Are teachers' subjective feelings linked with need-supportive and need-thwarting motivating styles? A cross-lagged pilot study in physical education

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Abstract

This article examines the relations between the teachers' subjective feeling and their motivating teaching style during physical education lessons. Doing so, it aimed at better understanding the emotional antecedents of the teaching behaviors. Twelve volunteer physical education teachers were filmed with their respective classes to assess the motivating style they used during their intervention. Immediately after, the subjective feelings they felt during the lesson were assessed using the affective slider in a video-based session. Cross-lagged multilevel modeling was then performed, controlling for emotional exhaustion level and demographic factors. Results showed that, at the within level, subjective pleasant feelings predicted positively the relatedness-supportive dimension of the motivating style, and negatively the controlling dimension. At the between level, the controlling dimension of the motivating style was positively related to the pleasant subjective feelings while the relatedness-thwarting dimension was negatively related to them. While literature has mainly examined the cognitive antecedents of teachers' motivating styles, this study emphasizes the emotional processes occurring during the lesson. Based on the conceptual framework of teachers' emotions model proposed by Frenzel (2014), results indicate that teachers react to their subjective feelings, modifying the way they interact with students accordingly. In parallel with cognitive determinants of teaching, the emotional dimension thus deserves to be more deeply considered in future teaching training programs.

Keywords Self-determination theory · Model of teacher's emotions · Motivating styles · Cross-lagged multilevel modeling · Observation

As evidenced in the literature, teachers are important determinants of classroom environments. Research in school context, and physical education in particular, has emphasized the influence

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of teachers' need-supportive motivating style on school motivation, positive behavioral outcomes, and students' academic outcomes (see Van den Berghe et al. 2014 for a review). Despite these benefits, observation studies in physical education have shown that teachers are weakly autonomy-supportive and more frequently use controlling behaviors (e.g., Sarrazin et al. 2006; Tessier et al. 2008). To better understand this phenomenon, several potential antecedent variables of the motivating style have been investigated and categorized into three broad categories: contextual factors (e.g., cultural norms), perceptions of other's behaviors and motivation (e.g., students' motivation), and personal factors (e.g., teachers' personality traits) (see Matosic et al. 2016; Reeve 2009, for a review). These previously explored antecedents are mainly cognitive in nature, leaving emotional avenues largely uninvestigated (see Stebbings et al. 2015). Following the conceptual framework of Frenzel's model of teacher's emotion (2014), teacher's emotions are indeed related to their teaching behaviors. This study therefore explores the relationships between teachers' emotions—via subjective feelings—and their teaching behaviors—via observed motivating style—across a physical education lesson.

Teacher's motivating style

Grounded in self-determination theory (SDT; Deci and Ryan 2002), teachers' motivating style has been shown to be a heuristic construct which can influence the teacher-student relationship (Reeve and Cheon 2014). It refers to "the interpersonal sentiment and behavior a teacher uses to motivate his or her students to engage in learning activities" (Reeve and Cheon 2014, p. 94). Within SDT, motivating style is comprised of three dimensions—autonomy support versus controlling, structure versus chaos, and involvement versus hostility—which nurture or thwart the needs for autonomy, competence, and relatedness, respectively (Reeve et al. 2004; Skinner and Edge 2002; Tessier et al. 2010).

A need-supportive motivating style is thus characterized by the provision of autonomy support, structure, and relatedness support intended to nurture students' psychological needs for autonomy, competence, and relatedness, respectively (Reeve 2009; Skinner and Edge 2002). More precisely, an autonomy-supportive teacher facilitates students' autonomy by feeding their inner motivational resources, providing them with explanatory rationales, relying on non-controlling and informational language, displaying patience to allow time for self-paced learning, and acknowledging and accepting expressions of negative affect (Reeve 2009). Providing structure serves complementarily to the amount and clarity of information that teachers supply to students regarding "what to do" and "how to do," which helps to develop desired skills and achieve valued outcomes (Reeve and Cheon 2014). For this purpose, teachers provide structure by clearly communicating guidelines and expectations (Jang et al. 2010), offering sufficient guidance during lessons, providing step-by-step directions following the pace of the learners (e.g., Jang et al. 2010), and giving positive and constructive feedback to help students build on their skills and sense of competence (e.g., Mouratidis et al. 2008). Finally, a relatedness-supportive teacher invests a considerable amount of time, energy, and resources in his/her students, and offers affection, unconditional respect, warmth, care, and nurturance (Skinner and Edge 2002).

By contrast, a need-thwarting motivating style is characterized by controlling, chaotic, and relatedness-thwarting teaching behaviors, which are assumed to undermine students' psychological needs for autonomy, competence, and relatedness, respectively. More precisely, a controlling teacher relies on external sources of student motivation to get the students to

behave in teacher-desired ways (Reeve 2009). Additionally, when a teacher veers towards the chaotic, the students' need for competence cannot be satisfied because the teacher provides unclear instructions and vague goals, and delivers no informational feedback to indicate if they are performing skillfully. Finally, a relatedness-thwarting teacher is neglectful or even aggressive in his/her interactions with students, which negatively impacts relatedness satisfaction (Skinner and Edge 2002).

Research reveals consistent benefits that both teachers and students receive from need-supportive teaching. For instance, teachers who participated in a need-supportive training program reported greater teaching motivation and well-being, improving more vitality and job satisfaction on the one hand, and lesser emotional and physical exhaustion on the other hand (Cheon et al. 2014). Evidence supporting effects on students reveals that both need-supportive and need-thwarting motivating styles are shown to be related to students' adaptive and maladaptive outcomes through two differentiated, yet complementary, explanatory processes (Cheon et al. 2018; Jang et al. 2016; Haerens et al. 2015). Haerens et al. (2015) have shown that through a dual-process model, teachers' autonomy-supportive motivating style was related primarily to students' autonomous motivation, as mediated by need satisfaction (bright pathway). Conversely, teachers' controlling motivating style was related to students' controlled motivation and amotivation, through need frustration (dark pathway).

Moreover, several studies have found that autonomy-supportive and controlling motivating styles are only moderately correlated (Haerens et al. 2015; Cheon and Reeve 2013). Thus, it is now increasingly recognized that these two aspects of motivating style are not opposite constructs to a same continuum, but are rather different constructs. Nonetheless, one remaining question in the perspective of the dual-process model is whether need-supportive and need-thwarting motivating styles are based on separate roots; that is, do they have different antecedents?

Emotional background of teaching

Despite the centrality of emotions in this profession (Hargreaves 1998), teaching remains traditionally considered as a mainly cognitive activity, in which professionalism, technical knowledge, and competence leave little space for consideration of teachers' emotions (e.g., Frenzel et al. 2008). In the last decade, however, researchers have become increasingly interested in the emotional dimension of teaching (for review, see Frenzel 2014). Investigations in this topic are attracting growing interest (e.g., Schutz and Zembylas 2011), focusing on the diversity of emotions felt by teachers (e.g., Frenzel et al. 2009), their antecedents (e.g., Schutz 2014), the correlation between teacher's emotions and teaching efficacy (e.g., Day and Gu 2013), the cumulative effect of teachers' emotions on burnout (e.g., Chang 2009), and the effect of emotional contagion between teacher and students (e.g., Bakker 2005; Becker et al. 2014). However, the body of knowledge on teacher emotions is still not extensive (Frenzel 2014).

Frenzel's model of teacher emotions defines emotions from an appraisal perspective (Scherer 2005). According to the model, teachers follow different teaching goals, observe the behavior of students related to their goals, and then appraise this behavior (e.g., in terms of goal attainment), which contributes to their respective emotions (Frenzel 2014).

Four main teaching goals and the respective student behavior are identified: achievement behavior (e.g., grades), motivational behavior (e.g., engagement), socio-emotional behavior

(e.g., discipline in class), and relational behavior (e.g., closeness). For instance, when students are voluntary, committed, cooperative, and concentrated during learning activities, and when they have good grades, teachers are likely to consider that they have reached their teaching goals, and thus feel pleasant emotions. In contrast, when students adopt disruptive behaviors, when they are disengaged, in conflict with each other, and when they have poor grades, teachers may think that they missed their teaching goals, and thus feel unpleasant emotions.

Following the recommendations of Becker et al. (2014), teachers' emotions might be studied at two different levels: trait-based and state-based emotions. Trait-based emotions are defined as an overall emotional tone linked to the cumulative aspect of temporal affective experiences (Frenzel et al. 2009). In this way, they are "relatively stable habitual emotions" (Becker et al. 2014, p. 16), halfway between fleeting emotions and character traits more deeply rooted in the personality of individuals.

Benefiting from the surge of research on burnout syndrome (see Chang 2009), one of the most studied trait-based emotions of teachers is emotional exhaustion. As a widely studied construct, teacher's emotional exhaustion has been shown to be negatively related to organization in the classroom (Dorman 2003) and positively associated to the use of a traditional approach of teaching where discipline maintenance is a priority (Dewe 1985). As for methodological concerns, its' potential influence on self-reported emotions has been pointed out (Goetz et al. 2015), making it an important variable to control. Although widely researched, trait-based emotions only address one global "emotional tone," which is not specific enough to capture the emotional dynamic of teaching.

Parallel to trait-based emotions, some researchers investigated the influence of fleeting "state-based" emotions on teaching (e.g., Becker et al. 2014; Goetz et al. 2015). For instance, Becker et al. (2014) examined the crossover process between teachers' and students' emotions, finding that teachers' emotions explain incremental variance in students' emotions, above and beyond teachers' interpersonal behaviors. However, they did not directly examine the relationship between teachers' state-based emotions and their interpersonal teaching behaviors themselves. Furthermore, Hagenauer et al. (2015) examined, using a cross-sectional design, the relations between students' behaviors and teachers' emotions on 132 teachers. Results showed that close teacher-student relationship was positively related to teachers' joy and negatively linked to teacher's anxiety.

Despite these breakthroughs, one important limitation of this approach of studying emotional processes during teaching is that these self-reported labels of emotions differ in their nature from the emotional experience itself (Scherer 2005). According to the component process model (CPM; Scherer 2001), an emotional episode relies on the dynamic and synchronous activation of physiological, behavioral, motivational, tendency-to-action, and subjective feelings subsystems, which together determine emotional complex qualia that the verbal declaration cannot fully describe (Scherer 2009). A multimodal approach mixing the monitoring of several subcomponents of emotional episodes would theoretically be the only methodological way to accurately reflect the wealth of the emotional experience. Unfortunately, this approach might be unrealistic in an actual teaching environment (Scherer 2009). Hence, in the school context, assessing teachers' dynamical self-reported statements about their subjective experience seems more appropriate. This subjective experience of emotion, or "feelings" (Damasio 1998), plays the role of continuous controller of the homeostasis of the emotional subsystems allowing the individual to become aware of an emotion (Scherer 2001, 2009). Feelings—such as pleasure or displeasure—therefore make it possible to express the emotion as it is experienced by the individual during a situated event (Scherer 2009). If these

self-reported feelings should not be considered strictly speaking as "emotions" (Scherer 2005), they nonetheless allow to monitor the continuous variations of the emotional subjective experience.

To our knowledge, no previous study has yet specifically examined the relationship between subjective feelings and teacher's motivating styles. In a recent study, Anderman et al. (2018) examined the mediating role of subjective feelings between experiences of violence and teachers' behavioral reactions. They showed that the unpleasant experience of feeling upset (i.e., scared and/or crying) was predictive of a lesser likelihood of either providing feedback or delivering a reprimand to the perpetrator. In contrast, increasing unpleasant feelings of anger were related to an increased likelihood of delivering a verbal reprimand to the perpetrator. In sport context, Stebbings et al. (2015) examined the effects of coaches' labeled emotions on their motivating style at three time points across an eleven-month period. Using multilevel modeling, results showed that within-person increases and individual differences in pleasant emotion were positively associated with autonomy-supportive coaching, and conversely, within-person increases and individual differences in unpleasant emotion were related to increased use of controlling motivating style. However, the study lacks a measure of subjective feeling and also relies on the use of self-report measures alone, which could increase the risk of bias (e.g., shared variance and retrospective bias).

The present study

The aim of this pilot study was to examine the relationship between teachers' subjective feelings and his/her motivating style across a physical education lesson, controlling for sex, age, years of experience in the workplace, and level of emotional exhaustion. Indeed, teachers have been shown to be particularly exposed to this phenomenon and this latter issue can affect teaching (Chang 2009). More specifically, on the basis of previous studies that examined the antecedents and emotional correlates of the motivating style (Stebbings et al. 2015; Reeve et al. 2018) and on the dual-process model within SDT (Cheon et al. 2018; Jang et al. 2016; Haerens et al. 2015), it was hypothesized that moment-to-moment higher scores of subjective feelings (i.e., pleasant feelings) would be positively related to need-supportive motivating styles (H1), and conversely that moment-to-moment pleasant feelings would be negatively or non-significantly associated with need-thwarting motivating styles (H2). Finally, based on studies showing that teachers benefit from giving need-supportive teaching (Cheon et al. 2014), we assumed that the adoption of a need-supportive motivating style was likely to be positively related to the emergence of pleasant feelings, and that the adoption of a need-thwarting motivating style was negatively associated with their appearance (H3).

The originality of this work is twofold. On the theoretical level, investigating the causal directionality between teacher's subjective feelings and his/her motivating style in an ecological school context is novel. On the methodological level, using external observation to measure the motivating style in place of a self-reported questionnaire is unique and could reduce shared variance biases. In addition, to capture the dynamical flow of episodic subjective feelings in teaching, and not only a one-time self-report overall "emotional tone" of classrooms subject to recall bias, the present study used a continuous measure of the teachers' subjective feelings.

Method

Participants and procedure

At the beginning of the school year (September), physical education teachers of fourteen middle schools of a large town in Eastern France were contacted to participate in this study. Twelve of the sixty-two solicited physical education teachers (5 women and 7 men; mean ± SD age 38.42 years (± 5.99) from 6 different schools agreed to participate in this study. All 12 participants have a substantial level of professional experience (mean ± SD = 15.25 years ± 7.11), along with at least 3 years of seniority in the school (mean ± SD = 9.75 years ± 5.19). These urban schools were not classified as disadvantaged schools by the French Ministry (i.e., students from these schools were not characterized by major disruptive behavior and low achievement).

In France, physical education is a compulsory subject for all students. They attend physical education lessons once a week for 2 h. A physical education lesson is generally structured along three different parts: warm-up, learning, and formative assessment. Generally, the physical education curriculum comprises 8-week sport units. In French curriculum, sports are classified according to 5 objectives: produce an optimal performance (e.g., track and field), adapt the behaviors to various environments (e.g., climbing), make an artistic and/or acrobatic performance (e.g., dance), deal with an individual or collective opposition (e.g., basketball), and develop and maintain his/her resources (e.g., fitness). Physical education teachers have to schedule a balanced planning of physical activities from these five categories. The present study was carried out in regular physical education lessons. The twelve teachers taught different sports: badminton, table tennis, volleyball, athletics, gymnastic, circus arts, and French boxing.

The subjective feelings and the motivational style of each teacher were measured during a single lesson. More specifically, before the lesson, teachers reported their levels of emotional exhaustion. During the lesson, teachers were filmed by two devices: a digital camcorder, which was positioned at a distance of 10 to 25 m capturing teachers' behaviors "in third-person perspective" with a large viewing angle, and was connected, via a transceiver, to a small microphone fixed on the collar of their sweatshirt to record the communications with students. The second device was an eye-tracker (i.e., ETG 2, SensoMotoric Inc.) used to film, "in first-person perspective", where and at what the teacher was looking. On average, lessons lasted $M_{Time} = 71.75$ min. Immediately after the lesson, teachers were invited to observe the video footage of the lesson and to assess their own subjective feelings. This assessment took about 1 h and half. Thus, only the lessons carried out at the end of the morning or at the end of the afternoon were eligible to be videotaped. The measurement and coding process are displayed in Fig. 1.
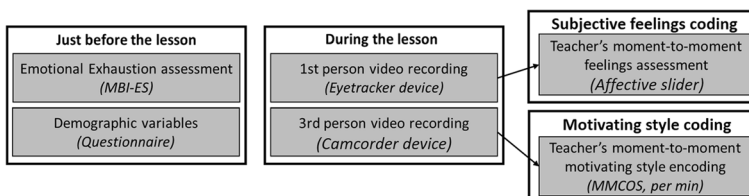

Fig. 1 Measurement and coding process

The study was not prospectively registered, but ethical approval was obtained from a university ethics committee and the local education authority. Furthermore, consent to participate in the study was obtained from head teachers of the schools and participants in the study.

Measures

Subjective feelings Being immersed in the lesson, it is not possible and too distracting for the teacher to continuously report his/her own feelings during the teaching task. Thus, in order to measure moment-to-moment change in teacher subjective feelings during the lesson, the affective slider recently developed by Betella and Verschure (2016) was adapted to the educational context. Relying on video recording, teacher's subjective feelings were assessed immediately after the lesson using a slider, allowing to move a cursor along an analogic visual scale indicating the levels of the pleasant/unpleasant valence of the feelings across the lesson. The video filmed in the first-person perspective (i.e., using the eye-tracker) provides support to the self-report, allowing the participants to report more accurately their subjective experience on the time-line of the lesson. One strength of this approach is providing insights into the continuous variation of the feelings' valence elicited during the lesson. In a set of experiments, Lottridge et al. (2012) demonstrated the reliability of this methodology. Recently, this approach has been used to measure remembered pleasure-displeasure in the exercise context (Zenko et al. 2016; Hutchinson et al. 2018).

In the present study, teachers were invited to continuously evaluate their subjective feelings (i.e., hedonic tone) at each moment of the video. Given the changing nature of emotions and in order to limit declarative latencies, if the teacher did not move the cursor over a period of more than 60 s, the experimenter was careful to confirm the said feeling by asking "how did you feel at this moment of the lesson?". The scale was a non-graduated analogic visual scale of 20 cm. From a central point considered as neutral (i.e., 10 cm), the more the teachers moved the cursor to the left, the more they declared a strong unpleasant valence of his/her feelings at this moment of the lesson (i.e., 10 cm to 0 cm). Conversely, the more they moved it to the right, the more they declared a strong pleasant valence of his/her feelings at this moment of the lesson (i.e., 10 cm to 20 cm). At 1-min intervals, an experimenter reported on a sheet the score of teachers' subjective feelings, arising in about 72 repeated measures per teacher.

Motivating style To assess the teachers' motivating style, the adapted version of the Multidimensional Motivational Climate Observation System (MMCOS; Smith et al. 2015) developed by Langdon et al. (2017) was used. This adapted version is based on the 5 environmental dimensions related to SDT (i.e., autonomy support, control, relatedness support, relatedness-thwarting, and structure), and their 25 lower-order behavioral strategies. As seen in Langdon et al. (2017), coding only 5 of the 7 environmental dimensions does not impede the psychometric properties of the MMCOS.

Each dimension is rated on a 4-point potency scale ranging from 0 (not at all) to 3 (strong potency). Potency refers both to frequency (i.e., number of behavioral strategies used for each dimension during the coding interval) and quality (i.e., pervasiveness and quality of teachers' behaviors) of each strategy. Decisions about potency ratings are based on a marking scheme, which includes anchor descriptions, as well as the list of 25 behavioral strategies that are believed to be differentially indicative of each of the environmental dimensions. For example, the following indicators are used for autonomy support: "acknowledges feelings and perspectives, provides meaningful choice, encourages intrinsic interest, provides rationale for tasks/

requests/constraints, provides opportunity for player input, and encourages initiative taking" (Smith et al. 2015, p. 22).

In order to examine the variation of motivating style across the lesson, each "third-person perspective" video footage of physical education lesson was coded every minute, resulting in approximately 72 repeated measures per teacher. To do so, in a table with the list of behavioral strategies in abscissa, and the time-line in ordered, coders had to tick each behavioral strategy that was used by teachers at each minute, and then rate the potency of each dimension of the motivating style.

Two independent coders were trained to assess the behaviors of interest. Rater 1 was one of the researchers, who has extensive experience in using systematic observation in conducting research using self-determination theory. Rater 2 was a student in a Master's degree in physical education program and was extensively trained by the researcher in using systematic observation. The training procedure was identical to the one developed by Smith et al. (2015), and took approximately 4 h. Training consisted of PowerPoint presentations (e.g., presentation of the SDT tenets and the observation tool), a seminar (e.g., review of quiz and clarification of the motivating style's dimensions), and collaborative and independent coding sessions (e.g., appropriation of the marking scheme and observation schedule). To finish his coder training, rater 2 was asked to rate two pilot videos using the observational instrument. These ratings were compared with a "gold standard" rating from the lead researcher (rater 1). Once the weighted Cohen's kappa coefficient surpassed an acceptable level of reliability (i.e., $K > 0.70$), coders began rating the 12 video recordings. Results of the inter-rater agreement were examined using a two-way random intraclass correlation coefficient (ICC) and reflected and adequate degree of reliability (i.e., M_{ICC} of the five motivating styles ranged from 0.73 to 0.79; see Table 1).

Control variable In order to assess control variable of emotional exhaustion, just before the beginning of the class, teachers were asked to complete the "Emotional Exhaustion" (EE) dimension of the French version of the Maslach Burnout Inventory – Educators Survey (MBI-ES) (Dion and Tessier 1994). More precisely, EE is measured by nine specific items (e.g., "I feel emotionally drained from my work") having a 7-point response scale ranging from 0 ("I never experience such a feeling") to 6 ("I experience such a feeling every day"). As for French educators, general score of EE, obtained by adding all these 9 items scores, is considered low if less or equal to 16, medium if comprised between 17 and 28, and severe if up or equal to 29.

Additional information on demographic control variables (sex, age, years of experience) were then asked at the end of the questionnaire. Age and experience were coded as eigenvalues, and gender was coded as binary classes (women "0"; men "1").

Statistical analysis Due to the nested nature of these data, a hierarchical linear modeling (HLM; Raudenbush and Bryk 2002) approach was performed to test the hypotheses using SPSS, version 18 (SPSS Inc., NY). HLM allows a correct estimation of parameters when data are hierarchically structured with repeated measurements (at level 1) nested within individual (at level 2). HLM is the preferred method for this type of data, as it accounts for shared variances due to multiple observations within the same participant (i.e., non-independence). To examine the moment-to-moment relationships between teachers' state-based experiences and their motivating style, cross-lagged multilevel modeling was used (Raudenbush and Bryk 2002), which allowed for examination of whether teachers' subjective feelings predicted the next moment of their motivating style (controlling for the immediately previous moment of motivating style), and also whether motivating style predicted the next moment of subjective feelings (controlling for the immediately previous moment of subjective feelings).

Table 1 Descriptive statistics

Variables	Scale range	M	SD	ICC	Correlations								
					1.	2.	3.	4.	5.	6.	7.	8.	9.
Level 1													
1. Autonomy-supportive	0–3	0.04	0.21	0.72									
2. Structure	0–3	2.49	1.63	0.72	0.6								
3. Relatedness-supportive	0–3	0.81	0.94	0.75	0.11**	0.12**							
4. Control	0–3	0.6	0.77	0.79	−0.08*	−0.11**	−0.30***						
5. Relatedness-thwarting	0–3	0.76	1.08	0.76	−0.07	−0.12**	−0.31***	0.40***					
6. Subjective feelings	0–20	10.59	2.99		0.04	0.18***	0.23***	−0.14***	−0.10**				
Level 2													
1. Autonomy-supportive	0–3	0.04	0.05	–									
2. Structure	0–3	2.46	0.64	–	0.24***								
3. Relatedness-supportive	0–3	0.82	0.47	–	0.31***	0.17***							
4. Control	0–3	0.64	0.28	–	−0.01	0.25***	−0.58***						
5. Relatedness-thwarting	0–3	0.76	0.36	–	−0.16***	0.07*	−0.67***	0.76***					
6. Subjective feelings	0–20	10.31	1.84	–	0.17***	0.61***	0.48***	−0.26***	−0.48***				
7. Exhaustion	13–45	28.61	9.10	–	−0.24***	−0.42***	−0.48***	0.43***	0.41***	−0.83***			
8. Sex	–	–			0.38***	0.61***	0.47***	−0.04	−0.47***	0.53***	−0.51***		
9. Age	30–49	38.42	5.99		−0.28***	0.10**	−0.10**	−0.07*	0.21**	0.17**	−0.07*	−0.60**	
10. Experience	4–28	15.25	7.11		−0.27***	−0.2	−0.003	−0.20**	0.11**	0.18**	.17**	−0.62***	0.97***

$*p < .05$; $**p < .01$; $***p < .001$

To prevent the risk of confounded estimations, a person-mean centering was applied to the predictor (i.e., state-based emotion and motivating style) variables, which helps to disaggregate the within-person from the between-person effects (Raudenbush and Bryk 2002). Indeed, the composite effect without disaggregation is "generally an uninterpretable blend" (p. 138) of between- and within-person effects (Raudenbush and Bryk 2002). Thus, the state-based emotions and motivating style variables were decomposed into two variables: an individual mean deviation score, which captures mean inter-individual differences, and an individual deviation score (from the individual mean value) for each time point, which captures mean intra-individual change.

Following the strategy suggested by Singer and Willet (2003), several models were tested. In a preliminary step, an unconditional model was tested—with only an intercept and no explanatory variables—to partition the variance of each dependent variable into within-individual and between-individual components. In step 2, the control variables (i.e., teachers' sex and teaching experience) were included in an unconditional growth model (model 1) as fixed parameters. In step 3, the lagged dependent variable and the predictors (i.e., the mean and the deviation scores) were added (model 2).

To compare models, -2 log likelihood (i.e., likelihood ratio test/deviance test; Heck et al. 2013) was used with lower values indicating better model fit. Because of space restrictions, only model 2 is presented. Pseudo R_1^2 and R_2^2 values were calculated to estimate the proportional amount by which errors of prediction have been reduced from the unconditional model to the conditional models. These values are an estimate of effect size, similar to the R^2 value in traditional ordinary least squares regression analyses (Singer and Willet 2003).

Results

Preliminary analyses

The observational procedures described above resulted in the coding of 864 subjective feelings ($M = 72$, ranging from 61 to 86) and 4083 teaching behaviors (i.e., the frequency of teaching behaviors) ($M = 340.2$; SD = 127), as summed across all teachers. Table 1 presents the means and standard deviations for each variable and revealed that all scores of motivating styles (i.e., potency rating), except structure, were under the scales' midpoints and subjective feeling variable average scores are around the scale midpoint. Both at the within- and between-person levels, need-supportive dimensions were positively correlated within themselves, with subjective feelings, and negatively correlated with exhaustion and need-thwarting dimensions.

The statistical assumptions associated with HLM were first checked by exploring the residuals in model 2 (full conditional). Plots of the standardized level 1 residuals against their normal scores showed a reasonably linear relationship, indicating relative normality and no extreme outliers. Furthermore, the residuals against the predicted scores of the outcome variables showed no major signs of heteroscedasticity.

Main analyses

The ICCs based on the level 1 and level 2 residual variance from unconditional models were above 5% for autonomy-supportive (ICC = .06), structure (ICC = .11), relatedness-supportive (ICC = .24), control (ICC = .12), and relatedness-thwarting (ICC = .10) motivating styles. This indicated that there was a hierarchical structure in the data and that multilevel analysis was appropriate (Raudenbush and Bryk 2002).

Results presented in Table 2 reveal that the teachers' subjective feelings only predicted the moment-to-moment relatedness support motivating style dimension. More specifically, the autonomy-supportive dimension was not significantly predicted by subjective feelings both at the within level ($b = 0.0005$, $p = .86$) and at the between level ($b = -0.004$, $p = 0.84$), neither by the lagged parameter ($b = 0.035$, $p = .48$). Teachers' structure was significantly related to the lagged parameter ($b = 0.37$, $p < .001$), and age ($b = 0.12$, $p < .05$), but not to subjective feelings ($b = 0.03$, $p = .13$, and $b = 0.01$, $p = 0.87$) at the within level and at the between level, respectively. Teachers' relatedness-supportive motivating style was significantly predicted by sex ($b = 0.88$, $p = .04$), age ($b = -0.13$, $p = .04$), professional experience ($b = 0.15$, $p = .02$), the lagged parameter ($b = 0.26$, $p < .001$), and subjective feelings at the within level ($b = 0.03$, $p = .02$), but not at the between level ($b = 0.07$, $p = .48$). Concerning effect size for relatedness support, R_1^2 value was 0.06 and R_2^2 value 0.81, indicating that, from the unconditional model to model 2, adding the lagged relatedness support and the subjective feelings reduced the unexplained variance by 6% at the within-person level and by 81% at the between-person level.

Pertaining the teachers' need-thwarting motivating style dimensions, Table 3 shows that the control dimension, in contrast to the relatedness-thwarting dimension, was significantly related to subjective feelings. More specifically, for the controlling dimension, the effect of the lagged parameter ($b = 0.19$, $p < .001$) and that of the subjective feeling at the within level ($b = -0.03$, $p = .01$) were significant. Conversely, the effect of the subjective feelings at the between level was not significant ($b = -0.005$, $p = .95$). Concerning teachers' relatedness-thwarting motivating style, the effects of age ($b = 0.12$, $p = .02$), professional experience ($b = -0.11$, $p = .04$), and lagged parameter ($b = 0.24$, $p < .001$) were significant, but not the effect of subjective feelings ($b = -0.007$, $p = .66$ and $b = -0.15$, $p = 0.07$) at the within level and at the between level, respectively. The effect size values for the control were $R_1^2 = 0.04$ and $R_2^2 = 0.58$, indicating that, from unconditional model to model 2, adding the lagged control and the feelings reduced the unexplained variance by 4% at the within-person level and by 58% at the between-person level.

With regard to teachers' subjective feelings, Table 4 reveals that the effects of sex ($b = -1.56$, $p < .05$), professional experience ($b = -0.16$, $p < .05$), exhaustion ($b = -0.07$, $p < .001$), the lagged parameter ($b = 0.75$, $p < .001$), control at the between level ($b = 1.00$, $p < .05$), and relatedness-thwarting at the between level ($b = -1.03$, $p < .05$) were significant. Conversely, autonomy support ($b = -0.15$ and $b = -1.34$ at the within level and at the between level, respectively), relatedness support ($b = 0.02$ and $b = 0.47$ at the within level and at the between level, respectively), structure ($b = 0.007$ and $b = 0.49$ at the within level and at the between level, respectively), control at the within level ($b = -0.07$), and relatedness-thwarting at the within level ($b = -0.003$) have no significant effect. The effect size values for the subjective feelings were $R_1^2 = 0.58$ and $R_2^2 = 0.89$, indicating that, from unconditional model to model 2, adding the lagged subjective feelings and the motivating style variables reduced the unexplained variance by 58% at the within-person level and by 89% at the between-person level.

Discussion

The purpose of this study was to examine the moment-to-moment relationship between teacher's subjective feelings and his/her motivating style. Controlling for the effects of sex, age, experience, and exhaustion, results revealed significant relationships between subjective feelings and motivating style at the within level—specifically relatedness-supportive and

Table 2 Results of cross-lagged multilevel modeling on autonomy-supportive, structured, and relatedness-supportive motivating style

	Autonomy support b (SE)	Structure b (SE)	Relatedness support b (SE)
Fixed effect			
Intercept	.09 (0.27)	− 2.32 (0.97)*	2.10 (1.28)
Sex	− 0.001 (0.08)	0.60 (0.31)	0.88 (0.39)*
Professional experience	− 0.004 (0.01)	− 0.07 (0.04)	0.15 (0.05)*
Age	0.002 (0.01)	0.12 (0.04)*	− 0.14 (0.06)*
Exhaustion	− 0.002 (0.004)	− 0.0007 (0.02)	0.3 (0.02)
Lagged dependent variable	0.035 (0.04)	0.36 (0.03)***	0.26 (0.01)***
Feelings (WPL)	0.0005 (0.003)	0.03 (0.02)	0.03 (0.02)*
Feelings (BPL)	− 0.004 (0.02)	0.01 (0.07)	0.07 (0.09)
Random effect			
Level 1	0.04 (0.002)***	2.06 (0.11)***	0.62 (0.001)***
Level 2	0.002 (0.001)	0.001 (0.01)	0.04 (0.06)
− 2 logV (unconditional model)	− 199.663	2853.365	1934.79
− 2 logV	− 202.427	2790.030	1864.897
R_1^2	0.1	0.71	0.06
R_2^2	0.15	0.99	0.81

R_1^2 and R_2^2 values indicated the proportional amount of variance by which errors of prediction have been reduced from the unconditional model to the model 2 at the within-person level (WPL) and at the between-person level (BPL), respectively

*$p < .05$; **$p < .01$; ***$p < .001$

Table 3 Results of cross-lagged multilevel modeling on control and relatedness-thwarting motivating style

	Control b (SE)	Relatedness-thwarting b (SE)
Fixed effect		
Intercept	− 0.75 (1.05)	− 1.47 (1.04)
Sex	0.001 (0.32)	− 0.35 (0.33)
Professional experience	− 0.04 (0.05)	− 0.11 (0.05)*
Age	0.04 (0.05)	0.12 (0.05)*
Exhaustion	0.01 (0.01)	− 0.03 (0.2)
Lagged dependent variable	0.19 (0.04)***	0.24 (0.03)***
Feelings (WPL)	− 0.03 (0.01)*	− 0.007 (0.01)
Feelings (BPL)	− 0.005 (0.08)	0.15 (0.08)
Random effect		
Level 1	0.50 (0.02)***	1.06 (0.05)***
Level 2	0.03 (0.01)	0.02 (0.02)
− 2 logV (unconditional model)	1737.907	2329.14
− 2 logV	1696.224	2275.18
R_1^2	0.04	0.04
R_2^2	0.58	0.83

R_1^2 and R_2^2 values indicated the proportional amount of variance by which errors of prediction have been reduced from the unconditional model to the model 2 at the within-person level (WPL) and at the between-person level (BPL), respectively

*$p < .05$; **$p < .01$; ***$p < .001$

Table 4 Results of cross-lagged multilevel modeling on feelings

	Feelings b (SE)
Fixed effect	
Intercept	3.12 (2.05)
Sex	−1.56 (0.72)*
Professional experience	−0.16 (0.07)*
Age	0.13 (0.07)
Exhaustion	−0.07 (0.02)***
Lagged dependent variable	0.75 (0.02)***
Autonomy support (WPL)	−0.15 (0.27)
Autonomy support (BPL)	−1.34 (1.30)
Structure (WPL)	0.007 (0.04)
Structure (BPL)	0.49 (0.31)
Relatedness support (WPL)	0.03 (0.07)
Relatedness support (BPL)	0.47 (0.24)
Control (WPL)	−0.07 (0.08)
Control (BPL)	1.001 (0.45)*
Relatedness-thwarting (WPL)	−0.003 (0.58)
Relatedness-thwarting (BPL)	−1.03 (0.39)*
Random effect	
Level 1	2.44 (0.12)***
Level 2	0.32 (0.17)
−2 logV (unconditional model)	3618.41
−2 logV	2899.53
R_1^2	0.58
R_2^2	0.89

R_1^2 and R_2^2 values indicated the proportional amount of variance by which errors of prediction have been reduced from the unconditional model to the model 2 at the within-person level (WPL) and at the between-person level (BPL), respectively

*$p < .05$; **$p < .01$; ***$p < .001$

control dimensions—and in the inverse, a relationship control and relatedness-thwarting at the between level and subjective feelings. In essence, these results show that teachers' subjective feelings emerging during the lesson deserve to be considered.

H1: Subjective feelings and need-supportive motivating style dimensions

As far as need-supporting styles are concerned, controlling for the immediately previous moment, results of the present study revealed that teachers' pleasant subjective feelings predicted the next moment of relatedness support, but not autonomy support or structure. Pertaining to relatedness support, this finding is in line with the Hagenauer et al.'s (2015) study which showed that teacher's joy was related to teacher-students closeness. Teachers who experience pleasant subjective feelings seem more likely to involve themselves into the interpersonal relation with the students, or to provide more positive and constructive attitudes during the lesson, creating a greater need-supportive motivating style. Moreover, this result is consistent with and extends the bright pathway of the dual-process model within SDT. To explain this finding, we can refer to the broaden-and-build theory (BBT; Fredrickson 2001). According BBT, positive emotion broadens a person's thought-action repertoire beyond typical patterns of thinking, which leads over time to build new resources. In social context, positive emotions tend to reinforce the self-other overlap, creating auspicious basis for

a closer relationship (Waugh and Fredrickson 2006). Based on BBT, we can assume that the teacher's pleasant subjective feelings feed their interactional resources (e.g., energy, patience, empathy), which in turn promote teacher's closeness and the adoption of a need-supportive motivating style.

Control variables of age and professional experience were also positively related to a relatedness-supportive motivating style. These results are in line with the literature on expertise in physical education. Expert teachers exercise more targeted supervision of the class and interact with students in a more individualized way than novice teachers (Wolff et al. 2016). Thus, being relatedness-supportive can be considered as evidence of expertise. According to the seminal article of Siedentop and Eldar (1989), effectiveness and experiences are the main conditions for expertise in physical education. Thus, it is not surprising that age and professional experience are positively related to relatedness-supportive style.

The lack of significant relationships between subjective feelings and autonomy support may be explained by the fact that this latter is still a relatively rare feature of teachers' motivating style (e.g., Sarrazin et al. 2006; Tessier et al. 2008). In line with this literature, present data in Table 1 show a very low mean of autonomy-supportive behaviors ($M = 0.04$) and thus a lack of variance to be explained.

Pertaining to the structure dimension, the variations occurring directly during the lesson align with the nature of dynamic teaching environments (Haerens et al. 2013). Involving practices such as giving advice and guidelines, monitoring whether pupils follow instructions, and giving feedback (e.g., Sierens et al. 2009), structure, in physical education context, is essentially made up of information on pupils' expected or observed compliance, which could explain the lack of relation with subjective feelings.

H2: Subjective feelings and need-thwarting motivating style dimensions

Subjective feelings are negatively related to the control dimension. One possible interpretation could be that the lower the valence of teacher subjective feelings, the more the teacher is controlling the following minute. Pleasant valence of feeling occurs when goals are perceived as reachable and when perceived situational control is high (Scherer and Moors 2019). Thus, we can assume that a situation perceived as dissonant with the teacher's goals is associated with a lower valence of subjective feelings, which triggers the use of controlling strategies to restore a feeling of control over the situation. Another possible interpretation could include that the higher the valence of subjective feelings, the less the teacher is controlling in the following minute. Here, mirroring the previous interpretation, pleasant feelings occurred when teachers perceived that the classroom was functioning as they expected, allowing them to distance themselves further from controlling strategies. Clearly favoring one of these two interpretive options would imply integrating data from the analysis of student behavior in a future study.

As for the relatedness-thwarting motivating style, subjective feelings were not a significant predictor. As defined previously, a relatedness-thwarting teacher is neglectful or even aggressive in his/her interactions with students. Thus, it seems that the lack of pleasant feeling is not enough to trigger relatedness-thwarting behaviors. Based on Bartholomew et al. (2011), we can assume that a lack of pleasant feeling might be associated with a lack of nurturance of students' need for relatedness, but this does not necessarily imply that teachers actively block or forestall this need. In other words, the lack of pleasant feelings does not necessarily imply that teachers become hostile towards students. For need-thwarting to occur, a more active contextual interference and undermining role is required (Haerens et al. 2016). Hence, the

separate influence of unpleasant feelings on teachers' relatedness-thwarting behaviors deserves to be examined. Another explanation could be that relatedness-thwarting behaviors are more predicted by cognitive than affective antecedents. As shown by Reeve et al. (2018), personality traits are strong determinants of elementary school teachers' need-thwarting motivating style (β = .49 and .47 for control causality orientation and authoritarianism, respectively). Future research may address this question by examining the effects of pleasant and unpleasant feelings separately, as well as personality traits, on both teachers' need-supportive and need-thwarting styles.

H3: Teachers' motivating style orientation and subjective feelings

Having shown the influence of subjective feelings on teachers' motivating style, we have hypothesized that teachers' need-supportive behavior was likely to facilitate the emergence of teachers' positive valence feelings, and conversely that adoption of a need-thwarting motivating style was likely to limit them (H3).

Results showed that autonomy support, structure, and relatedness support dimensions did not predict subjective feelings. This lack of relation certainly reflects that it is not the teacher's behaviors per se that generate his/her own subjective feelings, but the result produced by these behaviors (i.e., student success, understanding, and engagement). As feelings occur when the desired goals are attained or not (Scherer and Moors 2019), teachers' subjective feelings are probably more predicted by the students' behaviors (i.e., the goals of teaching according to Frenzel's model) than by their own teaching behaviors (i.e., the means to reach this goal). Thus, it would be interesting to examine to what degree teacher' motivating style predicts students' attitudes and, in turn, the influence of these latter on the valence of teachers' subjective feelings.

Results also showed that both control and relatedness-thwarting dimensions were related to the appearance of subjective feelings at the between level, but not at the within level. More specifically, teachers who are the most controlling are those who experience the most pleasant feelings, and teachers who are the most relatedness-thwarting are those who report the less pleasant feelings. As far as the control dimension is concerned, if the literature reveals this behavior as hampering student's positive functioning in the classroom (De Meyer et al. 2014), the control is sometimes valued by teachers. The ambiguous status of control can be explained by two main reasons. First, the control is culturally valued as teachers who use controlling instructional strategies are evaluated as competent (Reeve 2009). Indeed, controlling strategies are often seen as optimal ways to motivate students and to produce maximal performance because of its immediate impact on students' behavior (Barrett and Boggiano 1988). Secondly, teachers sometimes equate control with structure (Reeve 2009). Controlling strategies are often inappropriately associated with a structured learning environment because teachers do not want to risk losing control over their classes (Reeve 2009). They may hypothesize that a controlling style will provide them with the classroom structure they seek and then generate pleasant feelings linked to the effective control of the class. Pertaining to relatedness-thwarting, the negative relationship with subjective feelings tends to show that teachers are affected by this maladaptive relation created with their students. As emphasized by the literature on teachers' emotions, the affective relationship to the student remains indeed a eudemonic pillar of the profession (Frenzel 2014; Hagenauer et al. 2015; Hargreaves 1998).

Finally, three control variables—sex, professional experience, and emotional exhaustion—predicted negatively subjective pleasant feelings. Defined as feelings of being emotionally

overextended and having depleted one's emotional resources (Evers et al. 2004), emotional exhaustion impedes teachers from experiencing pleasant subjective feelings. Research shows that female teachers were more particularly exposed to this phenomenon (Chang 2009). Complementarily, some studies underline that female teachers less frequently report positive emotions than their male colleagues (Borrachero et al. 2014). Finally, in line with the literature, professional experience is associated with a loss of experienced enthusiasm for teaching (Kunter et al. 2011) and therefore lower enjoyment reported by senior teachers.

Limitations and future directions

In interpreting the results of the present study, some limitations must be considered. A first limitation of this study is that it is unknown whether our results could be generalized to participants from different backgrounds. Our work involved only twelve physical education teachers. Due to the demanding protocol (i.e., accept to be filmed by two camcorders and to report the subjective feelings just after the lesson during 1.5 h), it is probable that this sample was comprised of predominantly highly motivated teachers. In addition, it is probable that the school subject (e.g., physical education vs. other subjects), the nature of the lesson (e.g., learning vs. evaluation), and the type of children in the class (e.g., coming from well-off vs. disadvantaged families) may impact the teachers' subjective feelings and motivating style. As a pilot study, this work calls for an effort to broaden the exploration of the effects of feelings on motivational style to a larger and more diverse sample of teachers, to avoid the risk of overfitting. To go further in this line of research, it would be interesting in the future to examine environmental antecedents of teachers' subjective feelings and motivating style such as the school subject (e.g., physical education vs. other subjects), the nature of the lesson (e.g., learning vs. evaluation), and the type of children in the class (e.g., coming from well-off vs. disadvantaged families). Similarly, parallel to teacher's emotional exhaustion, other trait-emotions' influence should be investigated, as the emotional dimension of teachers' job satisfaction (Pepe 2011), for instance, as it might promote the emergence of the occurrence of pleasant feelings.

Secondly, it also has to be considered that in real-life contexts, feelings are complex phenomena that involve simultaneously or successively different kinds of emotional states. This emotional blend (Scherer 2009) contributes to average opposite feelings in a global subjective evaluation. To overcome this difficulty, future research could exploit a simultaneous double evaluation of a lessons' momentum, and measure occurrences of both pleasant and unpleasant feelings respectively. Proceeding that way could help to better understand the distinct relationships that these complex subjective feelings have with the dark and bright sides of the teachers' motivating style.

Conclusion

The current study is the first one to measure the teacher's subjective feelings related to his or her observed motivating style and to examine the causal directionality between these two variables. In line with the appraisal model of teachers' emotions (Frenzel et al. 2009; Frenzel 2014) which posits that teachers' emotions influence their teaching behaviors, it sheds new light on the teacher behaviors showing the need to pay more attention to affective process occurring across lessons. Results emphasize that the relationship between teachers' emotions and his/her motivating style is complex. As expected, at the within level, positive valence of teachers' subjective feelings predicts of a greater relatedness support and the use of less controlling

strategies. In that way, subjective feelings should be considered as antecedents of teachers' need-supportive motivating style and as playing a buffering role against controlling behaviors.

In line with the recent SDT literature on dark and bright motivational process, the antecedents of teachers' motivating style could be more deeply examined by studying the specific effects of teachers' pleasant and unpleasant feelings, as well as and the effect of cognitive antecedents. Aligned with that purpose, the continuous measure of subjective feelings used in the present study seems to be a promising approach.

Finally, this study calls for a review of teachers' education curricula. Highlighting the relationship between subjective feelings and motivating styles makes considering the challenge of developing teacher's emotional regulation competence (Sutton et al. 2009). In order to promote the development of a need-supportive motivating style, initial and in-service teacher education could incorporate affective skills improvement. The understanding of these issues might then be preponderant for the teacher's professional development, just as for the students' learning and well-being.

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