | .064 | .113 | .060 | .123 | .062 | **.135** | .063 | **.176** | .067 | .076 | .067 |
| Age → Ach | .081 | .063 | .048 | .060 | .071 | .064 | .047 | .063 | .079 | .065 | .101 | .067 |
| SAT → Ach | **.225** | 087 | **.256** | .073 | **.257** | .082 | **.244** | .078 | **.239** | .081 | **.276** | .082 |
| Gender → Emo | .014 | .069 | −.002 | .069 | −.031 | .068 | −.112 | .067 | **−.208** | .066 | .071 | .074 |
| Age → Emo | −.063 | .068 | .068 | .068 | −.017 | .068 | .100 | .067 | .019 | .067 | −.138 | .073 |
| SAT → Emo | **.195** | .076 | .066 | .080 | .075 | .078 | .140 | .076 | **.174** | .077 | .094 | .082 |
| Residual variances | .900 | | .692 | | .847 | | .826 | | .787 | | .908 | |

| Coefficient | Anger model | | Anxiety model | | Shame model | | Boredom model | | Hopelessness model | | Disappointment model | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Factor loadings | | | | | | | | | | | | |
| Emotion | .57–.85 | | .51–.87 | | .76–.84 | | .62–.89 | | .70–.91 | | .79–.92 | |
| Ach | .83–.91 | | .84–.89 | | .84–.90 | | .83–.90 | | .83–.92 | | .85–.88 | |
| SAT | .55–.96 | | .54–.96 | | .54–.97 | | .54–.96 | | .54–.96 | | .54–.96 | |
| Paths | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
| Emo → Ach | **−.268** | .073 | **−.274** | .086 | **−.275** | .071 | −.110 | .073 | **−.339** | .068 | **−.334** | .066 |
| Gender → Ach | .054 | .068 | **.140** | .068 | .118 | .066 | .062 | .067 | .114 | .064 | .113 | .064 |
| Age → Ach | .098 | .065 | .066 | .065 | .071 | .065 | .096 | .066 | .114 | .064 | .081 | .063 |
| SAT → Ach | **.289** | .081 | **.288** | .079 | **.281** | .078 | **.271** | .081 | **.262** | .079 | **.259** | .077 |
| Gender → Emo | **−.140** | .070 | **.229** | .071 | **.145** | .069 | −.136 | .069 | .025 | .066 | .102 | .068 |
| Age → Emo | .041 | .070 | −.124 | .070 | −.097 | .069 | −.021 | .068 | .087 | .065 | −.049 | .067 |
| SAT → Emo | −.002 | .082 | .032 | .082 | .028 | .080 | −.049 | .078 | −.099 | .076 | −.063 | .077 |
| Residual variances | .831 | | .837 | | .837 | | .897 | | .783 | | .797 | |

*Note*. Factor loadings, paths, and residual variances are standardized coefficients. Gender is coded 1 = male, 2 = female. Emo = emotion; Ach = achievement; SAT = scholastic aptitude test; *SE* = standard error. $p < .05$, 01, and .001 for $|\beta| > 1.96$, 2.58, and 3.29 *SE*, respectively. Bold path coefficients: $p < .05$.

antecedents and outcomes considered by assessing appraisals, context perceptions, and perceived health problems (Figure 1). The study included three assessments in a sample of German students and took place in the context of a university course. Using propositions from control-value theory, we hypothesized that achievement emotions would be linked to appraisals of control and value, and to individual perceptions of classroom instruction. Moreover, we explored whether achievement emotions relate to the frequency of everyday physical health problems; this study is the first to explore these relations for achievement emotions beyond test anxiety. All variables were assessed three times. Thus, we also aimed to investigate if achievement emotions, their interrelations, and their links with other variables are stable over time.

## Structure of Achievement Emotions

With multiple assessments of each achievement emotion, it was possible to jointly analyze convergent and discriminant validity of the emotion scales. Specifically, following recommendations by Marsh et al. (2020), we used a multitrait–multimethod (MTMM) perspective to examine validity. From this perspective, the emotions can be treated as different traits and the multiple assessments as different methods. Correlations between the same emotions across assessments represent convergent validity (monotrait-heteromethod relations), and correlations between different emotions within assessments represent discriminant validity (heterotrait–monomethod relations). In terms of convergent validity, we expected the emotions to show interindividual stability, rendering them trait-like across the time span covered by the study. In terms of discriminant validity, we expected to replicate the Study 1 and 2 findings on the intercorrelations and factor structures of the emotions. We also expected to replicate the facet-analytic findings from the first two studies on the relevance of the dimensions of the taxonomy for explaining variation in the emotion scores.

## Appraisal Antecedents

Based on control-value theory, we predicted that achievement emotions would relate to perceived control over achievement activities and their outcomes, and to the perceived value of these activities and outcomes (Pekrun, 2006, 2018, 2021). We expected that activity emotions depend on perceptions of control and the intrinsic value of the activity, and that outcome emotions depend on

perceptions of control and the value of success and failure. We hypothesized that perceived control generally promotes positive emotions and reduces negative emotions, with the possible exception of boredom. As proposed in control-value theory, boredom can be due to a lack of competence relative to task demands, implying overchallenge, or to high competence relative to task demands, implying underchallenge. As such, we left it open to question whether perceived control would relate negatively or positively to boredom. In addition, we considered the theory's proposal that relief in an achievement context is based on unexpected attainment of success and disappointment on unexpected failure.

We expected that the perceived intrinsic value of achievement activities promotes positive activity emotions (i.e., enjoyment, relaxation) and reduces negative activity emotions (anger, boredom). The perceived value of success was thought to promote positive outcome emotions related to success (hope, assurance, pride, and relief), and the perceived value of failure (i.e., the subjective importance of failure) was expected to increase negative outcome emotions related to failure (anxiety, hopelessness, shame, and disappointment).

Existing research has confirmed links between some of these appraisals and a few achievement emotions, including enjoyment, anxiety, and boredom (Forsblom et al., 2022; Pekrun & Perry, 2014; Putwain et al., 2021), but has not considered a broader range of appraisals and emotions. For example, evidence on the role of unexpectedness for achievement-related relief and disappointment is lacking. In addition, typically studies have considered summary variables of value but have failed to distinguish between different types of values. For example, research investigating differential relations between perceptions of the importance of success and failure, on the one hand, and hope and anxiety, on the other, is lacking. The present analysis extends previous research by including emotions from all cells of the proposed taxonomy as well as their differential relations with appraisals, including different types of values.

## Perceptions of Context

If appraisals function as proximal antecedents of emotion, then social environments should influence individuals' emotions by shaping their appraisals. Following this logic, environmental factors that impact perceived control and value should also influence achievement emotions (Pekrun, 2018). We assessed individual perceptions of classroom instruction in the present study. Based on research examining teaching effectiveness in classroom settings, we considered the following dimensions of instruction: cognitive stimulation, clarity of task structures and explanations, difficulty, classroom discussion, instructor enthusiasm, and rapport between instructor and students. These variables are crucial for academic achievement (Perry, 1991; Perry & Smart, 2007; Schneider & Preckel, 2017). Given their likely impact on control and value appraisals, we contend that they also influence students' emotions. We hypothesized the following relations with achievement emotions.

1. *Cognitive stimulation*: Cognitively stimulating materials can enhance interest and the intrinsic value of studying (Quinlan, 2019). Intrinsic value, in turn, is expected to promote positive activity emotions like enjoyment and to reduce negative activity emotions like anger and boredom. By implication, we expected perceptions of instruction as cognitively stimulating to promote students' enjoyment and reduce their anger and boredom.

2. *Clarity*: Instruction that is clearly structured and materials that are well explained should promote a sense of control, thereby influencing both activity emotions and outcome emotions. As such, we expected perceived clarity to positively relate to positive achievement emotions and negatively relate to negative achievement emotions.

3. *Difficulty*: Given that overly difficult materials can undermine a sense of control, we expected the perceived difficulty of the course to reduce positive emotions and increase negative emotions. For boredom, we left as an exploratory question whether relations with difficulty would be positive or negative given that boredom can be due to overchallenge or underchallenge, as argued earlier.

4. *Discussion*: Task-related discussion can facilitate reflection and the development of competencies (Resnick et al., 2015), thereby enhancing a sense of control. Furthermore, discussion involves social interaction, thus meeting needs for social relatedness (Ryan & Deci, 2017) and possibly enhancing perceived value. Given positive effects on both perceived control and perceived value, we expected discussion to strengthen positive and reduce negative emotions.

5. *Enthusiasm*: Enthusiasm displayed by teachers during instruction can influence students' ongoing activity emotions through emotional contagion and observational learning (Frenzel et al., 2018). Therefore, we hypothesized that perceived enthusiasm relates positively to students' enjoyment and negatively to their anger and boredom.

6. *Rapport*: Rapport between teachers and students implies that teachers provide support. Perceptions of being supported can enhance a sense of control, thus reducing low-control emotions like anxiety, shame, and hopelessness. As such, we hypothesized that perceived rapport mitigates these emotions.

## Health Problems

Exposure to stress contributes to a broad range of health problems, likely mediated by the immunosuppressive effects triggered by stress. Similarly, stress-related negative affect can relate to health problems, such as cardiovascular impairment, diabetes, and slow recovery from cancer (Everson-Rose & Lewis, 2005; Smith et al., 2004; Zhang et al., 2020). In addition, there is increasing evidence that positive affect relates negatively to health problems, even when controlling for negative affect (Chida & Steptoe, 2008; Kushlev et al., 2020; Pressman et al., 2019). Possible pathways that mediate the impact of emotions include health behavior as well as biological mechanisms, such as hormone secretion, the immune system, telomere length, proneness to inflammation, and cardiovascular functioning (e.g., Malouff & Schutte, 2017).

Given that negative achievement emotions such as anxiety and shame contribute to stress, it is reasonable to assume that they also

impact health. Evidence for the possible link between achievement emotions and health is lacking, except for a few studies on test anxiety. The findings have shown that anxiety before and during exams can relate to sleep problems (Dewald et al., 2014; Horn & Dollinger, 1989), cardiovascular parameters (Conley & Lehman, 2012; Hazlett et al., 1997), and reduced immune system functioning (Glaser et al., 1986; Segerstrom & Miller, 2004). Effects on the immune system may be mediated by the influence of test anxiety on cortisol secretion, with elevated levels before and during exams (Graham et al., 2022; Ringeisen et al., 2019; Spangler et al., 2002).

In the present study, we considered relations between achievement emotions and health problems that frequently occur in young and middle adulthood, such as headaches, stomach problems, and sleep problems (e.g., Freund et al., 2014; von Brevern & Neuhauser, 2011). Based on the evidence for test anxiety and negative affect, we hypothesized that stressful negative achievement emotions would exacerbate these problems. Stress is defined by low-control situations in which demands tax or exceed the individual's resources (Lazarus & Folkman, 1984). As such, we expected the link with health problems to be especially strong for low-control negative achievement emotions, including anxiety, shame, hopelessness, and disappointment. In addition, we expected positive achievement emotions that counteract emotional stress, including relaxation and assurance, to relate negatively to these problems.

We considered these possible relations separately for different achievement emotions. In addition, to make it possible to compare the findings to the extant evidence for general affect, we also examined these relations for summary constructs of achievement-related positive and negative affect that integrate single emotions.

## Method

### *Sample and Procedure*

Participants were 323 undergraduate students (82.4% female; mean age = 22.88 years, *SD* = 6.77) in a one-semester personality psychology course at a large research university in Germany. The majority of participants (94.1%) reported that German was their native language. Ethics approval was obtained from the institution's ethics committee (Protocol No. 32_Pekrun_a). Participation in the study was voluntary, and students received course credit for their participation. All self-report measures were completed in each of three different online assessments that were part of a broader project evaluating students' responses to the course. The three assessments were administered 3 weeks into the semester, in the middle of the semester, and toward the end of the semester, with 5 weeks between consecutive assessments (i.e., the overall length of the study was 2 and a half months).

### *Measures*

The self-report measures were translated into German using a translation and back-translation procedure that was carried out by two native speakers of each language. Of the two German native speakers, one was a bilingual English-German speaker, and the other was fluent in English as well.

**Achievement Emotions.** We used the same AEQ-R as in Studies 1 and 2 to assess achievement emotions. All 12 scales of the instrument were included. To contextualize the assessment, participants were instructed to report about the emotions they experience in the current personality course. Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (α range = .81–.96 across all emotions and assessments; Supplemental Table S1).

**Appraisals.** We assessed perceived control with seven items of the Perceived Academic Control Scale (Perry et al., 2001; e.g., "I have a great deal of control over my performance in this course"; α range .76–.81 across the three assessments, see Supplemental Table S14). Intrinsic value was measured with Pekrun, Vogl, et al.'s (2017) three-item intrinsic value scale (e.g., "In general, I find this course very interesting"; adapted from Wigfield, 1994; α range .92–.94 across the three assessments, Supplemental Table S14). Perceived value of success and value of failure were assessed with two single-item rating scales ("It is very important to me to perform well in this course" and "It would be very bad for me if I performed poorly in this course"). Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale to the perceived control and value items.

We used the following two items to assess appraisals of unexpected success and unexpected failure, respectively: "How often did it happen during the past weeks that you performed well in this course and understood the contents despite not having expected this; in other words, how often was it going better than expected?"; "How often did it happen during the past weeks that you performed poorly in this course and did not understand the contents despite having expected to do well; in other words, how often was it going worse than expected?" The two items were answered on a 1 (*never*) to 5 (*very frequently*) scale.

**Perceptions of Classroom Instruction.** Participants' perceptions of the quality of instruction in the course were assessed with scales from Marsh's (1982) Students' Evaluation of Educational Quality Questionnaire (SEEQ). Perceived cognitive stimulation was assessed with the following single item from the SEEQ: "I find the course intellectually challenging and stimulating." Perceived clarity, discussion, instructor enthusiasm, and instructor rapport were assessed with the respective three-item scales of the SEEQ (e.g., "The instructor's explanations are clear"; "Students are encouraged to participate in class discussions"; "The instructor is enthusiastic about teaching the course"; "The instructor makes students feel welcome in seeking help/advice in or outside of class"). Participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (α range = .77–.89 across the SEEQ scales and the three assessments; Supplemental Table S16). Perceived difficulty of the course was measured with a newly developed three-item scale based on the SEEQ instrument (e.g., "Relative to other courses in my study program, course difficulty is: very easy, easy, average, difficult, very difficult"; α range = .73–.80 across assessments, Supplemental Table S16).

**Health Problems.** We assessed participants' health problems with a 10-item scale derived from the Patient Health Questionnaire–15 (PHQ-15; Kroenke et al., 2002). Participants were asked the question, "How frequently did you experience the following problems during the past weeks?" Symptoms listed included headaches, stomach problems, back problems, dizziness, cardiovascular symptoms (heart pounding or racing), tiredness, and sleep problems. Responses were provided on a 1 (*never*) to 5 (*daily*) scale (α range = .84–.85 across the three assessments; Supplemental Table S19).

**Demographic Variables.** Gender, age, and participants' final high-school grade-point average (GPA) were controlled in the analysis. Grades ranged from 1 (*excellent*) to 6 (*poor*). Grade scores were reversed prior to the analysis to ease interpretation.

## Results and Discussion

### *Distributions of Emotion Scores*

Across all three assessments, mean values and standard deviations (see Supplemental Table S1) indicate that German students reported all of the emotions represented in the taxonomy, similar to their Canadian and American counterparts (Studies 1 and 2). The mean scores were similar across the three assessments.

### *Testing the Structure of the Taxonomy*

**Confirmatory Factor Analysis.** We used the same CFA procedure as in Studies 1 and 2. The CFAs for the emotion scales fit the data well (Supplemental Table S2), replicating the Study 1 and 2 results. Despite the sample size, $\chi^2$ was not significant for most of the models. Fit indexes were CFI > .97, TLI > .93, RMSEA < .09 (where applicable), and SRMR < .03 for all CFAs.

**Convergent and Discriminant Validity.** We estimated autoregressive models for the emotions to examine their stability across the three assessments. The models fit the data well (Supplemental Table S13). The latent correlations of the same emotions over time ranged from .74 to .88 for the Time 1–2 interval, and from .71 to .91 for the Time 2–3 interval. These coefficients indicate that there was substantial interindividual stability of the emotion scores across the semester. From an MTMM perspective, these monotrait-heteromethod correlations represent convergent validity, as described earlier. As for discriminant validity, the within-wave disattenuated correlations between factor scores derived from the CFAs (heterotrait-monomethod correlations; Supplemental Table S1) again demonstrate that the emotions were sufficiently independent. As in Studies 1 and 2, there were positive correlations between the positive emotions and between the negative emotions. Again, positive and negative emotions correlated negatively, except for relief which correlated positively with enjoyment and pride, but also with anxiety and shame. In sum, the findings document both convergent and discriminant validity of the scores for the 12 achievement emotion constructs.

**Facet Analysis.** Using the same facet-analytic approach as in Studies 1 and 2, we again found that all three dimensions of the taxonomy and their interactions contributed significantly to explaining variance (Table 2).

**Multiple-Emotion Models.** We used the same ESEM procedures as in Studies 1 and 2 to test multiple-emotion models for positive and negative emotions against one-factor and two-factor models (Table 3; for CFA results, see Supplemental Table S4). Replicating the Study 1 and 2 findings, the one-factor and two-factor models showed a poor fit to the data. In contrast, the multiple-emotion models fit the data well, with CFI > .94, TLI > .91, RMSEA < .06, and SRMR < .03 for the two positive and negative emotion models across all three assessments. These results further support our proposal to distinguish between the emotions represented in the three-dimensional taxonomy.

### *Appraisal Antecedents*

**Latent Correlations.** To investigate the bivariate links between appraisals and emotions, we estimated latent correlation models. Each model included one latent emotion variable and the six appraisal variables, with perceived control and intrinsic value evaluated as latent variables, and the one-item appraisal scales (unexpected success, unexpected failure, value of success, value of failure) as manifest variables. Supporting our hypotheses, perceived control related positively to the positive emotions except for relief, and negatively to the negative emotions across all three assessments (Supplemental Table S14). However, the negative relations with boredom were not significant.

Based on the proposition from control-value theory that boredom could be linked to either high or low control, we examined the possibility of a curvilinear relation between control and boredom. We conducted latent regression analyses including linear and quadratic terms for control as a predictor of boredom. The effects of the linear term were not significant but consistently negative ($\beta$s = −.117, −.134, and −.138 in the first, second, and third assessments, respectively). In contrast, the effects of the quadratic term were weak and not even consistent in direction ($\beta$s = .076, –.081, and –.027, respectively). This finding suggests that any relations between control and boredom take linear rather than quadratic forms in university students, in line with previous findings (Pekrun et al., 2010). More specifically, the results suggest that students' boredom was more related to overchallenge than to underchallenge in the present course.

In line with our hypotheses, relief and disappointment were related to unexpected success and failure, respectively. Furthermore, unexpected success also showed positive relations with other positive emotions, and unexpected failure correlated positively with other negative emotions. Although we had not predicted these relations, it is sensible that positive or negative developments in performance can generally boost positive and negative emotions, respectively. For example, a positive development in one's performance may facilitate enjoyment in further activities, and a negative development may exacerbate anxiety about possible further failures.

As expected, the positive activity emotions (enjoyment, relaxation) related positively, and the negative activity emotions (anger, boredom) related negatively to the perceived intrinsic value of studying across all three assessments. These associations were significantly stronger than the correlations between intrinsic value and the outcome emotions ($p$s < .05 for all pairwise comparisons of correlations). The positive outcome emotions hope, pride, and relief related positively to the value of success, and the negative outcome emotions anxiety, shame, and disappointment related positively to the value of failure.

**Latent Multiple Regression Analysis.** To examine the joint profile of appraisals related to achievement emotions, we conducted two sets of latent multiple regression analyses. In the first set (Table 6), Time 1 appraisals were used as predictors of Time 2 emotions. In the second set (Supplemental Table S15), Time 2 appraisals were used as predictors of Time 3 emotions. Autoregressive effects for the emotion variables were not included. Given the size of these effects depicted earlier (i.e., high stability of the emotion scores), no sufficient systematic residual variance would have been left at the second and third waves to be explained by the predictors. As such, the analysis examined the joint relations of the

**Table 6**

*Appraisals as Predictors of Achievement Emotions: Latent Multiple Regression Analysis (Study 3, Time 1–2)*

| Predictor | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Enjoyment | | Hope | | Pride | | Relaxation | | Assurance | | Relief | |
| Perceived control | .075 | .071 | **.386** | .111 | **.291** | .096 | **.494** | .086 | **.489** | .100 | **–.237** | .111 |
| Unexpected success | **.126** | .057 | .071 | .079 | **.269** | .069 | .039 | .066 | –.020 | .067 | .144 | .087 |
| Intrinsic value | **.634** | .048 | .092 | .086 | .129 | .083 | **.243** | .079 | –.017 | .087 | .245 | .083 |
| Value of success | **.114** | .053 | .117 | .079 | **.144** | .066 | –.057 | .062 | .029 | .078 | **.244** | .079 |
| Gender | .019 | .056 | –.038 | .081 | **.129** | .057 | .020 | .060 | **.131** | .073 | **–.186** | .076 |
| Age | **.158** | .050 | –.073 | .067 | –.052 | .064 | –.011 | .049 | .029 | .055 | –.084 | .086 |
| GPA | .080 | .043 | .037 | .111 | **.106** | .038 | .116 | .098 | .037 | .063 | .005 | .057 |
| $R^2$ | **.603** | .047 | **.207** | .079 | **.273** | .067 | **.377** | .070 | **.257** | .084 | **.281** | .070 |
| | Anger | | Anxiety | | Shame | | Boredom | | Hopelessness | | Disappointment | |
| Perceived control | –.156 | .106 | **–.455** | .103 | **–.428** | .116 | .000 | .105 | **–.515** | .104 | **–.459** | .100 |
| Unexpected failure | –.028 | .087 | **.254** | .075 | .158 | .094 | –.144 | .083 | .102 | .084 | **.220** | .082 |
| Intrinsic value | **–.624** | .052 | –.070 | .079 | .034 | .080 | **–.560** | .061 | –.114 | .081 | .002 | .072 |
| Value of failure | .079 | .061 | .091 | .065 | –.023 | .069 | .020 | .057 | –.023 | .067 | .047 | .065 |
| Gender | –.002 | .059 | –.021 | .064 | –.076 | .066 | .057 | .063 | .008 | .067 | .000 | .065 |
| Age | –.095 | .047 | .003 | .066 | –.043 | .054 | **–.215** | .058 | .001 | .057 | –.072 | .054 |
| GPA | –.082 | .029 | –.106 | .115 | –.086 | .056 | –.086 | .027 | –.100 | .087 | –.085 | .107 |
| $R^2$ | **.513** | .060 | **.410** | .074 | **.267** | .070 | **.392** | .058 | **.363** | .081 | **.361** | .067 |

*Note*. *SE* = standard error; GPA = grade-point average. Betas are standardized coefficients. Gender is coded 1 = male, 2 = female. $p < .05$, 01, and .001 for $|\beta| > 1.96$, 2.58, and 3.29 *SE*, respectively. Bold coefficients: $p < .05$.

predictors to subsequent levels of emotions rather than their change over time, similar to the Study 2 latent regression analyses.

We included perceived control and intrinsic value in all analyses. Based on our hypotheses, we additionally included unexpected success and the perceived value of success as predictors of positive emotions, and unexpected failure and the value of failure as predictors of negative emotions. Gender, age, and prior achievement were controlled in the analyses.

Most of the appraisal-emotion relations we found in the correlational analysis were observed again. Specifically, perceived control predicted most of the emotions. Unexpected success and failure predicted relief and disappointment, respectively, although these relations were no longer significant for relief with perceived control in the equation. Intrinsic value was a strong predictor of the activity emotions (positive for enjoyment and relaxation; negative for anger and boredom), and there were also links between the value of success and failure and outcome emotions.

Taken together, the findings are in line with control-value theory propositions that perceived control and value contribute to achievement emotions. Specifically, the findings support our hypothesis that perceived control influences achievement emotions, with control relating positively to positive emotions except relief, and negatively to negative emotions except boredom. Furthermore, the findings are also consistent with our hypothesis that value amplifies achievement emotions, with positive relations between intrinsic value and activity emotions, and between the value of success or failure and outcome emotions.

### *Perceptions of Context*

**Distributions of Perception Scores.** The standard deviations of the perception scores indicate substantial variation between participants in all three assessments (Supplemental Table S16), making it possible to examine links between these scores and emotions.

**Latent Correlations.** We used latent correlation models to investigate the bivariate links between perceptions and emotions. Each model included one latent emotion variable and the six perception variables, with the one-item cognitive stimulation scale evaluated as a manifest variable. As expected, perceived cognitive stimulation related to the activity emotions (Supplemental Table S16). Stimulation showed positive relations with enjoyment and negative relations with anger and boredom in all three assessments. These relations were significantly stronger than any of the correlations between stimulation and the outcome emotions ($p$s $< .001$ for all pairwise comparisons).

The perceived clarity of instruction related to both activity emotions and outcome emotions, with positive relations for enjoyment, relaxation, hope, pride, and assurance, and negative relations for all negative emotions. Conversely, perceived difficulty related negatively to hope, relaxation, and assurance, and positively to relief and the negative emotions, except for boredom. The relations for clarity and difficulty were stronger in the second and third assessments than in the first assessment (i.e., at the start of the semester), suggesting that it may take time and repeated exposure for an achievement environment to impact individuals' emotions. Finally, there were also clear positive relations of perceptions of instructor enthusiasm, classroom discussion, and rapport with students' enjoyment, and negative relations with their anger and boredom.

**Latent Multiple Regression Analysis.** We used latent multiple regression analysis to examine the profile of perceptions related to participants' emotions while controlling for gender, age, and prior achievement (see Table 7 for the Time 1–2 analysis and Supplemental Table S17 for the Time 2–3 analysis). The findings were generally consistent with the correlations and across the two time intervals, although not all coefficients remained significant with multiple predictors in the equation. Perceived stimulation was a positive predictor of enjoyment and a negative predictor of anger and boredom. Especially in the Time 2–3 analysis, perceived clarity negatively predicted the four negative outcome emotions (anxiety, shame, hopelessness, and disappointment), suggesting that transparent structures and clear explanations can help ameliorate these

**Table 7**

*Perceptions of Instruction as Predictors of Achievement Emotions: Latent Multiple Regression Analysis (Study 3, Time 1–2)*

| Predictor | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Enjoyment | | Hope | | Pride | | Relaxation | | Assurance | | Relief | |
| Stimulation | **.329** | .120 | **.215** | .101 | .159 | .099 | **.238** | .086 | .010 | .101 | **.289** | .111 |
| Clarity | .064 | .148 | .348 | .261 | .112 | .220 | .190 | .182 | –.012 | .209 | **–.297** | .186 |
| Difficulty | –.155 | .101 | **–.400** | .145 | –.146 | .125 | **–.636** | .100 | **–.569** | .112 | .134 | .118 |
| Discussion | .056 | .092 | –.108 | .099 | –.016 | .106 | –.021 | .087 | –.167 | .100 | –.122 | .120 |
| Enthusiasm | **.470** | .163 | –.254 | .206 | .093 | .197 | .153 | .163 | .125 | .198 | .116 | .172 |
| Rapport | **–.285** | .096 | .021 | .132 | –.074 | .121 | **–.215** | .101 | –.011 | .116 | .268 | .149 |
| Gender | .037 | .061 | –.132 | .079 | .099 | .069 | –.033 | .063 | .047 | .069 | –.149 | .084 |
| Age | **.147** | .054 | .010 | .066 | .004 | .070 | .085 | .044 | **.145** | .057 | –.090 | .081 |
| GPA | –.070 | .050 | .017 | .084 | .018 | .049 | .086 | .066 | .064 | .059 | –.084 | .094 |
| $R^2$ | **.521** | .064 | **.276** | .095 | .090 | .049 | **.484** | .070 | **.311** | .065 | **.263** | .068 |
| | Anger | | Anxiety | | Shame | | Boredom | | Hopelessness | | Disappointment | |
| Stimulation | **–.399** | .091 | –.016 | .080 | .023 | .069 | –**.208** | .096 | –.122 | .084 | –.014 | .077 |
| Clarity | –.041 | .170 | –.219 | .261 | –.344 | .243 | –.098 | .149 | –.259 | .238 | –.287 | .280 |
| Difficulty | **.249** | .111 | **.523** | .120 | .207 | .124 | –.152 | .092 | **.448** | .119 | **.453** | .128 |
| Discussion | –.014 | .106 | .142 | .086 | .122 | .092 | –.021 | .086 | .093 | .086 | .107 | .100 |
| Enthusiasm | –.325 | .181 | –.091 | .208 | .055 | .185 | –**.498** | .141 | .040 | .194 | –.037 | .227 |
| Rapport | .158 | .116 | –.021 | .143 | –.260 | .141 | .154 | .097 | –.106 | .140 | .034 | .133 |
| Gender | –.039 | .070 | .026 | .070 | –.062 | .061 | –.021 | .056 | .061 | .069 | –.051 | .069 |
| Age | –**.146** | .053 | –.120 | .056 | –.085 | .046 | –.159 | .049 | –.093 | .044 | –.161 | .043 |
| GPA | .039 | .052 | –.092 | .110 | .135 | .093 | .005 | .036 | –.102 | .086 | –.087 | .107 |
| $R^2$ | **.408** | .064 | **.391** | .086 | **.313** | .083 | **.557** | .053 | **.348** | .095 | **.356** | .085 |

*Note*. Betas are standardized coefficients. Gender is coded 1 = male, 2 = female. *SE* = standard error; GPA = grade-point average. $p < .05$, 01, and .001 for $|\beta| > 1.96$, 2.58, and 3.29 *SE*, respectively. Bold coefficients: $p < .05$.

emotions. Perceived difficulty of the course was a negative predictor of hope, relaxation, and assurance, and a positive predictor of anger and the negative outcome emotions. This suggests that materials that are perceived as too difficult reduce pleasant emotions during achievement activities, triggering anger, anxiety, and hopelessness instead. Furthermore, supporting our hypotheses, perceived teacher enthusiasm positively predicted enjoyment and negatively predicted boredom.

In sum, the findings show that perceptions can vary widely between individuals even in relation to the same achievement context (i.e., the same course in the present study; for similar findings, see Talić et al., 2022). Furthermore, they support our proposition that individuals' perceptions can influence their achievement emotions. Consistently across all analyses, the findings suggest that perceptions of cognitively stimulating materials and clear ways to present them promote positive and reduce negative activity emotions. In addition, they indicate that tasks that are perceived as overly difficult may reduce hope for success, undermine a relaxed attitude at work, and exacerbate negative outcome emotions. Nevertheless, given the correlational nature of the findings, caution is warranted in interpreting them. It seems likely that contextual factors, and perceptions of these factors, can influence individuals' emotions. However, emotions can reciprocally influence the environment and related perceptions (e.g., Frenzel et al., 2018). Research using change-sensitive longitudinal designs is needed to examine these possible reciprocal effects.

### *Health Problems*

**Confirmatory Factor Analysis.** CFA models for the health problems scale showed a good fit to the data in all three assessments (Supplemental Table S12). An integrated CFA across all three assessments was used to estimate the stability of health problems over time. The model also fit the data well (Supplemental Table S13). Autoregressive effects for the Time 1–2 and Time 2–3 intervals were .92 and .90, respectively, attesting to the high stability of health problems over the course of the semester.

**Latent Correlations.** We estimated correlations in separate models for the different emotions. Both emotions and health problems were estimated as latent variables. As expected, the low-control negative outcome emotions anxiety, shame, hopelessness, and disappointment correlated positively with health problems in all three assessments (Supplemental Table S19). The relations were especially strong for anxiety, shame, and hopelessness (ρ range = .34–.51), and significantly stronger than the correlations for anger and boredom (*p*s < .01 in all pairwise comparisons of these correlations).

All positive emotions except relief related negatively to health problems, with the strongest correlations observed for the deactivating emotions relaxation and assurance (ρ range = −.28 to −.38). For relief, correlations were low, consistent with the dual nature of relief as an emotion that is positive and deactivating, which could reduce health problems, but contingent on the prior occurrence of stressful events, which would imply a positive association with these problems.

**Structural Equation Modeling.** To examine the joint power of emotions to predict health problems while controlling for gender, age, and prior achievement, we used a similar strategy as in the Study 2 analyses of emotion and achievement. First, we estimated separate models for different single emotions, with emotions and health problems estimated as latent variables. Second, we estimated integrative four-factor models including all emotions. To test our hypothesis that low-control negative emotions relate to health problems, the four-factor models included one secondary factor integrating anxiety, shame, hopelessness, and disappointment.

Anger and boredom were modeled as a separate secondary negative emotion factor. The third secondary factor represented all positive emotions except for relief, which was modeled as a separate factor given its low correlations with the other positive emotions in the data set. We used ESEM with target rotation to estimate the secondary emotion factors. To limit the number of estimated parameters, we used factor scores derived from the single-emotion CFAs as indicators of the secondary factors. As in Studies 1 and 2, the factor determinacy indexes for the emotion factor scores (Supplemental Table S3) suggest that the loss of precision due to using factor scores was acceptable (Rigdon et al., 2019).

In all models, we included the emotion factors as predictors of health problems as measured at the subsequent wave. With separate single-emotion models and integrated four-factor models, the analysis represents the same strategy to deal with emotion collinearity as in the Study 2 analysis: focusing on single variables or integrating them into combined constructs.

The Time 1–2 and Time 2–3 single-emotion models fit the data well, with CFI > .92, TLI > .90, RMSEA < .06, and SRMR < .06 for all models (Supplemental Table S18). Replicating the correlational findings while controlling for gender, age, and achievement, the low-control negative emotions were positive predictors of health problems (β range = .20–.39; Table 8 and Supplemental Table S20). In contrast, the positive emotions negatively predicted health problems in both time intervals, except for enjoyment (in the Time 1–2 analysis) and relief (in both time intervals).

The two integrated Time 1–2 and Time 2–3 models also fit the data well; CFI > .95, TLI > .94, RMSEA < .04, and SRMR < .05 for both models (Supplemental Table S18). Further attesting to the robustness of these two models, all emotion variables showed significant loadings on their target factors (range of loadings .35–.91; Supplemental Table S21). There were a few cross-loadings, but most of them were smaller than the loadings on the target factors. In both models, the low-control negative emotion factor was a clear positive predictor of health problems (βs = .44 and .32 in the Time 1–2 and 2–3 analyses, respectively; *p*s < .001; Supplemental Table S21). In contrast, none of the other emotion factors were a significant predictor.

In sum, these findings support our hypothesis that low-control negative achievement emotions contribute to health problems. In contrast, with these emotions in the equation, other achievement emotions did not consistently relate to these problems. Again, in interpreting the findings, possible reciprocal effects need to be considered. While it is plausible that stressful achievement emotions contribute to health problems, reverse effects of health problems on emotions may also play a role. For example, before an important exam or presentation at work, sleep problems may exacerbate feelings of exhaustion and related anxiety and hopelessness. It is a task for future research to examine possible reciprocal effects, as

**Table 8**

*Structural Equation Models for Achievement Emotions and Health Problems (Study 3, Time 1–2): Factor Loadings, Path Coefficients, and Residual Variances*

| Coefficient | Enjoyment model | | Hope model | | Pride model | | Relaxation model | | Assurance model | | Relief model | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Factor loadings | | | | | | | | | | | | |
| Emotion | .48–.88 | | .72–.85 | | .56–.94 | | .78–.85 | | .84–.90 | | .52–.70 | |
| Health problems | .56–.67 | | .57–.67 | | .56–.67 | | .55–.67 | | .56–.67 | | .56–.67 | |
| Paths | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
| Emo → Health prob. | −.067 | .088 | **−.237** | .086 | **−.189** | .078 | **−.288** | .078 | **−.281** | .075 | .012 | .083 |
| Gender → Health prob. | **.210** | .068 | **.221** | .067 | **.212** | .069 | **.211** | .067 | **.177** | .068 | **.206** | .068 |
| Age → Health prob. | **−.276** | .069 | **−.259** | .061 | **−.277** | .067 | **−.247** | .063 | **−.223** | .064 | **−.288** | .068 |
| GPA → Health prob. | .035 | .048 | .029 | .035 | .022 | .043 | −.082 | .050 | .050 | .036 | .032 | .043 |
| Gender → Emo | .048 | .074 | .046 | .067 | .037 | .058 | .013 | .067 | −.080 | .068 | .135 | .070 |
| Age → Emo | **.189** | .073 | **.114** | .063 | .067 | .064 | .117 | .072 | **.212** | .069 | **−.221** | .074 |
| GPA → Emo | .044 | .075 | −.031 | .047 | −.070 | .043 | .165 | .071 | .048 | .057 | −.090 | .110 |
| Residual variances | .864 | | .813 | | .833 | | .793 | | .800 | | .867 | |

| Coefficient | Anger model | | Anxiety model | | Shame model | | Boredom model | | Hopelessness model | | Disappointment model | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Factor loadings | | | | | | | | | | | | |
| Emotion | .39–.83 | | .50–.88 | | .66–.96 | | .76–.87 | | .71–.88 | | .81–.97 | |
| Ach | .56–.67 | | .56–.68 | | .56–.68 | | .56–.67 | | .56–.68 | | .56–.67 | |
| Paths | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* | β | *SE* |
| Emo → Health prob. | .064 | .087 | **.391** | .075 | **.374** | .082 | .040 | .076 | **.345** | .080 | **.200** | .080 |
| Gender → Health prob. | **.209** | .068 | **.162** | .065 | **.192** | .066 | **.210** | .068 | **.184** | .065 | **.183** | .068 |
| Age → Health prob. | **−.279** | .066 | **−.223** | .055 | **−.247** | .061 | **−.282** | .068 | **−.261** | .061 | **−.251** | .064 |
| GPA → Health prob. | .037 | .047 | .041 | .030 | .037 | .033 | .034 | .047 | .053 | .035 | .035 | .035 |
| Gender → Emo | −.007 | .064 | .095 | .062 | .073 | .050 | −.043 | .071 | .075 | .054 | .090 | .058 |
| Age → Emo | **−.151** | .068 | **−.150** | .062 | **−.106** | .046 | **−.201** | .050 | −.076 | .040 | **−.203** | .047 |
| GPA → Emo | −.092 | .078 | −.003 | .058 | .008 | .034 | −.055 | .096 | −.033 | .046 | −.006 | .065 |
| Residual variances | .864 | | .727 | | .726 | | .866 | | .749 | | .831 | |

*Note.* All coefficients are standardized coefficients. Gender male = 1, female = 2. Ach = achievement; Emo = emotion; Health prob. = health problems; GPA = grade-point average (final high school achievement); *SE* = standard error. $p < .05$, .01, and .001 for $|\beta| > 1.96$, 2.58, and 3.29 *SE*, respectively. Bold path coefficients: $p < .05$.

well as the functional mechanisms that mediate the links between achievement emotions and health.

## Study 4

Study 4 used data from a weekly diary study. The study had three aims. First, we sought to investigate the within-person relations between achievement emotions; thus, complementing the between-person findings from Studies 1–3. The data make it possible to compare these within-person relations to between-person relations both in the present study and relative to the findings of the previous three studies. Second, we examined the longitudinal links between achievement emotions and one critically important group of antecedents, namely, control and value appraisals. Again, we used within-person modeling. This analysis complemented the cross-sectional between-person analysis conducted in Study 3. To our knowledge, this is the first within-person analysis of relations between appraisals and achievement emotions. Third, we aimed to broaden the range of contexts considered. The first three studies were situated in an educational context; the present study explored achievement emotions at work.

The data set is part of a broader, ongoing project to investigate emotions across three life domains, including work, health, and social relations, in a sample of adult participants in the United Kingdom. In the present study, we used data on achievement emotions and appraisals related to work from the first 12 waves of this project. The present findings are the first published from this project.

The data set included a range of achievement emotions representing 10 cells of the taxonomy, including four positive emotions (joy, hope, pride, and relief) and six negative emotions (anger, anxiety, guilt, boredom, hopelessness, and disappointment) at work. Due to limits on administration time, not all cells were represented. In addition, we included measures of perceived control at work and of the intrinsic value of work. As in Study 3, we hypothesized that control would relate positively to positive emotions and negatively to negative emotions. For intrinsic value, we expected positive relations with the positive activity emotion of joy and negative relations with the negative activity emotions anger and boredom. We left it as an exploratory question how intrinsic value relates to the outcome emotions included in the study.

In addition, we hypothesized that emotions reciprocally influence control and value appraisals over time. Emotions are known to ease the activation of like-valenced autobiographical memories and endorsement of like-valenced self-beliefs (e.g., Marroquín et al., 2016; Mayer et al., 1992). As such, we expected that positive emotions would relate positively to subsequent control and value appraisals, and that negative emotions would relate negatively to the appraisals. Taken together, the propositions on effects of appraisals on emotions, combined with effects of emotions on appraisals, amount to a reciprocal effects model of appraisals and emotions (see Figure 1 and Pekrun, 2006, 2021).

## Method

### Sample and Procedure

The overall sample of the project consists of $N = 350$ participants in the United Kingdom who are representative of the adult population (≥18 years) in the country in terms of gender, age, and ethnicity. For the present study, we included the subsample of participants who reported that they were working ($n$ = 269; 51.9% female; $M_{age}$ = 42.86 years, $SD$ = 14.54; English was the first language for 88.26%). The study received approval from the ethics committee of the first author's institution (Protocol No. ETH2122-0453). Participants provided written consent before participating in the assessments.

The assessments included an online weekly diary completed within a 48-hour time window in the middle of each week (Wednesday and Thursday). The diary included assessments of participants' life situation, overall emotions, and appraisals, as well as emotions and appraisals related to work, health, and social relations during the week. For the present study, we used data for emotions and appraisals at work.

### Measures

The work-related section of the survey was introduced with the following question: "How are you doing in your work this week?" The appraisal items were preceded by the question "What do you think about your work in this week?" and the emotion items by "How do you feel in your work this week?" Participants responded to all appraisal and emotion items using a 5-point Likert scale (1 = *not at all true*; 2 = *slightly true*; 3 = *partly true*; 4 = *mostly true*; 5 = *completely true*).

Perceived control was measured using a five-item scale adapted from Perry et al.'s (2001) measure of control (e.g., "This week I have a great deal of control over my work performance"; "This week my performance is determined by things beyond my control," reverse coded). Intrinsic value was measured with a four-item scale adapted from Pekrun, Vogl, et al.'s (2017) intrinsic value scale (e.g., "I find my work this week very interesting"; "My work is meaningful this week"). We tested the reliability of the composite control and value variables using a two-level CFA with Bayes estimation (measurement occasions at Level 1, persons at Level 2). To ensure that the variables had the same metric and meaning across the two levels, we kept the factor loadings invariant across the levels (see, e.g., Marsh et al., 2009; Niepel et al., 2022). For control, McDonald's ω was .71 and .77 on Levels 1 and 2, respectively. For value, ω was .86 and .94 on the two levels, attesting to good reliability. The 10 achievement emotions were assessed by single adjectives following the stem "In this week, I feel. …" The adjectives included "happy," "hopeful," "proud," "relieved," "angry," "anxious," "guilty," "bored," "hopeless," and "disappointed."

## Results and Discussion

### Correlations Between Emotions

Using Mplus 8.6 (Muthén & Muthén, 2017), we estimated a two-level model including the 10 emotion variables to examine their within- and between-person correlations. The model was saturated. As depicted in Table 9, the correlations showed the same pattern at the within- and between-person levels, with positive correlations among the positive emotions and among the negative emotions, and negative correlations between positive and negative emotions. This pattern replicates the relations found in Studies 1–3 and demonstrates their generalizability across different contexts. However, the vast majority of the correlations were lower at the within-person level than at the between-person level. The within-person

**Table 9**
*Correlations of Achievement Emotion Scores in Study 4*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Enjoyment | — | .682 | .687 | .600 | –.468 | –.401 | –.222 | –.495 | –.486 | –.513 |
| 2. Hope | .421 | — | .738 | .746 | –.181 | –.106 | .026 | –.284 | –.201 | –.203 |
| 3. Pride | .454 | .364 | — | .721 | –.101 | –.041 | .012 | –.208 | –.118 | –.167 |
| 4. Relief | .374 | .343 | .360 | — | –.081 | –.042 | .047 | –.140 | –.069 | –.143 |
| 5. Anger | –.320 | –.150 | –.182 | –.169 | — | .630 | .445 | .536 | .791 | .819 |
| 6. Anxiety | –.263 | –.110 | –.204 | –.154 | .351 | — | .539 | .407 | .770 | .665 |
| 7. Guilt | –.154 | –.041 | –.072 | –.046 | .155 | .227 | — | .425 | .575 | .554 |
| 8. Boredom | –.300 | –.154 | –.195 | –.148 | .200 | .197 | .164 | — | .559 | .557 |
| 9. Hopelessness | –.336 | –.216 | –.225 | –.205 | .408 | .346 | .235 | .281 | — | .827 |
| 10. Disappointment | –.411 | –.217 | –.246 | –.206 | .521 | .392 | .257 | .292 | .483 | — |

*Note.* *SE* = standard error. Within-person correlations are below the main diagonal; between-person correlations are above the diagonal. $p < .05$ for all within- and between-person coefficients $> |.05|$ and $> |.12|$, respectively. *SE* < .038 and < .076 for all within- and between-person coefficients, respectively.

correlations ranged up to $r = .48$; in contrast, the between-person correlations ranged up to $r = .82$. As such, the correlations attest to higher discriminant validity of the emotion scores at the within-person level and clear separability of different achievement emotions at this level.

### *Facet Analysis of the Taxonomy*

We used the same facet analysis approach as in Studies 1–3 to investigate the relevance of valence, arousal, and object focus to explain variance in the weekly emotion scores. Emotions and the facet variables were modeled at Level 1, waves at Level 2, and persons at Level 3. The model estimated the Level 2 and 3 variances and covariances of the Level 1 within-person effects of the facets. We report the Level 3 (person-level) variances of these effects, which can be compared to the person-level variances in Studies 1–3. Table 2 reports the variances of the different facets and their interactions, and the percentages of the total variation they explain. Again, all three dimensions of the taxonomy contributed to explaining the variation. Valence explained more of the variation than the other dimensions. Nevertheless, the variance components explained by arousal, the two object focus contrasts (activity vs. outcome emotions; prospective vs. retrospective emotions), and the interactions between the dimensions were significant as well. These findings attest to the generalizability of the findings from Studies 1–3 to weekly (rather than habitual) emotions, and to emotions in the work context rather than education.

### *Dynamic Structural Equation Modeling*

To test our reciprocal model of appraisals and emotions, we used dynamic structural equation modeling (DSEM; Asparouhov et al., 2018; Hamaker et al., 2018) in Mplus 8.6. We specified a multilevel first-order vector autoregressive (VAR[1]) model, a multilevel extension of a time series model (Hamaker et al., 2018, in press). The model represents an extension of a cross-lagged panel model that allows for between-person differences in the parameters representing within-person relations, including lagged effects (Hamaker et al., 2018).

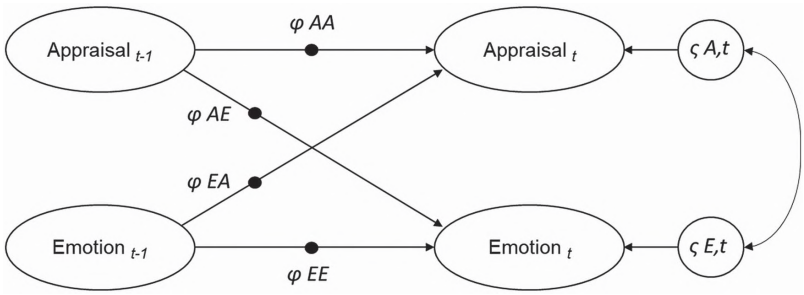
DSEM uses Bayes estimation and is computationally demanding. Even models including autoregressive structures for only two variables can fail to converge (Wang & Maxwell, 2015). To ensure that convergence criteria were met, we used bivariate modeling with either control or value considered as an appraisal antecedent of emotion. This approach also helped to keep the number of estimated parameters in a reasonable range (see Schultzberg & Muthén, 2018). Models were estimated separately for the ten emotions. For control and value, we used the composite scores described earlier (for a similar approach, see Hamaker et al., 2018; Niepel et al., 2022).

DSEM decomposes data into within-person (Level 1) and between-person (Level 2) components. Following Hamaker et al.'s (2018) Model 1, we specified autoregressive paths of appraisal and emotion from one week to the next, as well as cross-lagged paths between the two variables from week to week, at Level 1 (see Figure 3). The autoregressive paths indicate the amount of carryover (or inertia) from one week to the next for each participant. As such, they indicate how quickly participants return to their habitual, trait-like levels of appraisal and emotion after experiencing week-specific ups and downs. The larger the carryover, the more the current state depends on the previous week's state, and the longer it takes to return to the trait level. At Level 2, the model estimates the means of the autoregressive and cross-lagged effects (i.e., fixed effects), their between-person variances (random effects), and correlations between the effects.

To control for possible trends over time, we included time as a covariate at Level 1 in all DSEM models. We included effects of time on both appraisal and emotion (i.e., we detrended both predictors and outcomes; see recommendations by Wang & Maxwell, 2015). We used diffuse priors (the default option in Mplus), 50,000 iterations, two chains, and a potential scale reduction (PSR) of 1.05 as convergence criterion (Gelman & Rubin, 1992). The parameter estimates for Level 1 and 2 correlations, fixed and random effects, and their 95% credible intervals (CIs) are presented in Table 10 and Supplemental Table S23.

Across all models, the autoregressive effects for control, value, and the emotions were positive and significant. The unstandardized autoregressive coefficients ranged from .14 to .35 (Table 10; all $ps < .01$), with standardized coefficients in the $\beta = .20–.30$ range. Although these coefficients are smaller than typical between-person autoregressive stability coefficients for achievement emotions (see the Study 3 findings and Pekrun, Lichtenfeld, et al., 2017), they suggest substantial carryover effects of perceptions of control, perceptions of value, and emotions at work from one week to the

**Figure 3**
*Within-Person Part of the Multilevel VAR(1) Model*




*Note.* VAR = vector autoregressive; $t$ = time; φ *AA,* φ *EE* = autoregressive effects for appraisal and emotion, respectively; φ *AE,* φ *EA* = cross-lagged effects of appraisal on emotion, and of emotion on appraisal. The solid black circles signify that these are random effects; ς *A,t* and ς *E,t* = residuals of appraisal and emotion (see Hamaker et al., 2018).

next. Participants did not return immediately to habitual levels of control, value, and emotions, but tended to experience relatively similar levels in the subsequent week. However, the coefficients were sufficiently low to indicate that there also was substantial change, making it possible to examine links between the appraisals and the emotions.

As expected, all positive emotions showed significant positive correlations with control, and all negative emotions showed significant negative correlations (Table 10), at both the within-person and the between-person level. Furthermore, over and above the synchronous correlations, and controlling for autoregressive effects, the path coefficients suggest that control had positive effects on enjoyment and pride, and negative effects on all negative emotions over time. The path coefficient for hope was also positive, although this coefficient failed to reach significance.

In line with our hypotheses, intrinsic value correlated positively with enjoyment and negatively with anger and boredom, both within and between persons (Table 10). Value also correlated with the other emotions, although not all coefficients reached significance. In addition, the path coefficients indicate that value had significant effects on the emotions over time. Overall, these findings suggest that appraisals and emotions are linked not only from a between-person perspective but also within persons. Furthermore, they suggest that these links are at least in part due to effects of the appraisals on subsequent emotions.

In addition, supporting our hypotheses, the estimates suggest that the emotions reciprocally influenced subsequent appraisals. Most of the path coefficients for effects of emotions on appraisals were consistent in direction, and the majority were significant. Taken together, the estimates for effects of appraisals on emotions, and effects of emotions on appraisals, lend support to our notion that appraisals and emotions are reciprocally linked. The significant cross-lagged relations between appraisals and emotions were observed despite considerable inertia of both appraisals and emotions over time.

## General Discussion

In four studies across different countries, we investigated the empirical robustness of the proposed three-dimensional taxonomy of achievement emotions. The findings provide evidence for the convergent and discriminant validity of the 12 emotion scales representing the taxonomy, and they confirm the importance of all three dimensions of the taxonomy for explaining the structure of achievement emotions. In addition, the results document clear links with important antecedents and outcomes, including personality traits, appraisals, context perceptions, strategy use, performance, and health, thus further supporting the taxonomy.

We discuss each of these sets of findings in turn. In interpreting effect sizes, we follow Gignac and Szodorai's (2016) recommendations. These authors observed that traditional benchmarks to judge effect sizes were based on intuition rather than empirical data, and that strong effects as proposed by Cohen (1988; i.e., $r \geq .50$) are rarely observed in psychological research. To derive empirically grounded benchmarks, Gignac and Szodorai investigated the distributions of meta-analytically derived effect sizes reported in the literature. As a result, they propose $r = .10$, .20, and .30 for manifest correlations, as well as $\rho = .15$, .25, and 35 for latent correlations, as benchmarks demarcating small, moderate, and strong effects, respectively (see also Orth et al., in press).

### Internal Structure of the Domain of Achievement Emotions

Across the three studies, the score distributions document that all 12 achievement emotions were endorsed by participants and thus characterize individuals' achievement-related affective experiences. There was also substantial score variation, documenting clear interindividual differences in these emotions. The high stability coefficients found in Study 3 additionally show that these differences can persist over time, suggesting that achievement emotions can behave in a trait-like manner even if conceptualized in relation to a specific achievement context (i.e., as course-related emotions in the present research). From an MTMM perspective (Marsh et al., 2020), the stability coefficients represent monotrait-heteromethod relations, thus documenting convergent validity of the emotion scales.

Furthermore, across all three studies, the correlations between the emotion scales (heterotrait-monomethod correlations) indicate that all of them also showed discriminant validity. Across studies, the

**Table 10**

*Dynamic Structural Equation Models for Appraisals and Emotions (Study 4)*

| Emotion | Correlations | | Autoregressive effects | | Cross-lagged effects | |
|---|---|---|---|---|---|---|
| | $r_{within}$ | $r_{between}$ | App $t-1$ → App $t$ | Emo $t-1$ → Emo $t$ | App $t-1$ → Emo $t$ | Emo $t-1$ → App $t$ |
| | | | Perceived control and emotions | | | |
| Enjoyment | **.382** [.336, .430] | **.467** [.274, .599] | **.160** [.075, .251] | **.251** [.170, .332] | **.110** [.001, .224] | **.106** [.050, .180] |
| Hope | **.226** [.176, .276] | **.270** [.059, .435] | **.210** [.130, .290] | **.214** [.135, .300] | .042 [−.076, .149] | **.084** [.034, .137] |
| Pride | **.245** [.198, .290] | **.246** [.045, .400] | **.227** [.151, .301] | **.216** [.127, .309] | .063 [−.032, .160] | **.066** [.018, .121] |
| Relief | **.203** [.148, .256] | .131 [−.065, .303] | **.195** [.118, .277] | **.188** [.109, .266] | −.003 [−.110, .125] | **.063** [.009, .115] |
| Anger | **−.263** [−.311, −.215] | **−.506** [−.659, −.326] | **.218** [.131, .305] | **.297** [.208, .387] | **−.121** [−.232, −.008] | **−.148** [−.234, −.062] |
| Anxiety | **−.263** [−.308, −.214] | **−.355** [−.515, −.185] | **.263** [.188, .331] | **.173** [.090, .260] | **−.176** [−.286, −.067] | −.054 [−.108, .008] |
| Guilt | **−.177** [−.228, −.127] | **−.319** [−.522, −.063] | **.232** [.133, .320] | **.283** [.195, .366] | **−.129** [−.244, −.010] | −.065 [−.170, .062] |
| Boredom | **−.213** [−.263, −.169] | **−.404** [−.578, −.216] | **.186** [.099, .273] | **.313** [.227, .397] | **−.088** [−.195, .021] | **−.141** [−.194, −.084] |
| Hopelessness | **−.339** [−.382, −.290] | **−.665** [−.773, −.521] | **.221** [.139, .305] | **.241** [.154, .336] | **−.107** [−.228, .015] | **−.117** [−.199, −.038] |
| Disappointment | **−.305** [−.350, −.258] | **−.497** [−.632, −.321] | **.222** [.137, .311] | **.186** [.103, .271] | **−.181** [−.301, −.058] | **−.099** [−.156, −.039] |
| | | | Perceived value and emotions | | | |
| Enjoyment | **.520** [.483, .556] | **.866** [.797, .913] | **.285** [.197, .377] | **.157** [.073, .239] | **.177** [.082, .272] | **.093** [.016, .163] |
| Hope | **.373** [.327, .417] | **.668** [.533, .765] | **.291** [.202, .390] | **.143** [.056, .227] | **.152** [.057, .237] | **.101** [.034, .170] |
| Pride | **.407** [.362, .447] | **.666** [.531, .762] | **.315** [.230, .393] | **.161** [.083, .267] | **.159** [.072, .265] | **.081** [.014, .133] |
| Relief | **.325** [.276, .371] | **.515** [.359, .643] | **.292** [.199, .381] | **.154** [.078, .243] | .071 [−.025, .155] | .055 [−.001, .121] |
| Anger | **−.170** [−.216, −.122] | **−.141** [−.216, −.122] | **.306** [.221, .384] | **.266** [.176, .349] | **−.099** [−.171, −.031] | −.072 [−.158, .015] |
| Anxiety | **−.181** [−.231, −.128] | −.125 [−.347, .077] | **.359** [.273, .442] | **.195** [.123, .278] | −.082 [−.160, .000] | .012 [−.063, .076] |
| Guilt | **−.102** [−.155, −.055] | −.005 [−.207, .196] | **.313** [.219, .386] | **.259** [.183, .336] | −.036 [−.116, .047] | .028 [−.069, .114] |
| Boredom | **−.286** [−.332, −.240] | **−.393** [−.545, −.208] | **.289** [.205, .378] | **.250** [.161, .339] | **−.203** [−.289, −.124] | **−.098** [−.172, −.015] |
| Hopelessness | **−.279** [−.327, −.231] | **−.287** [−.452, −.098] | **.311** [.226, .398] | **.194** [.099, .282] | **−.101** [−.188, −.017] | −.057 [−.142, .029] |
| Disappointment | **−.251** [−.299, −.206] | −.190 [−.381, .003] | **.307** [.219, .390] | **.184** [.096, .269] | **−.107** [−.194, −.018] | −.033 [−.108, .042] |

*Note.* App = appraisal (control in upper part, value in lower part of the table). Emo = emotion. Autoregressive and cross-lagged effects are fixed effects (means). For random effects (variances), see Supplemental Table S23. 95% credible interval in brackets. Bold coefficients: $p < .05$ (one-tailed).

modal correlation between emotions was around $r = |.30|$, with positive correlations within each of the domains of positive emotions and negative emotions, and negative relations between these domains. An exception was relief which showed positive correlations not only with both positive emotions but also with negative emotions, likely due to its contingency with preceding stressful events that are associated with negative emotions.

The scores for the new construct of assurance also showed discriminant validity. Across studies and assessments, all latent correlations of assurance with other emotions were below $\rho = .60$. The strongest positive associations were the correlations with relaxation, likely due to the shared position of assurance and relaxation on the valence and arousal dimensions (positive, deactivating). The strongest negative associations were the correlations with anxiety. Both assurance and anxiety are prospective, but they may influence each other in antagonistic ways, with achievement anxiety undermining assurance about future success and assurance reducing anxiety.

In addition, the findings from facet analysis show that all three dimensions of the proposed taxonomy are important to explain variation in these different emotions. All three dimensions were important not only for explaining habitual achievement emotions (Studies 1–3), but also emotions that varied from week to week (Study 4). The findings also imply that all three dimensions need to be considered across two major achievement contexts, including education and work.

Among the three dimensions, valence explained the biggest share of the random variance in all four studies, in line with previous evidence on the power of this dimension to explain emotions (see, e.g., Fontaine et al., 2007). This finding suggests that valence is of prime relevance for understanding the structure of achievement emotions. However, arousal and object focus provided additional significant contributions, with object focus explaining more variance than arousal in all four studies. As such, the results lend credibility to the notion that object focus is indispensable to understanding achievement emotions, in addition to valence and arousal. Furthermore, the two- and three-way interactions also explained substantial amounts of variance in all four studies. This demonstrates that none of the three facets can be considered in isolation from the other facets.

The findings of ESEM comparing multiple-emotion factor models with one- and two-factor models lend further support to the notion that it is important to consider all three dimensions and to distinguish between the emotions representing the cells of the taxonomy. Across studies, the multiple-emotion models were superior to the one-factor and two-factor models. Furthermore, the findings document that the items used as indicators showed clear loadings on their target emotion factors. The few cross-loadings were substantially smaller. Combined with the good fit of the CFAs for the single emotion scales, the results render evidence both for the dimensional homogeneity of the single-emotion constructs and their separability in the broader domain of achievement emotions.

## Relations With Antecedents and Outcomes

The emotions representing our taxonomy not only hold unique positions within the taxonomy, they also show unique patterns of relations with important antecedents and outcomes. Both the direction and strength of these relations varied between emotions (see Table 11 for a summary). All of the emotion constructs showed substantial links with the external variables considered in this research, including, notably, the assurance construct. Furthermore, the observed links were largely in line with our hypotheses.

The relations with external variables generally differed between positive and negative emotions, suggesting that valence plays a primary role not only in the structure of achievement emotions, but also in explaining external relations. However, there were also substantial differences within the two groups of positive and negative emotions. Within each of the two groups, activity emotions differed from outcome emotions in the links with antecedent variables, including fear of failure, appraisals, and perceived instruction. Furthermore, there were specifically strong, theoretically meaningful associations between single emotions and relevant outcomes, including the links between hope and performance, and the relations of anxiety, shame, and hopelessness with health problems. Together the findings further confirm that it is important to attend not only to the valence and arousal dimensions of achievement emotions, but also to their object focus.

### *Antecedents*

**Personality Traits.** As expected, two of the Big Five trait factors showed substantial relations with the achievement emotions. Neuroticism related negatively to the positive emotions, except for relief, and positively to all of the negative emotions. These links were especially strong for anxiety, shame, and hopelessness, in line with the notion that neuroticism predisposes individuals to experience negative affect involving lack of confidence. Neuroticism was related positively, albeit weakly to relief, likely due to the contingency of relief and preceding negative affect as discussed earlier.

The opposite pattern was found for conscientiousness: positive relations with the positive emotions and negative relations with the negative emotions. The conscientiousness trait includes several facets, such as effort and efficient time management, that can benefit performance and, therefore, promote positive emotions in an achievement context. While the 60-item personality instrument used in the present research is not suited to examine differential relations for specific facets of the traits, it would be important to investigate these relations in future studies, based on more comprehensive trait assessments.

**Appraisals.** In line with propositions derived from control-value theory (Pekrun, 2006, 2018, 2021), control- and value-related appraisals also showed strong relations with the emotions. In the Study 3 between-person analysis, perceived control related positively to all positive emotions except for relief, and negatively to all negative emotions except for boredom. For appraisals of unexpected success and failure, we had predicted specific links with relief and disappointment, respectively. These links were indeed observed, in line with the notion that major variants of these emotions are based on counterfactual thinking (e.g., Sweeny & Vohs, 2012). However, the two appraisals also related to other emotions, with especially clear links with activity emotions (unexpected success and enjoyment; unexpected failure and anger). This finding suggests that violations of expectations can signal a positive or negative development in one's performance, thus affecting emotions related to the current achievement activity.

Intrinsic value also showed substantial links with most of the emotions. As predicted, these links were especially strong for the

**Table 11**

*Nomological Network of Achievement Emotions: Summary of Findings*

| Construct | Enjoyment | Hope | Pride | Relaxation | Assurance | Relief | Anger | Anxiety | Shame | Boredom | Hopelessness | Disappointment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Personality[a] | | | | | | | | | | | | |
| Neuroticism | − | −− | − | −− | −− | | + + | + + + | + + + | + + | + + + | + + |
| Extraversion | | + | + | | + | | | | | | − | |
| Openness | | | | | | | | | | | | |
| Agreeableness | | | | | | | − | | | − | | |
| Conscientiousness | + | + | + + | + + | + + | | − | − | − | | − | − |
| Appraisals[b] | | | | | | | | | | | | |
| Control | + + | + + + | + | + + + | + + + | | −− | −−− | −− | | −−− | −−− |
| Unexpected success | + + | + | + | + | | + + | −− | | | − | − | |
| Unexpected failure | − | −− | | −−− | −− | + | + | + + + | + + | | + + + | + + + |
| Intrinsic value | + + + | + | + | + + + | | + | −−− | − | − | −−− | −− | − |
| Value of success | + | + | + | | | + + | − | | | − | | |
| Value of failure | | | | | | + | | + | + | | | + |
| Perception of environment[b] | | | | | | | | | | | | |
| Stimulation | + + + | | + + | + | | + + | −−− | | | −−− | | |
| Clarity | + + + | + + | + + | + + + | + + | | −−− | −− | −− | −−− | −−− | −−− |
| Difficulty | | −− | | −−− | −−− | + | + | + + + | + + | | + + + | + + + |
| Discussion | + + | + | + | + + | | | −− | − | − | − | − | − |
| Enthusiasm | + + + | | + | + + | | | −− | | | −−− | − | |
| Rapport | + | + + | | + | | | −− | − | −− | | −− | −− |
| Strategy use[a] | | | | | | | | | | | | |
| Irrelevant thinking | − | − | − | − | − | | + + | + + | + + + | + + + | + + | + |
| Elaboration | + + | + | + | | | | − | | | − | | |
| Critical thinking | + + | + | | | | + | − | | | | | |
| Rehearsal | + | + + | + + | + + | + | + + | − | | | | | |
| Effort | + | + + + | + + | + + | + + | + + | − | | | | − | |
| Self-regulation | + + + | + + + | + + + | + + + | + + + | + | −− | − | − | − | −− | − |
| External regulation | | | | | | | | + | | | | |
| Performance[a] | + | + + + | + | + + | + + + | | −− | −− | −− | | −−− | −− |
| Health problems[b] | − | − | − | −− | −− | | + | + + + | + + + | + | + + + | + + |

*Note*. +/−, + +/−−, + + +/−−− denote small, moderate, and strong positive/negative latent correlations (ρ ≥ .15, .25, and 35, respectively; Gignac & Szodorai, 2016).
[a] Study 2, $N = 234$. [b] Study 3, $N = 323$. For Study 3, the entries in the table are based on the average (median) correlations across Waves 1–3.

activity emotions (i.e., enjoyment, relaxation, anger, and boredom). In contrast, perceptions of the value of achievement primarily related to outcome emotions, with positive relations between the value of success and hope, pride, and relief, as well as positive relations between the value of failure and anxiety, shame, and disappointment. Boredom was the only emotion that did not show positive relations with any of the value variables. Instead, boredom related negatively to intrinsic value and the value of success, consistent with the hypothesis that boredom occurs when no value is seen in the current activity. Taken together, these findings are in line with the control-value theory proposition that value generally amplifies achievement emotions except for boredom.

The Study 4 findings expand the perspective by addressing both between-person and within-person relations of appraisals and achievement emotions. Between- and within-person relations of variables can diverge substantially (Hamaker et al., 2018; Orth et al., 2021). In the present data, relations between appraisals (control, intrinsic value) and emotions were consistent across the between- and within-person levels. Without exception, perceived control and intrinsic value correlated positively with positive emotions and negatively with negative emotions, at both levels. Furthermore, the findings from cross-lagged dynamic structural equation modeling suggest that the control-value appraisals influenced the emotions from week to week, with effects showing the same direction as the correlations. In addition, the path coefficients suggest positive week-to-week effects of the emotions on the appraisals, supporting our reciprocal effects model of appraisal and emotion.

**Perceptions of the Environment.** There were clear links between students' perceptions of the environment and their achievement emotions. The findings add to the literature on effective teaching. They show that key dimensions including cognitive stimulation, clarity, and structure, and the match between task demands and capabilities not only affect achievement (e.g., Schneider & Preckel, 2017), but students' emotions as well. Based on the findings, it seems likely that these dimensions also influence people's achievement emotions in nonacademic contexts, such as work and sports.

Individual perceptions of classroom instruction as intellectually stimulating, which may increase interest and intrinsic value, were related to the activity emotions (positive relations with enjoyment and relaxation; negative relations with anger and boredom). In contrast, perceived difficulty was primarily related to outcome emotions (negative relations with hope and assurance, positive relations with anxiety, shame, hopelessness, and disappointment), which is sensible given that difficulty influences appraisals of control and related expectations of success and failure. Perceptions of structure and clarity showed substantial links with both activity and outcome emotions, likely because such perceptions can benefit both perceived control and the perceived value of the achievement task.

The perceptions considered in this research pertained to a single lecture-format course. The findings suggest that individuals can differ widely in their perceptions of the same achievement environment, and that these differences are reflected in differences in achievement emotions. Future research should explore whether different environments lead to similar differences in emotions. Studies including context variation could use behavioral observation as well as aggregation of individual perceptions to estimate contextual parameters (Marsh et al., 2012; Pekrun et al., 2019).

### *Outcomes*

**Strategy Use.** The relations with learning strategies were especially clear for the activity emotions enjoyment and anger. Enjoyment related positively, and anger related negatively to use of cognitive strategies, effort investment, and self-regulation. Furthermore, enjoyment related negatively, and boredom related positively to irrelevant thinking that distracts from task performance. However, there were important links for the other emotions as well. Specifically, all positive emotions related positively, and all negative emotions related negatively to self-regulation. In addition, and as predicted, anxiety related positively to external regulation of achievement behavior.

The findings for relief are especially interesting. In terms of the relations with antecedents summarized above, relief showed a similar pattern of links as negative emotions; this is likely due to covariation with these emotions. In contrast, in terms of effects on achievement activities, relief behaved like other positive emotions, relating positively to strategy use, effort, and self-regulation.

**Performance Outcomes.** The links with strategy use can explain why there were also substantial relations with resulting performance outcomes, even when controlling for SAT scores and demographic variables. The relation of achievement anxiety with exam performance ($\beta = -.27$ in structural equation modeling, Table 5) is consistent with prior evidence showing that achievement anxiety explains about 10% of the variance in performance scores (Barroso et al., 2021; Hembree, 1988; von der Embse et al., 2018). However, the present findings suggest that the links with performance may be even stronger for other emotions. Specifically, we observed effect sizes above $|\beta| = .30$ for two positive and two negative outcome emotions (hope, assurance, hopelessness, and disappointment), with an especially strong relation for hope ($\beta = .45$). Importantly, assurance was among the emotions that explained a sizable share of the variance in performance scores, suggesting that this emotion should be considered in future research on relations between emotion and achievement. Furthermore, the findings from the integrated positive and negative affect model show that both positive and negative emotions contribute to explaining cognitive performance.

The links between emotions and performance proved to be robust when adding personality traits in the equation. Among the Big Five traits, conscientiousness was the strongest predictor of exam performance, in line with existing evidence on the importance of this dimension for explaining performance. Nevertheless, the emotions continued to be significant predictors of performance and showed stronger effects than the traits. Taken together, the findings provide evidence that achievement emotions relate to performance, over and above the influence of gender, age, academic ability, and personality traits.

**Health Problems.** There were strong links between participants' achievement emotions and their reported health problems. Everyday health problems that occur frequently in young adulthood were considered, rather than more severe diseases that show low incidence in this age group. Across all three assessments in Study 3, especially the low-control negative emotions anxiety, shame, hopelessness, and disappointment related positively to health problems. Relations were also positive, albeit weaker, for anger and boredom. In contrast, there were negative links for positive emotions, with the high-control positive emotions relaxation and assurance showing the strongest negative relations.

However, in the integrated four-factor model analyzing the joint links of emotions with health problems, only the relation between the low-control negative emotion factor remained strong and significant (βs = .44 and .32 in the Time 1–2 and Time 2–3 analyses, respectively; *p*s <. 001; Supplemental Table S21). This finding suggests that negative achievement emotions like anxiety and hopelessness rather than positive emotions explain the occurrence (or nonoccurrence) of health problems in this age group. To further investigate the possible role of positive emotions in mitigating these problems, long-term studies will be needed that explore the link with health problems across the life span. In addition, research is needed that investigates possible biological and behavioral pathways that mediate the predictive effects observed in the present research, as well as reciprocal effects of health on achievement emotions.

## Limitations and Directions for Future Research

The present findings provide robust support for our proposed three-dimensional taxonomy. Nevertheless, we note several limitations and use them to suggest directions for future research. First, we employed data from nonexperimental field studies. These data made it possible to examine structural validity and profiles of relations with proposed antecedents and outcomes. However, the power of nonexperimental studies to derive causal conclusions about antecedents and outcomes is limited, even when using causal modeling procedures as in the present longitudinal SEM and DSEM analyses. In the absence of random assignment with experimental manipulation (and even when there is random assignment; Diener et al., 2022), typically there are alternative explanations for observed relations. Although we used longitudinal structural equation modeling and controlled for related variables, the possibility still exists that our findings are attributable to other unmeasured variables not included in the studies. Future studies should further pursue the approach taken herein while complementing this approach with experimental studies.

Second, we used self-report to assess achievement emotions. Self-report has several clear advantages (see, e.g., Pekrun, 2020). Specifically, self-report is suited to assess affective components of emotions (i.e., subjective emotional feelings). For this component, alternative measures are not available. Second, self-report can also assess the other components of emotions (cognitive, physiological, motivational, expressive), as long as they are consciously accessible. As such, in contrast to other measures, self-report can capture the full range of emotion components. Nevertheless, self-report has limitations as it is restricted to accessible processes and potentially subject to memory and self-report biases. Therefore, it can be useful to complement self-report with other methods, such as physiological indicators and observation of facial expression (while considering that these methods have their own limitations in terms of reduced sensitivity and/or specificity; see, e.g., Harley et al., 2015).

Third, the present studies included one or several assessments over several months. More research is needed to investigate generalizability across different time frames. Process-oriented research is needed that uses fine-grained temporal resolution to examine the situational dynamics of achievement emotions within minutes and hours, and longitudinal research should be conducted that considers their long-term development over the life span. By including multiple waves of assessments, such research could also facilitate tests of the mediational hypotheses that can be derived from our theoretical framework (Figure 1). This includes mediation of the effects of personality and environment on emotion by appraisals, and mediation of the effects of emotions on performance and health by strategy use, health behavior, and physiological processes.

Finally, the participants in our research were adults. Given that achievement emotions develop before entering formal education (Lewis et al., 2010; Stipek, 1995), it is reasonable to assume that the observed emotions emerge early in the preschool years. However, the degree of differentiation between emotions may differ. Specifically, there may be less differentiation in the early years (Lichtenfeld et al., 2012). As such, it is open to question whether the present findings generalize to younger age groups. Similarly, although the present research used samples from four different countries, they were all from a Western cultural context. For a few achievement emotions, such as test anxiety and math anxiety, there is evidence that their links with appraisals and performance are robust across a broad range of Western and non-Western countries (Organisation for Economic Co-operation & Development, 2017; Pekrun, 2009, 2018), suggesting cross-cultural universality. However, the generalizability of internal and external relations of other achievement emotions across cultures has yet to be established.

## Implications for Policy and Practice

From a policy and practice perspective, the proposed taxonomy and the findings should be of interest to all those responsible for the design of achievement settings in education, work, and sport, including policy-makers, administrators, supervisors, teachers, and coaches. Three crucial messages follow from the present research. First, it is clearly insufficient to consider only one or two achievement emotions, such as test anxiety, when trying to understand the affective impact of achievement settings. Instead, the present evidence suggests that a broad range of emotions play a role in these settings, including both positive and negative emotions, and that different emotions show distinct profiles of relations with other variables.

Second, these emotions relate to important outcomes. Confirming and extending previous research, the findings suggest that achievement emotions relate to cognitive performance. According to our findings, positive achievement emotions such as enjoyment, hope, and assurance typically have beneficial effects, and negative emotions like anxiety and hopelessness have overall negative effects. Beyond performance, the findings suggest that achievement emotions can also impact physical health. According to the present results, this is especially true for stressful, low-control negative emotions. In addition, it is important to emphasize that these emotions represent important outcomes in themselves. Across the life span, achievement settings are among the most important contexts that individuals encounter on a daily basis. As such, the emotions occurring in these settings are also core components of their psychological wellbeing and mental health.

Third, given the relevance of achievement emotions for vital outcomes, it is important to design achievement settings to promote adaptive and reduce maladaptive emotions (see also Ford et al., 2011; Linnenbrink-Garcia et al., 2016). The present findings suggest that this can be done by shaping settings to promote perceptions of control and intrinsic value. In contrast, as suggested by the findings, increasing the value of achievement can be a double-edged sword, as perceived achievement value can promote both positive and

negative emotions. As such, it may be preferable to promote intrinsic value rather than emphasize the importance of achievement outcomes. According to the present evidence, suitable practices may include creating tasks that are cognitively stimulating, clearly structured, and well calibrated to individual competencies. In addition, it may be fruitful for teachers, supervisors, and coaches to display their own enthusiasm to spark similar excitement in students, employees, and athletes.

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