

Profiles of emotional and motivational self-regulation following errors: Associations with learning[☆]



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ABSTRACT

University students may combine regulation strategies differently in response to a specific learning situation, namely after making errors. Strategy combinations may differ in how they support students' learning. These assumptions were investigated based on a sample of 469 German university students (undergraduate teacher trainees). Using latent profile analysis, we identified three distinct profiles with different values of cognitive reappraisal, mastery self-talk, performance-approach self-talk, and rumination following errors: The 'goal-directed learners', the 'worried performers', and the 'inhibited ruminators'. Moreover, we found that the strategy combinations differed in adaptivity regarding learning-strategy use, effort, self-efficacy, and adaptive dealing with errors. Practical implications for teacher education are discussed.

1. Introduction

University students have to deal with a host of academic errors during their academic career. In the best case they are able, and motivated, to take advantage of the learning opportunities that errors provide by adapting their learning behaviour, reflecting on the underlying misconceptions, and elaborating on the learning content. In addition to these (meta-) cognitive activities and learning actions, students have to deal with motivational setbacks and negative affective experiences following errors which must be successfully regulated. Hence, errors initiate self-regulation processes (Tulis, Steuer, & Dresel, 2015), but to foster improvements in academic learning, we need to further our understanding of how students regulate their emotions and motivation in educational settings effectively, in particular following errors. To maintain task engagement and motivation, students select and use different, more or less adaptive, emotional and motivational regulation strategies (Boekaerts, 2006; Gross, 1998; Schwinger, Steinmayr, & Spinath, 2009; Wolters, 1998). Some learners may be more concerned with emotion-focused coping (Lazarus, 1993), others may focus on strategies to re-direct attention and learning activities to master the task (Boekaerts, 2006; Kuhl, 2000). Taken together, learners actively (i.e., consciously or automated) use emotional and motivational regulation strategies following errors to activate and sustain their

cognitive, metacognitive and affective functioning (Butler & Winne, 1995; Wolters, 2003).

The present study focused on relevant and well investigated strategies for learning and achievement regarding their adaptivity/maladaptivity which will be described in the following sections into more detail. In short, cognitive reappraisal and rumination have been chosen as well investigated strategies to cope with one's emotions following errors (Strain & D'Mello, 2015; Hong, 2007; e.g. Davis & Levine, 2013). Furthermore, mastery self-talk and performance-approach self-talk have been confirmed as important and frequently used strategies for motivational self-regulation (Davis & Levine, 2013; Schwinger & Otterpohl, 2017), and therefore, they were added in our study as well. Based on the choice of these four strategies, the aim of our research was (1) to explore whether different combinations of emotional and motivational regulation strategies can be identified within a specific learning context, namely after making errors, and (2) to examine whether these profiles relate to relevant learning variables in order to provide empirical evidence for the assumed adaptivity/maladaptivity of such combinations.

1.1. Emotional and motivational self-regulation

Emotion regulation refers to a set of (automatic or controlled)

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processes and strategies by which individuals influence their affective states or particular emotions (Gross, 1998, 2008; Gross & Thompson, 2007). Similarly, Wolters (2003, p. 190) defines *motivational regulation* as “the activities through which individuals purposefully act to initiate, maintain, or supplement their willingness to start, to provide work toward, or to complete a particular activity or goal.” An emotional or motivational regulation *strategy* can be characterized as a purposeful, deliberate, and effortful procedure (manifested in specific patterns of thoughts and/or actions) that individuals use to influence their emotional experience and motivation (Wolters, 2003; Zimmerman & Martinez-Pons, 1986).

Particularly in the context of learning and achievement, there is an overlap between the regulation of emotions and the regulation of motivation in that the use of motivational regulation strategies may also impact students' emotional states, and effective emotion regulation may in turn also influence their motivation (for an overview see: Schunk, Pintrich, & Meece, 2008; Rothermund & Eder, 2011; for activating and deactivating emotions see: Pekrun, Goetz, Titz, & Perry, 2002). Although there has been a growing research interest on academic emotions within the last decade, and a large body of research on emotion regulation outside the context of learning and achievement, research on the use of *emotion regulation strategies in academic contexts* has been largely restricted to test anxiety (for an overview see Zeidner, 1998). But already Wolters (2003) proposed emotion regulation as a relevant motivational regulation strategy and described it based on earlier research (Corno, 1993; Schutz & Davis, 2000) as “students' ability to regulate their emotional experience to ensure that they provide effort and complete academic tasks” (Wolters, 2003, p. 199). Nevertheless, very few studies have examined emotion regulation as a strategy to enhance motivation and cognitive functioning in academic situations beyond testing situations (for an exception see Leroy, Grégoire, Magen, Gross, & Mikolajczak, 2012).

The need to use emotional and/or motivational regulation strategies is triggered when individuals experience problems with their affect (in terms of valence and arousal) or their ongoing level of motivation, learning, and performance (Wolters, 2003)—likely conditions following academic errors. Students are also likely to adopt more than one strategy (Gross, 2015) to cope with the setbacks and obstacles induced by errors. Thus, their self-regulatory attempts might include several strategies at the same time, based on their repertoire of specific regulation strategies. Explanations for combining different strategies can be found in Gross's dynamic model of emotion regulation (2015) which can also be applied to motivational regulation. According to the model, emotional experiences are not solely influenced by one single strategy, but are rather affected by an ongoing circular/spiral process comprising a combination of (more or less effective) strategies. Triggered by a perceived discrepancy between the actual situation and the individual's current active goals, emotions are always linked to appraisals, and, as Gross (2015, p.10) called it, different “valuation systems” (e.g., emotions can either be “good for me” or “bad for me”). These contextually based evaluations trigger the activation of emotion regulation (stage 1). This, in turn, motivates individuals to select (stage 2) and implement (stage 3) different regulation strategies, with the goal of successfully changing the respective evaluations and emotions. This cycle is repeated as often as necessary to up- or down-regulate one's emotional (or motivational) states by altering the intensity, duration or quality of the strategies selected. Furthermore, it is assumed that many different valuation systems are simultaneously active, supporting the need for a combination (or an intertwined series) of regulation strategies. Finally, individuals might use a combination of strategies when they are in different stages of the emotion-generative process. Empirical findings provide evidence for these assumptions. For example, Werner, Goldin, Ball, Heimberg, and Gross (2011) compared a clinical sample of individuals displaying social anxiety disorder with healthy controls and found groups of individuals which use specific combinations of strategies. However, the question is still open—particularly in the context of

learning and achievement—as to how strategies may be effectively combined.

1.2. Adaptive and maladaptive strategies for emotional and motivational regulation

During their academic years, students accumulate “metamotivational knowledge” (cf. Wolters, 2003; Wolters & Benzion, 2013) which comprises declarative, procedural, and conditional knowledge on how certain strategies influence their emotional and motivational functioning. Emotion regulation research as well as research on motivational regulation (for overviews see: Gross, 2008; Wolters, 2003) has suggested, and explored, different strategies that students may use to self-regulate both their emotions and motivation. With regard to academic learning contexts, researchers have also been interested in determining which strategies can enhance (or sustain) students' effort, persistence, metacognitions, and cognitive strategy use (e.g., Wolters, 2003). Despite a situation specific use of motivational regulation strategies (Engelschalk, Steuer, & Dresel, 2015; Schwinger, Steinmayr, & Spinath, 2012; Wolters, 1999) there is evidence that some emotional and motivational regulation strategies are more relevant for learning and achievement regarding their adaptivity/maladaptivity. In this regard, we focused on two particular cognitive emotional regulation strategies—cognitive reappraisal and rumination—for which studies have demonstrated their contrary effects on learning and achievement (Strain & D'Mello, 2015; Hong, 2007; e.g. Davis & Levine, 2013). This is evident in the divergent influences they have on the appraisal process: Cognitive reappraisal interrupts and changes the appraisal process, resulting in reduced negative emotions; whereas rumination holds up the individual's ongoing (maladaptive) appraisals, resulting in increased negative emotions (e.g. Davis & Levine, 2013; cf. Jacobs & Gross, 2014). Furthermore, we focused on two goal-directed motivational regulation strategies: Mastery-oriented self-talk and performance-approach self-talk. These strategies have been found to be highly effective and valuable for learning and achievement (Schwinger & Otterpohl, 2017), and are often used in academic contexts (Wolters, 2003). In the following we will describe each strategy in detail and explain its importance for learning and achievement.

Cognitive reappraisal implies systematically changing one's interpretation of a situation to alter its affective impact (Gross & Thompson, 2007). The basic idea is that the experiences of academic emotions can change by generating positive interpretations of an emotion-eliciting situation (Schutz & Davis, 2000). With respect to academic errors, cognitive reappraisals encompass a positive view of making errors and the acknowledgment that they are not only a natural part of learning but also present a learning opportunity rather than a threat to self-worth. Only a few studies have investigated the use of cognitive reappraisal in academic contexts, and even fewer with respect to specific learning situations. In two experiments, Strain and D'Mello (2015) found facilitative effects of cognitive reappraisal on affect and learning outcomes, and no indication of additional cognitive costs or interference with cognitive learning processes (for additional experimental evidence contrary to the cognitive-cost-hypothesis see: Leroy et al., 2012). Most parallels to the cognitive reappraisal of error-situations can be drawn from the findings of a study by Jamieson, Mendes, Blackstock, and Schmader (2010). They provide empirical evidence that the reappraisal of test anxiety (in terms of a positive view obtained by considering that the activating potential of anxiety can actually be beneficial to learning) has the potential to improve achievement.

Rumination refers to repetitively thinking about an emotion, its causes and consequences. Individuals often justify engaging in rumination as a means to deeply understand and solve their problems (Papageorgiou & Wells, 2003). However, rumination—especially in terms of brooding and being worried about a negative event rather than reflecting on the task at hand (Ciarocco, Vohs, & Baumeister, 2010; Raes et al., 2009)—was consistently found to be associated with

negative psychosocial outcomes and depression, as well as poor school related outcomes and inefficient problem solving (e.g., Hong, 2007; Košira, Tement, Licardo, & Habe, 2015; Lyubomirsky, Kasri, & Zehm, 2003; Mor & Winquist, 2002; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Hence, state-oriented rumination (i.e., focusing on current negative feelings and implications of failure) can be identified as a maladaptive strategy following errors (Ciarocco et al., 2010).

Consistent with achievement goal theory (e.g., Dweck & Leggett, 1988; Elliot, 1999), goal-oriented self-talk involves students' use of thoughts or sub vocal statements about their emphasized goals while they are engaged in academic activity (Wolters, 2003). Such articulated goals may either refer to the aim of mastering the task so as to improve personal skills (mastery self-talk), or to performance-goals which aim to demonstrate one's ability compared to others (performance-approach self-talk) (Schwinger et al., 2009; Wolters, 1999). Applied to error situations, students may thus regulate their motivation by thinking about the potential errors have for skill development and individual improvement, or by reminding themselves that they want to get high grades or outperform others when solving the task correctly. *Mastery self-talk* was consistently found to be associated with positive outcomes, such as cognitive and metacognitive strategy use and students' self-efficacy for learning (Park & Yun, 2017; Wolters, 1998, 1999). Furthermore, previous studies found, that mastery self-talk was positively correlated with the motivation to invest effort in learning (Schwinger et al., 2009; Schwinger & Stiensmeier-Pelster, 2012). These findings are in line with ample evidence indicating positive associations between mastery goal orientation and other motivational outcomes conducive to learning (for an overview see Schunk et al., 2008, for a meta-analysis see: Hulleman, Schrager, Bodmann, & Harackiewicz, 2010).

In contrast, when using *performance-approach self-talk*, students will motivate themselves to analyse and correct their errors by reminding themselves of their desire to outperform others or get high grades. Performance-approach self-talk turned out to be a predictor of effort management and achievement in terms of course grades (Schwinger et al., 2009; Schwinger & Stiensmeier-Pelster, 2012; Wolters, 2003). Furthermore, it has been found to be positively associated with students' self-efficacy and the use of cognitive and metacognitive strategies for learning (Wolters, 1999, 2003). On an empirical basis, performance-approach self-talk appears to be conducive to learning (Elliot & Moller, 2003). However, using performance-approach goals may not consistently characterise a beneficial approach to self-motivate following errors (Elliot & Moller, 2003). From a theoretical standpoint, performance-approach self-talk and the inherent normative striving for competence can also result in maladaptive motivational regulation, particularly in the face of the potential failure that errors may entail. Specifically, when learners make situation-specific appraisals following errors—either a positive view on errors (e.g., due to cognitive re-appraisal) or a negative view on errors accompanied by negative emotions and rumination—they might influence the function of performance-approach self-talk. In the first case performance-approach self-talk may foster achievement motivation whereas, in the latter, it might increase fear of failure and negative feedback from others. Mixed research findings regarding performance-approach goal orientation underpin this assumption: The effects of performance-approach goals on students' use of cognitive learning strategies, the use of self-regulatory strategies and effort have been ambiguous (e.g., Elliot, McGregor, & Gable, 1999; Lau & Nie, 2008; Wolters, 2004; Wolters, Yu, & Pintrich, 1996; for an overview see Harackiewicz, Barron, Pintrich, Elliot, & Trash, 2002). For example, effort management was found to be not associated (Lau & Nie, 2008), less associated (Wolters, 2004) or highly associated (Schwinger et al., 2009) with performance-approach self-talk, respectively goals.

Theoretical models acknowledge the associations of emotional and motivational self-regulation strategies with students' learning-strategy use, self-efficacy and effort management (Wolters, 2003). Based on a large body of self-regulated learning research that has continuously

expanded its focus on motivational self-regulation within the last twenty years (e.g. Boekaerts, 2006), it can be assumed that well-regulated learners may use more metacognitive strategies to regulate their learning process and, in turn, adopt effective cognitive strategies, like elaboration and organisation or rehearsal—pending on the task. As we focus on regulation strategies following errors, *metacognitive strategies* and in-depth learning strategies, such as *elaboration*, should be more helpful to reflect on the error cause and to modify the underlying misconception. In contrast, cognitive learning-strategies such as *rehearsal* or *organisation* seem to be less appropriate following errors. Furthermore, adaptive self-regulation is associated with motivational outcomes, like self-efficacy (Wolters, 2003). More specifically, in the context of error situations during learning, the use of adaptive emotional and motivational regulation strategies should also increase *error-related self-efficacy*, that is, the learners' confidence in their ability to deal with errors effectively. Finally, also a learner's volition should be positively affected in that students who regulate their emotions and motivation effectively invest more *effort* to identify and correct the error they have made and show adaptive responses to errors. In this regard, Dresel, Schober, Ziegler, Grassinger, and Steuer (2013) differentiated two types of adaptive reactions following errors: Adaptive learning behaviour specifically adjusted to the error at hand (i.e., *action adaptivity of error reactions*) encompasses the planning, initiation and evaluation of learning activities and (meta-)cognitive processes, whereas *affective-motivational adaptivity* involves the maintenance of motivation and activating emotions following errors. Adaptive motivational and emotional self-regulation is expected to enhance both types of adaptive reactions.

With respect to the simultaneous usage of emotional and motivational regulation strategies it can generally be assumed that students who adopt high levels of putatively adaptive regulation strategies show better learning outcomes compared to those who adopt high levels of maladaptive strategies. However, it is reasonable to assume that some strategies compensate for the negative effects of other strategies. In line with a growing understanding in mental health and coping research (e.g., Aldao & Nolen-Hoeksema, 2012) showing that putatively adaptive and maladaptive emotion regulation strategies can reinforce or counterbalance each other, it can be assumed that the flexible implementation of various emotional and motivational regulation strategies in the learning context might interact with each other as well.

1.3. Latent profile analysis and advantages of a person-centered approach

Most of the above-reviewed findings on coping and self-regulation are based on the investigation of one specific regulation strategy. More specifically, most studies followed a variable-centered approach, and did not address the possibility that students may integrate different emotional and motivational regulation strategies into a personal regulation profile, as proposed by Gross (2015). Person-centered research on within-subject combinations of achievement goals (Daniels et al., 2008; Luo, Paris, Hogan, & Luo, 2011; Tuominen-Soini, Salmela-Aro, & Niemivirta, 2008) might support our emphasis on modelling combinations of emotional and motivational regulation strategies. In detail, the findings of Daniels et al. (2008) provide evidence that achievement goal profiles are related to different degrees of vulnerability, e.g. students who primarily pursue performance-approach goals (and at the same time report low scores on other achievement goals) might be more emotionally vulnerable compared to students of other profiles. Luo et al. (2011) identified a cluster with high scores on both mastery and performance-approach goals. Compared to a cluster with high scores on performance-approach and avoidance goals, students within this group were higher in the use of learning strategies, engagement and reported less negative affect. However, Tuominen-Soini et al. (2008) found a profile they labelled as “success-oriented students”. Students within this group were mainly characterized by striving for getting good grades and outperforming others (performance-approach goal orientation) in

combination with mastery goal orientation. Although these students were high in academic commitment, effort and achievement they reported more emotional exhaustion, depressive symptoms, and stress than primarily mastery-oriented students. Therefore, the regulation of emotions might play an important role when students focus on performance goals. We particularly assume that adaptive emotion regulation strategies, like cognitive reappraisal, are able to reinforce the positive aspects of performance-approach goals, whereas maladaptive emotion regulation strategies, like rumination, enhance their negative aspects.

Regarding individual regulation profiles, latent profile analysis (LPA), have proven to be an adequate method for analysing the complex structure of individual self-regulation (e.g., Abar & Loken, 2010; Schwinger et al., 2012) or the complexity of self-regulation in more detail (Bergman & Andersson, 2010; Marsh, Lüdtke, Trautwein, & Morin, 2009). Hence, LPA considers the composition of different strategies within individuals and enables researchers to analyse the interaction or compensatory effects of multiple strategies and their relation to important outcomes.

To date, we are only aware of one study in the educational context that attempted to analyse students' motivational regulation profiles (Schwinger et al., 2012). In two samples, the authors found nearly the same regulation profiles. One of the key findings was true to the principle "the more/the higher, the better": Students who reported using all motivational regulation strategies more frequently showed better outcomes in terms of higher effort and achievement. Furthermore, the authors found a 'performance self-talk profile' (i.e., performance-approach self-talk combined with high levels of performance-avoidance self-talk and low levels for all other regulation strategies) which was negatively associated with effort and achievement. This result might be a first indication about the ambivalent nature of performance-approach self-talk in combination with other regulation strategies. Triggered by these findings, and keeping the theoretically plausible ambivalence of performance-approach goals in mind, we assume that linear models may hide interactions of performance-approach self-talk with either adaptive (cognitive reappraisal, mastery self-talk) or maladaptive strategies (rumination) and, their effects on learning.

1.4. Research questions

The present study investigated latent profiles of error-specific emotional and motivational regulation strategies through LPA. Hence, learners may use more than one strategy to regulate their emotions and motivation after making errors, but their preferred strategies may not always be adaptive. Based on their theoretically and empirically proven (mal)adaptivity and (in)effectiveness, the four different strategies were chosen: Cognitive reappraisal, mastery self-talk, performance-approach self-talk, and rumination. These strategies have been found to be used frequently (e.g., Wolters, 1999), the adaptivity of mastery self-talk and reappraisal (Schwinger & Otterpohl, 2017; Strain & D'Mello, 2015) as well as the maladaptivity of rumination (e.g., Gross, 2015) have been consistently shown, but the function of performance-approach self-talk, especially in the face of failure, is still unclear. Based on the assumption that learners not only adopt one regulation strategy but a combination of (adaptive and/or maladaptive) strategies (Gross, 2015), we formulated our hypotheses as follows:

Hypothesis 1. Different groups with distinct emotional and motivational regulation profiles can be identified. These profiles reflect differences in the self-reported use of emotional and motivational regulation strategies following the experience of errors during academic learning.

Additionally, we examined the theoretically assumed associations between regulation profiles on the one hand and the use of metacognitive strategies, as well as elaboration, organisation and rehearsal, effort, error-related self-efficacy, and adaptive dealing with errors (i.e.,

action adaptivity and affective-motivational adaptivity of error reactions) on the other hand. More specifically, we were interested in the possibility that some combinations of different emotional and motivational regulation strategies might be more adaptive than other combinations. In particular, the combination of performance-approach self-talk with either adaptive or maladaptive strategies might influence the expected effects on the learning variables. In detail, the combination with rumination, performance-approach self-talk (i.e., keeping the goal of good grades in mind) might change its subjective meaning (in terms of increased perceived performance pressure, for example). This, in turn, might impact a learner's metacognitive activities (e.g., in the form of a hasty and less planned adaptation of one's learning behaviour adjusted to the error at hand).

Hypothesis 2.1. Profiles with high levels of mastery self-talk and cognitive reappraisal (two generally adaptive strategies), and low levels of rumination (as a generally maladaptive strategy) are associated with higher levels of deep learning strategies, effort, self-efficacy, and adaptive responses to errors.

Hypothesis 2.2. Depending on how it is combined with other, either adaptive or maladaptive strategies, performance-approach self-talk is associated with either higher levels of deep learning strategies, effort, self-efficacy, and adaptive responses to errors (i.e., when combined with high levels of mastery self-talk and cognitive reappraisal, and low levels of rumination) or lower levels of these outcomes (i.e., when combined with high levels of rumination, and low levels of other adaptive regulation strategies).

The findings of the study would extend the existing literature in several regards: First, as learners are at certain risk for negative emotions and reduced motivation after making errors, it is of particularly importance to investigate how emotional and motivational regulation strategies should be combined effectively to handle their affective states and goal-pursuit in such situations. Second, in order to validate the profiles and their assumed adaptive or maladaptive nature, a broad range of dependent variables (e.g., learning-strategies, self-efficacy, effort and adaptive dealing with errors) were investigated. Finally, the results will shed light on the ambivalent nature of performance-approach self-talk: Other adaptive or maladaptive strategies might enhance or suppress the putatively adaptive nature of this strategy.

2. Method

2.1. Participants and procedure

In addressing the present research objectives, we drew on data from undergraduate teacher trainees enrolled in University Psychology courses. Four hundred and sixty-nine teacher trainees at a medium-sized public university in Germany participated in the paper-pencil-questionnaire study in exchange for undergraduate course credits. Data collection was conducted by trained research assistants, approximately two months after the start of the semester, whereby ethical protocols were enforced, such as the assurance of anonymity, confidentiality and voluntariness. Based on the standards of the German Research Association, in case of our study an official ethical approval was not required. The participating students were mostly female (77.4%) which is typical for teacher trainees and Education majors in Germany (Statistisches Bundesamt, 2018). The average age was 21.67 years ($SD = 3.04$), and the majority (97%) of the participants were German; 9.1% had an immigrant background. The sample ranged from university freshman (45.2% students were in their first academic year) to senior levels at the teacher training program (range = 13, $Md = 3$ semesters).

2.2. Instruments

All measurements were operationalized with respect to the context of decreased motivation due to making errors during learning (“If I lose my motivation in an important task (e.g. learning for an exam, working on a task for an exercise/seminar) because I make mistakes, then...”).

2.2.1. Emotion regulation strategies

Cognitive reappraisal was assessed by four self-developed items based on the FEEL-KJ scale (Grob & Smolenski, 2009; for its validation see Cracco, Van Durme, & Braet, 2015). Rumination was assessed by using four modified items from the preoccupation dimension of the German Action Control Scale (HAKEMP-90, Kuhl, 1994), for which construct validity is assured (Dieffendorf, Hall, Lord, & Streat, 2000). The state-orientation pole of this dimension is associated with impaired effectiveness due to the strong recurrence of thoughts related to some unpleasant experience (Kuhl, 1994). All strategies were rated in reference to making errors during learning, on a five-point scale, ranging from 1 (completely not true) to 5 (completely true). Both, cognitive reappraisal (e.g., “I tell to myself that it is not so bad to make mistakes sometimes”) and rumination (e.g., “I think it is really annoying to do that task”) showed good reliability coefficients (see Table 1).

2.2.2. Motivation regulation strategies

Mastery self-talk and performance-approach self-talk were assessed using four items each from two subscales of a standardized German questionnaire (Schwinger et al., 2009). Again, the strategies were rated in reference to making errors during learning, all along a five-point scale, ranging from 1 (completely not true) to 5 (completely true). Mastery-self talk (e.g., “I persuade myself to work intensely for the sake of learning”) as well as performance-approach self-talk (e.g., “I call my attention to the fact of how important it is to obtain good grades”) showed good reliabilities coefficients (Table 1).

2.2.3. Dependent variables

Learning strategies are defined as “actions directed at acquiring information or skill that involve agency, purpose (goals), and instrumentality self-perceptions by a learner” (Zimmerman & Martinez-Pons, 1986, p. 615). In accord with Marton and Saljo (1976), we focused on strategies which can be divided into deep-level (elaboration and metacognition) and surface-level strategies, like organisation (such as highlighting, note taking or summarisation), and rehearsal (Hattie & Donoghue, 2016). We used these four subscales from an adapted German questionnaire (LIST, Wild, Schiefele, & Winteler, 1992). Evidence for reliability and validity was presented by Boerner, Seeber, Keller, and Beinborn (2005). The items were rated on a five-point scale, ranging from 1 (completely not true) to 5 (completely true). Metacognition

comprised seven items of the three subdimensions planning, monitoring and regulation (e.g., “When I recognize difficulties I adjust my learning approach”) and elaboration was tapped by eight items (e.g., “I try to connect what I have learned with what I already know”). Short versions of the respective scales were used to assess organisation (four items, e.g., “I try to structure extensive learning content to get a better overview”) and rehearsal (three items, e.g., “I memorize the subject matter by mental rehearsal”). Effort management (i.e., a student's willingness to invest effort) was also assessed with items from the respective subscale of the German inventory for academic learning strategies (LIST, Wild et al., 1992; Wild & Schiefele, 1994). Our scale comprised four items adapted to making errors while learning, for instance, “I work hard to do well even if I don't like the subject matter”. All items were answered on a five-point scale ranging from 1 (rarely) to 5 (very often). Error-related self-efficacy was assessed with five items, based on a scale from Jerusalem and Satow (1999) which measures students' self-efficacy (i.e., “students' beliefs in their capabilities to produce given attainments”, Bandura, 2006, p. 307, see also Bandura, 1997). We modified the items so that they refer to capabilities after making errors (e.g., “I am confident that I can overcome the error”). Adaptive dealing with errors was assessed with two scales (Dresel et al., 2013), measuring (a) affective-motivational adaptivity of error reactions (i.e., maintaining activating emotions and motivation following errors), and (b) action adaptivity of error reactions (i.e., planning, initiating and evaluating learning activities and (meta-) cognitive processes, specifically adjusted to be in response to errors). Affective-motivational adaptivity was assessed with six items (e.g., “When I make an error, then I will have less fun studying later on”, reversed item), action adaptivity was assessed with seven items (e.g., “When I do something wrong, then I specifically try to work it out”). Previous findings have repeatedly proved evidence for the distinctiveness of these two components and the validity of their measurement (e.g., Dresel et al., 2013; Tulis, Steuer, & Dresel, 2016). The reliability coefficients for all dependent variables were good (Table 1). The factor structure of emotional and motivational regulation strategies, learning strategies, and error related variables (effort management, self-efficacy and adaptive dealing with errors) were confirmed by confirmatory factor analysis. The preliminary analysis of the measurement models and the respective results are presented in an online supplemental.

2.3. Analysis

Latent profile analysis (LPA) was used to identify subgroups of students with different emotional and motivational regulation profiles. The goal of this type of analysis is to identify a number of profiles that have comparable value patterns on the observed variables. This approach is model-based (Pastor, Barron, Miller, & Davis, 2007). “This

Table 1
Descriptive statistics (N = 469).

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 Cognitive reappraisal	3.25	0.71	(0.77)											
2 Mastery self-talk	3.50	0.62	0.37**	(0.82)										
3 Perf.-app. self-talk	3.54	0.93	-0.00	0.33**	(0.90)									
4 Rumination	3.44	0.85	-0.29**	-0.34**	0.14**	(0.88)								
5 Effort management	3.80	0.68	0.09*	0.40**	0.25**	-0.34**	(0.81)							
6 Self-efficacy	3.12	0.40	0.34**	0.28**	-0.03	-0.23**	0.19**	(0.74)						
7 Aff.-mot. adaptivity	3.90	0.81	0.38**	0.21**	-0.26**	-0.39**	0.21**	0.35**	(0.80)					
8 Action adaptivity	4.58	0.64	0.44**	0.49**	0.20**	-0.30**	0.37**	0.45**	0.35**	(0.84)				
9 Metacognition	3.66	0.56	0.38**	0.41**	0.10*	-0.28**	0.48**	0.27**	0.23**	0.50**	(0.72)			
10 Elaboration	3.59	0.73	0.26**	0.15**	-0.02	-0.10*	0.11*	0.22**	0.11*	0.23**	0.41**	(0.88)		
11 Organisation	4.23	0.70	0.11*	0.21**	0.19**	-0.04	0.26**	0.12*	0.03	0.24**	0.34**	0.28**	(0.79)	
12 Rehearsal	3.87	0.86	0.08	0.13**	0.30**	-0.03	0.20**	0.05	0.04	0.23**	0.32**	0.04	0.39**	(0.79)

Note. The diagonal entries depict McDonalds (1970) omega (ω).

* p < .05.

** p < .01.

means that a statistical model is postulated for the population from which the sample under study is coming" (Vermunt & Magidson, 2002, p. 1). Furthermore, it is a model assumption that the data may involve a mixture of probability distributions which allows specifying models as adjustable, and less restricted, when compared to traditional cluster analysis. The model-based specification further allows one to estimate missing data on the basis of model specification. In our study, missing values were due to item non-response (less than 0.002%) and were estimated through the maximum likelihood method. Thus, all model parameters were estimated based on the available data, resulting in reduced bias of the results compared to list-wise deletion techniques (e.g., Arbuckle, 1996).

To examine our hypotheses we used a three step approach (Pastor et al., 2007), implemented in Mplus 8 (Muthén & Muthén, 2017). These steps include 1.) identifying a cluster solution, 2.) examining the classification accuracy (Hypothesis 1), and 3.) analysing the relationship between cluster membership and outcome variables (learning strategies, effort, self-efficacy and adaptive dealing with errors, Hypotheses 2.1 and 2.2). Regarding the first step, emotional and motivational regulation strategies served as latent profile indicators. As latent profile analysis is characterized by different probability distributions in the observed parameters, the variances were not set to be equal across all profiles.¹ Because we had no a priori assumptions concerning the number of profiles (exploratory LPA) we estimated different models, with increasing numbers of profiles, starting with a one-profile model as baseline model. The decision for the final solution was driven by the fit indices of the specified models (i.e., when no improvement of model fit was found after the inclusion of an additional cluster). Commonly used information criteria are the AIC (Akaike), the BIC and the adjusted BIC, and finding the lowest values on these three criteria leads to the best cluster solution. The significance test we used to compare the fit indices was the Lo-Mendell-Rubin Likelihood Ratio-Test (Lo, Mendell, & Rubin, 2001), which was implemented in Mplus. This test compares a k solution of clusters with a k-1 solution. If there is no significant improvement between the two solutions, the k-1 solution should be chosen. Therefore, the researcher's decision about the number of profiles is more informed compared to traditional cluster analysis (Marsh et al., 2009; Pastor et al., 2007).

With respect to the second step, after we decided in favour of a profile, the average posterior class probability (AvePPk) and the entropy allowed a separate decision on the goodness for every class. AvePPk can have values between 0 and 1, where 1 represents a perfect classification for all persons who were chosen for this class. A criterion value higher than 0.70 denotes a good classification (Masyn, 2013; Nagin, 2005). The entropy can have values between 0 and 1 whereas greater values indicate a better classification utility (Pastor et al., 2007).

Finally, we included the dependent variables, learning strategies, effort management, error-related self-efficacy, and adaptive dealing with errors in the model and used the BCH method in Mplus. This method compares the means between the profiles and was used to validate the cluster-solution (Bakk & Vermunt, 2016).

3. Results

The results are divided into two sections. First, we convey the findings of the latent profile analysis (Hypothesis 1). Then, based on the final LPA solution, we looked at differences in learning variables (Hypotheses 2.1 and 2.2).

¹ The non-invariant model was compared with an invariant model (fixed variances across profiles) using a scaled difference test. A significant difference indicates that the non-invariant model would fit better to the data than the invariant model.

3.1. Latent profiles of emotion and motivation regulation strategies

Based on the fit indices we decided that the three-profile solution provides the best fit to the data (see Table 2).² In detail, all fit indices indicate that the two-profile solution fitted the data better than one general profile. Adding an additional third profile, a similar result pattern was found indicating that the three-profile solution should be preferred over the two-profile solution. Comparing the three-profile solution with the four-profile solution no clear results were found. The BIC increased, whereas the AIC and ABIC decreased. With respect to the LO-Mendell Test the four-profile solution did not fit better than the three profile solution indicating that the additional fourth profile might not add an additional explanatory value. Therefore, we chose the three-profile solution based on the BIC and LO-Mendell test.

In the second step, we looked at the classification criteria, like entropy and the AvePPk for each profile. The entropy was 0.73 and the classification values were all above 0.8 indicating a good classification utility (see Table 3). Moreover, the three profiles comprised in nearly all comparisons significant different values of emotion- and motivation-regulation strategies (see Fig. 1).

The first profile, which comprises most of the students (65%), was characterized by high levels of adaptive strategies (cognitive reappraisal, mastery self-talk) combined with a high score for the ambivalent strategy of performance-approach self-talk and a low value for the maladaptive strategy of rumination. Thus, students with this profile are prone to reinterpret their mistakes in a positive way and primarily focus on their individual learning gains without dwelling on previous failures and the associated negative consequences. Therefore, members of this profile were labelled 'goal-directed learners'.

The second profile consisted of 17.5% of the students. Typical for this profile were low scores in cognitive reappraisal and mastery self-talk (i.e., adaptive strategies) combined with high values for performance-approach self-talk as well as high levels of the maladaptive strategy rumination. In other words, students defined by this profile are prone to worry about (anticipated) failure after making errors, instead of holding the positive belief that errors represent an important element of learning and contribute to personal improvement. However, at the same time they focus on performance-approach goals and strive to get good grades. Due to this combination of strategies, we labelled members of this profile 'worried performers'.

In the third profile (17% of the students), both of the adaptive strategies as well as the ambivalent strategy were rather less pronounced in comparison to the maladaptive strategy of rumination. Thus, students with this profile show the most maladaptive pattern: Triggered by the errors they made, they tend to ruminate about their experiences of failure and are likely to brood about what they did wrong instead of focusing on the task at hand. They are further characterized by maladaptive beliefs about errors which seem to inhibit them from focusing on a desire to learn and improve their knowledge and skills. Therefore, we labelled members of this profile the 'inhibited ruminators'.

3.2. Differences based on latent profiles

We analysed differences, according to the means between these three profiles, in the following variables: learning strategies, effort management, error-related self-efficacy, and adaptive dealing with errors. All results are summarized in Table 4.

Regarding the use of learning strategies, the 'goal-directed learners' reported more elaboration and metacognition than both the 'worried performers' and the 'inhibited ruminators' (both groups used these

² The non-invariant model differs significantly from the invariant model, TRd ($df = 8$) = 51.53, $p = .00$ indicating that the non-invariant model fits better to the data.

Table 2
Fit indices for LPA (N = 469).

Number of classes	1	2	3	4
Number of free parameters	8	17	26	35
AIC	4357.039	4232.818	4185.912	4160.672
BIC	4390.244	4303.379	4293.828	4305.943
ABIC	4364.853	4249.424	4211.309	4194.860
LO-Mendell	NA	0.049	0.017	0.422
Entropy	NA	0.622	0.728	0.626

Note. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; ABIC = Adjusted BIC, NA = Test is not available for one-class-model.

Table 3
Classification probabilities for the three-profile solution (N = 469).

	n	1	2	3
1. Goal-directed learners	307	0.910	0.051	0.038
2. Worried performers	82	0.119	0.810	0.053
3. Inhibited ruminators	80	0.137	0.047	0.834

Note. Values in bold = average posterior probabilities (AvePPk).

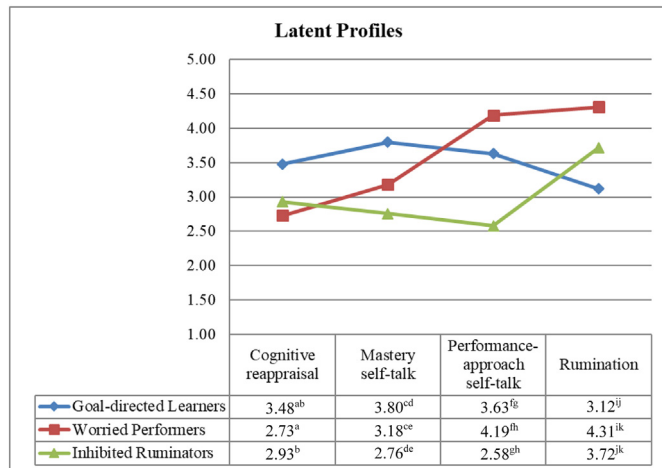


Fig. 1. Latent profiles based on cognitive reappraisal, mastery self-talk, performance-approach self-talk, and rumination (N = 469).
Note: Values with the same superscript letter differ significantly at $p < .05$.

Table 4
Differences in learning variables between profiles (N = 469).

	Meta-cognition		Elaboration		Rehearsal		Organisation		Self-efficacy		Effort management		Aff.-mot. adaptivity		Action adaptivity	
	M	Chi ²	M	Chi ²	M	Chi ²	M	Chi ²	M	Chi ²	M	Chi ²	M	Chi ²	M	Chi ²
Overall-test		71.28**		14.53**		19.73**		15.71**		54.36**		72.97**		65.86**		101.89**
Goal-directed learners vs. Worried performers	3.85	48.40**	3.70	13.16**	3.94	1.76	4.33	0.93	3.24	50.28**	4.04	27.52**	4.15	64.32**	4.84	44.26**
Worried performers vs. Inhibited ruminators	3.32	0.03	3.31	1.30	4.11	17.89**	4.22	5.11*	2.80	10.12**	3.51	4.63*	3.13	19.23**	4.19	1.67
Inhibited ruminators vs. Goal-directed learners	3.31	37.61**	3.47	3.63	3.39	15.14**	3.86	15.53**	3.04	13.12**	3.21	55.23**	3.82	7.22**	4.03	74.20**

Note:
* $p < .05$.
** $p < .01$.

types of deep-level strategies with nearly the same frequency). With respect to rehearsal and organisation, the ‘goal-directed learners’ and the ‘worried performers’ reported using these strategies significantly more frequently than the ‘inhibited ruminators’. Thus ‘goal-directed learners’, characterized by the use of adaptive emotional and motivational regulation strategies, adopt both deep-level and surface-level

learning strategies to process their knowledge in an adaptive way compared to the ‘worried performers’, who reported using only surface-level strategies to the same degree. The ‘inhibited ruminators’ generally reported a lower use of the respective learning strategies (although only marginally less elaboration strategies compared to the ‘goal directed learners’). Furthermore, the ‘goal-directed learners’ exerted more effort on learning activities than the ‘worried performers’ and the ‘inhibited ruminators’. Comparing the latter two profiles, the ‘worried performers’ put more effort into learning activities than the ‘inhibited ruminators’.

Error-related self-efficacy was also significantly higher for the ‘goal-directed learners’ compared to the other groups. This finding indicates that ‘goal-directed learners’ may have a stronger belief in their own ability to both overcome errors and impasses, and get good grades, despite (or even because of) making errors. As an interesting result, we found that ‘worried performers’ reported significantly lower self-efficacy than the ‘inhibited ruminators’. However, this might be explained by significantly higher values on rumination of the ‘worried performers’.

Finally, the ‘goal-directed learners’ reported a more adaptive approach to dealing with errors, i.e. affective motivational adaptivity as well as action adaptivity, when compared to ‘worried performers’ and ‘inhibited ruminators’.

4. Discussion

The current study investigated teacher trainees’ profiles of emotional and motivational regulation strategies induced by academic errors. Using latent profile analysis, as the most appropriate technique, we identified three distinct profiles with different levels of cognitive reappraisal, mastery self-talk, performance-approach self-talk, and rumination following errors. We used these profiles to investigate adaptivity with respect to specific learning variables, namely learning-strategy use, effort management, error-related self-efficacy and adaptive dealing with errors.

4.1. Latent profiles

According to the theory developed by Gross (2015), our results underpin the assumption that different strategies may be used (simultaneously) to regulate one’s emotional (and motivational) states after making errors, and that they might interact with each other. We

performance-approach self-talk—a motivation regulation strategy which has been found to produce ambivalent results with respect to learning and achievement (e.g. Elliot et al., 1999; Lau & Nie, 2008; Wolters, 2004; Wolters et al., 1996). Regarding Gross's model (2015), it would be plausible to assume that these students reappraise error situations (first cycle; Gross, 2015) to regulate negative emotions and reduce arousal. In the next step (second cycle; Gross, 2015), this positive view of errors and their potential as a learning opportunity—in combination with reduced arousal—could build the basis for the use of strategies to enhance one's motivation. For instance, students can motivate themselves with different self-talk strategies, such as reflecting on the goals of personal improvement (mastery self-talk) or obtaining good grades (performance-approach self-talk). Thus, 'goal-directed learners' seem to be able to regulate their emotional experiences following errors (emotion-focused coping; Lazarus, 1993), which, in turn, enables them to focus on strategies to redirect attention and learning activities to master the task (Boekaerts, 2006; Kuhl, 2000). In line with Kuhl's theory (2000) of self-monitoring and the differentiation of state- versus action-oriented individuals, it can also be assumed that 'goal-directed learners' might be more action-oriented. Instead of deeming their errors to be personal deficits or inabilities, they regulate their feelings and try to focus on approach goals in terms of mastery and performance. Evidence for the validity of this result can be found by comparing them to results obtained by Schwinger et al. (2012). The authors describe a similar profile—although exclusively based on motivational regulation strategies—characterized by high levels in all motivational regulation strategies as well as mastery self-talk and performance-approach self-talk.

Typical for the second profile, the 'worried performers', was the use of performance-approach self-talk combined with high levels of rumination. They reported low levels of cognitive reappraisal and mastery self-talk (i.e., both adaptive strategies) but scored high on performance-approach self-talk and rumination (i.e., maladaptive strategy). Hence, this group of teacher trainees seem to simultaneously think about the goal of getting good grades while ruminating about failure and worrying about the errors they made and their negative consequences. One explanation might be that the low level of cognitive reappraisal makes it somewhat difficult for those students to focus on their goals and transfer them into learning actions—in Kuhl's wording (2000): They may want but cannot cross the Rubicon. Instead, in that they are unable to regulate their emotion adequately, they are less prepared to focus on strategies which redirect attention and learning activities so as to master the task at hand (Boekaerts, 2006; Kuhl, 2000). Obviously, emotion-focused coping seems to be the prerequisite for adaptive self-regulation following errors. A further particularity of this profile is the combination of performance-approach self-talk—previously found to be ambivalent (e.g. Elliot et al., 1999; Lau & Nie, 2008; Wolters, 2004; Wolters et al., 1996)—with rumination, identified in former studies as a maladaptive strategy (e.g., Hong, 2007). Schwinger et al. (2012) found a comparable pattern: One profile (called 'performance self-talk-profile') was characterized by high levels of performance-approach self-talk as well as high levels of performance-avoidance self-talk (which was also identified as having maladaptive effects on learning and achievement in previous research) combined with low values for all other motivation regulation strategies. The authors were perplexed by the finding that students displaying this profile showed achievement results similar to that for members of a profile with low scores on all motivation-regulation strategies. A possible explanation, based on our results, could be that these students fail at emotion-focused regulation, e.g. through cognitive reappraisal. In combination with high levels of rumination as well as performance-approach self-talk strategies, these students might be less able to transfer their thoughts into the actions needed learn effectively for their exams. More research is needed to determine which combinations of performance self-talk and other motivation strategies can be adaptive for learning and achievement, and which appear to be mostly maladaptive (see also Schwinger et al.,

2012).

The picture for the 'goal-directed learners' is diametrically opposed to that associated with the 'inhibited ruminators' which showed the most maladaptive pattern. This profile was characterized by a high degree of rumination following errors, indicating that these learners fall into a vicious cycle of negative thoughts, worries and emotions. They are not able to reinterpret the situation so as to regulate negative emotions and arousal, nor to focus on mastering the task. Comparable to the 'all-low profile' in the study of Schwinger et al. (2012), these students showed low mastery self-talk as well as performance-approach self-talk. Based on our results, it could be assumed that these students are less able to use motivational regulation strategies because they remain entrenched in the failure situation, and resultant negative emotions inhibit them from taking the next step. Compared to Gross's model (2015), these students might value the learning situation with increased negativity in each cycle due to their preference for rumination. In turn, they are less able to escape these negative regulation cycles by implementing appropriate motivational regulation strategies.

To differentiate the effects on learning, we compared all of the student profiles identified in the present study with respect to the self-reported use of learning strategies, effort management, error-related self-efficacy and adaptive dealing with errors.

4.2. Learning strategy use

First we compared the three profiles regarding the use of specific learning strategies, comprising both deep-level strategies and surface-level strategies. Here we found that students with the most adaptive profile reported using more deep-level strategies when compared to members of the other profiles. One explanation could be the more adaptive manner in which they regulate the negative emotions inherent to a failure situation. It has already been shown that high levels of cognitive reappraisal and a low level, or the absence, of rumination positively influences the effective down-regulation of negative emotions and sets cognitive capacities free (Leroy et al., 2012; Strain & D'Mello, 2015). These cognitive capacities can be used for deep-level strategy use. Compared to 'worried performers', we found no differences in the surface-level processing strategies. We also assume that the 'worried performers' want to improve their knowledge with the goal of achieving good grades (high value in performance approach self-talk), but due to a more maladaptive approach to regulating negative emotions (low in cognitive reappraisal and high in rumination), the lower cognitive capacities only allow for the use of surface-level processing strategies such as rehearsal and organisation. Compared to the 'inhibited ruminators', the 'worried performers' use significantly more surface-level strategies, which indicates that the high levels of performance-approach self-talk is responsible for the focus on learning. However, regarding the deep-level strategies one contra-intuitive result was found: There is only a marginal difference between the 'inhibited ruminators' compared to the 'goal-directed learners' regarding the use of elaboration. One explanation could be that during their permanent thinking on their fault they may also activate their former knowledge to some degree.

4.3. Effort management, error-related self-efficacy, and adaptive dealing with errors

Comparing the profiles with regard to effort management, error-related self-efficacy and adaptive dealing with errors, we found 'goal-directed learners' score highest in all of these dependent variables, indicating this to encompass the most adaptive combination of strategies regarding these learning variables. As mentioned above, these students can be seen as more action-oriented and therefore, they invest more effort in their learning processes. Furthermore, explanations for the high degrees of self-efficacy and dealing with errors can be found in the willingness to study more and focus on getting good grades despite

making errors.

In contrast, the ‘worried performers’ reported significantly lower values on these variables. The lower degree of effort among members of this profile can be discussed in terms of a more state-oriented focus regarding rumination. As a result, students may invest less effort because their permanent thinking about their errors inhibits them from focusing on the subsequent steps. Regarding the low value for self-efficacy, the poorer use of cognitive reappraisal can be understood as a reason why they cannot surmount their fault and, in turn, believe less in themselves to attain their goals.

Finally, ‘inhibited ruminators’ invest the lowest degree of effort and deal with errors, in the case of action adaptivity, less adequately than other students. On the other hand, self-efficacy as well as affective-motivational adaptivity is significantly higher when compared to ‘worried performers’. One explanation could be the high levels of performance-approach self-talk among ‘worried performers’, indicating that the worry component implemented in performance approach self-talk (showing their abilities compared to other students) hinders them from adapting their affective-motivational state to the same degree as action adaptivity. In other words, they do a lot to learn from their errors, aspiring to get good grades, but they might not have positive feelings about it because of the fear of making further errors. Regarding self-efficacy, the ‘inhibited ruminators’ probably worried more about their ability compared to ‘worried performers’, due to their penchant for performance-approach self-talk combined with the highest level on rumination.

4.4. Limitations and practical implications

The first limitation relates to the sample. Our sample showed a high percentage of female students. Indeed this is typical for psychology courses in Germany, but some studies provide evidence that there might be differences between females and males, especially in the use of emotional regulation strategies (e.g., [Nolen-Hoeksema & Aldao, 2011](#)). Rumination has been identified as being more frequently used by females ([Johnson & Whisman, 2013](#)). Thus, it would be of interest for future studies to investigate regulation profiles differentiated by gender.

Second, emotion and motivation regulation strategies were assessed retrospectively. Therefore, the ecological validity is limited (e.g., [Bronfenbrenner & Morris, 2006](#)). However, the associations with relevant learning variables replicate earlier findings, and point to high construct validity. Moreover, the results are based on a cross sectional study. It is also possible that learning variables, like the level of self-efficacy, foster or hinder the use of some regulation strategies. Finally, interrelations with achievement would be of interest. Theoretical concepts as well as empirical results (e.g., [Schwinger et al., 2009, 2012](#)) underpin the mediating role of metacognitive strategies, motivation and volition on achievement. In line with other researchers in the field of motivation regulation ([Pintrich, 2004](#); [Schwinger & Otterpohl, 2017](#); [Wolters, 2003](#)) we considered these variables to be the proximal, and thus relevant outcome variables in motivational regulation. However, future studies might focus on the proposed mediation models to predict academic achievement indirectly through learning behaviour variables that are affected by different emotional and motivational regulation profiles.

Another interesting aspect would relate to the question if specific context characteristics may foster the transition of one regulation profile to another (i.e., to a more adaptive one). For example, peers may communicate or show different (adaptive and maladaptive) ways to deal with academic errors. By observing their peer's error management behaviour, individuals may compare and reconsider their own strategy use and, in turn, they may adopt other regulation strategies from their fellows. An additional analysis of our data revealed that the ‘goal-directed learners’-profile particularly consisted of older students compared to the other profiles. With respect to the hypothesis raised above,

this result would, for instance, imply to use tandem groups consisting of older and younger undergraduate student teachers to provide resources for learning—not only of the course contents but also with respect to adaptive handling of academic errors. Based on our study and due to the importance for future teaching practices, we emphasize that teacher trainees should be explicitly treated as active learners during teacher education. Therefore, teacher training programs not only have to support teacher trainees' learning about teaching, (and how to establish a positive error climate in the classroom, for example) they should also provide learning opportunities to reflect on one's own learning behaviour, dealing with errors, and self-regulation strategies. There are different ways—underpinned by empirical evidence with respect to their effectiveness—to foster such reflection processes, such as the use of portfolios ([Zeichner & Wray, 2001](#)) or modelling as a teaching method in teacher education ([Lunenburg, Korthagen, & Swennen, 2007](#)). Besides these explicit or more indirect ways of enquiry into one's own learning, teacher trainees can also be directly supported in their emotional and motivational self-regulation regulation. [Zeidner \(1998\)](#) has already provided an overview on how intervention approaches should be conceptualized to promote the regulation of a special negative emotion, like test anxiety, systematically. This approach might also be transferred to other negative emotions. In accordance with the two facets of test anxiety, namely the emotional component and the worry component ([Liebert & Morris, 1967](#)), respective emotion regulation programs include both emotion-focused treatments to alleviate dysfunctional affect and arousal, and cognitive-focused treatments to cope with worry and task irrelevant thinking. Both, the ‘worried performers’ and the ‘inhibited ruminators’ would probably benefit from such programs because both groups of students are unable to adaptively regulate their emotions following errors through cognitive reappraisal. Second, they report high levels of rumination resulting in worry and task-irrelevant thinking.

Finally, someone might question our selection of emotional and motivational regulation strategies and the relevance of their combination for learning and achievement compared to other regulation strategies and their possible interactions. In the current study, we explicitly focused on four different strategies—including putatively functional and dysfunctional ones for learning and achievement—to clarify the ambiguous benefit of performance-approach self-talk. Our selection was based on the following criteria: frequency of use, relevance in the learning context and in particular in the context of making errors during learning, and empirical evidence on their adaptivity or maladaptivity, respectively. Therefore, our results make an important contribution to the existing literature on motivational and emotional self-regulation during academic learning (and following errors). The person-centered approach allows us to draw more detailed conclusions about the ambivalent nature of performance-approach self-talk. More specifically, linear models (variable-centered approach) propose that the use of performance-approach self-talk would result in better learning strategies, increased effort, higher self-efficacy and adaptive dealing with errors. But our LPA results indicate that—although the ‘worried performers’ show even higher values on performance-approach self-talk compared to the ‘goal-directed learners’—in combination with maladaptive emotion regulation, performance-approach self-talk yields to poorer outcomes (despite the use of surface-level learning strategies). Thus, it can be assumed that the combination with other (adaptive or maladaptive) regulation strategies either triggers the positive or the negative aspects of performance-approach self-talk. In turn, this might explain its different associations with relevant learning variables. Nevertheless, our findings are restricted to the composition of the selected strategies. Future research is needed to gain more insights on different sets of regulation strategies.

4.5. Conclusion

In summary, the present study provides interesting insights on

combinations of different strategies to regulate emotion and motivation in the face of academic errors and failure, and their associations with students' learning. We found three different profiles which differed significantly in their adaptivity of learning behaviour and motivation. In particular, the combinations of performance-approach self-talk with adaptive and maladaptive regulation strategies point for an ambivalent strategy regarding the regulation of emotional and motivational states in error situations, and give cause to focus on additional learning situations in which emotional and motivational regulation is necessary.

Appendix A

Items to assess emotional and motivational regulation strategies:

If I lose my motivation in an important task (e.g. learning for an exam, working on a task for an exercise/seminar) because I make mistakes, then...

Cognitive reappraisal

... I am glad that I now know where there are still difficulties in understanding.

... I think that it is part of learning to make mistakes.

... I tell to myself that it is not so bad to make mistakes sometimes.

... I tell to myself that it is good that I now know my gaps in knowledge.

Rumination

... I think it is really annoying to do that task.

... I think that I would like to do something else now.

... I think that I would rather do other things.

... I am totally annoyed.

Mastery self-talk

... I persuade myself to work intensely for the sake of learning.

... I persuade myself to keep on learning in order to find out how much I can possibly learn.

... I challenge myself to finish the task and thus learn a lot for me personally.

... I tell to myself that I should keep on learning in order to learn as much as possible for me personally.

Performance-Approach Self-Talk

... I call my attention to the fact of how important it is to obtain good grades.

... I call my attention to the fact of how important it is to do well in tests and exams.

... I tell myself that I should keep on learning if I wish to reach a good exam.

... I think about how my grades will worsen if I refrain from learning.

Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.lindif.2019.101806>.

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