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Psychology & Philosophy

Need support, need satisfaction and types of motivation in Physical Education for children aged 8 to 13. Development and preliminary validation of the German SMoPE-instrument

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Abstract: More self-determined motivation of young children in physical education (PE) has been shown to improve physical activity through the lifespan. According to Self-Determination Theory, an educational environment that supports the three basic psychological needs of autonomy, competence, and relatedness is expected to facilitate need satisfaction and, therefore, more self-determined types of motivation. However, thus far there are no appropriate instruments to investigate the psychological need support, need satisfaction, and motivation for younger students simultaneously. The present study aims to develop and preliminarily validate the German SMoPE-instrument (Students' motivation in Physical Education) for the constructs need support, need satisfaction, and types of motivation for 8-13-year-old children in PE. Therefore, after a cognitive lab study, . = 1,011 students from grade 3 to 6 answered a questionnaire with items that based on research in the field of extracurricular sports with regard to the three constructs. The result is a questionnaire of 33 items including three need-support-subscales, three need-satisfaction-subscales and five subscales regarding the types of motivation. Confirmatory factor analyses with acceptable to excellent fit indices for all scales as well as a satisfactory simplex structure concerning the types of motivation support the suitability of the constructs. In addition, multiple regression analyses show positive relationships between the support of competence and both intrinsic and identified motivation. Consistent with theoretical considerations, both relationships were partially mediated by the satisfaction of competence.

Introduction

The preventive role of physical activity for the health and well-being of children and youth is largely unquestioned (Janssen & LeBlanc, 2010). The World Health Organization (WHO, 2010) recommends 60 minutes of moderate- to vigorous-intensity physical activity per day for children and youth from the age of 5-17. A recent study shows that in Germany as well as globally, the majority (more than 80%) of children and youth aged 11-17 years do not meet these physical activity guidelines (Guthold et al., 2020). Usually, German children participate once or twice a week for 45-90 minutes in physical education (PE) classes in school. Thus, PE classes alone cannot sufficiently meet the WHO requirements. However, it is well known that students' motivational experiences in PE can positively affect intentions for leisure-time physical activity (e.g. Hagger et al., 2003) and, thus, could positively influence their sports-related

behaviour outside of school. Also against the background of empirical findings showing that the degree of physical activity in the pre-school age already positively affects the physical activity level as an adult (Telama et al., 2014), a core curricular objective of PE is to promote students' lifelong physical activity. Thus, motivational processes in PE play an important role in supporting future engagement in physical activity.

Most research regarding the support of physical activity levels via motivation concentrates on the age of adolescents whereas less attention has been paid to the effects of PE with regard to younger children. Yet, early joyful learning experiences in the exercise domain at the age of 7-11 years already have a great impact on future sports participation (Kirk, 2005). For an education that encourages lifelong physical activity it is therefore important to understand the processes underlying younger children's motivation in PE, too. Against this background, the Self-Determination Theory (SDT) with its six mini-theories (Ryan & Deci, 2017) can be called as one of the most prominent motivational meta-theories in educational research. Essential components of this theory include different types of motivation (Organismic Integration Theory) as well as explanations on how to support these regulations by the satisfaction of basic psychological needs (Basic Psychological Needs Theory; Standage & Ryan, 2020). More precisely, a need supporting environment created by the teacher is expected to facilitate students' need satisfaction and therefore more self-determined types of students' motivation (Cognitive Evaluation Theory), which in turn lead to positive outcomes, e.g. effort, persistence and positive affect (e.g. Standage et al., 2005). In summary, the relationships assumed in SDT (see Figure 1) have been largely supported by empirical findings in diverse areas including the context of physical activity (Teixeira et al., 2012). SDT can therefore function as a useful theoretical framework to understand the individuals' motivational processes in PE.

One way to investigate the fundamental assumption of SDT, which says that a need supportive environment in PE classes leads to more self-determined forms of motivation, is to analyse students' self-reported perceptions assessed by questionnaires. Ideally, these questionnaires differentiate students' types of motivation as well as their perceived support and their perceived satisfaction of the basic psychological needs. While perceived support asks the extent to which students take notice of teacher-initiated supports, perceived satisfaction asks the extent to which the students perceive the need to be adequately met. However, in a review only 11 out of 70 studies in the context of SDT in PE included students younger than 12 years (van den Berghe et al., 2014), and, thus, it can be noted that there is a lack of research and questionnaires with regard to children at the age of 8-13 years. Therefore, following the SDT the purpose of this study is to develop and to preliminarily validate a German questionnaire for children in this age range that allows measuring the students' types of motivation and both their perceived support and their perceived satisfaction of the basic psychological needs in PE.

Theoretical background

Self-Determination Theory

According to SDT, the reasons for engaging in physical activity can be classified along a self-determined continuum (Ryan & Deci, 2017) between intrinsic motivation, extrinsic motivation and amotivation. Intrinsic motivation implies engaging in an activity out of pleasure with a strong sense of volition. On the opposite end of the continuum, amotivation represents a lack of intention and therefore the absence of motivation. In between these two ends, extrinsic motivation refers to engaging in behaviours for external or instrumental outcomes rather than the participation itself. Further, with regard to extrinsic motivation SDT proposes four different types distinguishing the extent of self-determination (Ryan & Deci, 2002). The least self-determined type of extrinsic motivation is defined as externally regulated, which implies engaging in an activity for external means. In contrast, an introjected regulation refers to behaviours being relevant for self-esteem and driven by an inner demand; however, the reasons for engaging in the activity are only partially internalised. Identified regulated behaviours are more self-determined and judged as personally important and therefore relevant. The most self-determined extrinsic motivation involves an integrated regulation, which implies that reasons for engaging in an activity are considered part of the individual's sense of self and are concordant with the individual's value system (Deci & Ryan, 2000).

Ryan and Deci (2002) assume that activities that satisfy the three basic psychological needs for autonomy, competence and relatedness foster self-determined motivation. These basic psychological needs are defined as basic innate requirements regardless of an individual's culture or age. Whereas the needs may vary in their expressions in different contexts, the core character remains unchanged. Accordingly, an educational environment created by the PE teacher that supports the needs of autonomy, competence and relatedness increases students' need satisfaction (e.g. Ntoumanis & Standage, 2009). That is why SDT distinguishes between *need support* and *need satisfaction*. While need support refers to the social context, the conditions and the teacher's strategies to support the basic psychological needs, need satisfaction refers to the individual's feelings of being satisfied. An autonomy supportive teaching environment is characterized by providing choices for students, involving them in decisions in a meaningful way and responding to their lives and interests. Students' competence can be supported by the teacher e.g. by providing positive feedback as well as challenging activities and directions to perform behaviours that fit the developmental level of the children. The teacher supports students' feelings of relatedness by creating a context characterized by warmth, a sense of security and connection to others (Deci & Ryan, 2000). With regard to need satisfaction, the need of autonomy is satisfied if individuals perceive themselves as the origin of one's own behaviour, i.e. performing according to one's interests

and innate values as a true expression of self. The need of competence is satisfied if individuals experience their own abilities and feel effective in interactions within the social environment. The need of relatedness is satisfied if individuals feel connected to others and have a secure sense of belongingness with them. Altogether, need support is expected to show positive relationships to self-determined types of motivation (intrinsic, integrated and identified) mediated by need satisfaction, and negative relationships to less self-determined motivations (introjected, external and amotivation; Deci & Ryan, 2000). The types of self-determined motivation will eventually lead to various positive cognitive, affective and behavioural outcomes (e.g. Ntoumanis & Standage, 2009).

Empirical state of research

While most findings with regard to the relationships between need support and types of motivation, mediated by the need satisfaction, refer to adolescents, only a few refer to younger children (for an overview see e.g. van den Berghe et al., 2014): A study amongst English 11-14-year-old students showed that the perceived PE teachers' support for the students' basic psychological needs (measured as one overall factor) predicted the students overall need satisfaction (Standage et al., 2005). The latter predicted positively intrinsic motivation and negatively external motivation and amotivation. In this study, the authors only examined relationships between the overall second-order factors need support and need satisfaction. They did not examine separate effects with regard to the three basic psychological needs. The relationship between an overall need support factor and students' self-determined types of motivation was also confirmed with Estonian 12-16-year olds (Koka, 2013). The author further investigated the specific mediation effect of each of the three basic psychological needs. He found that only the satisfaction of competence (neither relatedness nor autonomy) was positively related to self-determined motivation. On the contrary, another study confirmed positive relationships between the satisfaction of *all* three basic psychological needs (three factors) and self-determined motivation reported by American upper-elementary students (8-11 years; Chen & Hypnar, 2015). The measurement of perceived need support was beyond the scope of this latter study. Contrarily, the importance of perceived need support was emphasized by a cross-cultural study which supported the positive relationship between perceived autonomy support and self-determined motivation for British, Greek and Singaporean samples (the only exception was a Polish sample; Hagger et al., 2005). Both Hagger et al. (2003) as well as Hagger et al. (2005), however, only concentrated on the support of autonomy and neither measured the support of competence nor relatedness.

Based on these empirical evidences it can be assumed that there is a positive relationship between the support of autonomy, competence and relatedness and self-determined types of motivation (intrinsic, identified) and a negative relationship between the three need support

dimensions and more controlled types of motivation (introjected, external, amotivation). These relationships can be assumed to be mediated by the satisfaction of autonomy, competence and relatedness. However, as the prior studies were conducted primarily with older individuals, it is questionable if these relationships also apply for young children. Koka (2010) for example showed that for younger students (7th grade) only the satisfaction of competence was significantly related to self-determined motivation, whereas for older students (12th grade) competence, autonomy and relatedness were significantly related. Therefore, it is unsure if all theoretical relationships can be supported with a sample of young children. Beyond, the majority of the revised studies concentrate on single aspects in the assumed chain of constructs (e.g. support of autonomy), whereas only few studies examined all theoretical constructs addressed within SDT (three need support dimensions, three need satisfaction dimensions, types of motivation; e.g. Standage et al., 2005). In this regard, van den Berghe et al. (2014) provide a critical review of key findings on SDT in PE. Accordingly, educational research requires further investigations that distinguish between all of the three need support dimensions. Overall, it can therefore be stated that as a starting point suitable instruments that differentiate all aspects of SDT for younger students are necessary. To be able to do this, an instrument for younger students is needed that is able to differentiate all aspects of SDT – such an instrument, however, is not yet available, as will be shown in the following.

Existing questionnaires

In the following, an overview of questionnaires (see Table 1) and their limitations with regard to the present research is presented. We first reflect on measures concentrating on need support, second on measures that concentrate on need satisfaction and we finish with measures concentrating on the types of motivation. We included German and English language instruments in the overview.

Need support

We found only a few instruments for children that cover at least one of the need support constructs. The English Sport Climate Questionnaire (SCQ) measures the support of autonomy (and nothing else) in sports training and has been used with children from the age of 13; it showed satisfactory reliabilities (α = .86; Amorose & Anderson-Butcher, 2007; Lim & Wang, 2009). However, it seems inadequate to use this scale as a measure of support of autonomy in addition to (other) scales measuring the support of competence and the support of relatedness, since the SCQ mixes aspects of other need supportive behaviours with the scale to measure support of autonomy. For example, the item "My coach conveys confidence in my ability to do well at athletics" also comprises aspects of

the support of competence, as it refers to the students' abilities. Moreover, the wording of the items might not be appropriate for 8-13 due to their language abilities, e.g. they might misunderstand words like "encourage" or "suggest".

To measure the perceived support of competence and relatedness in PE, Standage et al. (2005) provided English scales for the use with children from the age of 11, which also showed good internal consistencies (both $\alpha > .80$). It can also be questioned if the wording of these scales is adequate for younger children. More English scales including the support of autonomy, competence and relatedness are available for secondary school children (Sánchez-Oliva et al., 2018). However, statistical analyses showed high factor correlations and therefore insufficient differentiation of the three constructs. Another German questionnaire for children at the age of 9-12 measures two need support dimensions (support of autonomy, $\alpha = .63$; support of competence and relatedness, $\alpha = .73$) in the context of sports training (Kohake & Lehnert, 2018). It is also a weakness of this questionnaire that via exploratory factor analysis it was not possible to differentiate between a support of competence and a support of relatedness. Moreover, this questionnaire was developed for use in an extracurricular sport setting which implies the necessity of modifications and re-evaluation for the use in a PE context.

Need satisfaction

With regard to need satisfaction, some more scales are available. The Greek Basic Psychological Needs in Physical Education Scale (BPN-PE; Vlachopoulos, Katartzi & Kontou, 2011) covers all three subscales: the satisfaction of autonomy, competence and relatedness. Sánchez-Oliva et al. (2018) report acceptable reliabilities for the English translation in their study with secondary school children. However, the questionnaire has only successfully been used with children and youth not younger than 11 years (all subscales with $\alpha > .80$; Vlachopoulos, Katartzi & Kontou, 2011). Moreover, scales previously used by Ntoumanis (2001) and Standage et al. (2005) with adolescents have been modified by Chen and Hypnar (2015) to suit the understanding of 8-11 year olds. They report reliabilities between .62 and .71. Additional scales exist in the context of sports training, e.g. German-language scales for children's satisfaction of autonomy, competence and relatedness (Kohake & Lehnert, 2018) and English-language scales for youths' and younger adults' satisfaction of autonomy (Hollembeak & Amorose, 2005), satisfaction of competence (Amorose, 2003) and satisfaction of relatedness (Hollembeak & Amorose, 2005; all subscales with $\alpha > .70$).

Motivation

Finally, there are several English studies with regard to the motivational constructs. Most instruments comprise four to six subscales along the motivational continuum. An intrinsic, identified, introjected and external motivation as well as amotivation can be assessed with the Exercise Self-Regulation Questionnaire for grade 3-6 students (.62 < α < .82; Ryan & Connell, 1989) as well as the Behavioral Regulation in Exercise Questionnaire (BREQ; Mullan et al., 1997) or BREQ 2 (Hein & Hagger, 2007). The scales showed good internal consistencies for the use with adults (.78 < α < .90; Mullan et al., 1997) and also for a modified version suiting the PE context and 11-15-year-old children (.75 < α < .84; Hein & Hagger, 2007). The Situational Motivation Scale developed by Guay et al. (2000) was also used with children from the age of 12 and contains all six subscales (Standage, Treasure et al., 2003; .83 < α < .90). All the previously mentioned questionnaires refer to the sports training. Also developed for sports training, a German questionnaire exists for the types of motivation for a similar age group (9-13 years) containing four subscales (intrinsic, identified, introjected and external; .66 < α < .83; Kohake & Lehnert, 2018). The only identified instrument measuring types of motivation in the PE context and a similar age group as targeted in this study is the English Children's Perceived Locus of Causality Scale (Pannekoek et al., 2014; α > .60). Accordingly, it is possible to differentiate five motivational constructs for children at the age of 9-12 (intrinsic, identified, introjected, external and amotivation). However, the authors report strong correlations between the intrinsic and identified regulation scales also resulting in a lack of confident discriminant validity. These weaknesses did not occur when using a revised form of the PLOC with 10-11-year-olds (Vlachopoulos, Katartzi, Kontou et al., 2011).

All in all, there are many questionnaires to be used in adolescence or adulthood, but few were developed for younger students. In addition, it can be noted that most questionnaires were developed for sports training, but not PE. Finally, most questionnaires only cover certain parts of the SDT. However, in order to examine more differentiated relationships between the individual constructs, more differentiated instruments are also required.

Table 1
Overview of existing questionnaires for children in the context of SDT

Questionnaire	Included scales	Number of items per scale
Sport Climate Questionnaire (SCQ)[1]	Support of autonomy	15 items
Standage et al. (2005)	Support of competence Support of relatedness	4 items 5 items
Sánchez-Oliva et al. (2018)	Support of autonomy Support of competence Support of relatedness Satisfaction of autonomy Satisfaction of competence Satisfaction of relatedness	4 items 4 items 4 items 4 items 4 items 4 items
Kohake & Lehnert (2018)	Support of autonomy Support of competence and relatedness Satisfaction of autonomy Satisfaction of competence Satisfaction of relatedness Intrinsic motivation Identified motivation Introjected motivation External motivation	5 items 5 items 3 items 3 items 3 items 3 items 3 items 3 items 3 items
Basic Psychological Needs in Physical Education Scale (BPN-PE), Vlachopoulos, Katartzi & Kontou (2011)	Satisfaction of autonomy Satisfaction of competence Satisfaction of relatedness	4 items 4 items 4 items
Chen & Hypnar (2015)	Satisfaction of autonomy Satisfaction of competence Satisfaction of relatedness	3 items 3 items 3 items
Sense of Autonomy and sense of Relatedness Scales, Hollembeak & Amorose (2005)	Satisfaction of autonomy Satisfaction of relatedness	6 items 10 items
Self-Perceptions of Competence Scale, Amorose (2003)	Satisfaction of competence	3 items
The Exercise Self-Regulation Questionnaire (SRQ-E), Ryan & Connell (1989)	Intrinsic motivation Identified motivation Introjected motivation External motivation	4 items 4 items 4 items 4 items
Behavioral Regulation in Exercise Questionnaire (BREQ), Mullan et al. (1997)	Intrinsic motivation Identified motivation Introjected motivation External motivation	4 items 4 items 3 items 4 items
Situational Motivation Scale (SIMS), Guay et al. (2000)	Intrinsic motivation Identified motivation External motivation Amotivation	4 items 4 items 4 items 4 items
Children's Perceived Locus of Causality Scale (C-PLOC), Pannekoek et al. (2014)	Intrinsic motivation Identified motivation Introjected motivation External motivation Amotivation	3 items 3 items 3 items 3 items 3 items

The present study

Adhering to SDT, the present study aims to develop and to preliminary validate German measurements to investigate the perceived need support, need satisfaction and types of motivation of children aged 8 to 13 in PE. The SDT differentiates three basic psychological needs (Ryan & Deci, 2002). Therefore, we hypothesise a 3-factor structure with regard to the perceived need support (support of autonomy, support of competence and support of relatedness; Hypothesis 1). Comparably, we assume a 3-factor structure with regard to the need satisfaction (satisfaction of autonomy, satisfaction of competence and satisfaction of relatedness; Hypothesis 2). With regard to motivation, previous research indicates that young children are already capable of differentiating five types of motivation (e.g. Pannekoek et al., 2014). For this reason, we assume a 5-factor structure (intrinsic, identified, introjected, external and amotivation; Hypothesis 3). According to SDT, the types of motivation lie on a self-determined continuum (Ryan & Deci, 2002). Consequently, to test the construct validity of the types of regulations scale, we expect a *simplex structure* (Guay et al., 2000): i. e., we assume adjacent subscales (motivation types more proximally situated on the continuum of self-determination) to share more similarities and, consequently, these subscales should show higher correlations than subscales further apart (motivation types more distally located on the continuum; Hypothesis 4). Finally, to further test the predictive validity of the developed scales, we test whether the support of autonomy, competence and relatedness positively predict self-determined types of motivation (intrinsic and identified) and negatively predict more controlled types of motivation (introjected, extrinsic and amotivation; Deci & Ryan, 2000; Hypothesis 5.1). Also, with regard to previous research with older children and youth (e.g. Standage et al., 2005) we assume that the effect of a need support scale on the types of motivation is mediated by the corresponding need satisfaction scale (Hypothesis 5.2).

Methods

Development of the first item pool

With regard to all scales for the development of the Students Motivation in Physical Education (SMoPE) instrument, we used 82 items in the preliminary analysis. The items were both derived from existing questionnaires (with a back-and-forth translation procedure) and newly developed. We used 30 items (10 items for need support, 9 items for need satisfaction, and 11 items for types of motivation) that were originally used in sports training (Kohake & Lehnert, 2018) and we modified them to suit the PE context. As some original items had limitations (e.g. a lack of differentiation between the three need support scales), we developed 47 additional items (20 items for need support, 13 items

for need satisfaction, and 14 items for types of motivation) based on other already existing questionnaires (Hollembeak & Amorose, 2005; Standage et al., 2005; University of Rochester, 2017; Vlachopoulos, Katartzi, & Kontou, 2011) or following the work of Mageau and Vallerand (2003). Additionally, as sports training outside school is usually voluntary and, thus, amotivation does not play an important role in sports training, Kohake and Lehnert (2018) did not integrate amotivation in their study. However, amotivation might play an important role in PE classes. Therefore, we added five items of amotivation to the item pool (Pannekoek et al., 2014).

Preliminary analysis

Five boys and three girls aged 8-11 (M = 9.6, *SD* = 1.3) who attended grades 3 to 6 in and around Hamburg, Germany, participated in a preliminary analysis. We performed cognitive pretesting procedure and conducted qualitative interviews with the students to test the first pool of items with regard to understanding and clarity (Bowen et al., 2004; Pannekoek et al., 2014). We explained the purpose of the study and both children and their parents agreed to audiotape the interviews. We ensured the students that the interviews would be kept in confidence and would not be available to their parents or teachers. The cognitive pretesting procedure contained 4 steps: At the beginning the child was asked to read the item aloud in order to identify possible reading difficulties with the particular wording. Secondly, the child chose the answer that best reflected his or her personal experience in PE. Afterwards, the child was invited to explain in his or her own words what the question means to him or her and why he or she chose the specific answer. Furthermore, children were encouraged to ask questions, articulate difficulties and express their thoughts throughout the whole interview("think-aloud-method"). The interviews lasted between 30 and 60 minutes. Short breaks were taken regularly so that it could be ensured that the participants were sufficiently concentrated. After each interview, the item pool was reviewed and iteratively modified if applicable.

The cognitive pretesting showed that the students understood the majority of the items the way intended by the researchers. However, due to reading difficulties and misinterpretations, some items were deleted. In the context of extracurricular sports, items with negative phrasing were also shown to be especially problematic for children (Kohake & Lehnert, 2018) and were therefore excluded from further steps. We further reduced the item quantity to an age appropriate number to help elementary students stay focused while completing the questionnaire independently (Chen & Hypnar, 2015). Since the items of existing scales have already been validated, we excluded the newly formulated items where necessary.

Final measures

The result of the preliminary study was a 33-item questionnaire, which was deemed to be understandable and clear for 8-13-year-old PE-students. The questionnaire contained 9 items measuring the perceived need support, 9 items measuring the perceived need satisfaction and 15 items measuring the types of motivation. Since four response options have been shown to be optimal for children (Borgers et al., 2004) and therefore avoid tendencies to choose the middle answer, response options ranged on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). In addition to the wording and in order to facilitate the scaling for the children, answers were visualized by happy and sad smileys. Table 2 shows example items for all subscales.

Table 2
Sample items for the subscales of the main study

	Scale	Example item	Number of items
Need support	Support of autonomy	My PE teacher often provides me with choices and options	3
	Support of competence	My PE teacher makes me feel like I am good at PE	3
	Support of relatedness	For my PE teacher it is very important that everyone gets along well	3
Need satisfaction	Satisfaction of autonomy	I have a say in what I do when participating in PE	3
	Satisfaction of competence	In PE I am able to succeed in all of the tasks provided	3
	Satisfaction of relatedness	In PE, I feel like my classmates like me	3
Types of motivation		I participate in PE...	
	Intrinsic	because I find it interesting	3
	Identified	because I want to exercise regularly to improve	3
	Introjected	because I would feel bad if I did not	3
	External	because I think my parents want me to	3
	Amotivation	but there is no point in doing it	3

Main study participants and procedure

Five elementary schools and four secondary schools located in the North of Germany agreed to participate in the main study. In total, N = 1,011 3rd to 6th grade students from 66 classes completed the questionnaire (M = 15.3 students per class). They were between 8 to 13 years old (M = 10.54; SD = 1.14), 47.1% of the students were girls. Students were informed that participation was voluntary, that there were neither right nor wrong answers and that their answers would remain confidential. The faculty's ethics committee and the education authorities of Hamburg and Lower Saxony granted permission to conduct this study.

Data analysis

We conducted Confirmatory Factor Analyses (CFA) with MPlus (Muthén & Muthén, 1997-2017) to assess the construct validity of the need support, need satisfaction and motivation types constructs (Hypotheses 1, 2 and 3). We took the multilevel-structure of the data into account by using the complex-option and including learning group as the cluster variable. We used Maximum Likelihood with Robust Standard Errors Estimation, which is relatively robust for violations of normal distribution and data independence (Muthén & Muthén, 1997-2017). By considering the Full Information Maximum Likelihood (FIML) estimation procedure, the small amount of missing values (< 0,01% per item) could be estimated based on the model. According to recommendations by Hu and Bentler (1999) we evaluated the overall model fit by means of multiple goodness-of-fit indices, including the χ^2 test. The p-value associated with the χ^2 test is supposed to be nonsignificant. However, as the χ^2 test is highly oversensitive to sample size (Schermelleh-Engel et al., 2003), we present alternative fit indices, including the Comparative-Fit-Index (CFI), the Tucker-Lewis-Index (TLI), the Standardized-Root-Mean-Square-Residual (SRMR), and the Root-Mean-Square-Error-of-Approximation (RMSEA). A model that fits the data well is indicated when values for the CFI as well as the TLI are greater than .95 (good fit) or .97 (excellent fit) and for the RMSEA as well as the SRMR are less than .10 (good fit) or .05 (excellent fit; Marsh, 2007; Schermelleh-Engel et al., 2003).

For the need support construct we compared a G-factor (single-factor) model (Model 1) with a 3-factor model (Model 2) in order to examine if children are already capable of differentiating the three basic needs or rather perceive an overall need support. Comparably, with regard to need satisfaction we also compared a G-factor (single-factor) model (Model 3) to a 3-factor model (Model 4). Regarding the types of motivation scale, we compared the 3-factor model (Model 5) to a 5-factor model (Model 6). Thereby we tested whether it was better only to distinguish between rather self-determined motivation (intrinsic and identified), non-self-determined motivation (introjected and external) and amotivation or

whether the more differentiated 5-factor model was appropriate. A 3-factor model might be appropriate as a self-determined vs. a controlled motivation mark the endpoints of the motivational continuum, while amotivation, on the contrary, marks the absence of motivation. Other studies have also shown the necessity of a reduction to three factors (e.g. Standage, Duda, et al., 2003).

For hypothesis 4, we analysed correlations between the motivational subscales. According to the continuum assumption, we assumed correlations between adjacent subscales (e.g. intrinsic and identified regulations) to show higher correlations than subscales further apart (e.g. intrinsic and extrinsic regulations).

To test if the perceived support of autonomy, competence and relatedness predict types of motivation, we conducted multiple multivariate regression analysis (Hypothesis 5.1). We entered the predictors (support for autonomy, support for competence and support for relatedness) simultaneously (single step) since no variable is given greater priority than another (Model 7). If the assumed regressions were shown to be significant, we conducted further latent path analyses: For significant regressions we tested in separate models for each need if the relationship between the support of the need and the specific type of motivation was mediated by the satisfaction of this same need (Hypothesis 5.2; Model 8 and 9).

Results

Hypothesis 1: Need support – factorial validity

With regard to the factor structure of need support, the G-factor model (Model 1) showed a poor model fit whereas the 3-factor-model showed a good model fit (see Model 2 in Table 3). All standardized item-factor loadings were significant ($p < .01$) and above .50. The final Model 2 contained three items on each of the three factors support for autonomy, support for competence and support for relatedness. Cronbachs's Alpha for all subscales is provided in Table 5. Moderate latent correlations between the three subscales indicate that the constructs can be sufficiently distinguished ($r_{\text{Autonomy,Competence}} = .69$; $r_{\text{Autonomy,Relatedness}} = .57$; $r_{\text{Competence,Relatedness}} = .80$).

Hypothesis 2: Need satisfaction – factorial validity

For the need satisfaction scale, the fit of the G-factor was not acceptable (see Model 3 in Table 3). The model fit remarkedly improved when three factors were specified and showed good fit to the data (Model 4). All standardized factor loadings were significant ($p < .01$) and at least moderate in size with one exception (.29), ranging from .46 to .81. Sufficient differentiation of the three constructs is supported by moderate

latent correlations between the subscales ($r_{\text{Autonomy,Competence}} = .28$; $r_{\text{Autonomy,Relatedness}} = .46$; $r_{\text{Competence,Relatedness}} = .47$).

Table 3
Model fit indices of the proposed models

Model		χ^2	*df*	*p*	RMSEA	CFI	TLI	SRMR
Model 1	Need support (G-factor; 9 items)	275.14	27	<.01	.10	.89	.85	.06
Model 2	Need support (3-factor; 9 items)	67.05	24	<.01	.04	.98	.97	.03
Model 3	Need satisfaction (G-factor; 9 items)	411.59	27	<.01	.12	.74	.66	.09
Model 4	Need satisfaction (3-factor; 9 items)	66.15	24	<.01	.04	.97	.96	.03
Model 5	Type of motivation (3-factor; 15 items)	400.13	87	<.01	.06	.92	.90	.05
Model 6	Type of motivation (5-factor; 15 items)	198.13	80	<.01	.04	.97	.96	.04
Model 7	Need support, need satisfaction and types of motivation (11-factor, 33 items)	956.00	440	<.01	.03	.94	.93	.04
Model 8	Regression of need support on motivation	444.61	224	<.01	.03	.97	.96	.04
Model 9	Competence satisfaction mediating the effect of competence support on intrinsic motivation	156.61	24	<.01	.07	.95	.93	.06
Model 10	Competence satisfaction mediating the effect of competence support on identified motivation	158.04	24	<.01	.07	.94	.91	.05

Hypothesis 3: Types of motivation – factorialvalidity

For the analysis of the types of motivation, a CFA of the 3-factor model showed an unsatisfactory model fit (see Model 5 in Table 3). Yet, the 5-factor model showed a better fit to the data (see Model 6). In this model, all items loaded significantly ($p < .01$). With one exception (.38) standardized factor loadings were greater than .50, ranging from .55 to .88.

Complementing the analyses to test hypotheses 1 to 3, we conducted a CFA in which all 11 subscales were modelled simultaneously. The model fit is satisfactory (see Model 7 in Table 3), indicating that the hypothesized constructs are adequately represented side by side.

Hypothesis 4: Types of motivation – simplex-structure

The bivariate correlation matrix with regard to the types of motivation constructs supported a simplex-pattern (see Table 4): Types of regulations that are theoretically closer (e.g. intrinsic and identified regulation) showed higher positive manifest correlations ($r = .66^{**}$) than more distal regulations (e.g. intrinsic and introjected: $r = .05$; intrinsic and external: $r < .001$; intrinsic and amotivation: $r = -.37^{**}$). Likewise, the manifest correlation between the introjected and external regulations were higher ($r = .60^{**}$) than those between the external and intrinsic ($r < .001$), the external and identified ($r = .03$) and the external and amotivation ($r = .24^{**}$). This picture is also evident with regard to the latent correlations, which are naturally somewhat higher. Overall, a simplex pattern was largely supported by the data.

Table 4

Manifest (above the main diagonal) and latent (below the main diagonal) correlations between types of motivation

	Intrinsic motivation	Identified motivation	Introjected motivation	External motivation	Amotivation
Intrinsic motivation	–	.66*	.05	.00	-.37*
Identified motivation	.86*	–	.07*	.03	-.43*
Introjected motivation	.04	-.02	–	.60*	.20*
External motivation	-.06	-.04	.75*	–	.24*
Amotivation	-.50*	-.65*	.25*	.33*	–

* correlation significant at .01 level; Pearson correlations shown above diagonal; latent correlations shown below diagonal

Table 5
Descriptive statistics, reliabilities and factor loadings on subscale level

	M	*SD*	α	No. of items	Factor loadings
Support for autonomy	2.13	0.69	.63	3	.50-.68
Support for competence	3.06	0.78	.73	3	.67-.73
Support for relatedness	3.21	0.72	.77	3	.69-.74
Satisfaction of autonomy	2.37	0.71	.48	3	.29-.81
Satisfaction of competence	2.88	0.76	.83	3	.75-.82
Satisfaction of relatedness	2.76	0.59	.56	3	.46-.63
Intrinsic motivation	2.78	0.81	.70	3	.38-.88
Identified motivation	3.23	0.76	.71	3	.55-.88
Introjected motivation	1.53	0.72	.74	3	.67-.71
External motivation	1.89	0.86	.71	3	.55-.76
Amotivation	1.22	0.50	.74	3	.60-.82

Hypothesis 5.1: Need support and types of motivation

The proposed multivariate multiple regression model fitted the data well (see Model 8 in Table 3). In line with our assumptions, the analysis showed significant positive effects of support of competence on both intrinsic motivation (β = .57*) and identified motivation (β = .57*). Additionally, the analysis showed a significant negative effect of support of autonomy on amotivation (β = -.18*). In contrast to the assumptions, no further paths were significant (see Table 6).

Table 6
Results of multivariate multiple regression analysis

Predictor	Types of motivation				
	intrinsic	identified	introjected	external	amotivation
	β (S.E.)	β (S.E.)	β (S.E.)	β (S.E.)	β (S.E.)
Support for autonomy	-.09 (.07)	-.13 (.06)	.04 (.07)	-.02 (.07)	-.18* (.07)
Support for competence	.57* (.14)	.57* (.13)	-.16 (.13)	-.22 (.12)	-.18 (.14)
Support for relatedness	.09 (.12)	.18 (.12)	.03 (.11)	.14 (.09)	-.11 (.12)
R^2	.34	.41	.01	.02	.18

** correlation significant at .01 level

Hypothesis 5.2: Mediating effect of need satisfaction on the correlation between need support and types of motivation

Since only three paths in the above-mentioned regression analysis turned out to be significant, only these relationships were of interest for further investigation with regard to the mediating effect of the need satisfaction subscales.

To test whether the relation between support of competence and intrinsic motivation was mediated by the satisfaction of competence, the latter was included in the model (Model 9). The model-fit indices were acceptable. The standardized regression coefficients shown in Figure 2 indicate significant direct latent correlations between the support of competence and the satisfaction of competence (β = .35**) as well as the satisfaction of competence and intrinsic motivation (β = .20**). Additionally, the mediation model still shows a significant direct effect between the support of competence and intrinsic motivation (β = .51**). However, we also found a significant indirect effect (β = .07**) of support of competence on intrinsic motivation through the satisfaction of competence. Consequently, the correlation between the support of competence and intrinsic motivation is partially mediated by the satisfaction of competence.

We found the same pattern for the relation between the support of competence and identified motivation (see Figure 3: The Model 10 with the satisfaction of competence included shows acceptable model fit. The standardized regression coefficients show significant direct latent correlations between the support and satisfaction of competence (β = .36**) as well as the satisfaction of competence and identified motivation (β = .35**). Moreover, there is a significant direct effect between the support of competence and identified motivation (β = .53**). Nevertheless, we found a significant indirect effect (β = .13**) of support of competence on identified motivation through the satisfaction of competence. Comparable to the previous analysis, we conclude that the

relation between the support of competence and identified motivation is also partially mediated by the satisfaction of competence.

Discussion

The aim of the present study was to develop and to preliminarily validate SDT-based measurements that can examine the perceived need support, need satisfaction and types of motivation of German children at the age of 8-13 in PE. A core basis for the development of the measurements was a questionnaire in the field of sports training (Kohake & Lehnert, 2018). This questionnaire showed some weaknesses, especially in the differentiation of the constructs support of competence and support of relatedness. Moreover, we classified items with negative phrasing to be problematic in the extracurricular physical activity setting, as also stated by Kohake & Lehnert (2018). This was in line with other studies showing that negative phrased items with preadolescent children were problematic (e.g. Borgers et al., 2000; Marsh, 1986). To meet these concerns, we eliminated these items from the current study and instead modified and extended the existing item pool with positive phrased items. Furthermore, with regard to the whole item pool, the wording of the items was changed to suit the PE context and an amotivation subscale was added.

Preliminary interviews following cognitive pretesting procedures with eight children helped to further identify problematic items, which were subsequently eliminated. This was an important step since language skills are still developing in middle childhood (de Leeuw et al., 2004). The children understood the final items as it was intended according to SDT. The result was the German SMoPE-Instrument (Students' Motivation in Physical Education).

The results of the CFAs largely supported a 3-factor structure for the need support (Hypothesis 1) as well as the need satisfaction (Hypotheses 2). The final 3-factor models both showed excellent model fit and were superior to the G-factor models. Thus, children seem capable to differentiate the three basic needs with regard to support and satisfaction at the age of 8 to 13.

With regard to the types of motivation scale, the 5-factor model showed excellent fit (Hypothesis 3). These results are in line with previous work that supported the suitability of self-report questionnaires for the measurement of children's types of motivation (Pannekoek et al., 2014). Previous research has also shown that it is almost impossible to statistically distinguish an integrated regulation from an identified or intrinsic regulation (Howard et al., 2017). It is further noticeable that the amotivation as well as the extrinsic regulation constructs showed floor effects. Similar results were also found in other studies (e.g. Kohake & Lehnert, 2018; Mullan et al., 1997; Pannekoek et al., 2014). This indicates that extrinsic reasons might only play a limited role in young children's physical activity commitment both in and out of school. Moreover, the validity of the questionnaire of the motivation types was supported

by the simplex-like structure of the correlations between the subscales, i.e., adjacent motivational subscales on the continuum showed higher correlations than non-adjacent subscales (Hypothesis 4). Research with young adults largely confirmed the presence of a continuous order of the types of motivation (e.g. Guay et al., 2000). This was also supported by results of a meta-analysis conducted by Howard et al. (2017).

Multivariate multiple regressions analysis brought partly unexpected results. Only the support of competence, but neither autonomy nor relatedness turned out to be significantly related to intrinsic and identified motivation (Hypothesis 5.1). No significant correlations were found to introjected and external motivation. In line with our assumptions we found a significant indirect effect between the support of competence and both the students' intrinsic motivation and their identified motivation through the satisfaction of competence (Hypothesis 5.2). However, the indirect effects were small and the relations only partially mediated. Therefore, there seem to be other sources explaining the relations between perceived support of competence and intrinsic/identified motivation that need further investigation.

The perceived support of autonomy, competence and relatedness have not often been measured separately. Standage et al. (2005), for example, included all three dimensions but only examined relationships between a second order factor need support, a second order factor need satisfaction and the different types of motivation. However, the satisfaction of competence has also been shown to have stronger relationships to intrinsic motivation in several studies in the physical activity context (Koka, 2013; Koka & Hagger, 2010; Ntoumanis, 2001; Standage et al., 2012). There are two explanations for the strong influence of the need for competence. First, competence could play an outstanding role in physical activity contexts since motor performance plays a major role and can easily be assessed by the children themselves: Information with regard to success often do not need social feedback but the child alone can see that the task is mastered e.g. like scoring a goal. This could be the reason why competence largely influences the degree of enjoyment and, consequently, intrinsic motivation in this context. This explanation can be supported by results of Richartz et al. (2009) who found that children elite athletes felt a high degree of enjoyment especially when feeling competent while doing their sports. Accordingly, PE teachers should pay special attention to the support of competence in their PE classes since this seems to be especially important for the self-determined motivation of children. Support of competence can be achieved by providing tasks with appropriate degrees of difficulty, differentiating tasks within the class, offering help and support as well as praise and recognition for effort and persistence (Standage & Ryan, 2020). Secondly, another explanation could be the age of the participants in this study. Maybe for young children the needs of relatedness and autonomy just play a minor role: Koka (2010) found that for 12th graders the satisfaction of all of the three basic psychological needs were significantly related

to intrinsic motivation, while for 7th graders only the satisfaction of competence (not relatedness or autonomy) significantly predicted self-determined motivation. Moreover, he found different effects of the various teaching behaviors on need satisfaction and types of motivation. Koka (2010) concluded that students in different grades may have varying interpretations of different teaching behaviors. Nevertheless, this should not undermine the importance of all of the three basic needs. For example, the support of autonomy – regardless of its importance for the motivation of the learner – proves to be a central variable in motor learning (e.g. Wulf et al., 2014).

Limitations and future research

All analyses of this study relied on one set of data. Even though the initial evaluation has produced acceptable psychometric characteristics, cross validations with additional samples could further strengthen the present results. Moreover, the data were cross-sectional and therefore not adequate to examine change over time, which could be interesting for future research.

Considering that assessments in classes always build on data with a multi-level structure, future research should also investigate to what extent the individual assessments of SDT constructs differ between the children in a class and between the classes (e.g. Lüdtke et al., 2006).

The measurements presented in this study can be used for further research that aims at investigating relationships between children's perceptions of their PE teacher's behaviour, their types of motivation and the resulting outcomes, e.g. extracurricular physical activity engagement. The results underline the importance of examining the impact of each need support separately in order to be able to predict the impact on specific types of motivation.

Building on the Work of Koka (2010), future research should further investigate possible age effects by comparing children of different age groups. Future research might also consider adding further subscales that focus on, e.g. controlling teacher behaviours (in contrast to need supporting behaviours) and need thwarting (in contrast to need satisfaction). Instruments examining need thwarting in the sports training context have already successfully been validated for youths and adults (Psychological Need Thwarting Scale; Bartholomew, Ntoumanis, Ryan & Thøgersen-Ntoumani, 2011). Depending on the research question, controlling behaviours might explain additional variance: while need support and satisfaction in the sports context have shown to be highly related to positive outcomes, controlling behaviours and need thwarting were better predictors of negative outcomes, e.g. emotional and physical exhaustion (Bartholomew, Ntoumanis, Ryan, Bosch et al., 2011). However, the scales' invariance across participants' age as well as the suitability for the PE context is still to be tested.

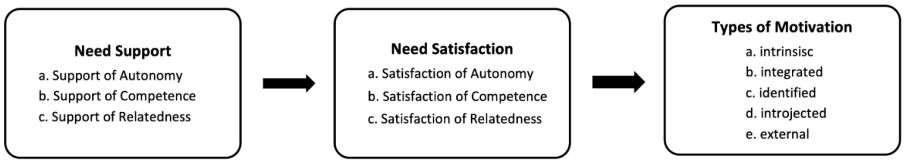

Figure 1
Hypothesized relations based on SDT (see also Kohake & Lehnert, 2018).

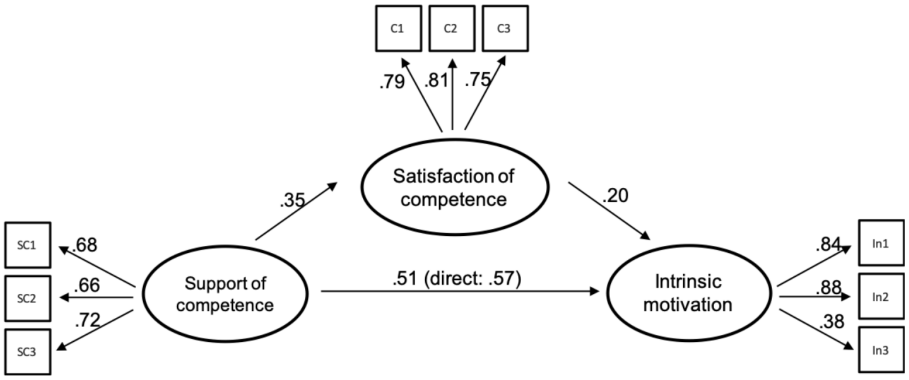

Figure 2
Model of the mediating effect of satisfaction of competence on the relationship of support of competence on intrinsic motivation. All paths are significant with $p < .01$.

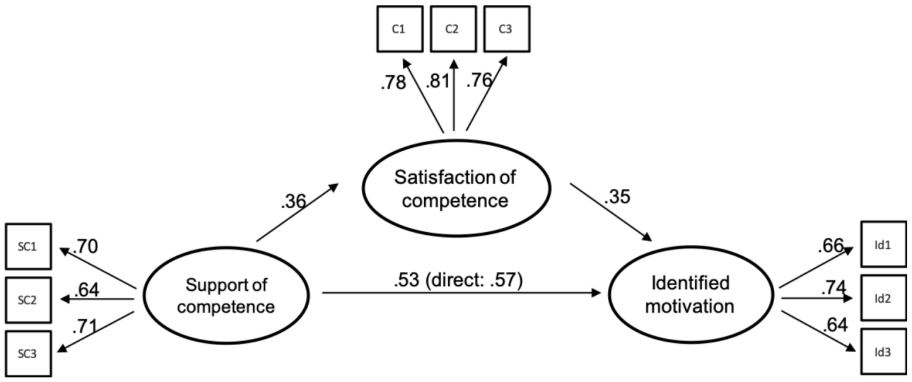

Figure 3
Model of the mediating effect of satisfaction of competence on the relationship of support of competence on identified motivation. All paths are significant with $p < .01$.

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