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The Relationship of Teachers' Multidimensional Autonomy Support in Physical Education and Students' Leisure-Time Physical Activity Mediated by Cognitive Appraisals and Achievement Emotions

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Teach a child to swim,
and he will learn how to move in the water.
Teach a child with the joy of learning,
and he will acquire not only the skill to swim,
but a lifelong passion!

- Bryan Yap

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List of Abbreviations

AEQ	Achievement Emotions Questionnaire
APC	Average path coefficient
ARS	Average R^2
ART	Affective-reflective theory
AVE	Average variance extracted
AVIF	Average variance inflation factor
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CVT	Control-value theory
GoF	Goodness-of-fit index
KiGGS	German Health Interview and Examination Survey for Children and Adolescents
MD-PASS-PE	Multi-Dimensional Perceived Autonomy Support Scale for Physical Education
MG-CFA	Multigroup confirmatory factor analysis
MVPA	Moderate-to-vigorous physical activity
NFI	Bentler-Bonett normed fit index
NNFI	Bentler-Bonett non-normed fit index
PA	Physical activity
PE	Physical education
PEmo	Students' Emotions in Physical Education
PISA	Programme for International Student Assessment
PSDQ	Physical Self-Description Questionnaire
RMSEA	Root mean square error of approximation
SDT	Self-determination theory
SES	Socioeconomic status
VB-SEM	Variance-based structural equation modeling
WHO	World Health Organization

Abstract

The health benefits of regular physical activity for children and adolescents are widely known. However, various studies have shown that young people do not sufficiently participate in physical activity. Since physical activity behavior in childhood and youth also acts as an important predictor of physical activity participation in adulthood, physical activity promotion should start at a young age. This underscores the important role of physical education as an available platform to help students become more physically engaged. This is particularly valuable for students from households of low socioeconomic status, who are characterized by even less physical activity compared to their peers with a higher socioeconomic background. Subjective emotional experiences are of crucial importance in educational settings as they may have an impact on students' learning process, behavior, engagement in school, and academic achievement. Based on current theories and previous research, it can be assumed that positive experiences in physical education have an effect on children and adolescents in terms of being more willing to engage in physical activity throughout their lives. However, although positive emotions have been found to be relevant determinants of sport and exercise behavior, intervention studies in physical education aiming to promote students' physical activity in leisure time do not sufficiently consider students' distinct emotional experiences when establishing the interventions' theoretical foundation. If physical education is to make a valuable contribution to a lifelong healthy lifestyle with regular physical activity, it is essential to know about students' subjective emotional experiences in physical education, and secondly, to integrate these findings in future intervention studies that aim to promote students' physical activity in leisure time. The control-value theory of learning and achievement emotions provides an appropriate framework for analyzing distinct emotions experienced in physical education since it also refers to the respective outcomes of these emotions. The control-value theory assumes that cognitive appraisals of subjective control and value are of crucial importance in the arousal of emotions. The appraisals, and thus the emotions, can in turn be influenced by learning environment variables, e.g., autonomy support provided by the teacher, which can be offered and perceived in a multidimensional way. Based on the control-value theory and using data of 1030 students from the German Mittelschule, this doctoral thesis examined the mediation of the relationship between teachers' multidimensional autonomy support in physical education and leisure-time physical activity in a sample of adolescents with low socioeconomic status. The purpose of the first study was to translate and validate the German version of the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education. The three subscales cognitive autonomy support, organizational autonomy support and procedural autonomy support were used to provide a more detailed insight into

how physical education teachers promote autonomy. The factorial validity of the scale was examined using a confirmatory factor analysis. Based on the findings of previous validation studies, three different models were tested: a general factor model with only one latent factor, a three-factor model and a bi-factor model in which the variance in the manifest items is explained by three specific latent factors as well as a general latent autonomy factor. In addition, multigroup comparisons were used to determine whether the factor structure was invariant across gender and age. To determine internal consistency of the scale, Cronbach's alpha was used. To investigate criterion validity, the extent to which the autonomy support by the physical education teacher can contribute to the explanation of students' academic self-efficacy and intrinsic value was examined. In the second study, a mediation analysis examined whether the relation between multidimensional autonomy support and leisure-time physical activity is mediated by students' control (self-efficacy) and value (intrinsic value) appraisals and their emotions during physical education. Variance-based structural equation modeling was used to test the proposed model. The results indicated that especially cognitive autonomy support positively predicted students' self-efficacy and intrinsic value. Whereas appraisals of self-efficacy were negatively related to the experience of anxiety, intrinsic value was a major positive predictor of enjoyment. Enjoyment, in turn, was of substantial relevance for leisure-time physical activity. The results offer an important contribution in understanding students' emotional experience and remind physical education teachers of the opportunity to positively influence their students' emotions through an autonomy-supportive teaching style.

1 Introduction

It is widely known that children and adolescents benefit from physical activity (PA) in various ways. Higher levels of regular PA are, for example, associated with a lower risk of overweight and obesity, diabetes mellitus type II and metabolic syndrome (Poitras et al., 2016; Saint-Maurice, Welk, Russell, & Huberty, 2014). Furthermore, children's regular PA is positively related to cardiovascular and mental health (Andersen, Riddoch, Kriemler, Hills, & Hills, 2011; Biddle, Ciaccioni, Thomas, & Vergeer, 2019). Despite its role as a potentially powerful protective factor for health, children do not engage sufficiently in PA. Self-report studies show that not even one fifth of children aged between 11 and 17 years fulfill the World Health Organization (WHO) guideline of a daily average of 60 min of moderate-to-vigorous physical activity (MVPA) across the week (Bull et al., 2020; Guthold, Stevens, Riley, & Bull, 2020). These results are highly similar to the PA level reported by children aged between 3 and 17 years living in Germany (Finger, Varnaccia, Borrmann, Lange, & Mensink, 2018). Furthermore, PA behavior of children both worldwide and in Germany is characterized by a gender and age effect, with male and younger children exhibiting higher PA levels than female and older children, respectively (Demetriou et al., 2018; Dumith, Gigante, Domingues, & Kohl, 2011; Finger et al., 2018; Guthold et al., 2020).

Since PA behavior is not only associated to short-term consequences on health but also acts as a significant predictor of PA levels later in adulthood (Telama, 2009), PA should be promoted starting at a young age. This brings up the role of physical education (PE), which represents a platform for confronting students with PA experiences irrespective of their personal PA behavior, their talents or attitudes. Furthermore, PE may be even more important for students stemming from households of low socioeconomic status (SES), as these students tend to exhibit even higher physical inactivity rates and a worse health status (Finger et al., 2018; Lampert, Hoebel, Kuntz, Müters, & Kroll, 2018; Stalsberg & Pedersen, 2018). However, there is substantial concern if and to which extent PE is able to fulfill this mandate with regard to ambiguous empirical findings (Demetriou & Höner, 2012; Errisuriz, Golaszewski, Born, & Bartholomew, 2018). The often small effects of intervention programs implemented in PE on students' PA behavior may be associated with the theoretical foundation of the programs, which mostly neglect the role of students' emotional experiences associated with PE (Klos, Feil, Eberhardt, & Jekauc, 2020; Rhodes, McEwan, & Rebar, 2019). Affective experiences and concrete emotions have been found to be relevant determinants of sport and exercise behavior (Antoniewicz & Brand, 2016; Rhodes & Kates, 2015). Although in recent years affect-related concepts have begun to be applied more and more in the endeavor to understand and promote PA behavior (Ekkekakis, 2017),

the number of studies that specifically concentrate on affective experiences is still small (Klos et al., 2020).

To consider the role of emotions when examining the association between the experiences that students make during PE lessons and their PA behavior, theories which specifically focus on emotions may be helpful. Theoretical frameworks like the affective-reflective theory of physical inactivity and exercise (ART; Brand & Ekkekakis, 2018) acknowledge the relevance of emotions in the determination of long-term regular PA. Besides reflective processes, the ART posits that automatic affective evaluations that are partly based on past experiences influence the PA behavior of an individual (Rhodes & Kates, 2015). Applied to the PE context, it can thus be assumed that the experience of positive emotions during PE classes may foster regular PA, whereas negative emotions make it less likely that students voluntarily engage in PA outside of PE.

Based on the assumed relevance of affective experiences in the determination of PA behavior, in a next step it is important to be aware of the antecedents that may have an impact on the emotional experience in the first place. The control-value theory of learning and achievement emotions (CVT; Pekrun, 2006) not only differentiates and defines distinct emotions that are typically experienced in achievement settings like school and refers to the respective outcomes of these distinct emotions. Additionally, the CVT also makes assumptions regarding the students' cognitive appraisals of subjective control and value as the most proximal antecedents of emotions, which can in turn be influenced by the learning environment (Pekrun & Perry, 2014). One important aspect of the learning environment is the autonomy support provided by the teacher. It is suggested that the empowerment of students in taking their own learning decisions enhances students' appraisals of subjective control and value (Linnenbrink-Garcia, Patall, & Pekrun, 2016; Pekrun, 2006).

These assumed relations suggest the possibility of PE teachers to structure the learning environment of PE lessons in a way that may enhance students' control and value appraisals, which may then lead to a more intense and frequent experience of positive emotions and finally to a healthier PA behavior outside of class. Therefore, this dissertation aims to examine the relation of the learning environment and adolescent PA behavior with control and value appraisals and achievement emotions as possible mediators. Additionally, in terms of the learning environment a specific focus is set on autonomy support provided by the PE teacher in a possibly multifaceted manner (Stefanou, Perencevich, DiCintio, & Turner, 2004).

These research questions are examined in a high-risk sample for physical inactivity comprising students of lower-track secondary schools mainly stemming from households with a low SES. The findings of the studies presented in this dissertation may be of practical use for PE teachers who are interested in feedback tools that reflect the way they structure

their students' learning environment. Furthermore, the studies may show teachers and other practitioners how they can generate insights into the emotional experience of their students. Also, the findings may serve as a promising groundwork for future PE interventions that build upon the use of specific strategies to influence student emotions and their respective consequences regarding health behavior, in particular PA. Finally, with regard to methodological aspects, this work provides advice about how to prepare and conduct assessments of psychological constructs in a sample of academic underachievers who might additionally have to struggle with possible language barriers.

1.1 Physical Activity of Adolescents

Adolescents benefit in manifold ways from regular engagement in PA. Reduced overweight or obesity, a decreased risk for colon or breast cancers, improved cardiovascular and mental health, a higher probability of leading an active life in adulthood and finally a lower risk of premature death are only a few of the desirable effects of regular PA (Andersen et al., 2011; Biddle et al., 2019; Granger et al., 2017; McKinney et al., 2016; Poitras et al., 2016). In addition to these long-term effects, PA also provokes more instant health effects, such as a reduced blood pressure or improved glucose control after being physically active (Thompson et al., 2001).

Results of German, European and worldwide studies yet indicate that adolescents mainly do not take advantage of the potential benefits of regular PA. Using self-reports of children and adolescents aged 3 to 17 years, the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) concluded that in Germany only 22.4% of girls and 29.4% of boys aged 3 to 17 are physically active in moderate-to-vigorous intensity for at least 60 min per day (Finger et al., 2018). Based on self-reports of 1.6 million participants from 146 countries around the world, activity rates were even lower with 22.4% of male and 15.3% of female adolescents aged between 11 and 17 years reaching daily 60 minutes of MVPA (Guthold et al., 2020). The reported PA levels in the respective studies depend to some degree on the used measurement instruments. Large-scale studies using pooled accelerometer data suggest both lower and higher average MVPA levels for adolescents mostly assessed in Europe and North America when compared to the results of self-report studies presented above (Brooke, Corder, Atkin, & van Sluijs, 2014; Cooper et al., 2015). However, both self-report studies and studies using device-based assessments with accelerometry support the effects of gender and age with older and female adolescents exhibiting even worse activity rates (Brooke et al., 2014; Cooper et al., 2015; Dumith et al., 2011; Finger et al., 2018; Guthold et al., 2020). In spite of internationally ambiguous results (e.g., Corder et al., 2011; Molina-García, Queralt, Adams, Conway, &

Sallis, 2017; Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017), PA behavior in German adolescents seems to be subject to an effect of SES, since physical inactivity rates - here defined as the prevalence of less than two days with 60 min MVPA per week - are higher in groups of low SES (Finger et al., 2018). Since in Germany SES of the students and the level of formal education of the different school forms are related (Nold, 2010), this finding points to the relevance of examining and promoting the PA behavior of adolescents attending the German Mittelschule, which represents the lowest formal education of secondary schools in Germany.

1.2 The Role of Physical Education for Adolescents' Physical Activity

In view of the worrying PA behavior of adolescents (e.g., Demetriou et al., 2018; Finger et al., 2018), the potential role of PE as a platform that may improve PA behavior of students outside of school becomes obvious. This notion might apply even more to students with a lower socioeconomic background attending lower-track secondary schools in Germany (Nold, 2010). Consequentially, the PE curriculum of the German Mittelschule explicitly emphasizes the mandate of PE to foster students' interest in and enjoyment of regular and voluntary PA in a lifelong perspective (Staatsinstitut für Schulqualität und Bildungsforschung München, 2017). Positive associations between participation in PE and PA levels in leisure time seem to generally corroborate this mandate (Ekblom-Bak, Ekblom, Andersson, Wallin, & Ekblom, 2018; Vilhjalmsson, 2019). However, in line with research showing that intervention studies aiming to promote PA often have limited success (Klos et al., 2020; Rhodes & Nigg, 2011), intervention programs implemented in PE with the explicit aim of promoting student PA outside of PE mainly generate small effects (Demetriou & Höner, 2012; Errisuriz et al., 2018; Slingerland & Borghouts, 2011). As these findings may certainly be attributed to various reasons, one fundamental factor could be the theories that are commonly used in the design of intervention programs. The theoretical frameworks that have mostly been used in the past three decades are social-cognitive theories, humanistic theories, socioecological theories and, to a smaller extent, dual-process approaches (Rhodes et al., 2019). With the exception of the dual-process framework, which comprises theories like the ART (Brand & Ekkekakis, 2018), these most prominent models ignore the possible impact of the general affect and the subjective emotions that are experienced by students during PE lessons.

In recent years, the relation between affect and PA levels has been supported (Ekkekakis & Dafermos, 2012; Rhodes & Nigg, 2011). Thereby, more broadly defined ratings of pleasure and displeasure but also concrete emotions have been indicated as correlates and predictors of sport and exercise behavior (Antoniewicz & Brand, 2016;

Rhodes & Kates, 2015). Thus, the inclusion of students' subjective emotional experiences in the context of PE could improve the understanding of the role of PE and may eventually enhance its power in promoting student PA outside of school. Theoretical models that acknowledge the relevance of student emotions may therefore provide a helpful foundation for PE interventions that aim to increase students' PA (Ekkekakis & Zenko, 2016; Sniehotta, Presseau, & Araújo-Soares, 2014).

1.3 The Control-Value Theory of Learning and Achievement Emotions

In accordance with the ART (Brand & Ekkekakis, 2018), the CVT (Pekrun, 2006) recognizes the fundamental importance of emotions for the explanation of human behavior. Moreover, the CVT additionally sets a specific focus on learning and achievement contexts like school. Furthermore, the CVT argues for a holistic approach and provides assumptions about which distinct emotions can be experienced within learning and achievement contexts, how these emotions are influenced by distal and proximal antecedents in a first step and how the emotions subsequently provoke certain behavioral outcomes (Pekrun, 2006). An overview of the CVT is presented in Figure 1.

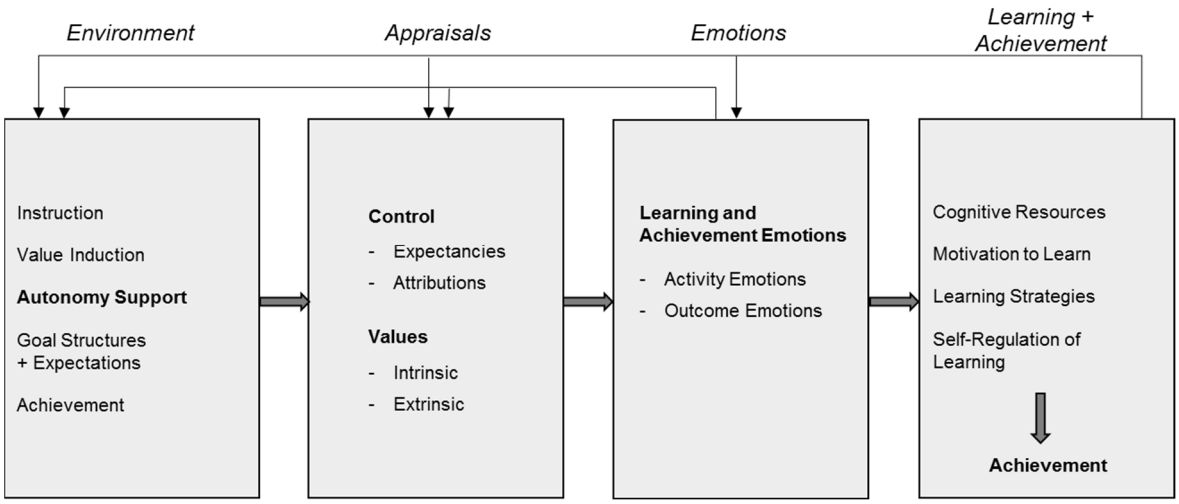

Figure 1. The control-value theory of learning and achievement emotions (adapted from Pekrun, 2006).

1.3.1 Classification of Learning and Achievement Emotions

Some previous studies have approximated a consideration of emotions, for example enjoyment, in activity-related school contexts (e.g., Jaakkola, Wang, Soini, & Liukkonen, 2015). However, in these cases enjoyment has mostly been used as a marker that may indicate the general affect of students. It has to be noted, however, that there is a conceptual

difference between measuring students' general affect and assessing their experience of distinct emotions. Emotions can be characterized with regard to their reference to a specific task and they can be differentiated in terms of their various antecedents (Simonton & Garn, 2019). The more accurate differentiation between distinct emotions compared to the rather superordinate differentiation between positive and negative affect not only allows for a more detailed description of the emotional experiences of students (Garn, Simonton, Dasingert, & Simonton, 2017), but also provides these distinct emotions with a larger predictive power regarding subsequent outcomes (Mouratidis, Vansteenkiste, Lens, & Auweele, 2009).

In the framework of the CVT (Pekrun, 2006), three major dimensions serve to classify the distinct achievement emotions. First, it is differentiated between emotions of positive or negative valence. Pride or enjoyment represent emotions of positive valence, whereas anxiety, anger, shame or boredom are classified as negative emotions. Second, emotions are classified as to whether they are of activating or deactivating nature, and thus may drive or inhibit student behavior in a learning context. The third dimension finally describes the object focus, thereby differentiating whether the emotion applies to the achievement activity per se or to the possible achievement outcome, that is success or failure. Thus, when a student experiences enjoyment while studying to prepare for an exam, this enjoyment would be classified to be of positive valence, activating nature and related to the achievement activity itself. Boredom on the other hand would be characterized as a negative, deactivating and activity-related achievement emotion. If a student anticipates failure in an exam while preparing for it, the felt anxiety would be classified as a negative outcome-related achievement emotion of activating character, since it may drive the student to work harder in order to prevent the anticipated failure (Pekrun, 2006).

1.3.2 Antecedents of Learning and Achievement Emotions

According to the CVT, the quality of the emotions that is experienced by students in a learning and achievement context is influenced by attributes within the individual and aspects of the learning environment (Pekrun & Perry, 2014). The individual attributes of students' subjective appraisals of personal control and the value that is attached to the subject matter represent the more proximal antecedents of students' emotional experiences.

Students' subjective appraisals of control are characterized by their beliefs regarding their own competences, their style of attributing success and failure and three different types of expectancies (Pekrun, 2006). Situation-outcome expectancies relate to considerations whether the student is generally in the position to have an effect on the outcome of the situation at all. Action-control expectancies reflect students' appraisals whether they are

able to initiate and perform an action which may then lead to an outcome. Action-outcome expectancies, finally, refer to students' thoughts about the effects that their actions may provoke, such as producing a success or preventing negative consequences like failure or embarrassment.

Students' subjective appraisals of value represent the relevance they ascribe to the subject matter. Value appraisals can in turn be differentiated into intrinsic and extrinsic value. Intrinsic aspects, such as a student's personal interest attached to the achievement, determine the intrinsic value. External factors, such as a reward the student aims at or a threatening punishment the student wants to prevent, influence the extrinsic value of the achievement (Pekrun, Elliot, & Maier, 2006).

Not only students' subjective appraisals of control and value separately, but also the interaction of these two dimensions contribute to the quality and magnitude of emotions that are experienced by the students. Positive control and value appraisals tend to provoke positive emotions like enjoyment while studying or pride about an achieved outcome while they are able to reduce emotions of negative affect, like anger or boredom (Pekrun, 2006). If, however, a student ascribes a high value to an achievement outcome, e.g., the grade in an upcoming exam, but at the same time appraises her or his level of control as being low, then negative outcome emotions like shame or anxiety are probably evoked (Pekrun, 1992, 2006).

The CVT suggests that the subjective appraisals of control and value, being the proximal antecedents of distinct learning and achievement emotions, mediate the effects of the learning environment, which thus comprises more distal antecedents of the emotional experience (Pekrun & Perry, 2014). This means that the students' appraisals of control and value - although representing personal considerations - may be influenced by aspects outside of the student. This is where the teachers and their teaching strategies come into play. Theoretical aspects suggested within the framework of the self-determination theory (SDT; Deci & Ryan, 2000) can be used to examine the assumed relevance of the learning environment for students' appraisals of control and value (Pekrun, Lichtenfeld, Marsh, Murayama, & Goetz, 2017). More concretely, Pekrun and colleagues (2017) relate the support of the so-called basic psychological needs (Deci & Ryan, 2000) to control-value appraisals. Representing one important aspect of the learning environment, the autonomy support that is provided by the teacher may be of high importance. The need for autonomy is defined as the desire to be the author of one's actions and to experience volition and psychological freedom in the activities that are conducted (Deci & Ryan, 2000). In general, students' beliefs about class-related experiences can be influenced to some extent by the way teachers structure the learning environment (Goetz, Lüdtke, Nett, Keller, & Lipnevich, 2013). The more teachers support their students' need of autonomy and thus manage to

lead them to take learning decisions on their own, the more they contribute to strengthening students' subjective cognitive appraisals (Linnenbrink-Garcia et al., 2016; Pekrun, 2006). It is assumed that actions which are controlled by the students themselves facilitate their appraisals of control and value (Pekrun & Perry, 2014; Wang et al., 2017).

1.3.3 Multidimensional Autonomy Support as an Antecedent of Learning and Achievement Emotions

Teachers who successfully manage to support their students' need for autonomy can be characterized by several characteristics and behaviors. They are able to establish a kind of relationship that allows them to identify their students' interests, preferences and personal goals and subsequently nurture and develop these resources (Assor, Kaplan, & Roth, 2002; Reeve, 2009). Furthermore, teachers offering high levels of autonomy support give their students a feeling of being understood by taking over their perspective (Reeve, 2015).

In order to provide high-quality autonomy support and evoke the described positive effects in students, teachers have a variety of strategies to choose from (e.g., Assor et al., 2002; Reeve & Cheon, 2016; Stefanou et al., 2004). A prominent strategy is to provide students with choice that should be offered in a way that emphasizes internal locus and volition (Deci & Ryan, 2000; Reeve, Nix, & Hamm, 2003; Ryan & Deci, 2000). However, it is important to note that in order to support students' need for autonomy, there are more strategies than the provision of choice, and that autonomy support is thus not synonymous with choice (Reeve et al., 2003). In line with different strategies available to support student autonomy, different qualitative manifestations of autonomy support in a learning context have been suggested (Stefanou et al., 2004). To do so, Stefanou and colleagues (2004) took up the concept of choices and differentiated between the provision of cognitive, organizational and procedural choices, which has then become the foundation for the three suggested manifestations of teacher autonomy support.

Cognitive autonomy support focuses on promoting students' responsibility for the learning process. Respective teaching behaviors comprise asking students to justify their point, to find solution paths on their own or to reflect and evaluate their own ideas and the ones of their classmates. Teachers high in cognitive autonomy support have been found to proactively demand student feedback, allow their students to reflect and criticize the learning tasks, explain the relevance of lesson contents and answer student questions more regularly (Assor et al., 2002; Reeve, Bolt, & Cai, 1999).

Organizational autonomy support can be defined as the support of students' responsibility to manage their learning environment. This refers to, for example, developing rules together in a group, the choice of group members or seating arrangements. With

specific regard to the context of PE lessons, supporting students' choice of equipment and exercise place have been added (Tilga, Hein, & Koka, 2017).

Procedural autonomy support is characterized by the support of students' responsibility for how the learning process is conducted with regard to, for example, how competences are introduced and demonstrated or whether students get the possibility to present their work in an individual manner (Stefanou et al., 2004).

Since research about the different manifestations of teacher autonomy support has originally been embedded within the theoretical framework of the SDT (Deci & Ryan, 2000), these constructs have mainly been linked to intrinsic motivation or student engagement as the most relevant criterion variables. With regard to these associations, cognitive autonomy support has been deemed to be the most influential type of autonomy support. However, it has been suggested that organizational and procedural autonomy support may be of incremental value beyond the contribution of cognitive autonomy support in the endeavor to facilitate optimal learning circumstances for students (Hastie, Rudisill, & Wadsworth, 2013; Stefanou et al., 2004).

1.3.4 Behavioral Outcomes of Learning and Achievement Emotions

With regard to its holistic design, the CVT not only serves as a theoretical framework for describing the character of learning and achievement emotions and how they evolve, but also considers concrete behavioral consequences of the emotions experienced in different settings (Pekrun, 2006). Besides associations between emotions and other determinants of behavior, such as student motivation (Pekrun & Perry, 2014), direct effects of achievement emotions in educational settings on achievement outcomes, like performance, can be assumed (Pekrun et al., 2017).

An important performance-related outcome within the educational setting of PE is student PA during class as well as regular PA behavior outside of school. CVT-based assumptions are supported in that the enjoyment students experience during PE is positively related to engagement both during PE lessons (e.g., Dishman et al., 2005; Hashim, Grove, & Whipp, 2008) and during leisure time (e.g., Engels & Freund, 2020; Sallis, Prochaska, Taylor, Hill, & Geraci, 1999). Furthermore, the experience of enjoyment during PE lessons has been shown to be able to significantly attenuate the PA decrease that is typically observed during adolescence (Dumith et al., 2011; Guthold et al., 2020; Yli-Piipari, Barkoukis, Jaakkola, & Liukkonen, 2013).

On the other hand, also possible negative PA-related effects of achievement emotions of negative valence have to be considered. The role of anxiety in terms of PA, for example, is ambiguous to some extent. However, it has been shown that anxiety can be

related to negative thoughts about PA which may finally lead to a negative association with PA engagement (Simonton, 2020; Yli-Piipari et al., 2013). Furthermore, results of a qualitative analysis based on semi-structured interviews suggest student anxiety to be a barrier for participation in PA (Ntoumanis, Pensgaard, Martin, & Pipe, 2004).

1.3.5 Indirect Effects within the Control-Value Theory of Learning and Achievement Emotions

Alongside the assumed direct effects described above, the CVT also proposes several indirect effects between the included variables (Pekrun, 2006). The mediation of the effect of the learning environment on emotions by students' subjective appraisals of control and value constitutes the most important indirect effect. It has been empirically supported in different settings with autonomy support as the chosen representation of students' learning environment. In the setting of tennis courses, university students' control and value appraisals mediated the positive indirect effect of autonomy support on enjoyment as well as the negative indirect effect on boredom (Simonton, Solmon, & Garn, 2021). In the educational setting of math courses in middle school, the examined mediation effect was extended by student engagement as an achievement outcome. It could be shown that students' math-related self-efficacy and the intrinsic value they ascribed to the subject, mediated the statistically significant effect of teacher autonomy support on students' experienced boredom. In addition, there was a statistically significant indirect effect of teacher autonomy support on student engagement in math courses, which was mediated by the control-value appraisals and boredom (Wang et al., 2017).

1.4 Psychometric Assessment of Constructs with Self-Report Questionnaires in a Sample of Academic Underachievers

Reliable and valid measurement instruments constitute basic prerequisites for the assessment of psychosocial constructs by means of self-administered questionnaires (Bühner, 2011). In samples of academically underachieving children and adolescents stemming from a lower socioeconomic background, in which a substantial part of the sample might additionally struggle with language problems, thorough piloting of the psychometric scales is of highest importance. Thereby, it has to be made sure that the items are designed in such a way that the respondents can meet the expectation of completing the questionnaire based on the cognitive and communicative skills they possess (Bell, 2007). The challenges that respondents face when taking part in a questionnaire assessment can be classified into four consecutive stages. In the first stage, the participants

have to be able to understand the vocabulary used in the introduction and in the items and they have to comprehend what they are expected to do in order to respond, i.e., fill in a form field or marking the best-fitting response option provided by Likert scales with a cross. Secondly, participants have to recall the information that is related to the content of the respective item. In the third stage, participants have to reflect on the recalled information in order to make an accurate judgement. In the fourth stage, participants finally have to communicate their response (Schwarz & Sudman, 1996). Piloting of the items should lead to final versions of the psychometric scales that allow the participants to go through all of the described stages. If a participant fails to go through one or even more of the described stages, response quality is most probably impaired (Bell, 2007).

There are some guidelines that may assist in designing items that are appropriate for the specific use in samples comprising children and adolescents. First of all, wording of the items should not be complicated, phrasing should not be convoluted. Thus, short and simple items that may unfold the intended meaning in straightforward manner should be preferred. Furthermore, whenever possible, items should not be inversely formulated. Also, items should not be presented in a suggestive manner to prevent participants from being affected by social desirability effects (Bell, 2007). Additionally, besides item content and formulation, also the response format should be thoroughly chosen. In doing so, the average ability of the sample to reliably differentiate between several response options should be considered. Usually, 11-year-olds and older adolescents are able to respond to items by use of a 5-point Likert scale (Borgers, de Leeuw, & Hox, 2000). Additionally, not only the two extremes but each of the response options should be labelled (Borgers, Hox, & Sikkel, 2003).

However, to obtain accurate and valid self-report data in research with adolescent samples, investigators do not only have to pilot the scales to make sure that they are appropriate for the examined sample. Personally conducting the assessments on site and introducing the participants in detail to the project also contributes to a successful data assessment. Here, the challenge the assessment team faces is to render a standardized introduction into the procedure of completing the questionnaires to ensure the objectivity of the assessment on the one hand, while they should react and adapt to the different cognitive skills and motivational resources of every participating class of students on the other hand. When academic underachievers are part of the examined sample, it is more relevant than in other samples to try to motivate and support the students to take part and give their best in concentrating and responding accurately to the posed questions and items. Furthermore, researchers also have to motivate the participants to answer truthfully. Therefore, it is helpful to explain the participants the purpose of the assessments in sufficient detail to make them aware of the fact that they have the chance to contribute to a relevant project. In

addition, it could be very helpful to highlight aspects of data protection. This might apply even more in a sample of academic underachievers. Even if the effects should not be overestimated, Simonson (2009) could show that in class surveys students with a low level of parental education and with a migration background are more likely to respond in socially desirable manner. Simonson (2009) also draws attention to the fact that the teacher could have an impact on this behavior through his or her presence. Hence, students should be made aware that they are provided with the opportunity to freely express their thoughts and feelings as nobody is able to link the responses to a specific person. In samples with academic underachievers, researchers may additionally have to deal with students facing massive language problems or students with cognitive disabilities. Even though, in some cases this data might not be usable for further analysis, each student should be encouraged to participate and should be given the feeling that he or she is part of it like every other student.

1.5 Critique of Previous Research

Although it is widely assumed that PE has the potential to support children and adolescents in leading an active life both in the short and in the long run, empirical research seems to question the potential of PE. The positive associations between students' PA during PE lessons and their activity behavior in leisure time might at first support the contribution of PE to students' leisure-time PA (e.g., Ekblom-Bak et al., 2018; Vilhjalmsson, 2019). However, the correct interpretation may also be that students who are highly active during leisure time also tend to be more active during PE, since it is simply another opportunity for them to follow their personal interest in being physically active. Furthermore, the effects of PE interventions aiming to increase students' leisure-time PA are mostly negligible when evaluated in terms of an everyday relevance (Demetriou & Höner, 2012; Errisuriz et al., 2018; Slingerland & Borghouts, 2011; Sturm, Bachner, Renninger, Haug, & Demetriou, 2021). A possibly relevant factor explaining these deficits might be the neglect of students' affective experiences they make in relation to PA in general or regarding PA during PE specifically (Brand & Ekkekakis, 2018; Rhodes et al., 2019). Although theoretical frameworks that may help to examine the role of emotions in PA research have been available for more than a decade (e.g., Pekrun, 2006), it was only recently that children's and adolescents' PA-related affective experiences have been increasingly incorporated in research (Garn et al., 2017; Simonton & Garn, 2019; Simonton, Garn, & Solmon, 2017). Still, however, there is a clear deficit of studies that would empirically examine PA-related student emotions both with regard to their antecedents in the PE learning environment and with regard to their consequences in everyday leisure-time PA.

With regard to the antecedents of students' emotional experiences that pertain to the learning environment, autonomy support provided by the teacher has been identified as a relevant factor (e.g., Simonton et al., 2021). Although there are manifold strategies to support students' autonomy (Assor et al., 2002; Reeve & Cheon, 2016), which is also reflected in theories that propose qualitatively different manifestations of autonomy support (Stefanou et al., 2004), teacher autonomy support is mostly assessed in unidimensional manner. Thus, the potential cognitive, organizational and procedural facets of teacher autonomy support are ignored (Stefanou et al., 2004; Tilga et al., 2017), which prevents both researchers and teachers from receiving more detailed insights into the quality and quantity of autonomy support and their respective effects on student outcomes.

Besides theoretical considerations, the practical relevance of examining student emotions, their antecedents and outcomes, such as leisure-time PA, in the specific group of academic underachievers mainly stemming from a low socioeconomic background has not been met to date. Research in this specific sample may not only contribute to content-related findings about the antecedents and outcomes of students' emotional experiences, but might also lead to practical insights into how the respective assessments should be prepared and conducted in order to get reliable and valid data from these specific participants (Bühner, 2011).

1.6 Aims of the Studies

In this dissertation, the holistic approach for examining student emotions in educational contexts that is suggested by the CVT (Pekrun, 2006), is applied to a sample of academic underachievers of the German Mittelschule mainly stemming from households with a low SES. Following the holistic approach (Pekrun, 2006), not only the emotional experience of the students in PE is assessed, but also the emotions' antecedents with regard to the more distal learning environment and the more proximal subjective appraisals of control and value are considered. Finally, the consequences of students' PE-related affective experience are examined with regard to their PA behavior in leisure time.

Students' perception of their learning environment is represented by their evaluation of teacher autonomy support. To obtain insights into the potentially multifaceted nature of autonomy support, a multidimensional instrument assessing cognitive, organizational and procedural autonomy support is translated into German and thoroughly validated. Potentially incremental contributions of the different manifestations of autonomy support to the explanation of students' subjective control and value appraisals, to their emotional experiences and their PA behavior in leisure time are examined. Figure 2 gives an overview of the hypothesized mediation model.

Additionally, the identification of practical suggestions for preparing and conducting self-report assessments in a sample of academic underachievers is pursued.

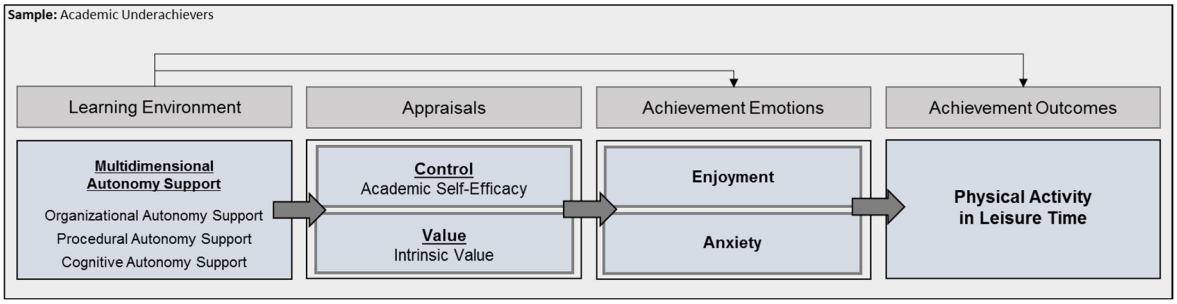

Figure 2. Hypothesized mediation model.

2 Methodology

The studies presented here were conducted within the 'Students' Emotions in Physical Education' project, in short PEmo. The sample of the project comprised 1030 students aged between 11 and 18 years (M = 13.4, SD = 1.48), 408 participants were female (39.6%), 622 participants were male (60.4%). The students attended grades 6 through 10 of the school form with the lowest educational level among secondary schools in Germany, called Mittelschule. Ten schools participated in the project, including three urban, three semi-rural and four rural schools. German was the main language spoken at home for 51.8% of the participants, whereas a predominant use of a foreign language at home applied to 26.7% of the students. The remaining 20.9% of the students spoke both German and another language to a similar degree at home. The average value for SES was at 41.3 (SD = 12.8, n = 991) on a scale with a possible range from 10 to 89 (Ganzeboom, 2010). Thus, SES of the PEmo participants was substantially lower when compared to participants of large-scale studies with German-speaking samples, such as the Programme for International Student Assessment (PISA) study which indicated a mean SES of 51.8 (SD = 21.0, n = 4346) for its participants of grades 7 through 10. To indicate students' weight status, age- and sex-dependent BMI percentiles were used. Mean percentile was 79 for girls and 86 for boys, both being within the range of normal weight (Kromeyer-Hauschild et al., 2001). The students had two school hours of mandatory single-sex PE lessons per week.

The scales used in the PEmo project were rigorously pilot tested before the beginning of the main data assessments. One hundred ninety-three students of grades 6 through 10 from one urban and one rural German Mittelschule took part in the pilot study. Results of the pilot study argued for the general feasibility of a questionnaire study in this specific sample of academic underachievers mainly exhibiting a low socioeconomic background. Furthermore, the applicability of the translated and adapted scales was supported with regard to results of initial reliability and validity analyses and cognitive interviews (Prüfer & Rexroth, 2005) that were conducted with both academically under-performing and over-performing students of each class. Insights generated by the pilot study also led to a manual that helped the assessment team of the main study in answering participants' questions about the items and the procedure in a consistent manner.

The paper-and-pencil data assessment was conducted during regular school lessons. To make sure that the assessed PE-related constructs represented trait measures instead of state measures, assessments were not scheduled directly after PE lessons. Students took on average 35 min to complete the questionnaire. With regard to the aspects described in section 1.4., the data assessements were conducted according to a precise protocol that was rigorously followed. Thus, before participants started to fill in the

questionnaire, the head of the assessment team and a research assistant informed the participants about the purpose and the procedure of the assessment and about how to handle the different response scales. To assist the participants in providing valid responses, they were reminded of the fact that the assessments were not about whether they personally like their teacher or the general teaching style. Instead, the participants were asked to indicate their approval to each item separately with regard to its specific content and context. Short paragraphs were included above each scale to help the participants in focusing on the respective content and context. After a student had completed the questionnaire, one after the other went outside of the classroom where two research assistants measured height and weight with a stadiometer and a digital weight scale.

In the following, the scales that were used and the specific data analyses that were conducted in the respective studies are described in detail.

2.1 Study 1

In order to provide a reliable and valid self-report instrument that is able to assess the multifaceted autonomy support by the teacher in German-speaking samples, the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE; Tilga et al., 2017) was translated into German and validated by means of structural equation modeling. The MD-PASS-PE includes three 5-item subscales aiming to assess cognitive, organizational and procedural autonomy support. Participants were to respond to the items on a 7-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. The original items were translated into German by means of the back-translation technique (Brislin, 1970). Thereby, the original version was translated from English into German by a team of bilingual native speakers and experts from the field of sports pedagogy. The newly formed German version was then back-translated into English by another team of bilingual native speakers. A remaining difference in one item between the original and the translated version was discussed and solved within a committee of bilingual researchers.

Data analyses were conducted with SPSS Statistics and SPSS AMOS (Version 23.0; IBM Corp., Armonk, NY, USA). The study variables exhibited less than 5% of missing values, data were missing completely at random. The Expectation Maximization algorithm was used to impute missing values. Univariate normal distribution was examined with regard to skewness and kurtosis of each item. Cronbach's alpha was used to measure internal consistency of the MD-PASS-PE subscales. Confirmatory factor analysis (CFA) was used to examine the factor structure. The comparative fit index (CFI), the Bentler-Bonett normed fit index (NFI), the Bentler-Bonett non-normed fit index (NNFI), and the root mean square error of approximation (RMSEA) were used as goodness-of-fit indices (Hu &

Bentler, 1999). An acceptable fit of the data with the hypothesized model is indicated by values ≥ 0.90 for the CFI, NFI and NNFI indices, and values ≤ 0.08 for the RMSEA index. Furthermore, standardized regression weights of the items should exceed 0.40 (Hair, Black, Babin, & Anderson, 2018).

Multigroup confirmatory factor analysis (MG-CFA) was used to examine measurement invariance of the MD-PASS-PE across gender and age. Therefore, several constraints are added in stepwise manner to an initially unconstrained model. The gradually applied constraints assume factor loadings, item intercepts, latent variances and factor covariances to be equal across groups (Byrne, 2010; Cheung & Rensvold, 1999; Raju, Laffitte, & Byrne, 2002). If an added constraint produces changes in CFI and RMSEA of < 0.01 and < 0.015, respectively, measurement invariance is supported (Chen, 2007). Weak measurement invariance is given if the MG-CFA supports the assumption of equal factor loadings across groups. Strong measurement invariance is suggested if both factor loadings and item intercepts can be considered to be equal across groups (Byrne, Shavelson, & Muthén, 1989).

Academic self-efficacy in PE and the intrinsic value that students ascribe to PE were used as criterion variables in examining the criterion validity of the MD-PASS-PE. Self-efficacy was assessed with a 5-item scale originally designed to measure general academic self-efficacy (Jerusalem et al., 2009). Items were adapted to the context of PE. Participants responded on a 4-point Likert scale. A 6-item scale originally assessing the intrinsic value of mathematics was adapted to measure intrinsic value of PE (Markus, 2019). Participants responded by use of a 5-point Likert scale. Structural equation modeling, based on maximum likelihood estimation, was used to test the assumption that multidimensional autonomy support is a positive predictor of self-efficacy and intrinsic value (e.g., Buhr, Daniels, & Goegan, 2019; Wang et al., 2017).

2.2 Study 2

To examine the potentially mediating role of cognitive appraisals and achievement emotions in the relationship of multidimensional autonomy support in PE and leisure-time PA, variance-based structural equation modeling (VB-SEM) was used. The scales used to assess multidimensional autonomy support, academic self-efficacy in PE and intrinsic value of PE are described in section 2.1. The achievement emotions enjoyment and anxiety were assessed with five items, respectively, that stemmed from the Achievement Emotions Questionnaire (AEQ; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011) and the Achievement Emotions Questionnaire-Mathematics (Pekrun, Goetz, & Frenzel, 2005). In the framework of the AEQ, items for the assessment of achievement emotions as a trait in

three different academic achievement settings are available, i.e., during class, while studying and in exams. In this study, items assessing achievement emotions during class were used. The items were adapted to the context of PE and slightly simplified in terms of language. Participants responded on a 5-point Likert scale. The 6-item physical activity subscale of the German Physical Self-Description Questionnaire was used to estimate leisure-time PA of the participants (PSDQ; Stiller & Alfermann, 2007).

The assumed associations between autonomy support, cognitive appraisals, achievement emotions and leisure-time PA were examined with VB-SEM, since it is distribution-free and less affected by potential non-normality. Furthermore, models with higher complexity can be examined better as VB-SEM is based on ranked rather than ordinal data (Henseler, Ringle, & Sinkovics, 2009). Data analysis was conducted with Warp PLS v7.0 (Kock, 2015). Missing data were replaced by arithmetic mean imputation. Discriminant validity of every latent variable was considered as given if the square root of the average variance extracted (AVE) for each latent variable exceeded its correlation coefficient with the other latent variables. General model fit was assessed using the goodness-of-fit index (GoF), the average variance inflation factor (AVIF), average R^2 (ARS) and average path coefficient (APC). GoF values of 0.100, 0.250 and 0.360 indicate small, medium and large effect sizes, respectively (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005). The AVIF should be below 5.000 (Kock, 2018). ARS and APC should differ significantly from zero for the model to be considered as adequate. Mediation effects were examined by calculating indirect effects by means of a “stable 3” method that increases accuracy and statistical power (Kock, 2017).

3 Publications

3.1 Article 1

Authors: Julia Zimmermann, Henri Tilga, Joachim Bachner, & Yolanda Demetriou
Title: The German Multi-Dimensional Perceived Autonomy Support Scale for Physical Education: Adaption and Validation in a Sample of Lower Track Secondary School Students
Journal: International Journal of Environmental Research and Public Health
Doi: 10.3390/ijerph17197353

Summary:
Autonomy support provided by the teacher can positively affect students' behavioral and affective outcomes in physical education. With cognitive, organizational and procedural autonomy support, three different forms of autonomy support have been suggested in educational settings. Nevertheless, instruments to assess autonomy support in a multidimensional way are lacking. Therefore, the aim of this study was to translate and validate the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE) for the use in German-speaking samples. The sample comprised 1030 students of grades 6 through 10 of the German Mittelschule, which represents the lowest educational level among secondary schools in Germany. Internal consistency of the three subscales was examined by Cronbach's alpha. Factorial validity was examined by testing the fit of the assumed three-factor structure by means of confirmatory factor analysis. Measurement invariance across age and gender was tested by multigroup confirmatory factor analysis. Criterion validity was examined by structural equation modeling using academic self-efficacy in and intrinsic value of physical education as criterion variables. The three subscales exhibited acceptable to good internal consistency. The three-factor structure was confirmed in a bi-factor model comprising a general factor and three specific group factors for cognitive, organizational and procedural autonomy support. Strong evidence for measurement invariance across gender was found, whereas results regarding measurement invariance across age groups were ambiguous. Multidimensional autonomy support explained 15% and 14% of the variance in self-efficacy and intrinsic value, respectively, thus supporting the instrument's criterion validity. The German MD-PASS-PE represents a reliable and valid tool that may help physical education teachers in providing autonomy support in a more holistic way.

The manuscript was submitted in September 2020, and accepted and published in October 2020 in the special issue *New Advances in Self-Determination Theory in Physical Education* of the *International Journal of Environmental Research and Public Health*. The *International Journal of Environmental Research and Public Health* is an international peer-reviewed open-access journal publishing research in the interdisciplinary area of environmental health sciences and public health.

Contribution:

Julia Zimmermann was the leading author of the article, developed the idea for the study and collected the data. Julia Zimmermann and Henri Tilga developed the study design and analyzed the data. Julia Zimmermann and Joachim Bachner wrote the initial version of the article, Henri Tilga and Yolanda Demetriou contributed to review and editing.

International Journal of
Environmental Research and Public Health

MDPI

Article

The German Multi-Dimensional Perceived Autonomy Support Scale for Physical Education: Adaption and Validation in a Sample of Lower Track Secondary School Students

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Abstract: Teachers' autonomy support (AS) in physical education (PE) has positive effects on students' affective and behavioral outcomes in PE. Even though the existence of three different dimensions of AS, namely cognitive, organizational and procedural AS has been suggested in educational settings, there is a lack of multidimensional instruments for the assessment of autonomy-supportive teaching in PE. The aim of this study was to validate the German Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE). The sample comprised 1030 students of grades 6 through 10. Internal consistency was used to test the reliability of the assumed subscales. Factorial validity and measurement invariance across gender and age were examined by confirmatory factor analyses. Structural equation modeling was used to evaluate criterion validity. The subscales exhibited acceptable to good internal consistency. The assumed three-factor structure was confirmed within a bi-factor model including a general factor and three specific group factors. Results strongly supported measurement invariance across gender while tentatively suggesting measurement invariance across age. Criterion validity was supported as the MD-PASS-PE explained 15% and 14% of the variance in the constructs of self-efficacy and intrinsic value, respectively. The German MD-PASS-PE provides PE teachers with deeper insights into their autonomy-supportive teaching behavior, helping them to support their students' autonomy in a holistic way.

Keywords: autonomy support; teaching; self-determination theory; questionnaire; self-efficacy; intrinsic value; bi-factor model; cognitive autonomy support; organizational autonomy support; procedural autonomy support

1. Introduction

Teachers' interpersonal style is of crucial importance in forming students' psychological experiences both in the classroom and in physical education (PE) settings [1,2]. The way students perceive their interaction with their teachers may affect students' intrinsic motivation, autonomous self-regulation, and several educational outcomes in psychomotor, cognitive, and affective learning domains [1,3–7]. Autonomy-supportive teaching is one of the most important aspects by which the interaction of teachers and students can be described [1]. This study aimed to provide a reliable and valid multi-dimensional instrument, which enables a deeper understanding of autonomy support in German PE classes.

The self-determination theory (SDT) [4] explains human motivation, emotions and personality processes in social contexts and has thus been intensively applied in PE [1,7]. The Basic Psychological Needs Theory (BPNT) [4,8] is one of the mini-theories included in the SDT framework. It postulates that teachers can influence students' quality of motivation, well-being, and behavioral persistence by supporting students' basic psychological needs for autonomy (i.e., experiencing a sense of volition), competence (i.e., experiencing a sense of effectiveness), and relatedness (i.e., experiencing a sense of connection) through need-supportive teaching [9–12]. In addition, need-supportive teaching relates positively to higher PE enjoyment [13], better performance [14], and higher physical activity levels in leisure time [15].

In the field of PE, the benefits of interacting with autonomy-supportive teachers are well documented [16]. Additionally, the effects of autonomy-supportive teaching have been examined about three times more often than the ones of competence or relatedness support [7]. Various effects of teacher autonomy support have been demonstrated with regard to students' motivation for health behavior change [17], intention to be physically active outside the school setting [18], physical self-esteem [19] or experience of positive emotions [20,21].

There are various ways to support students' need for autonomy, and different authors describe autonomy-supportive teaching in diverse ways [22–26]. In the framework of the SDT, the need for autonomy is characterized as a human desire to be the author of one's actions and to experience a sense of volition and psychological freedom when engaging in an activity [23,27]. Thus, autonomy includes the pursuit of self-realization and self-determination that requires support from the social environment and interpersonal relationships. Within this theory, the provision of choice is regarded as one strategy to support autonomy [4,27,28]. Accordingly, autonomy-supportive teaching comprises more than just giving students a choice of different options [23]. To promote perceived self-regulation or intrinsic motivation, choice needs to be designed in such a way that it increases internal locus and volition [23]. Hence, teachers who successfully support their students' need for autonomy, identify, nurture, and develop students' motivational resources, like their interests, preferences, and personal goals [22,29]. Furthermore, autonomy-supportive teachers are able to convey an interpersonal message of support, understanding and the adoption of the students' perspective, which students generally perceive as need-supportive [30].

Stefanou et al. [24] also argued that autonomy need not be synonymous with choice in a general way and proposed that there are multiple, distinct ways for teachers to support autonomy. Based on this assumption, Stefanou et al. [24] identified three manifestations of autonomy support in a learning environment, including cognitive choices as well as organizational and procedural choices. The first manifestation is called cognitive autonomy support (cAS), which promotes students' responsibility for the learning process. This includes teaching behaviors like asking students to justify or argue their point, to generate their own solution paths or to evaluate their own and others' solutions or ideas. cAS can further imply aspects such as the discussion of multiple approaches, strategies and ideas or the provision of informal feedback. Studies of autonomy-supportive teaching found that teachers offering higher rates of cAS tend to listen more, collect regular feedback from students, allow students to criticize the learning tasks, promote relevance, encourage students to think for themselves and answer students' questions more often [22,31,32]. The second type of autonomy support is called organizational autonomy support (oAS), which can be considered as students' responsibility to manage their learning environment. This includes aspects like developing rules together, choice of group members or seating arrangements. Tilga, Hein, and Koka [33] expanded this feature with regard to PE and further named the opportunities to choose equipment and exercise place as aspects of oAS. Finally, Stefanou et al. [24] characterized procedural autonomy support (pAS) as promoting students' ownership about how to conduct the teaching and learning process. Teacher behaviors that are associated with pAS are, for example, providing the students with a choice regarding how competencies are demonstrated or with the possibility to present work in an individual manner. Tilga et al. [33] also added teaching behaviors like the explanation of a lesson structure and providing rationales.

Stefanou et al. [24] stated that cAS may be the essential component without which motivation and engagement may not be increased. Therefore, one might suppose that cAS is the most influential aspect of optimal learning. However, they further pointed out that oAS and pAS alone may not be sufficient, but may still be necessary to foster student engagement and intrinsic motivation. If students benefit from choice in all three aspects of autonomy support within regular lessons [24,34], a learning environment with high cAS, oAS and pAS may also be ideal for maximizing students' engagement and intrinsic motivation in PE settings.

Therefore, multidimensional measurement of the perceived autonomy-supportive teacher behavior is able to provide more detailed insights into effective teaching behavior in PE. By means of the Learning Climate Questionnaire (LCQ) [35,36], the Sport Climate Questionnaire (SCQ) [37] and the Perceived Autonomy Support Scale for Exercise Settings (PASSES) [38], autonomy support has been measured in a unidimensional way, equaling cAS [16,21,33]. Based on the lack of multidimensional scales to assess the perceived autonomy-supportive teacher behavior in PE settings, Tilga et al. [33] developed the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE). Following the conclusions of Stefanou et al. [24], the items of the MD-PASS-PE were assigned to three categories (i.e., cognitive, organizational, and procedural autonomy support) with five items each to describe the autonomy-supportive teacher behavior in more detail. Confirmatory factor analysis supported the hypothesized three-factor solution, which was invariant across gender and age. The composite reliability coefficients of the cAS, oAS and pAS support subscales indicated good reliability (ρ between 0.83 and 0.89). Incremental criterion validity of the MD-PASS-PE compared to the unidimensional LCQ was examined with the satisfaction of the three BPN used as criterion variables. Both instruments significantly predicted need satisfaction. However, the MD-PASS-PE explained significantly more variance in competence need satisfaction than the LCQ [33].

To the best of the authors' knowledge, there is no survey instrument in Germany that enables the assessment of students' perceived autonomy support in PE in a multidimensional way. Therefore, the purpose of this study is to analyze the psychometric properties of the MD-PASS-PE with a sample of secondary school students from the least academically demanding track in Germany called *Mittelschule*.

2. Materials and Methods

2.1. Participants

The sample of this study included 1030 students aged between 11 and 18 years (M = 13.4, SD = 1.48). The students attended grades 6 through 10 of the German *Mittelschule*. The *Mittelschule* represents the lowest educational level among secondary schools in Germany. The data was drawn from 67 classes of 10 schools (3 urban schools, 3 semi-rural schools, and 4 rural schools) and it involved 408 girls (39.6%) and 622 boys (60.4%). Of the participants, 51.8% indicated that German was the language spoken at home. Of the participants, 26.7% stated that another language was the one mainly spoken with their parents at home. The remaining 20.9% of the participants spoke German and another language to a comparable extent at home. Mean socioeconomic status (SES), calculated by the International Socio-Economic Index of Occupational Status (ISEI) [39] was 41.3 (SD = 12.8; n = 991) and thus clearly lower than in larger studies in Germany like the Programme for International Student Assessment (PISA) study in the year 2018, whose participants in grades 7 through 10 exhibited a mean SES of 51.8 (SD = 21.0; n = 4346). Body mass index (BMI = kg/m^2) was on average 22.2 (SD = 4.8) which is within the healthy range of 18.5 to 24.9. The students participated in mandatory single-sex PE lessons for two hours a week.

2.2. Measures

2.2.1. Pilot Study

The psychometric scales used in the main study were rigorously pilot tested in advance. The sample of the pilot study comprised 193 students of 11 classes from one urban and one rural German *Mittelschule* (grades 6 through 10). The main goal of the pilot study was to examine the applicability of the translated and adapted items as well as the scale format. Piloting was also used to test the general feasibility of a questionnaire study in this specific sample of academic underachievers mainly stemming from a low socioeconomic background.

While the students were completing the questionnaire, members of the assessment team marked the items that caused the students problems in understanding. After the questionnaire was completed, structured cognitive interviews [40] were conducted with two academically over-performing and two under-performing students compared with the level of each class. The interviews took place in a separate area, so that each student was able to express his/her opinion freely and independently from the classmates. The insights of the pilot study led to the final version of the questionnaire, in which the wording of the items was slightly adapted. Furthermore, based on the pilot study, a manual was prepared that should help the assessment team of the main study to answer consistently to the questions of the students regarding the respective items.

2.2.2. Autonomy Support by PE Teacher

- MD-PASS-PE Questionnaire Assessment

The autonomy-supportive behavior of the PE teachers was measured with the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE) [33]. The MD-PASS-PE includes three subscales measuring cognitive, procedural and organizational autonomy support. Each subscale contains five items. An example item for cognitive autonomy support taken from the English version would be: "My PE teacher allows me to express my opinion". "My PE teacher guides students in finding solutions" and "My PE teacher allows me to do exercises using different methods" are representative for the procedural and organizational autonomy support items, respectively. Students responded by means of a 7-point Likert scale from 1 = strongly disagree to 7 = strongly agree. The back-translation technique [41] was used to translate the items into German. First, the original items were translated from English into German by a team of researchers comprising bilingual native speakers and experts from the field of sports pedagogy. The translated German version was then back-translated into English by another team of bilingual native speakers. After comparing this version with the original scale, a remaining difference in one item between the versions was discussed and solved within a committee of bilingual researchers. The German version of the MD-PASS-PE is provided as supplementary material.

Former confirmatory factor analyses supported both a three-factor solution and a second-order model, which underlined the assumption of three conceptually distinct but highly related factors [33]. Further studies supported the reliability and factorial validity of the scale [42–45].

2.2.3. Academic Self-Efficacy in PE

Academic self-efficacy in PE was assessed using a German 5-item scale originally designed to measure academic self-efficacy [46]. The items were adapted to the context of PE. Students responded on a 4-point Likert scale.

2.2.4. Intrinsic Value of PE

To measure the intrinsic value that students ascribe to PE, a German 6-item scale including a 5-point Likert scale was used. The original scale was designed to measure the intrinsic value of

mathematics and exhibited acceptable factorial validity and good internal consistency [47]. For the present study, the items were adapted to the PE context.

2.2.5. Socioeconomic Status

To estimate their socioeconomic background, the students had to name and describe their parents' jobs. The students' answers were classified with regard to the International Socioeconomic Index of occupational status (ISEI), which is based on the International Standard Classification of Occupation 2008 (ISCO-08) [39]. If the jobs of both parents could be classified, the job with the higher ISEI value (HISEI) was used. The ISEI has a possible range from 10 to 89, with higher values indicating a higher socioeconomic status. Socioeconomic status could not be estimated for every student, because some students did not know or could not sufficiently describe their parents' jobs.

2.3. Procedures

The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics commission of the Technical University of Munich (304/19 S) and the supervisory school authorities in charge. After approval of the ethics committee and the supervisory school authorities, the principals of the schools in the participating school district were contacted via phone and e-mail. They were provided with the documents informing the teachers, parents and students about the study. Additionally, they were sent the consent forms several weeks before the scheduled beginning of the study. The students did not participate unless they themselves as well as their parents, their PE teacher and the school principal had approved the participation. The students were not rewarded for participation in any form. They could leave out questions if they did not want to answer. They also had the possibility to withdraw their participation at any time before, during or after data collection without any personal consequences.

The paper-and-pencil data collection took part within regular school lessons and lasted on average 35 min. To make sure that the PE constructs represented trait measures instead of state measures, data assessments did not take place directly after PE lessons. Before the beginning of the data collection, the head of the assessment team and one research assistant informed the students about the purpose and the procedure of the assessments. After the students were explained in detail how to handle the different response scales, they started to fill in the questionnaire on their own. The students could give a signal at any time and ask questions quietly in case of uncertainties. After a student had completed the questionnaire, he/she went outside of the classroom where height and weight were measured by means of a stadiometer and a digital weight scale by two other research assistants. These procedures applied to the preparation and implementation of both the pilot and main study.

2.4. Statistical Analysis

SPSS Statistics and SPSS AMOS (Version 23.0; IBM Corp., Armonk, NY, USA) were used for the data analysis. Data screening showed that the study variables had less than 5% of missing values. The non-significant Little's [48] test indicated that the data were missing completely at random ($\chi 2 = 990.631$, df = 950, $p = 0.175$). Since missing values inhibit structural equation modelling based on maximum likelihood estimation with 5000 bootstrap samples, which would be used later in the statistical analysis in AMOS, missing values had to be replaced [49–51]. Therefore, the Expectation Maximization algorithm was used to impute missings. The data was screened for univariate normal distribution based on the Byrne [49] recommendations, which consider values for skewness and kurtosis of each item ranging between −7 to +7 as acceptable. Internal consistency was estimated by means of Cronbach's alpha coefficients. In a preliminary evaluation of the factor structure, an exploratory factor analysis (EFA) based on a principal component analysis was conducted. A direct oblimin rotation was used to account for the assumption of significantly related factors.

Fit of the proposed factor structure of the scales with the data was examined by means of confirmatory factor analysis (CFA). The following goodness-of-fit indices suggested by Hu and

Bentler [52] were used to evaluate model fit: the comparative fit index (CFI), the Bentler–Bonett normed fit index (NFI), the Bentler–Bonett non-normed fit index (NNFI), and the root mean square error of approximation (RMSEA). An acceptable fit of the data with the hypothesized model is indicated by values ≥ 0.90 for the CFI, NFI and NNFI indices, and values ≤ 0.08 for the RMSEA index. Additionally, the items should exhibit standardized regression weights higher than 0.40 [53].

Measurement invariance across gender and age was tested by means of multi-group confirmatory factor analysis (MG-CFA). Thereby, the fit of one model is compared to the fit of another model in which one constraint is added. Thus, after an unconstrained model is introduced, more and more constraints are added in a stepwise manner, which assume factor loadings, item intercepts, latent variances and factor covariances to be equal across groups [49,54,55]. The commonly used comparative fit index (CFI) and the root mean square error of approximation (RMSEA) were considered for model comparison [56]. According to Chen [57], invariance is supported if the changes in CFI and RMSEA values are below 0.01 and 0.015, respectively, every time a new constraint is added. If the MG-CFA supports the assumption that factor loadings are equal across groups, weak measurement invariance is given. Strong measurement invariance requires both factor loadings and item intercepts to be equal across groups [58].

Self-efficacy and intrinsic value were used to examine criterion validity of the MD-PASS-PE. For this, structural equation modelling based on maximum likelihood estimation with 5000 bootstrap samples was used [49,50]. Based on the control-value theory (CVT) of learning and achievement emotions [59,60], the impact of the social environment (e.g., autonomy support) on students' learning and achievement emotions should be mediated by the cognitive appraisals of subjective control and subjective values [59]. Subjective control relates to expectations and attributions about the perceived controllability of achievement-related actions and outcomes (e.g., self-efficacy expectations, which refer to one's perception of his/her capacity to perform a learning task). Subjective values refer to the individual significance of achievement-related activities and outcomes (e.g., intrinsic value, which refers to the students' beliefs about the learning activity itself). The effects of perceived teachers' autonomy support on students' self-efficacy and intrinsic value have been empirically assessed in different educational settings [61–65]. The findings indicated that autonomy-supportive teaching increases self-efficacy and intrinsic value. Hence, autonomy support should positively influence the two cognitive appraisals of self-efficacy and intrinsic value in PE settings as well.

3. Results

3.1. Preliminary Analysis

Univariate normal distribution of the MD-PASS-PE items was supported as skewness ranged between—1.94 and 0.68 and kurtosis between—1.07 and 3.25. Cronbach's alpha values and the non-latent correlations between the scales are presented in Table 1. In the EFA, three factors with an eigenvalue > 1 were extracted, including a strong first factor. The extracted factors explained 54.62 % of the variance in the 15 items. Two items of the pAS and oAS exhibited cross-loadings.

Table 1. Cronbach's alpha coefficients and correlations between scales.

	cAS	oAS	pAS	SE	iVa
cAS	0.81				
oAS	0.61 *	0.76			
pAS	0.66 *	0.54 *	0.72		
SE	0.32 *	0.25 *	0.23 *	0.78	
iVa	0.36 *	0.20 *	0.23 *	0.61 *	0.91

Note. cAS = cognitive autonomy support; oAS = organizational autonomy support; pAS = procedural autonomy support; SE = academic self-efficacy in PE; iVa = intrinsic value of PE; * = correlation is statistically significant ($p < 0.001$); Cronbach's alpha values of the scales are presented in italics.

3.2. Factorial Validity

With the first CFA, the assumed three-factor structure of the MD-PASS-PE was tested. Fit indices suggested an acceptable model fit (see Table 2, Model 1). Standardized regression weights ranged between 0.37 and 0.78 with one factor loading below 0.40. The correlations between the latent factors were strong and significant ($0.77 \leq r \leq 0.94$). Because the high factor correlations might suggest a unidimensional solution, the fit of a one-factor model was also tested. Goodness-of-fit indices did not indicate a satisfying model fit (see Table 2, Model 2). With regard to these findings, a bi-factor model with both a general factor, defined by all 15 items, and three specific group factors (cAS, pAS, and oAS), defined by the items of the respective subscales, was tested. Goodness-of-fit indices indicated a good model fit to the data (see Table 2, Model 3 and Figure 1). The standardized regression weights on the general factor ranged between 0.34 and 0.72 with one factor loading below 0.40. The factor loadings on the specific domains of autonomy support were mostly lower than in model 1 ($-0.02 \leq \lambda \leq 0.64$).

Table 2. Fit indices for confirmatory factor models.

	Model		
Model Parameter	**Model 1: Three-Factor Model**	**Model 2: One-Factor Model**	**Model 3: Bi-Factor Model**
$\chi 2$	499.04	678.66	281.97
df	85	88	71
CFI	0.921	0.887	0.960
NFI	0.906	0.872	0.947
NNFI	0.902	0.865	0.940
RMSEA	0.069	0.081	0.054

Note. $\chi 2$ = chi-squared; df = degrees of freedom; CFI = comparative fit index; NFI = Bentler–Bonett normed fit index; NNFI = Bentler–Bonett non-normed fit index; RMSEA = root mean square error of approximation.

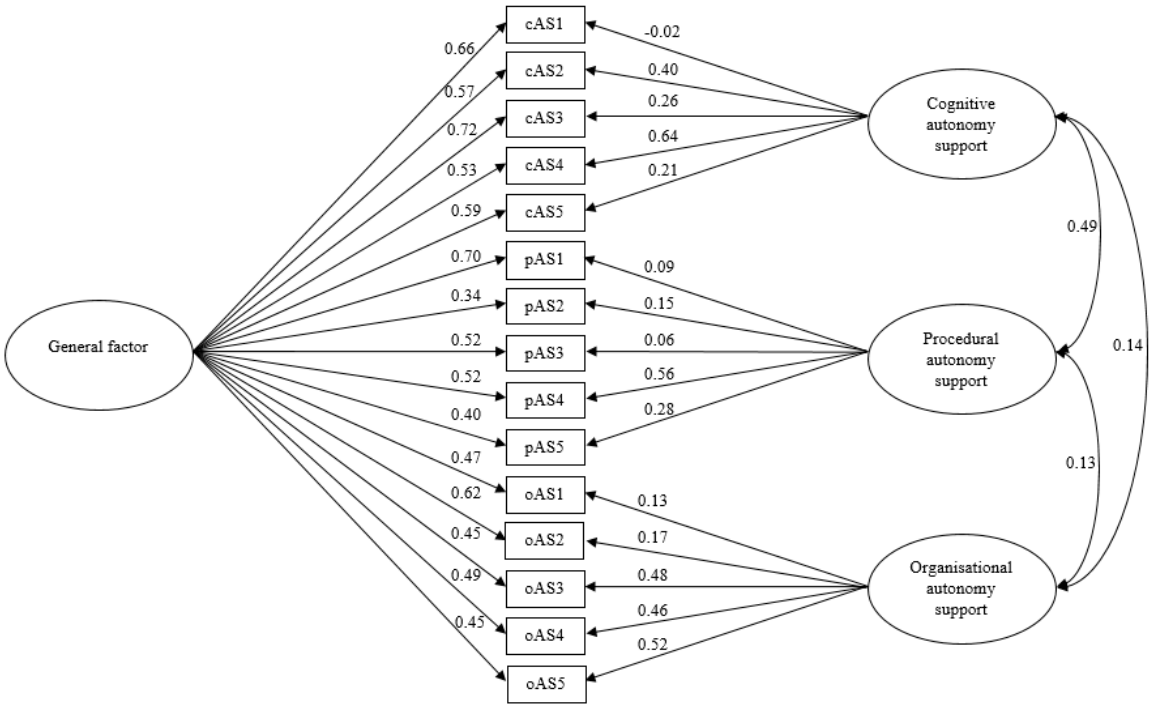

Figure 1. Bi-factor model of the German Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE). Standardized regression weights are presented next to the single-headed arrows, factor correlations are presented on the right of the double-headed arrows. Based on high modification indices, covariances were set between the error terms of items pAS3 and pAS5, and between the error terms of items oAS1 and oAS2.

3.3. Measurement Invariance

To test for measurement invariance across gender, multigroup analyses examined the fit of the bi-factor model in girls' and boys' subsamples. When adding the constraints of equal factor loadings and item intercepts across gender groups, the changes in CFI and RMSEA were below 0.01 and 0.015, respectively. Thus, strong measurement invariance across gender was supported.

Measurement invariance across age groups was examined by comparing students of grades 6 and 7 (n = 490), representing the German "Unterstufe", with students of grade 8 through 10 (n = 540), who belong to the "Mittelstufe". Factor loadings and item intercepts of the bi-factor model were equal across groups, which speaks for strong measurement invariance across age groups. To compare groups with the largest age difference, another multigroup analysis was conducted including only sixth (n = 237, mean age = 11.73) and ninth graders (n = 230, mean age = 14.85). Students from grade 10 could not be selected for this comparison, as there were only 50 tenth graders taking part in the study. Changes in CFI were at 0.02 when introducing the constraint of equal factor loadings. Changes in RMSEA, however, were marginal and supported strong measurement invariance.

3.4. Criterion Validity

To evaluate criterion validity, self-efficacy and intrinsic value were used as criterion variables in structural equation models. The latent criterion constructs were regressed on a latent multidimensional autonomy support factor, which was further regressed on the three specific autonomy support domains. In both cases, the multidimensional autonomy support factor served as a statistically significant predictor and was able to explain 15% and 14% of the variance in self-efficacy and intrinsic value, respectively (see Figures 2 and 3).

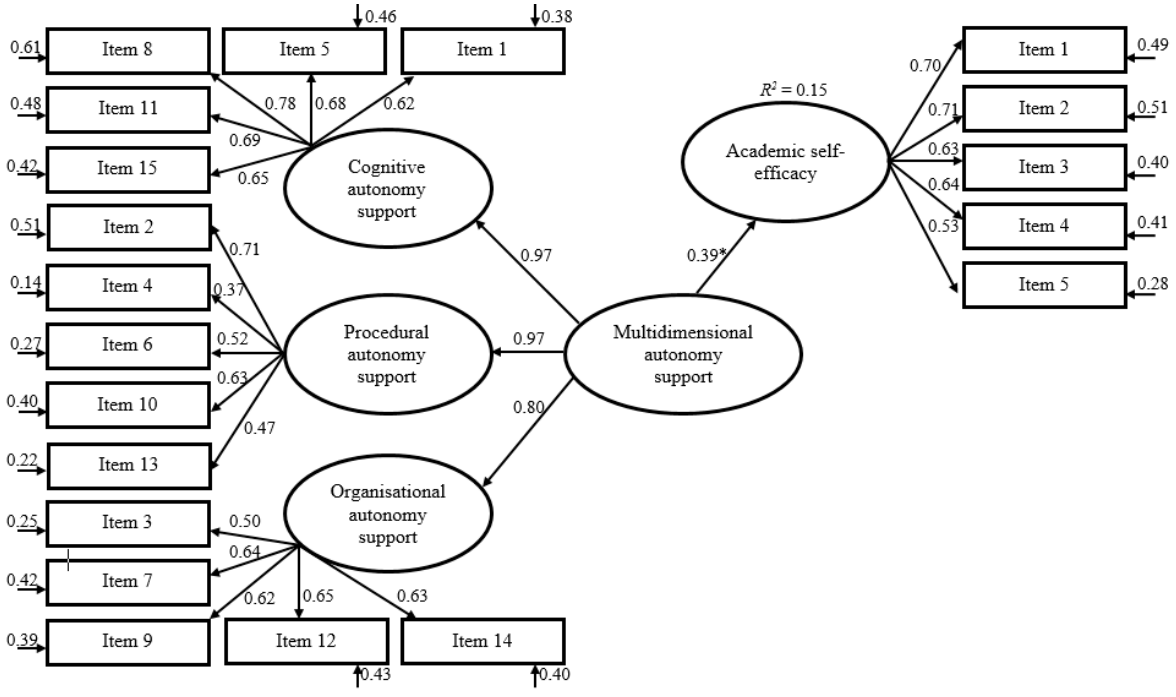

Figure 2. Structural equation modelling to predict academic self-efficacy in physical education (PE) from the latent multidimensional autonomy support of PE teachers. Including standardized regression weights. Regression weight of academic self-efficacy on multidimensional autonomy support is statistically significant ($p < 0.001$). R^2 = coefficient of determination.

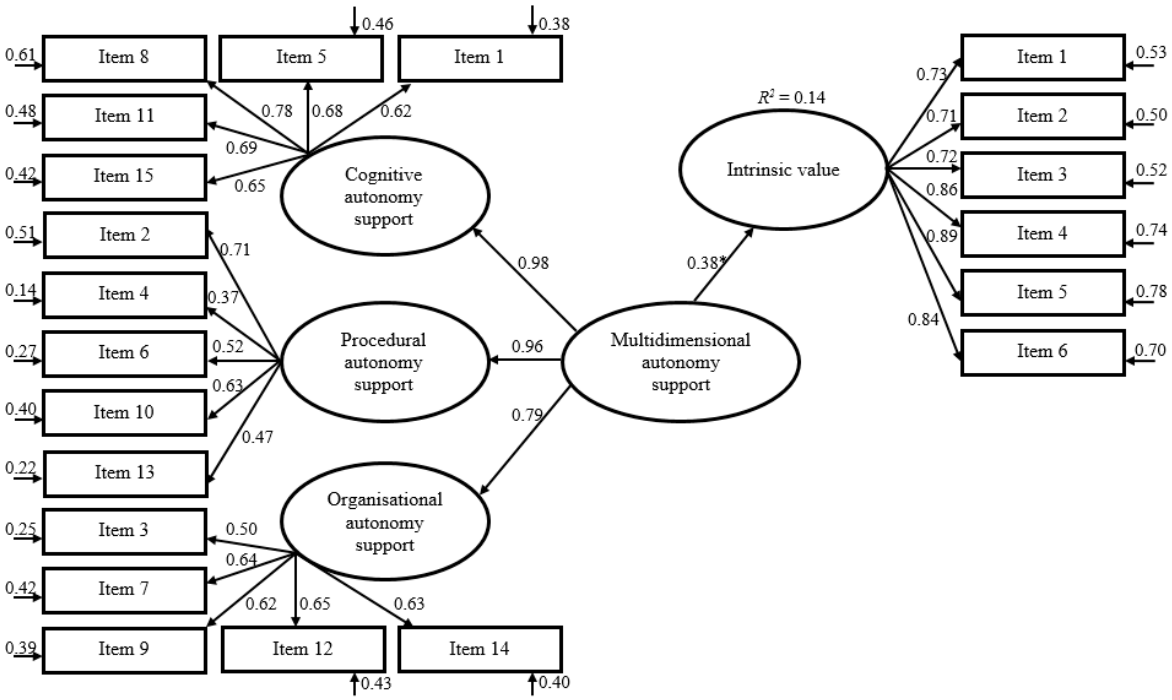

Figure 3. Structural equation modelling to predict intrinsic value of PE from the latent multidimensional autonomy support of PE teachers. Including standardized regression weights. Regression weight of intrinsic value on multidimensional autonomy support is statistically significant ($p < 0.001$). R^2 = coefficient of determination.

4. Discussion

4.1. General Discussion

In this study, the MD-PASS-PE was adapted to the context of German PE lessons and was validated with regard to its internal consistency, structural validity and measurement invariance as well as its criterion validity. In a sample of German lower-track secondary school students, the three-factor structure could be replicated within a bi-factor model, thus supporting the existence of the three conceptually distinguishable but highly correlated factors cognitive, organizational and procedural autonomy support [33]. The German MD-PASS-PE offered acceptable to good levels regarding internal consistency. Results provided strong support towards measurement invariance across gender while tentatively suggesting measurement invariance across age. Criterion validity regarding constructs of subjective control and value was demonstrated.

After internal consistency analysis suggested that the subscales exhibited satisfying reliability and that each of them consistently measured one construct, the structural validity of the MD-PASS-PE was analyzed. CFA of the proposed three-factor structure showed an acceptable model fit (see Table 2, Model 1). However, together with the high correlations between the three latent factors, model fit indices gave reason to find solutions that fit the data better. To make sure that the three factors exhibited discriminant validity, the fit of the three-factor model was compared to the fit of a one-factor solution. The unidimensional model did not fit well to the data (see Table 2, Model 2), which indicated that by means of the MD-PASS-PE autonomy support is measured in a multidimensional manner. Finally, to reflect a factor structure that represents distinct constructs, which are still highly correlated, a bi-factor solution was modeled. In this model, variance in the manifest items should be explained both by a general latent factor and by a specific group factor representing the respective domain of autonomy support. The bi-factor model fitted well to the data (see Table 2, Model 3). The comparison of the fits of the tested models indicates that the constructs of cognitive, organizational and procedural autonomy support represent factors that are conceptually and empirically distinguishable but highly

relate to each other. This interpretation was also supported in studies validating the MD-PASS-PE in samples of secondary school students in Estonia and Spain [33,42].

To account for high correlations between the three suggested aspects of autonomy support in the Estonian sample, Tilga et al. [33] tested a second-order model in which the three first-order factors (cAS, pAS, and oAS) were represented by one second-order factor. This model fitted the data equally well as a standard first-order three-factor model, which also supported the assumption of distinct but highly related autonomy support factors [33].

Although second-order and bi-factor models produce similar fits in various situations and suggest the same conclusions regarding factor structure, they implicate different features for further interpretations. In a second-order model, standardized path coefficients comprise both the direct influence from the first-order factor and mediated influences from the second-order factor [66]. The bi-factor model, however, is able to independently explain the direct effects of the general factor and the specific group factors on subtest performance, i.e., item scores. This way, it can be examined if an item rather represents a general trait or a more specific sub-trait [67]. Therefore, a bi-factor model is less ambiguous and thus more easy to interpret, as inferences regarding the influence of latent factors on item scores can be drawn immediately rather than using inferences from inferences, which are present in higher-order models [68–70]. In the present bi-factor model, standardized path coefficients of the general factor to the items were mostly higher than the ones of the specific group factors. This indicates a dominant general factor to which the unique effects of the specific group factors are added. The dominance of the general latent factor might be attributed to a possible deficit in the ability of lower track students to differentially rate their learning environment [71]. Instead, when completing the questionnaire, they might rather think of the choices they are provided with by their PE teacher during the lesson. Thus, the most likely interpretation of the general latent factor in the bi-factor model would be the overall autonomy support during PE in a sense of choice.

An alternative interpretation of the general latent factor would be an even more global evaluation of PE in terms of a rating from good to bad. Studies in the school context have shown that students in a given class come to highly similar ratings in scales assessing different aspects of lesson quality [47,72]. This suggests that students tend to evaluate lessons from a more emotional standpoint expressing their general approval of the lesson. In the case of the dominant general factor found here, one might therefore conclude that it represents a personal rating of lesson quality [47].

On the other hand, it has to be noted that the dominant general factor and the high correlations between the specific autonomy support factors do not necessarily have to be a consequence of a deficit in differentiation. With respect to the concepts of the specific autonomy support factors, high correlations should be expected. The teaching strategies used to support procedural autonomy [24] have a wide overlap with the teaching strategies for implementing structure [73], which is considered as an important part of the teaching process [74,75]. Furthermore, the unidimensional measurement of autonomy support widely represents the assessment of cAS [33]. In classroom and PE settings, a high correlation between autonomy support, usually measured in a unidimensional way, and the provision of the structure was reported [73,76]. Thus, it is not surprising that there are also high correlations between cAS and pAS.

Overall, the examination of the factorial validity of the MD-PASS-PE clearly speaks for a bi-factor model that includes a dominant general factor and three specific group factors. The group factors were highly correlated. This result was further supported by an exploratory factor analysis, which identified cAS as the most important group factor explaining most of the variance in the items. However, pAS and oAS substantially accounted for variance over and above the parts explained by cAS. Additionally, a unidimensional solution clearly exhibited the worst model fit. Summed up, variance in the manifest items is best explained by both a general factor, most likely representing overall autonomy support, and three distinct but highly related specific factors representing cAS, pAS and oAS.

The bi-factor model was used to check the invariance of the measurements across gender and age. Multigroup analyses supported the assumption of equality regarding factor loadings and item

intercepts across gender. Hence, strong measurement invariance was fulfilled. It can thus be assumed that the measured constructs have the same conceptual meaning and that the association between the manifest items and the respective latent factor is the same regardless of the gender of the participant.

Results of the multigroup analyses concerning age clearly suggested strong measurement invariance when students of the German Unterstufe (grades 6–7) were compared to the ones of the Mittelstufe (grades 8–10). When sixth graders and ninth graders were compared, results were rather ambiguous. Changes in CFI values did not indicate equal factor loadings across groups, which might lead to the assumption that the cognitive development of students between grades 6 and 9 on this educational level impedes measurement invariance. Changes in RMSEA values, however, were small and clearly spoke for equal factor loadings and item intercepts, which indicated strong measurement invariance. This finding was unusual because CFI and RMSEA normally are equally sensitive to different factor loadings across groups [57]. Above all, with regard to the influence of the type of factor models or the types of invariance models being compared, the cut-offs for maximum change in model fit in invariance testing should not be considered as strict rules [77]. Therefore, multigroup analyses rather speak for measurement invariance across the age groups included in this study. However, these results need to be replicated and examined closer in future studies.

Structural equation models including academic self-efficacy in PE and intrinsic value of PE as criterion variables supported the criterion validity of the German MD-PASS-PE. About 15% of the variance in these variables was explained by a latent factor representing multidimensional autonomy support. This is in line with the assumptions of CVT [59] and empirical studies about the effect of autonomy support on self-efficacy and intrinsic value in educational settings other than PE [65].

4.2. Strengths and Limitations

This study provides a thorough validation of the German MD-PASS-PE in a large sample. A reliable and valid instrument for the multidimensional measurement of teacher autonomy support in PE is provided. Results of former studies with Spanish and Estonian samples were replicated to a large extent. By means of a bi-factor model, independent contributions of the general latent factor and the specific autonomy support factors to variance in item scores could be differentiated. Specific implications regarding the use of the MD-PASS-PE and the interpretation of the scores in a sample of academic underachievers are discussed.

Future studies should replicate the analyses concerning measurement invariance across age as results were ambiguous to some extent and because the range of the participants included in this study lay between grades 6 and 10. Additionally, measurement invariance across time could be examined in a longitudinal design. Furthermore, results should be replicated with students from schools with different levels of formal education. Lastly, a comparison of the MD-PASS-PE with an instrument measuring autonomy support in a unidimensional way in terms of their predictive abilities of school-related psychological constructs would be interesting.

5. Conclusions

Numerous effects of teacher autonomy support have been demonstrated with regard to positive affective and behavioral outcomes in PE [17–19,21]. This validation of the German MD-PASS-PE not only provides a reliable and valid measurement tool for autonomy support in PE, but also supports the assumption that teachers' autonomy support can be provided in a multifaceted way [22–24,26]. Although different authors suggested different strategies of how to support autonomy in classroom and PE settings, the construct of autonomy was usually measured in a unidimensional way (e.g., LCQ) [33,42]. In this study, it was shown that cognitive, procedural and organizational aspects of autonomy support can be differentiated in PE lessons. This offers PE teachers the possibility to gain deeper and more exact insights into their teaching behavior. Furthermore, as a feedback tool, this instrument may help them in supporting their students in a holistic way as optimal learning benefits can be expected if cAS as well as pAS and oAS are provided [24].

Supplementary Materials: The following are available online at http://www.mdpi.com/1660-4601/17/19/7353/s1, data set S1: data set.

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3.2 Article 2

Authors: Julia Zimmermann, Henri Tilga, Joachim Bachner, & Yolanda Demetriou
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Summary:
Students' emotional experience during physical education lessons is often neglected when the role of physical education with regard to students' leisure-time physical activity is examined. Based on the control-value theory of achievement emotions, this study examined whether multidimensional autonomy support of the physical education teacher may affect students' leisure-time physical activity through their control and value appraisals in physical education and their achievement emotions enjoyment and anxiety that they experience during class. Variance-based structural equation modeling was used to test the fit of the proposed model to data of 1030 students of grades 6 through 10 of the German Mittelschule. Results showed that especially cognitive autonomy support positively predicted constructs of control and value, i.e., self-efficacy in and intrinsic value of physical education. Whereas appraisals of self-efficacy acted as a negative predictor of anxiety, intrinsic value was a highly relevant positive predictor of students' enjoyment during physical education. Anxiety, in turn, hardly affected leisure-time physical activity. However, enjoyment was an important positive predictor of students' activity behavior outside of school. Besides these direct effects, the assumed indirect effect of autonomy support by the physical education teacher on students' leisure-time physical activity via physical education-related self-efficacy, intrinsic value, enjoyment and anxiety was supported as well. These findings corroborate the potential of the relationship between teacher autonomy support and students' emotional experiences in physical education with regard to students' physical activity behavior outside of school.

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Contribution:

Julia Zimmermann was the leading author of the article, developed the idea for the study and collected the data. Julia Zimmermann and Henri Tilga developed the study design and analyzed the data. Julia Zimmermann and Joachim Bachner wrote the initial version of the article, Henri Tilga and Yolanda Demetriou contributed to review and editing.

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Article

The Effect of Teacher Autonomy Support on Leisure-Time Physical Activity via Cognitive Appraisals and Achievement Emotions: A Mediation Analysis Based on the Control-Value Theory

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Abstract: Analyzing students' emotional experience in physical education (PE) is of crucial importance as it may fill an important gap in research examining the role of PE for students' leisure-time physical activity (PA). Based on the control-value theory of achievement emotions, the purpose of this study was to test the assumption that multi-dimensional autonomy support of the PE teacher may affect students' leisure-time PA via their appraisals of control and value and achievement emotions experienced in PE. Variance-based structural equation modelling was used to test the proposed model in a sample of 1030 students aged between 11 and 18 years (M = 13.4, SD = 1.48) stemming from schools with the lowest educational level among secondary schools in Germany. The results indicated that in particular cognitive autonomy support positively predicted students' self-efficacy and intrinsic value. Whereas appraisals of self-efficacy were negatively related to the experience of anxiety, intrinsic value was a major positive predictor of enjoyment. Enjoyment, in turn, was of substantial relevance for leisure-time PA. The findings offer a meaningful contribution in understanding students' emotional experiences and remind PE teachers of their opportunity to adopt an autonomy-supportive teaching style to positively influence the emotions of their students.

Keywords: achievement emotions; control-value theory; autonomy support; self-efficacy; intrinsic value; enjoyment; anxiety; physical activity; physical education

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1. Introduction

The health benefits of regular physical activity (PA) for children and adolescents, such as lower risk of being overweight or obesity, type II diabetes mellitus and metabolic syndrome, are widely known [1,2]. Additionally, the findings suggest that high levels of PA and low levels of sedentary behavior are related to better mental health in children and adolescents [3,4]. However, self-report studies have shown that only 19% of students worldwide aged 11 to 17 fulfil the World Health Organization (WHO) recommendation of a daily average of 60 min of moderate-to-vigorous PA per day across the week [5,6]. Results of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) indicated that in Germany only 22.4% of girls and 29.4% of boys aged 3 to 17 reach the WHO guideline and that PA decreases significantly from age 3 to 17 [7]. Furthermore, PA over the life course is subject to a tracking effect, meaning that PA during adolescence is positively associated with PA in adulthood [8].

These findings suggest that promotion of PA in adolescents should be a priority for policymakers, parents and teachers [9]. This in turn points to the relevance of physical education (PE). PE exhibits great potential in fostering a healthy lifestyle since students

take part in PE lessons regardless of their PA level, personal attitudes, previous experiences or socioeconomic background. Therefore, PE should be used as a platform for increasing students' commitment and decreasing their dropout rates in physical activities and sports in a lifelong perspective. This refers particularly to students of low socioeconomic background since socioeconomic status (SES) has been found to be positively related to leisure-time PA [10]. Furthermore, there are indications that children and adolescents from families with low SES are significantly more likely to have a moderate, bad or very bad health status than their peers from families with high SES [11].

However, based on ambiguous findings, there is substantial concern if and to what extent PE is able to positively affect students' PA during leisure time [12,13]. In line with the overall finding that intervention studies focusing on PA behavior change often failed to increase PA [14,15], intervention programs specifically implemented in PE mostly reached small effects on leisure-time PA [16–18]. This may partly be due to the theories that are mainly used in intervention design, most of them being of social-cognitive or humanistic nature [14,19]. While the applied theories still vary to some extent, they share the common neglect of affect and subjective emotional experiences students make during PE lessons. Intrinsic motivation, one of the central constructs of the often used self-determination theory (SDT; [20]), does relate closely to the concept of emotions [21]. However, although the extent of intrinsic motivation and the experience of emotions can be explained by similar needs and triggers [22], they still are conceptually different. Whereas motivation refers to the energy that drives a specific action, emotions describe the physiological and psychological processes determining the subjective experiences while engaging in a certain behavior [21].

Over the last years, research has focused more and more on affect-related concepts to understand and promote PA behavior change [23–25] and evidence for the relation between affective experiences and PA already exists [15,26]. Emotions, affective associations and ratings of pleasure and displeasure during exercise have been identified as significant correlates and predictors of sport and exercise behavior [27,28]. Nevertheless, until recently, the number of interventions explicitly focusing on emotions and affective experiences to increase exercise maintenance or long-term PA behavior was small [14,29]. To summarize, by considering students' subjective emotional experiences, a more holistic understanding of the processes taking place in PE lessons could be attained. Consequently, if theory-guided PE interventions want to successfully change the experience of PA and promote fundamental motivation for PA, the role of affect, feelings and emotions experienced in PE must form part of the theories underlying these interventions as well [30–32]. Therefore, alternative theoretical models need to be taken into account [25,33].

Complementary to social-cognitive or humanistic theories, Brand and Ekkekakis [34] have introduced an alternative model with a dual-process theory that concentrates on the psychological processes that guide behavior and focuses specifically on exercise-related feelings. The affective-reflective theory of physical inactivity and exercise (ART) wants to explain and predict behavior in situations where people either remain in a state of physical inactivity or initiate an action. People tend to repeat behavior if they experience joy, while on the other hand, negative emotional experiences decrease the probability of repeated, and thus regular PA [28,34]. Applied to the PE context, it can be assumed that automatic affective evaluations and remembered emotions regarding PA and sports are partially influenced by experiences made in PE and that these experiences may thus have decisive effects on lifelong activity behavior. Therefore, positive and negative experiences in PE can be seen as highly relevant for long-term activity behavior [35]. PE teachers should aim to facilitate the experience of positive emotions while reducing the frequency of negative affect.

To be able to generate emotional experiences that may eventually trigger regular PA in leisure time, an overview of emotions that are potentially experienced by students during PE as well as their determinants and consequences is needed. The control-value theory of learning and achievement emotions (CVT; [36]) serves as an appropriate and

established theoretical framework as it presents antecedents and outcomes of emotions in school settings. The CVT comprises a range of distinct achievement emotions, which specifically occur within achievement settings like school [37]. Pekrun [36] describes and classifies achievement emotions according to three major dimensions. The first dimension differentiates between positive and negative valence of an emotion. Whether the emotion is of activating or deactivating character is described by means of the second dimension. The third dimension specifies the object focus and indicates whether the emotion refers to an achievement activity (e.g., learning) or an achievement outcome, namely success or failure. The achievement emotions represented in the CVT reflect both positive and negative affect. Anxiety, anger, shame and boredom are examples for achievement emotions of negative affect. Enjoyment and pride are examples for positive affect. With regard to the three major dimensions proclaimed by Pekrun [36], these emotions can be classified more specifically. Enjoyment while studying, for example, is thus classified as being of positive valence, activating character and related to an achievement activity. Anxiety is classified as a negative, activating and outcome-related achievement emotion.

In previous studies, enjoyment has often been used as an indicator for general positive affect, comprising feelings of fun and pleasure [38,39]. However, it is important to highlight the difference between distinct emotions and global affect. Emotions are specifically related to a given task and have different antecedents [40]. Additionally, disentangling distinct emotions offers a higher precision in the description of students' emotional experiences compared to the report of general positive and negative affect [41,42]. Furthermore, the predictive power of distinct achievement emotions is higher than the one of global tendencies in affect [43]. Therefore, despite minor conceptual similarities between the achievement emotions, they should be considered as discrete, separate manifestations of emotion.

According to the CVT, the most proximal antecedents of students' emotional experience in achievement situations are students' subjective appraisals regarding control and value. These cognitive appraisals are in turn influenced by the specific characteristics of the learning environment [44]. Thus, students' control and value appraisals are seen as the constructs mediating the link between the characteristics of the learning environment and the experience of distinct achievement emotions [44].

Control-related appraisals refer to students' competence beliefs, attributional style and their expectancies. According to Pekrun [36], three types of expectancies can be differentiated. Situation-outcome expectancies and action-outcome expectancies refer to the general controllability of a situation and possible effects of an action. Action-control expectancies are relevant one step before, when students appraise whether they are able to initiate and perform an action. Self-efficacy expectation, as it is introduced by Bandura [45], is highly similar to the concept of action-control expectancies and is most popular in representing control appraisals [36]. Value appraisals represent the perceived value of an achievement. These value appraisals can be seen with regard to intrinsic aspects, when the achievement is rated in terms of internal reasons, such as the personal interest attached to it. On the other hand, extrinsic value reflects the relevance of an achievement because of external reasons like a desirable reward [46]. Students' appraisals of control and value as well as the interaction of the two appraisal dimensions are assumed to determine which emotions are experienced and to which extent. Generally, positive appraisals of control and value regarding a given achievement activity are expected to provoke positive activity emotions, such as enjoyment of studying, and decrease negative activity emotions like anger [36]. However, high scores on value appraisals regarding an achievement outcome, for instance failure in an exam, can also lead to negative outcome emotions like shame or anxiety when paired with negative appraisals of control [36,47]. Several studies have supported the role of control and value appraisals as predictors of achievement emotions [48,49]. In a sample of high school students, control and value appraisals in PE were positive predictors of enjoyment and negative predictors of boredom [50].

Although control-value appraisals reflect personal convictions, they are not unchangeable. In fact, the CVT proposes that antecedents of cognitive appraisals can be identified

in the learning environment. Pekrun et al. [48] draw a theoretical link between the SDT with its basic psychological needs [20] and the control-value appraisals [36]. It is assumed that autonomy support influences the cognitive appraisals [36]. Thus, autonomy support provided by the teacher may represent one important aspect of the learning environment. Generally, the way teachers structure the learning environment can form students' beliefs regarding class-related experiences [51]. It is assumed that if teachers manage to empower their students to take important learning decisions by themselves, their cognitive appraisals should be enhanced [21,36]. Furthermore, self-controlled actions are suggested to facilitate the development of convictions of internal control [44]. Despite conceptual relations between autonomy support and subjective determinants of emotions, the association of autonomy support by the teacher and students' appraisals of control and value has not been empirically examined in the context of school PE [52]. However, the effects of autonomy support on constructs of control and value have been examined in other educational settings [53–55]. Findings indicated that autonomy-supportive teaching enhances students' ratings of self-efficacy and intrinsic value.

The examination of achievement emotions and their antecedents in PE is no end in itself but may imply insights into highly relevant consequences, such as performance- and health-related outcomes. The CVT assumes emotions to be crucial for understanding student motivation [44]. It is further proclaimed that the achievement emotions students experience in educational settings influence achievement outcomes, such as their performance [48]. Engagement in regular PA can be seen as a performance-related achievement outcome of PE. In line with the theoretical assumptions of the CVT, studies conducted in the context of PE indicate that the experience of enjoyment in PE is related with PA engagement both in PE [56,57] and during leisure time [56,58,59]. With regard to the age effect underlying the development of PA behavior in childhood and adolescence [5,60], enjoyment has been found to delay or even prevent the decline of motivation for PA [61]. Considering emotions of negative affect, emotional experiences may also contribute to a decrease in PA. For example, anxiety has been shown to be related to negative thoughts about PA engagement and consequentially was negatively associated to PA [61,62]. Furthermore, anxiety has been identified as a barrier to future PA engagement [63]. Whereas the experience of anger was not related to PA, anxiety and boredom as a joint representation of negative affect was negatively related to PA, yet without further insights into the separate predictive contributions of anxiety and boredom [64].

Besides direct effects, the CVT also proposes indirect effects between its variables, with the effect of the learning environment on student emotions mediated by control-value appraisals being the most important one [36]. Empirical support for the proposed mediation effect with teacher autonomy support representing the learning environment was found in the context of sports. In a sample of university students attending tennis courses, control and value appraisals mediated the positive indirect effect of teacher autonomy support on enjoyment as well as the negative indirect effect on boredom [52]. In a sample of middle school students, the CVT-based mediation effect could also be supported. Students' self-efficacy in math and the intrinsic value they assigned to the subject mediated the relationship between teacher autonomy support and boredom [54]. Additionally, since the CVT further assumes that mediated effects of the learning environment do not necessarily end with achievement emotions [36,40], Wang et al. [54] also included academic engagement as an achievement outcome in their analysis. They could show that teacher autonomy support indirectly affected students' academic engagement in math via self-efficacy, intrinsic value and boredom.

While there are approaches that aim to identify facilitators of emotions to explain exercise maintenance [22,65], so far, the role of emotions has rarely been examined in PA settings [40,61]. Furthermore, key factors that lead to a positive emotional response in a sporting environment are still far from being fully understood [22,33] and there are few empirical findings how potential key factors may be manipulated [14,65]. In order to examine the widely unknown influence of students' emotional experience in PE on leisure-

time PA behavior, distinct achievement emotions have to be measured in PE-specific manner [40] and potential ways to evoke PA-enhancing achievement emotions have to be examined.

Therefore, using the CVT as a theoretical framework, we want to examine how the learning environment in PE predicts student leisure-time PA via appraisals of control and value and achievement emotions. This is examined in a high-risk sample for physical inactivity comprising lower-track secondary school students mainly stemming from households with a low SES. With regard to previously scarce insights in the specific PE context, teacher autonomy support will represent the learning environment. Self-efficacy and intrinsic value will reflect students' appraisals of control and value, respectively. Enjoyment and anxiety have been chosen as distinct emotions, since they frequently emerge in achievement settings. Furthermore, by means of this selection both activity- and outcome-related emotions of positive and negative affect are represented [36] (Figure 1). We hypothesize that students perceived autonomy support by the PE teacher is positively related to their appraisals of self-efficacy and intrinsic value (Hypothesis 1). Further, we hypothesize that self-efficacy and intrinsic value exhibit positive associations with enjoyment and negative associations with anxiety (Hypothesis 2). Subsequently, it is hypothesized that enjoyment relates positively while anxiety relates negatively to students' leisure-time PA (Hypothesis 3). Finally, we hypothesize that perceived teacher autonomy support exhibits a positive indirect relationship with leisure-time PA that is mediated by students' control-value appraisals and their experience of achievement emotions in PE (Hypothesis 4).

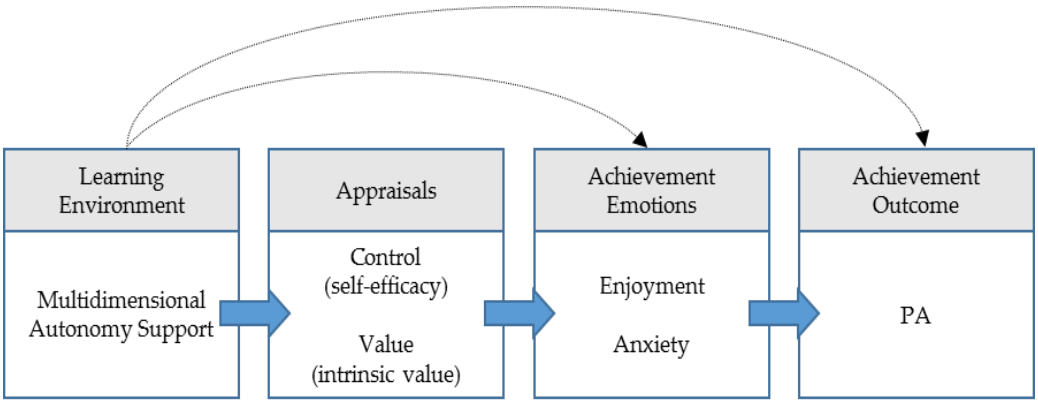

Figure 1. Hypothesized model of the present study based on the control-value theory (CVT) (Pekrun, 2006).

2. Materials and Methods

2.1. Participants

The study sample comprised 1030 students aged between 11 and 18 years (M = 13.4, SD = 1.48), 408 participants were female (39.6%), 622 participants were male (60.4%). The students attended grades 6 through 10 of the German Mittelschule, which is the school form with the lowest educational level among secondary schools in Germany. The participants stemmed from three urban, three semi-rural and four rural schools. For 51.8% of the participants, German was the language spoken with family members at home. Predominant use of a foreign language at home was indicated by 26.7% of the students. The remaining 20.9% of the participants spoke German and another language to similar extents at home. The average value for SES was at 41.3 (SD = 12.8, n = 991). Thus, SES was substantially lower than in large-scale studies with German-speaking samples, such as the Programme for International Student Assessment (PISA) study, which indicated a mean SES of 51.8 (SD = 21.0, n = 4346) for its participants of grades 7 through 10. Age- and sex-dependent BMI percentiles were used to define cut-off points. Mean percentile (%) was 79 and 86 for girls and boys, respectively, which is in the range of normal weight [66]. All students participated in mandatory single-sex PE lessons for two school hours per week.

2.2. Measures

2.2.1. Pilot Study

The questionnaire used in this study was thoroughly pilot tested in advance. In the pilot study, 193 students (11 classes) of grades 6 through 10 from one urban and one rural German Mittelschule completed the questionnaire. By means of the pilot study, the general feasibility of a questionnaire study in a sample of academic underachievers mainly stemming from households of low SES was tested. Furthermore, the pilot study was conducted to gather insights regarding the applicability of the translated and adapted items and the response format. To obtain these insights, participants of the pilot study were to give a signal to the members of the assessment team when they experienced difficulties in understanding or responding to items. After completion of the questionnaire, two academically over-performing and two academically under-performing students of each class participated in structured cognitive interviews [67]. The interviews were conducted with each student separately and took place outside of the classroom, so that the students could express their opinion freely and independently from their classmates. In response to the insights of the pilot study, the wording of some items was slightly adapted. Another important output of the pilot study was a manual that was designed to help the assessment team of the main study to answer consistently to possible questions of the participants about the items and the procedure.

2.2.2. Autonomy Support by PE Teacher

Students rated the perceived autonomy support provided by the PE teacher on the German Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE; [68]). Based on the assumption that there are multiple ways for teachers to support student autonomy [69], the MD-PASS-PE comprises the three subscales cognitive, procedural and organizational autonomy support with each of them containing five items [70]. Cognitive autonomy support refers to the promotion of students' responsibility for their own learning process. An English example item is "My PE teacher is interested in what students want to do." Procedural autonomy support is defined as the promotion of students' participation in deciding how the teaching and learning process is conducted. An example item is "My PE teacher explains why we learn certain exercises." Organizational autonomy support represents the promotion of students' responsibility to manage their learning environment. An example item is "My PE teacher allows me to choose sport equipment." Participants rated the items on a 7-point Likert scale from 1 = strongly disagree to 7 = strongly agree. Items were translated by means of the back-translation technique [71]. Thereby, the original items of the English version were translated into German by a team of bilingual native speakers and experts from the field of sports pedagogy. The translated items were then back-translated into English by another team of bilingual native speakers. Finally, this version was compared with the original English items. A difference in one item was solved by a committee of bilingual researchers.

The German MD-PASS-PE represents a reliable measurement instrument with Cronbach's alpha values of the three subscales ranging between 0.72 and 0.81 in the validation study [68]. Evidence for factorial validity was given since the assumed three-factor structure was supported within a bi-factor model comprising three specific group factors next to a general factor [68,70,72].

2.2.3. Academic Self-Efficacy in PE

To measure self-efficacy in PE, a German 5-item scale originally developed to measure general academic self-efficacy was used [73]. The items were adapted to the context of PE. Participants responded by means of a 4-point Likert scale. An example item in English would be "If I am asked to perform something challenging in PE class, I believe I will be able to do it."

2.2.4. Intrinsic Value of PE

The intrinsic value that students ascribe to PE was measured by means of a German 6-item scale. The original scale measured the intrinsic value of mathematics, providing good internal consistency and acceptable factorial validity [74]. Therefore, items were adapted to the PE context. Students responded by use of a 5-point Likert scale. An example item in English would be "No matter what grades I get, PE is very important to me."

2.2.5. Achievement Emotions in PE

The achievement emotions enjoyment and anxiety were assessed with five items, respectively, which were taken from the Achievement Emotions Questionnaire (AEQ; [75]) and the Achievement Emotions Questionnaire—Mathematics (AEQ-M; [76]). The AEQ provides items for the assessment of achievement emotions as a trait in three different academic achievement settings, i.e., during class, while studying and in exams. In this study, items assessing achievement emotions during class were used. The items were adapted to the context of PE and slightly simplified in terms of the used vocabulary. Students responded on a 5-point Likert scale. An English example item for enjoyment is "I enjoy being in class." An example item for anxiety is "Thinking about class makes me feel uneasy." Internal consistency scores of the enjoyment and anxiety subscales in the original AEQ were 0.85 and 0.86, respectively. Factorial validity of the subscales was supported by means of structural equation modeling [75].

2.2.6. Physical Activity

Leisure-time PA of the participants was assessed by means of the 6-item physical activity subscale of the German Physical Self-Description Questionnaire (PSDQ; [77]). Internal consistency of the subscale was tested with three different samples. Cronbach's alpha values ranged between 0.90 and 0.95. Factorial validity of the PSDQ was supported by means of confirmatory factor analyses [77].

2.2.7. Socioeconomic Status

In order to estimate the socioeconomic status, the students had to indicate their parents' current jobs and had to provide a short description of the jobs. The classification of the responses was conducted with regard to the International Socioeconomic Index of Occupational Status (ISEI), which is based on the International Standard Classification of Occupation 2008 (ISCO-08) [78]. If an ISEI value could be assigned to the occupations of both parents, the higher value was considered. ISEI values range on a scale from 10 to 89 with higher values indicating a higher SES. Not every participant could be assigned an ISEI value since some students did not know or could not clearly describe their parents' jobs.

2.3. Procedures

The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics commission of the Technical University of Munich (304/19 S) and the supervisory school authorities in charge. After receiving these approvals, school principals of the participating school district were provided with study information documents for teachers, parents and students. Afterwards, interested schools were sent consent forms several weeks before the scheduled beginning of the data assessments. Students did only participate if they themselves, their parents, their PE teacher and the school principal had provided positive consent forms. Neither students nor schools were rewarded for study participation in any form. Students could leave out questions if they did not want to answer and they could withdraw their participation at any time before, during or after data collection without any consequences.

The paper-and-pencil data collection was conducted during regular school lessons. Students took on average 35 min to complete the questionnaire. Data assessments did not take place directly after PE lessons to make sure that the assessed PE-related constructs represented trait measures instead of state measures. Before participants started to complete

the questionnaire, the head of the assessment team and a research assistant informed the participants about the purpose and the procedure of the assessment. Using example items whose content was independent of the assessment subject, students were also explained how to handle the different response scales. The participants were explicitly informed about the fact that the assessments were not about whether they personally like their teacher or appreciate the general teaching style. Instead, the participants were asked to indicate their approval to each statement separately with regard to the specific content and context of the items. Short paragraphs were included in the questionnaire to help the participants in setting the focus on the respective content and context of the different scales. During completion of the questionnaire, students could give a signal at any time and quietly ask questions in case of problems in understanding the items. After a student had completed the questionnaire, he/she went outside of the classroom where two other research assistants measured height and weight with a stadiometer and a digital weight scale. The described procedures applied to the preparation and implementation of both pilot and main study.

2.4. Statistical Analysis

Variance-based structural equation modeling (VB-SEM), also known as partial least squares analysis, was used to test the proposed model by using the Warp PLS v7.0 software [79]. The advantage of VB-SEM is that it is distribution-free and less affected by non-normality, model complexity and smaller sample sizes because it is based on ranked rather than ordinal data [80]. Arithmetic mean imputation was used to handle missing data.

Discriminant validity of the latent variables is considered as given if the square root of the average variance extracted (AVE) for each latent variable exceeds its correlation coefficient with the other latent variables. The overall model fit was assessed using multiple criteria: the goodness-of-fit (GoF) index with values of 0.100, 0.250, and 0.360, corresponding to small, medium, and large effect sizes, respectively [81], the average variance inflation factor (AVIF) value for model parameters, which should be below 5.000 [82], and average R^2 (ARS) and average path coefficient (APC), which are both expected to be significantly different from zero for an adequate model. Hypothesized mediation effects were tested by calculating indirect effects using a "Table 3" method to increase accuracy and statistical power as suggested by Kock [83]. The dataset analyzed for this study is provided as Supplementary File S1.

3. Results

3.1. Preliminary Analysis

Skewness (range = −0.918 to 1.575) and kurtosis (range = −0.816 to 2.616) values of all latent variables were within the acceptable range [84], which supported the assumption of normality of the variables included in this analysis. Correlations between the latent variables and composite reliability coefficients are presented in Table 1. All the composite reliability coefficients were on the acceptable level. Discriminant validity was given for every variable. GoF statistics demonstrated a very good overall fit of the proposed model with the data according to fit indices. The GoF index was at 0.400. The AVIF value for the model parameters was 1.642. ARS and APC were at 0.266 and 0.218, respectively (both $p < 0.001$). Factor loadings of the items on the latent variables were at least 0.56, no substantial cross-loadings were identified.

Table 1. Correlations between latent variables and composite reliability coefficients.

Variable	1.	2.	3.	4.	5.	6.	7.	8.
1. Cognitive autonomy support	**0.87**							
2. Procedural autonomy support	0.67 **	**0.81**						
3. Organizational autonomy support	0.61 **	0.55 **	**0.84**					
4. Academic self-efficacy	0.32 **	0.23 **	0.25 **	**0.85**				
5. Intrinsic value	0.35 **	0.24 **	0.20 **	0.61 **	**0.93**			
6. Joy	0.47 **	0.35 **	0.28 **	0.55 **	0.79 **	**0.95**		
7. Anxiety	−0.16 **	−0.14 **	−0.10 *	−0.45 **	−0.37 **	−0.42 **	**0.84**	
8. Physical activity	0.20 **	0.11 **	0.15 **	0.52 **	0.64 **	0.49 **	−0.24 **	**0.95**

Note. Composite reliability coefficients for each variable are shown in bold on the diagonal. * = $p < 0.01$, ** = $p < 0.001$.

3.2. Main Analyses

3.2.1. Direct Effects

Direct effects of the proposed model are presented in Figure 2. Statistically significant effects are described in the following. Perceived cognitive autonomy support provided by the PE teacher was a positive predictor of students' academic self-efficacy in PE (β = 0.29, $p < 0.001$, $R^2 = 0.10$) and of the intrinsic value students ascribe to PE (β = 0.34, $p < 0.001$, $R^2 = 0.12$). Perceived organizational autonomy support provided by the PE teacher also positively predicted students' academic self-efficacy in PE (β = 0.07, $p = 0.01$, $R^2 = 0.02$). Thus, Hypothesis 1 was supported, particularly with respect to cognitive autonomy support as a predictor of control and value appraisals.

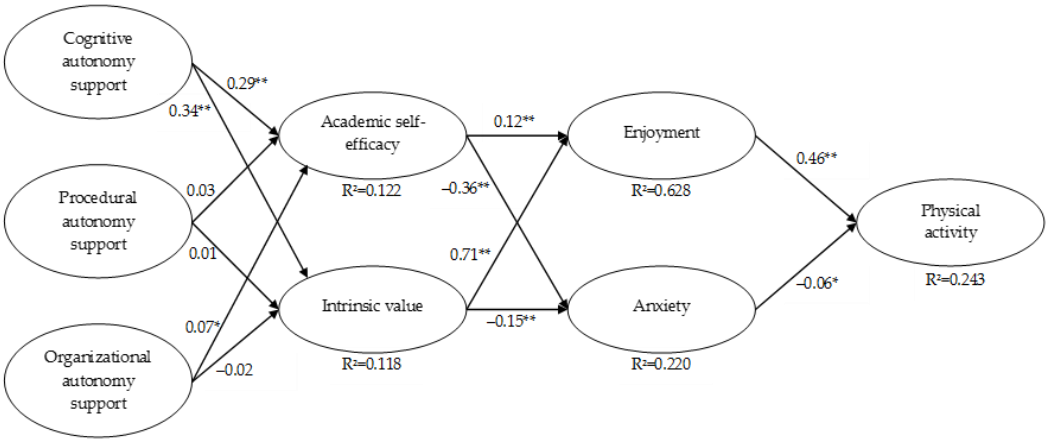

Figure 2. Standardized path coefficients for the variance-based structural equation model. * = $p < 0.05$, ** = $p < 0.001$.

While students' academic self-efficacy in PE positively predicted their enjoyment in PE (β = 0.12, $p < 0.001$, $R^2 = 0.07$), it had a negative effect on their anxiety in PE (β = −0.36, $p < 0.001$, $R^2 = 0.16$). The intrinsic value that students ascribe to PE also positively predicted students' enjoyment (β = 0.71, $p < 0.001$, $R^2 = 0.56$) and negatively predicted their anxiety in PE (β = −0.15, $p < 0.001$, $R^2 = 0.06$). Therefore, Hypothesis 2 was supported.

Finally, students' enjoyment in PE was a positive predictor of their PA during leisure time (β = 0.46, $p < 0.001$, $R^2 = 0.23$). Students' anxiety in PE negatively predicted their PA level in leisure time (β = −0.06, $p = 0.02$, $R^2 = 0.02$). Thus, Hypothesis 3 was supported as well.

3.2.2. Indirect Effects

Statistically significant indirect effects and the respective effect sizes are presented in Table 2. The effects are briefly described in the following. Perceived cognitive autonomy support provided by the PE teacher positively predicted students' enjoyment in PE via students' academic self-efficacy in PE and the intrinsic value they ascribe to PE (β = 0.27,

$p < 0.001$). Moreover, perceived cognitive autonomy support negatively predicted students' anxiety in PE via their PE-related academic self-efficacy and the intrinsic value of PE ($\beta = -0.15$, $p < 0.001$).

Table 2. Standardized parameter estimates for the indirect effects from the partial least squares analysis.

Independent variable	Dependent variable	Mediator(s)	β	*p*	ES
Cognitive autonomy support	Enjoyment	Academic self-efficacy Intrinsic value	0.27	<0.001	0.13
Cognitive autonomy support	Anxiety	Academic self-efficacy Intrinsic value	−0.15	<0.001	0.02
Cognitive autonomy support	Physical activity	Academic self-efficacy Intrinsic value Enjoyment Anxiety	0.14	<0.001	0.03
Academic self-efficacy	Physical activity	Enjoyment Anxiety	0.08	0.006	0.04
Intrinsic value	Physical activity	Enjoyment Anxiety	0.34	<0.001	0.22

Note. ES = Effect size estimate.

Enjoyment and anxiety in PE mediated the positive effect of students' academic self-efficacy in PE on their leisure-time PA ($\beta = 0.08$, $p = 0.006$). Likewise, enjoyment and anxiety also mediated the positive effect of the intrinsic value students ascribe to PE on PA in leisure time ($\beta = 0.34$, $p < 0.001$).

Finally, perceived cognitive autonomy support provided by the PE teacher positively predicted students' PA in leisure time via students' PE-related academic self-efficacy, intrinsic value, enjoyment and anxiety ($\beta = 0.14$, $p < 0.001$). Thus, Hypothesis 4 was supported.

4. Discussion

4.1. General Discussion

This study analyzed the relationship of multidimensional teacher autonomy support in PE and leisure-time PA mediated by the PE-related cognitive appraisals academic self-efficacy and intrinsic value and the achievement emotions enjoyment and anxiety. Using VB-SEM in the data of students from grades 6 through 10 of German lower-track secondary schools, the proposed chain of effects was supported. Autonomy support provided by the PE teacher was a positive predictor of PE-related cognitive appraisals, explaining 12.2% and 11.8% of the variance in self-efficacy and intrinsic value that students associate with PE, respectively. The control-value appraisals in turn acted as significant predictors of PE-related achievement emotions, together explaining 62.8% of enjoyment and 22% of anxiety. Finally, achievement emotions experienced in PE significantly predicted students' PA during leisure time, with 24.3% of the variance in PA being explained by the emotions. Besides supporting the hypothesized direct effects, results also indicated several indirect effects. Cognitive autonomy support exhibited an indirect effect on achievement emotions via cognitive appraisals as well as on leisure-time PA via cognitive appraisals and achievement emotions. Furthermore, the appraisals had an indirect effect on leisure-time PA via achievement emotions in PE.

As assumed in Hypothesis 1, students' perceived autonomy support provided by the PE teacher was positively related to their appraisals of self-efficacy and intrinsic value. This finding is not only in line with theoretical assumptions [36,45], but also with the findings of previous empirical studies which showed that autonomy support positively predicted appraisals of control and value in other academic contexts [54,55]. These findings suggest that if students are provided the opportunity to influence their learning environment, they tend to have higher action-control expectancies and assign more relevance to the subject of PE. These relations can be corroborated with regard to conceptual considerations about

autonomy support, self-efficacy and intrinsic value. With regard to teacher strategies, autonomy-supportive teachers convey an interpersonal message of support and try to understand and adopt the students' perspective [85]. They provide students with choice, make them feel understood and allow criticism. Available strategies for teachers aiming to promote students' self-efficacy are similar in that they comprise an honest and open communication, the provision of constructive feedback and the intention to motivate the students to try their best [45,86]. Due to these similarities in the teacher strategies to promote autonomy and self-efficacy, it is likely that successful autonomy support leads to higher appraisals of self-efficacy. The relation between autonomy support and intrinsic value might mainly be attributed to the concept of interest that is shared by the two constructs. Teachers who successfully support students' autonomy develop student resources that are necessary for their motivation, such as their interest [87,88]. Interest, in turn, is considered a main reason for students to assign a high intrinsic value to an activity or achievement [36,75]. Thus, autonomy support may inherently have a positive effect on the intrinsic value of the learning activity.

The studies that have previously examined the relationship of autonomy support and appraisals of control and value in other academic contexts [54,55,89] measured autonomy support in a unidimensional way, which equals the assessment of cognitive autonomy support [68,70]. In the present study, autonomy support was assessed in a multidimensional way. The results indicate a major role of cognitive autonomy support, which was a significant predictor of both self-efficacy and intrinsic value. While organizational autonomy support was still a significant predictor of self-efficacy, procedural autonomy support was not a relevant factor in the present model. Organizational autonomy support includes aspects like developing rules together, or the choice of group members, equipment and exercise place [69,70]. Being responsible for managing their learning environment, students are supported in making their own decisions, which might make them feel more in control and, more specifically, more self-effective [86]. Contrarily, students' involvement in how the learning process is arranged, which was assessed through procedural autonomy support [69] does not strengthen the selected control and value appraisals.

The control and value appraisals served as proximal antecedents of discrete achievement emotions, which is in line with the CVT [36]. In accordance with Hypothesis 2, self-efficacy and intrinsic value showed positive relations with enjoyment and negative relations with anxiety. Indications for the negative relationship between self-efficacy and anxiety have also been found in school subjects other than PE and in the context of athletic competitions [90–93]. The positive relationship between self-efficacy and perceived enjoyment in university courses and PA has been found in samples of university students [49,94]. The negative relation between value appraisals and anxiety has also been identified in a sample of fifth graders in the context of mathematics [95]. Empirical support for the assumed positive relationship between intrinsic value and enjoyment has been provided in a sample of university students [49]. The high regression weight of enjoyment on intrinsic value (Figure 2) and the strong latent correlation (Table 1) between the two constructs could raise some doubts regarding their unique contributions to the proposed model of the present study. Based on similar concerns, Simonton and Garn [49] addressed the conceptual similarities of intrinsic value and enjoyment. Several studies have measured intrinsic value based on the expectancy-value theory of motivation [49,96], in which intrinsic value is characterized as students' enjoyment of a task or domain [96]. Researchers using intrinsic value items based on the expectancy-value theory of motivation therefore tend to use terminology and address contents that are also found in enjoyment items. Consequently, the respective manifest items measure highly similar latent constructs in these cases, which would explain the conceptual overlap between intrinsic value and enjoyment [49]. Therefore, to prevent a potential overlap between these two constructs, Pekrun [36] makes a clear distinction between intrinsic value and enjoyment by characterizing intrinsic value as an antecedent of achievement emotions. Like in the study by Simonton and Garn [49], the scales used in the present study adhered to this distinction. In both studies, this approach

resulted in highly correlated but distinct constructs since intrinsic value and enjoyment exhibited discriminant validity.

With regard to a potentially PA-enhancing composition of achievement emotions, it is important to note that the cognitive appraisals added to each other in a complementary way, since self-efficacy was particularly important for the reduction of anxiety in PE whereas the intrinsic value ascribed to PE was a major positive predictor of the enjoyment the students experienced in class. This shows that when students feel more confident to perform an action, they experience less anxiety. Furthermore, students' interest in the activity seems to be of high importance for enjoyment. These results are in line with CVT-based assumptions, showing that positive appraisals of self-efficacy and intrinsic value can evoke positive achievement emotions and are able to reduce negative achievement emotions [36].

In line with Hypothesis 3, both of the assessed achievement emotions were significant predictors of leisure-time PA. However, the role of enjoyment as a positive predictor was by far more important than the role of anxiety as a negative predictor. Both results align with previous findings. Whereas enjoyment was consistently identified as a powerful trigger for PA [56,59,97–100], ambiguous findings were shown for anxiety [61,62,92]. In the present study, almost one quarter of the variance in leisure-time PA was explained by enjoyment in PE. This is even more remarkable in view of the fact that the predicting variable exclusively refers to processes and experiences in the context of PE, but still managed to explain a substantial amount of variance in a behavior taking place outside of school. The fact that, although being a statistically significant predictor, anxiety in PE only explains two percent of the variance in leisure-time PA suggests that affective experiences made in PE provide more chances than risks with regard to their effects on PA during leisure time. Therefore, PE can be seen as a potentially powerful platform for the promotion of leisure-time PA, especially if it is conducted in a way that evokes regular positive achievement emotions in students while keeping negative ones on a minor level.

As proposed by Hypothesis 4, the significant indirect effect of teacher autonomy support on leisure-time PA via cognitive appraisals and achievement emotions (Table 2) provides an example for how PA-enhancing achievement emotions can be triggered in the context of PE. However, it is necessary to apply several teaching strategies in order to provoke further PA-enhancing chains of effects, since students' enjoyment and the overall level of positive experiences in PE decrease with age [100–102].

4.2. Strengths and Limitations

Based on the theoretical framework of the CVT [36], this study aimed to provide new insights in lower-track secondary school students' emotional experiences in PE. Additionally, the antecedents of emotions were examined with regard to both students' learning environment and their subjective control-value appraisals. The applied holistic approach was completed by examining the consequences of students' emotional experiences with respect to their PA behavior in leisure time. To the authors' knowledge, this holistic approach had not been applied in the context of PE before. A further strength is the examination of the proposed model in the specific population of lower-track students mainly stemming from households with a SES below average. Autonomy support as a representation of the learning environment was measured in multidimensional manner [68,69], thus providing insights into the effectiveness of different teaching strategies. In contrast to the majority of previous studies, value appraisals were measured separately, which has been recommended to enable a focus on the unique role of students' appraisals of intrinsic value as an antecedent of achievement emotions experienced in PE [62,95]. Finally, given the substantial concern about the role of PE as a facilitator of students' leisure-time PA [12,13], this study suggests a substantial potential of emotional experiences in PE as a powerful predictor of PA behavior outside of school.

Some limitations yet should be considered. The cross-sectional design does not allow for definite conclusions regarding causal effects. Future research could adapt a residual change score approach to measure change in constructs over time while controlling for their

covariance stability [103]. Leisure-time PA was measured by students' self-reports. The use of accelerometer-based measurements might have provided a deeper understanding of students' PA levels and patterns in leisure time [104]. Although evidence for the validity of the scale used to assess autonomy support was provided [68], it cannot be guaranteed that every participant in fact rated perceived autonomy support. Using self-report instruments does not necessarily capture the actual teacher behavior but reflects a participant's internal representation that is triggered by the content of the items. This representation can be affected by different conditions [105]. Although autonomy support can be rated with regard to concrete teaching behaviors [69,87,106] that are learnable [107] and despite the detailed introduction that participants received before completing the questionnaire, it is possible that some students rather expressed their general approval or disapproval of the teacher or the lesson as being good or bad from a more emotional and less specific standpoint. Approval of the teacher or the lesson may, for example, depend on teachers' personality traits, such as extraversion, openness or rather motivational characteristics like enthusiasm. Thus, it may be assumed that in some cases students' ratings of autonomy support could be biased or even replaced by their ratings of teacher personality. Therefore, it would be informative to add direct or video-based observations of teachers' autonomy support in PE to the perceived autonomy support reported by the students [87,108]. Furthermore, it would be interesting to integrate other CVT-based achievement emotions into the proposed model since each emotion may be determined by different types of appraisals and have different consequences [36]. Provided that the questionnaire would not exceed a reasonable length for the respective study sample, also including extrinsic value in the assumed model would extend the understanding of achievement emotions [49]. Generally, this study assessed students' trait emotions, which are more general and relate to interpersonal differences in the experience of emotions. A state emotion on the other hand is closer to the emotional experience [109]. Although in academic situations measuring trait emotions may indeed be more useful to describe and explain their impact on learning and outcome [109], one-time trait surveys can be influenced by subjective beliefs, since the participant has to rely more on semantic rather than on episodic knowledge, which eventually allows limited conclusions about students' current state of emotions [105]. To allow a direct self-report in the respective situation, future studies could include diary studies [110] or experience time sampling [111] in their assessments. Furthermore, even if self-reports are regarded as standard tools for measuring emotions in school settings, it would be interesting to combine behavioral and neurophysiological assessment tools with video-based PE lesson studies to capture all components of emotions [109,112].

5. Conclusions

The importance of high-quality PE in schools is well known. Positive emotional experiences in PE could be seen as a main factor to increase PA in a lifelong perspective and could thus help students to improve their overall health. The findings of this study indicate that PE teachers have the opportunity to create positive emotional experiences for students and to reduce the experience of negative emotions by use of autonomy-supportive teaching strategies. It is further shown that behavior of the PE teacher does not directly lead to positive or negative student achievement emotions. Instead, teacher autonomy support first affects the students' appraisals of control and value. If these appraisals tend to be positive, the possibility of experiencing positive and activating achievement emotions is increased. The results suggest that PE exhibits the potential to affect students' thoughts and feelings related to PA in leisure time and thus is a promising starting point for children and adolescents with regard to an active lifestyle in the long term.

Supplementary Materials: The dataset analyzed for this study can be found as supplementary file S1 online at https://www.mdpi.com/article/10.3390/ijerph18083987/s1.

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Informed Consent Statement: All subjects gave their informed consent for inclusion before they participated in the study.

Data Availability Statement: The data presented in this study are available as Supplementary File S1.

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4 General Discussion

The studies presented here picked up theoretical suggestions made in the field of educational research and implemented them in the context of physical education in German lower-track secondary schools (Pekrun, 2006; Stefanou et al., 2004). The identified empirical findings are discussed in the following.

The MD-PASS-PE (Tilga et al., 2017) was translated into German and validated in terms of reliability as well as structural validity and criterion validity. A bi-factor model that added a general factor for overall autonomy support next to three specific group factors reflecting cognitive, organizational and procedural autonomy support exhibited the best fit to the data. Thus, in line with the suggestion of Stefanou and colleagues (2004), three qualitatively different manifestations of teacher autonomy support were empirically distinguished. The model exhibited strong measurement invariance across gender. Measurement invariance across age groups may be assumed with caution and needs further empirical examination. The subscales assessing the three types of autonomy support exhibited acceptable to good internal consistency. Criterion validity was supported with regard to students' appraisals of self-efficacy and the intrinsic value ascribed to PE. Thus, the German MD-PASS-PE may serve as a reliable and valid measurement instrument for multidimensional autonomy support in PE, which provides teachers with the opportunity to gather more detailed insights into the quality and possible consequences of their teaching behavior.

Furthermore, results of a mediation analysis implementing the holistic approach of the CVT (Pekrun, 2006) indicated that cognitive teacher autonomy support during PE may have an indirect effect on students' PA behavior in leisure time. In particular, cognitive autonomy support positively predicted students' subjective appraisals of self-efficacy and intrinsic value attached to PE. Further direct effects suggested that the appraisals may influence students' affective experience in PE. Whereas intrinsic value may foster students' enjoyment during PE, self-efficacy helps to prevent students from feeling anxious during the lesson. Students' enjoyment during PE, in turn, served as an important predictor of their PA levels in leisure time. The findings underline the possibility of PE teachers to positively influence students in their PA behavior by implementing autonomy-supportive teaching strategies.

The gathered findings of the studies are based on a thorough selection and piloting of the used measurement instruments. Furthermore, after giving a motivating introduction into the background and the relevance of the research project, a specific focus was set on reminding the participants of their opportunity to express their own opinion regarding their teachers' behavior in an anonymous way as well as to indicate how they feel during class.

These aspects resulted in a high compliance of the participants during the data assessments, which built the foundation for reliable and valid questionnaire data.

4.1 Measurement and Implications of Multidimensional Autonomy Support Provided by the Physical Education Teacher

The MD-PASS-PE was designed to reflect the different strategies that PE teachers may apply in order to support their students' autonomy (Reeve & Cheon, 2016; Tilga et al., 2017). The German translation of the scale corroborated the assumption that these strategies can be classified in the best way by means of three different manifestations of autonomy support, i.e., cognitive, organizational and procedural autonomy support (Stefanou et al., 2004). Although the unsatisfactory fit of a unidimensional model clearly argued for a multidimensional latent construct, the fit of the proposed three-factor model and the high correlations between the three latent factors raised some doubts about the discriminant validity of the three factors. To test the emerging assumption of discriminant but highly related factors, a bi-factor model was introduced. Within this bi-factor model, variance in the items is supposed to be explained both by a general latent factor and three specific group factors representing the different manifestations of autonomy support (Stefanou et al., 2004). Since the bi-factor model clearly exhibited the best fit to the data, the assumption of distinguishable but highly related aspects of autonomy support was finally supported. Similar conclusions were drawn in Estonian and Spanish studies validating the MD-PASS-PE in samples of secondary school students (Burgueño, Macarro-Moreno, & Medina-Casaubón, 2020; Tilga et al., 2017).

Besides reflecting the structure of teacher autonomy support in the best way, the bi-factor model has an important advantage over a possible second-order model with regard to the interpretation of the findings (e.g., Tilga et al., 2017). Different from second-order models, whose path coefficients indicate the cumulated effects of first-order and second-order factors as a whole (Canivez, 2016), bi-factor models allow for a clear differentiation between the respective influences of the general and the specific group factors on item variances. This allowed for an evaluation if item responses are rather affected by the general factor or by the respective facets of autonomy support (Chen, Hayes, Carver, Laurenceau, & Zhang, 2012; Reise, 2012; Reise, Moore, & Haviland, 2010).

With regard to the standardized path coefficients, the general factor had a larger impact on participants' response behavior in the majority of the items of the German MD-PASS-PE. Thus, in most cases, the specific effects of the group factors reflecting cognitive, organizational and procedural autonomy support add to the dominant influence of the general latent factor. This dominance of the general factor - and the underlying high

covariation between the three manifestations of autonomy support - can be attributed to different possible reasons.

One possible explanation would ascribe this finding to person-related attributes by focusing on the participants who comprise the present sample. Since the sample also included students as young as eleven years old and because the students exclusively attended secondary schools of the lowest level of formal education (Borgers et al., 2000), one might speculate that the dominant general factor is a consequence of the participants' deficits in differentiating between the different facets of teacher autonomy support (Schwarz & Sudman, 1996). The age-related part of this attribution would in parts be supported by the ambiguous results regarding measurement invariance across age groups. Thus, one would assume that with regard to the stages which participants must go through in order to successfully complete a questionnaire (Schwarz & Sudman, 1996), in stage two, students would probably recall information that is related to the amount of choices that they are normally presented with in PE classes. This would mean that the participants evaluate autonomy support on a broader level instead of setting a specific focus on the various facets of autonomy support. Consequentially, in this case the content-related interpretation of the general factor would be overall autonomy support during PE in the sense of provided choices.

However, there are some results and also content-related considerations that argue against the possible person-related attribution onto the potentially deficient skills of the participants. With regard to the found results, it has to be noted that the three latent factors representing cognitive, organizational and procedural autonomy support exhibited discriminant validity in that the square root of their AVE exceeded their latent correlations with each other. Second, although the general factor is of superior importance compared to the specific group factors, a unidimensional model could not reflect the data structure in a satisfying way. These aspects suggest that the participants had at least to some extent different mental representations in mind when responding to the items of the respective MD-PASS-PE subscales, and thus were able to differentiate between different facets of autonomy support (Stefanou et al., 2004; Tilga et al., 2017). With regard to content-related thoughts, one has to conclude that the high correlations between the different autonomy support factors should not be seen as an artefact of potentially deficient participant skills in completing self-report questionnaires (Borgers et al., 2000; Schwarz & Sudman, 1996). Rather, the high correlations should indeed be expected. For example, the strategies that teachers may use to implement structure in the teaching process widely resemble the teaching strategies used to establish procedural autonomy support (Jang, Reeve, & Deci, 2010). Former studies have found high correlations between the implemented structure, i.e., procedural autonomy support, and cognitive autonomy support, assessed with the

usual unidimensional measurement of autonomy support, in regular classes and in PE lessons (Hospel & Galand, 2016; Jang et al., 2010). These findings suggest that different forms of autonomy support accompany each other in complementary way and thus should not be expected to be orthogonal towards each other but to add to each other based on a common foundation. Therefore, a bi-factor model including a dominant general factor that represents the common foundation, and specific group factors reflecting the incremental addition of each autonomy support facet might finally be the best reproduction of reality. With regard to teaching practice, it can thus be assumed that it is hardly possible for a teacher to successfully provide organizational or procedural autonomy support while thwarting their students' cognitive autonomy. Therefore, the dominant general factor in the German MD-PASS-PE most likely stands for overall autonomy support that should be understood as the inevitably shared foundation of the different autonomy support manifestations rather than an inaccurate description of teacher autonomy support on a broader, superordinate or less concrete level.

The validation of the German MD-PASS-PE underlines that teachers can support their students' autonomy in a multifaceted manner (Assor et al., 2002; Reeve, 2009; Stefanou et al., 2004). With the use of the measurement instrument, teachers are provided the chance to get deeper insights into the teaching process. Furthermore, they have the opportunity to receive detailed feedback from their students if they want to adapt or improve their teaching strategies in different aspects of autonomy support.

4.2 Autonomy Support as an Opportunity to Strengthen Students' Physical Activity via Control and Value Appraisals and Achievement Emotions

Whereas it was shown that different manifestations of autonomy support can be differentiated by the present sample (Stefanou et al., 2004), the question remained whether multidimensional autonomy support would also implicate additional value over unidimensional autonomy support with regard to possible outcomes and consequences. Based on the theoretical framework of the CVT (Pekrun, 2006), assumed indirect effects of the three forms of autonomy support on students' PA behavior during leisure time were examined. Possible mediating effects of subjective control and value appraisals and achievement emotions were tested.

While the assumed chain of effects was supported, it became apparent that the incremental value of multidimensional autonomy support over and above unidimensional, i.e., cognitive, autonomy support was small (Tilga et al., 2017). Cognitive autonomy support was a statistically significant and important predictor of academic self-efficacy in PE and the intrinsic value ascribed to PE. Organizational autonomy support was a significant predictor

of self-efficacy, however of minor importance. Procedural autonomy support did not explain variance in the control and value appraisals in a statistically significant way. Thus, providing students with choices and participation in the development of rules, in the composition of teams or in deciding for equipment or exercise location seems to further strengthen students' academic self-efficacy in PE in addition to the contribution of cognitive autonomy support. Students' participation in the arrangement of the learning process, i.e., procedural autonomy support, was not of incremental value beyond the other two manifestations of autonomy support (Stefanou et al., 2004; Tilga et al., 2017). In line with the examination of direct effects, cognitive autonomy support was the only manifestation of autonomy support that provoked indirect effects on achievement emotions and leisure-time PA. Therefore, for the present sample, it must be concluded that the multidimensional measurement of autonomy support may in fact provide interested teachers with deeper insights into their provision of autonomy support, but the purposeful support of the different facets of autonomy would probably not increase the effects on the chosen outcome variables to a meaningful degree.

Direct and indirect effects indicate that using cognitive autonomy support to increase academic self-efficacy and the intrinsic value ascribed to PE seems to be of high importance for the achievement emotions that students experience during PE. In their effects on achievement emotions, the assessed control and value appraisals cover a broad range including emotions of positive and negative valence (Pekrun, 2006). In complementary manner, higher scores in academic self-efficacy reduce the experience of anxiety in PE while an increase in intrinsic value facilitates students' enjoyment during PE. These results are in line with previous evidence (e.g., Jameson, 2014; Luo, Ng, Lee, & Aye, 2016; Schnell, Ringeisen, Raufelder, & Rohrmann, 2015; Simonton & Garn, 2020) and indicate that by providing cognitive autonomy support, teachers can trigger a chain of effects that implies various positive consequences on students PE-related control-value appraisals and their affective experience.

Another finding that gives rise for optimism regarding the relevance of PE and certain PE teachers' behaviors emanates from the association between the achievement emotions in PE and students' leisure-time PA behavior. Although both achievement emotions were statistically significant predictors of PA, the positive effect of enjoyment during PE was by far greater than the negative effect of anxiety during PE. These findings not only support previous findings (e.g., Engels & Freund, 2020; Hashim et al., 2008; Nicholls, Polman, & Levy, 2010; Simonton, 2020; Yli-Piipari et al., 2013), but they indicate that PE teachers can easily do more right than wrong regarding the teaching strategies they use. The findings suggest that if PE teachers create a learning environment which eventually leads to an atmosphere that creates anxiety in students, they indeed may

indirectly compromise their students PA behavior outside of school. However, the potential damage they provoke by using inappropriate teaching strategies seems to be negligible in comparison to the benefit students may have if their PE teacher creates a learning atmosphere that may lead to the experience of control, interest and enjoyment. These findings underline the power of PE as a platform that implies greater potential than risks in the promotion of a physically active lifestyle of students.

4.3 Limitations and Future Research Perspectives

By thoroughly validating the German translation of the MD-PASS-PE (Tilga et al., 2017), it was shown that three different manifestations of PE teacher autonomy support can be distinguished and empirically assessed in students attending German lower-track secondary schools. However, doubts regarding measurement invariance across age groups should be dispelled by further examinations. Additionally, invariance across students of different levels of formal education should be examined. Also, a comparison of the predictive power of the MD-PASS-PE with a unidimensional measurement instrument of autonomy support should be conducted (Tilga et al., 2017). The necessity of such a comparison is underlined by the deficient predictive power of organizational and procedural autonomy support regarding the control-value appraisals of academic self-efficacy and intrinsic value of PE. The model presented in this work focused on two variables from the spectrum of control-value appraisals and two achievement emotions (Pekrun, 2006). Extending the model, for example by including extrinsic value or choosing other achievement emotions, would increase the empirical findings presented here. Another approach would be to assess state emotions instead of trait emotions, since state emotions might be closer to the actual affective experience (Pekrun & Bühner, 2014).

To be able to empirically corroborate the considerations about how data assessments with academic underachievers should be conducted to obtain highly accurate and valid data, the data assessment itself should be extended. The considerations presented in this work are based on previous literature and on a comparison of the quality of the data assessed in the pilot study and the main study. The experiences during the pilot study led to adjustments regarding the data assessments in the main study. It is assumed that the better data quality in the main study, e.g., less missing values or higher internal consistencies, can be attributed to these adjustments, which probably increased participants' motivation, concentration and honesty. Since this attribution could not be empirically substantiated in this work, future research should extend the data assessments to allow for quantitative and qualitative data that reflect how participants experience the data assessments, which aspects are easy and which ones pose a challenge for them.

In order to further strengthen the construct validity of the scale and its subscales, questionnaire data of the MD-PASS-PE could be compared to data assessed by other methods, such as direct or video-based observation (Jiang, Vauras, Volet, Salo, & Kajamies, 2019). Additionally, since PA behavior of the participants was measured by self-report data, results should be replicated using device-based measures like accelerometry, which imply a higher potential regarding resolution and accuracy of PA data (Bachner, Sturm, & Demetriou, 2020; Migueles et al., 2017). Finally, in order to corroborate the findings presented in this work, a longitudinal study design should be used, which may allow for definite conclusions regarding causality.

5 Conclusion

This work presents insights into the assessment of teacher autonomy support in PE, its different manifestations and their effects on students' control-value appraisals, their emotional experience during PE and their PA behavior outside of school. The presented findings support the assumption that student autonomy may not only be supported by using different strategies, but that these strategies manifest themselves in different measurable types of autonomy support. Whereas the measurement of cognitive, organizational and procedural autonomy support can provide PE teachers with more detailed feedback regarding their teaching strategies, the incremental value of the different aspects of autonomy support with regard to student outcomes remains questionable. In particular, cognitive autonomy support may be a valuable facilitator of students' academic self-efficacy and the intrinsic value they ascribe to PE. Higher scores in control-value appraisals may in turn lead to more positive achievement emotions during PE, like enjoyment, and less negative emotions like anxiety. Finally, especially enjoyment can be a positive predictor of student PA behavior in leisure time. This chain of effects shows that PE teachers have the chance to contribute to an active life of their students by adopting teaching strategies that support their students' autonomy.

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