

## Associations between teachers' interpersonal behavior, physiological arousal, and lesson-focused emotions



Monika H. Donker<sup>a,\*</sup>, Tamara van Gog<sup>a</sup>, Thomas Goetz<sup>b</sup>, Anna-Lena Roos<sup>c</sup>, Tim Mainhard<sup>a</sup>

<sup>a</sup> Department of Education, Utrecht University, the Netherlands

<sup>b</sup> Department of Developmental and Educational Psychology, Faculty of Psychology, University of Vienna, Austria

<sup>c</sup> Institute for Research and Development of Collaborative Processes, School of Applied Psychology, University of Applied Sciences and Arts Northwestern Switzerland FHNW, Switzerland

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### ABSTRACT

Interpersonal aspects of teaching have repeatedly been linked to teacher emotions and well-being on a general level. However, it is unclear how teachers' moment-to-moment interpersonal behavior is associated with their physiological arousal during teaching and how this contributes to their lesson-focused emotional outcomes. Eighty secondary education teachers with a mean age of 43.7 years ( $SD = 11.5$ ) and 13.4 years of teaching experience ( $SD = 9.7$ ) participated during one real-life lesson. We coded teacher behavior from an interpersonal perspective on the dimensions of agency (i.e., social influence) and communion (i.e., friendliness). Teachers' physiology (in terms of heart rate) was measured as a proxy for their affective arousal. Teachers differed widely in their behaviors and in how behavior and physiology were associated from moment to moment. Being generally agentic was associated with higher levels of self-reported positive emotions after the lesson, also when being agentic went together with a high heart rate. In contrast, the stronger and the more positively a teacher's physiological arousal was associated with displaying communal behavior, the more likely a teacher was to report negative emotions. We conclude that combining moment-to-moment data of teachers' interpersonal behavior and physiological arousal has the potential to explain differences in teachers' emotional outcomes. Such an approach might ultimately provide teachers and teacher educators with the fine-grained and personalized information needed to foster teacher well-being.

### 1. Introduction

Social relations and the quality of interpersonal interactions are central to human well-being, but also a potential source of psychological problems. This is especially true for high-contact professions such as teaching (CBS/TNO, 2015; Van Droogenbroeck, Spruyt, & Vanroelen, 2014). Teaching can be rewarding when teachers are able to interpersonally connect to their students and provide structure and guidance (Irvine & Fraser, 1998), but teachers who have difficulty to accomplish this may encounter negative emotions and, ultimately, burnout (Chang, 2009, 2013; Spilt, Koomen, & Thijs, 2011). Evidence on this link between interpersonal aspects of teaching and teachers' emotional outcomes so far is mainly based on questionnaire research and cross-sectional between-person designs (Becker, Keller, Goetz, Frenzel, & Taxer, 2015; Evers, Tomic, & Brouwers, 2004; Hoglund, Klinge, & Hosan, 2015; Klassen, Perry, & Frenzel, 2012). Although these studies led to

important insights, they do not allow for drawing conclusions about actual teaching processes or individual teacher's areas of improvement.

To go beyond cross-sectional and between-person designs, we present a within-person approach including moment-to-moment observations of interpersonal teacher behavior (Pennings, Brekelmans, et al., 2014; Sadler, Ethier, Gunn, Duong, & Woody, 2009) and physiological data (i.e., heart rate) as a proxy for teachers' affective arousal during real-life teaching (Blascovich, 2008; Donker, Van Gog, & Mainhard, 2018; Myrtek, 2004). We computed several statistical indicators based on the moment-to-moment data: the mean level, range, and stability of interpersonal teacher behavior, and the within-person cross-correlation between teachers' interpersonal behavior and physiological arousal. The goal of the current study was to evaluate to what degree these statistical indicators could explain between-person differences in teachers' self-reported and lesson-focused emotions.

\* Corresponding author.

E-mail addresses: [m.h.donker@uu.nl](mailto:m.h.donker@uu.nl) (M.H. Donker), [t.vangog@uu.nl](mailto:t.vangog@uu.nl) (T. van Gog), [thomas.goetz@univie.ac.at](mailto:thomas.goetz@univie.ac.at) (T. Goetz), [annalena.roos@fhnw.ch](mailto:annalena.roos@fhnw.ch) (A.-L. Roos), [m.t.mainhard@uu.nl](mailto:m.t.mainhard@uu.nl) (T. Mainhard).

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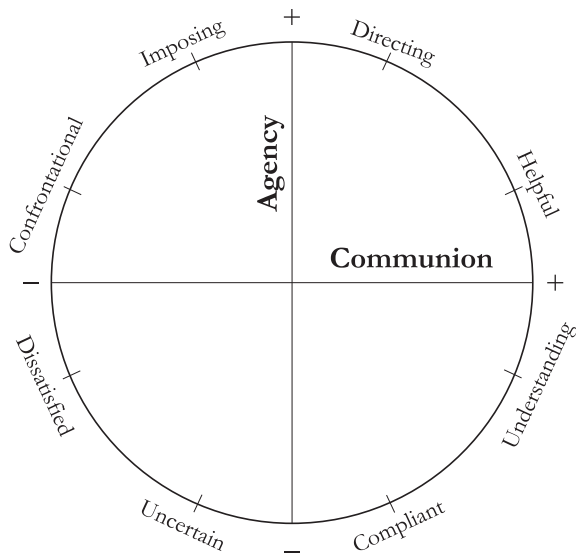


Fig. 1. The Interpersonal Circle for the Teacher (IPC-T; Wubbels et al., 2012).

### 1.1. An interpersonal perspective on teacher behavior

Social interaction have been put forward as an important antecedent of emotions and well-being in general (e.g., Butler, 2011; Fischer & Van Kleef, 2010) as well as in the context of teaching (Aldrup, Klusmann, Lüdtke, Göllner, & Trautwein, 2018; Becker et al., 2015; Chang, 2013; Spilt et al., 2011). In the current study, we focus on *interpersonal* aspects of teaching and their associations with teachers' emotional outcomes (Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006). Interpersonal theory describes two dimensions that are necessary and at the same time sufficient to describe behavior someone exhibits in the presence of others: *Agency* and *Communion* (Fabrigar, Visser, & Browne, 1997; Horowitz & Strack, 2011). Agency refers to taking the lead, conveying social influence or being in control. Communion refers to friendliness, affection or warmth. Because interpersonal theory posits that both dimensions underlie every behavior to a certain degree, interpersonal properties of behavior are represented with a circumplex structure. Fig. 1 shows the adaptation of the interpersonal circumplex to the educational context, describing interpersonal properties of teacher behavior in class (Wubbels et al., 2012). The eight words placed around the circle should be viewed as prototypical teacher behaviors that reflect certain combinations of agency and communion. It should be noted that the interpersonal circle is not a didactic model. For example, both a teacher lecturing in front of a group of students as well as a teacher supervising students' small-group work can convey high levels of agency and communion. A teacher can be uncertain in either situation (i.e., low agency in combination with moderately low communion) or provide a clear, guiding structure for students (i.e., relatively high levels of both agency and communion or directing; see Pennings et al., 2018).

#### 1.1.1. Mean levels of teacher behavior

Previous studies showed that most students prefer teacher behavior that is warm and friendly (i.e., relatively high levels of communion) as well as characterized by moderately high levels of agency (Sun, Mainhard, & Wubbels, 2018; Wubbels & Brekelmans, 2005; Wubbels & Levy, 1991). Teachers exhibiting these kind of behaviors have also been described as *warm demanders* (Irvine & Fraser, 1998; Ross, Bondy, Bondy, & Hambacher, 2008), because they make clear what is expected of students but at the same time make sure students feel understood and can build trust in their abilities. Students do not only flourish cognitively when teachers are warm demanders, but also affectively, reporting higher well-being and motivation (Brekelmans, 1989; Den Brok,

Brekelmans, & Wubbels, 2004; Roorda, Jak, Zee, Oort, & Koomen, 2017). Teachers who are able to build a warm and demanding relationship with their students have been found to report lower levels of emotional exhaustion and more work enthusiasm (Aldrup et al., 2018).

Many teachers' personal ideals resemble being a warm demander (Veldman, Admiraal, Mainhard, Wubbels, & Van Tartwijk, 2017) and as such, conveying high levels of agency and communion in class may function as a display rule for teachers (Barber, Grawitch, Carson, & Tsouloupas, 2011). Problems for teachers, such as negative emotions and decreased well-being, may arise when teachers have the idea that they cannot comply with such display rules or when this behavior does not come naturally to them (Barber et al., 2011; Hagenauer & Volet, 2014; Pennings et al., 2018; Veldman, Admiraal, Van Tartwijk, Mainhard, & Wubbels, 2016). For example, it might be hard for teachers to fake communal or friendly behavior (Barber et al., 2011) or to take the lead in class when subjectively experienced communion and agency are actually low (Wubbels & Brekelmans, 2005).

Previous studies on interpersonal teacher behavior in secondary education have mainly focused on habitually exhibited behaviors (e.g., the general interpersonal classroom climate or general levels of teacher agency and communion as students perceive it) using questionnaire data (Harmsen, Helms-Lorenz, Maulana, & Van Veen, 2018; Van Tartwijk, Brekelmans, Wubbels, Fisher, & Fraser, 1998; Wubbels & Brekelmans, 2005). The present study goes beyond these typically used measures that summarize entire lessons with one general teacher or student perception, in two ways. First, we used external observers to code teachers' interpersonal behavior as their outsider perspective might yield a more objective picture of teacher behavior compared to teacher self-reports or student perceptions (Praetorius, Lenske, & Helmke, 2012; Scherzinger & Wettstein, 2019). Second, we implemented moment-to-moment observation of teacher behavior to calculate teachers' mean level of agency and communion during the lesson instead of relying on data from one (or only a few) measurement point (s) in time (often after the lesson has ended).

#### 1.1.2. Range and instability of teacher behavior

To date, the literature about interpersonal teacher behavior and teacher emotions provides little information about variability *within* individual teachers during a lesson (Fisher, Medaglia, & Jeronimus, 2018; Molenaar, 2008; Murayama, Goetz, Malmberg, Pekrun, Tanaka, & Martin, 2017). Yet, this within-person perspective may be essential to understand teachers' lesson-focused emotional outcomes. Studies in areas other than education have shown that statistical indicators based on moment-to-moment data, such as the variability of behavior, helped to explain differences in psychological well-being (Hollenstein, 2015; Houben, Van den Noortgate, & Kuppens, 2015; Kuppens, 2015). On a smaller scale, it has been shown that moment-to-moment variability predicted daily emotions (De Ruiter, Van der Steen, Den Hartigh, & Van Geert, 2016; Hollenstein, 2015). Daily experienced emotions, in turn, are often viewed as the building blocks of longer-term teacher outcomes such as well-being and burnout (Chang, 2013; Grayson & Alvarez, 2008; Houben et al., 2015).

Interpersonal behavior can also be operationalized as a within-person process by using observational data (Sadler et al., 2009). In the educational setting, moment-to-moment teacher behavior has mainly been studied during the lesson start. These studies demonstrated that more variability in interpersonal teacher behavior and longer return-times to high levels of teacher agency and communion were found in classrooms with poorer interpersonal climates as reported by students (Mainhard, Pennings, Wubbels, & Brekelmans, 2012; Pennings et al., 2018; Pennings, Brekelmans, et al., 2014). More variable teacher behavior implicates more chaotic and for students less predictive teacher behavior. Also, because most teachers habitually display positive levels of agency and communion in class (Wubbels & Brekelmans, 2005; Wubbels et al., 2012), more variable teacher behavior seems to imply displaying (short) episodes of more negative teacher behavior (e.g.,

hostility or low communion; Mainhard et al., 2012). In the present study, we investigated within-person variability in teachers' interpersonal behavior in terms of teachers' *range* of behavior during the lesson (i.e., the diversity in behavior they showed) as well as their *instability* of behavior (i.e., the size and frequency of moment-to-moment changes in behavior). Previous findings suggest that a wide range of behavior and low behavioral stability may result in more negative teacher emotions.

### 1.1.3. Associations between teachers' behavior and physiological arousal

Although we know that interpersonal interactions are important for teacher emotions, it may in particular be teachers' affective experiences that determine their emotions (Becker et al., 2015). Previous studies found that teacher's positive or negative appraisal of (similar) classroom situations differed and that this perception was predictive of their emotional outcomes (Becker et al., 2015; Bower & Carroll, 2017; Frenzel, Goetz, Stephens, & Jacob, 2009; Hagenauer, Gläser-Zikuda, & Volet, 2016). However, these studies mainly used self-reported appraisals. Such measures might contain biases, do not allow for capturing the moment-to-moment changes in teacher reactions, and might disturb the ongoing teaching situation (Becker et al., 2015; Chang, 2009; Wilhelm & Grossman, 2010). Moreover, self-reports do not capture the more implicit, preverbal stage of emotional functioning, which includes the thoughts, physiological reactions, feelings, and automatic behavior displays that might eventually lead to the verbalization of an emotion (Scherer, 2009). Therefore, the present study explored the potential of physiological measures (i.e., heart rate) as a proxy for teachers' affective arousal during the lesson.

Although heart rate is first and foremost a biological process, physiological measures are increasingly being used as indicator of psychological phenomena (Cacioppo, Tassinary, & Berntson, 2017; Ebner-Priemer & Kubiak, 2007; Mauss & Robinson, 2009). In principle, an increased heart rate 'just' facilitates the body with the oxygen needed to take action (Kreibig, 2010; Van Reekum et al., 2004). However, by controlling for teachers' physical activity, one gets a more pure measure of emotional or affective arousal, which has been referred to as Additional Heart Rate and has been linked to emotional outcomes (Donker et al., 2018; Myrtek, 2004). According to biopsychosocial theories (e.g., Blascovich, 2008; Lazarus, 2006; Seery, 2011), an increased heart rate should be seen as a general indicator of importance, urgency, or task engagement which only occurs in motivated performance situations which a person has judged as personally relevant (Scheepers, De Wit, Ellemers, & Sassenberg, 2012; Scholl et al., 2018; Storbeck & Clore, 2008). In the classroom, an increased heart rate could for example be triggered when the teacher needs to attract student attention (i.e., show relatively high agency) in order to switch between different work forms. Although heart rate has been used as an objective and continuous indicator of affective arousal, the exact link with discrete emotions is not clear (Kreibig, 2010). Kreibig showed in her meta-analysis that a high heart rate has been associated with both negative (e.g., anger, anxiety) and positive (e.g., happiness, joy) emotions. This corresponds with the predictions of Blascovich's biopsychosocial model (Blascovich, 2008; Seery, 2011). According to this model, an increase in heart rate occurs regardless of whether the situation is appraised positively (e.g., as challenge that can be met) or negatively (e.g., as a threat that has to be faced). An increased heart rate could thus result in both positive and negative emotions, depending on a person's evaluation of the demands of the situation and the resources they have for coping with the situation.

To map the association between teachers' behavior and physiology, we calculated the intra-individual *cross-correlation* between teachers' interpersonal behavior (i.e., agency and communion) and their physiological arousal (i.e., heart rate). By coupling continuous measures of teachers' heart rate with their moment-to-moment interpersonal behavior, we explored teachers' affective arousal connected to exhibiting agency and communion in class. The way in which teachers differ in

how interpersonal behavior and physiological arousal are connected during teaching may help us to understand why teachers differ in their emotional outcomes, and could help us to interpret their physiological arousal as something positive or negative. For example, we might see that one teacher has a high heart rate when showing agency in the classroom, which could indicate the importance of the situation and the teacher's task engagement. Another teacher might have an increased heart rate while being friendly, thereby indicating the urgency to be friendly (even when one does not feel so), and this might be associated with more negative emotional outcomes.

### 1.2. The present study

The present study aims to explore the relation between moment-to-moment interpersonal teacher behavior (observed in terms of agency and communion), physiological arousal (in terms of heart rate), and self-reported discrete lesson-focused emotions in secondary education teachers. The available research on the link between teachers' interpersonal behavior and their emotions has mainly focused on secondary education (Becker et al., 2015; Evers et al., 2004). In Dutch secondary education (as in most other countries), students have different teachers for different subjects. This set-up of secondary schools might lead to more difficulty to form close relationships with students (Hargreaves, 2000; Kyriacou, 2001). The present study advances previous research by including continuous observation of teacher behavior and heart rate measurements of teachers during real-life teaching. Our research question was: 'What is the predictive value of statistical indicators of teachers' moment-to-moment interpersonal behavior, physiological arousal, and their intra-individual association, for teachers' emotions?' We investigated the mean level, range, and instability of teachers' interpersonal behavior and the intra-individual cross-correlation between teachers' behavior and physiological arousal as potential interesting statistical indicators (see Fig. 2 for the model).

In line with previous research, we expected to find that overall teachers would display positive mean levels of agency and communion during their lessons (Pennings et al., 2018; Pennings, Brekelmans, et al., 2014). Furthermore, we expected substantial diversity in teachers' individual range and instability of interpersonal behavior as well as a large range of cross-correlations between behavior and physiology (i.e., ranging from positive to negative). Specifically for the latter expectation no evidence from earlier studies is available as yet, but questionnaire-based studies have indicated that teachers differ in how they perceive interpersonal aspects of teaching (Aldrup et al., 2018; Becker et al., 2015; Keller, Becker, Frenzel, & Taxer, 2018). Regarding the association between these statistical indicators of the moment-to-moment data and discrete lesson-focused emotions, we expected that relatively low levels of both agency and communion would go together with a high heart rate (i.e., affective arousal) and be associated with more negative lesson-focused emotions, as earlier research has indicated that teacher ideals in secondary education often include relatively high rather than low agency and communion (Barber et al., 2011; Veldman et al., 2017). Similarly, we expected that if a teacher tends to have a high heart rate while displaying interpersonal behaviors many teachers and students view as desirable (i.e., relatively high levels of agency and communion; Wubbels & Brekelmans, 2005; Wubbels et al., 2006), these teachers may report more negative emotions as well, because for these teachers physiological arousal in high agency and/or communion situations may indicate effortful engagement rather than more habitual or authentic teacher behavior (cf. Blascovich, 2008; Seery, 2011). Furthermore, in line with Mainhard et al. (2012) and Pennings et al. (2018), we expected that teachers who show a larger behavioral range and more instability in their interpersonal behavior, might experience more negative emotions after the lesson.

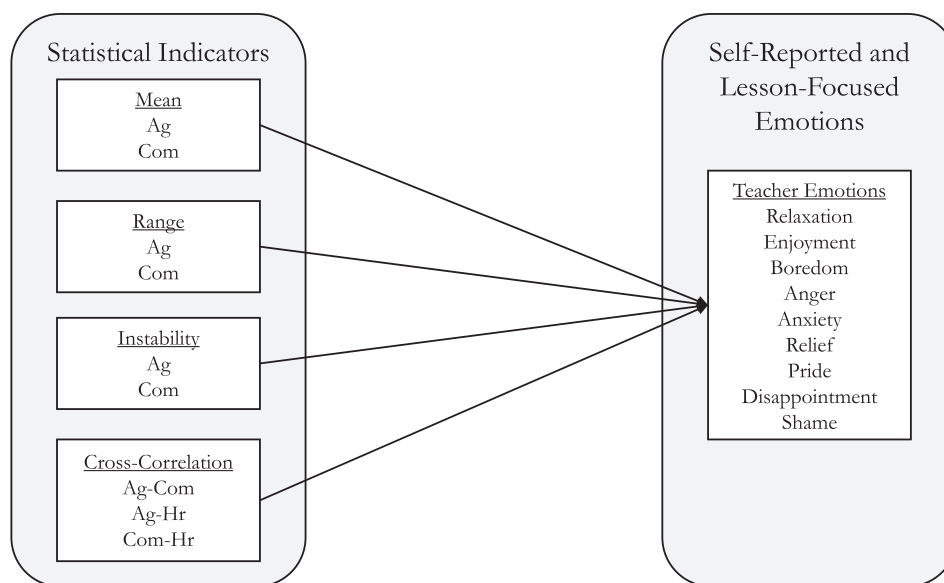


Fig. 2. Conceptual model of the analysis. Ag = agency, Com = communion, Hr = heart rate.

## 2. Method

### 2.1. Participants

The current paper is the first analysis of the data set collected within the project Dynamics of Emotional Processes in Teachers (DEPT<sub>H</sub>). The project was approved by the local ethics committee (FETC16-074). Data was collected in a sample of 80 Dutch teachers in secondary education (41 females) and their students during one of their lessons. All participants cooperated voluntarily and all teachers and students included in the present paper gave their written informed consent. In 85% of the groups, all students participated or only one student decided not to participate in the study. In total, 57 out of 1819 students (3.1%) did not consent. As the recorded lessons were in fact regular ones, these students participated in class but were seated in a section of the classroom that was not visible on camera.

On average, the participating teachers were 43.7 years old ( $SD = 11.5$ ), had 13.4 years of experience as teacher ( $SD = 9.7$ ), and had a contract for four days a week (i.e., 0.78 fte,  $SD = 0.19$ ). Secondary education teachers in the Netherlands are often specialized in one subject area and students thus usually have a different teacher for each subject. A variety of subjects was represented in the current study: science (35%), social studies (25%), languages (23.75%), mathematics (13.75%), and arts (2.5%). We asked teachers to select a potentially challenging lesson (e.g., in terms of student characteristics, moment, or subject) to be included in the current study, because we wanted to heighten the chance that the lesson would provoke a broad range of interpersonal behavior, physiological arousal, and emotions. The majority of teachers selected a group in the third (student age 14/15) or fourth grade (student age 15/16) of secondary education (80%; range 1st to 6th grade). The Netherlands has a tracked secondary education system with three tracks, all of which were represented in the current sample: pre-vocational education (in Dutch: VMBO; 23.8%), higher general secondary education (in Dutch: HAVO; 48.8%), and pre-university education (in Dutch: VWO; 27.5%). There were about 22 students in each group ( $SD = 5$ ) with a mean age of 15.1 years ( $SD = 1.1$ ). The student gender distribution was approximately equal (50.3% female). Most teachers taught this particular group of students two or three times a week (73.8%; range 1 to 7 times) and lessons typically lasted for 45 or 50 min (76.3%; range 45 to 90 min).

### 2.2. Design and procedure

Teachers were recruited individually via social media, school newsletters, and educational consultants. Data was collected in one classroom lesson. Teachers were instructed to proceed as they would normally do and did not receive any training or intervention. They received a personalized report of the questionnaire data collected in their lesson.

To be able to observe teachers' interpersonal behavior and code it in terms of agency and communion, we installed two video cameras: one in the back and one in front of the classroom. Teachers wore a small microphone to ensure that we could discern teachers' interaction with the whole class as well as with individual students. During the lesson, teachers' physiological arousal was measured continuously with a heart rate device that used electrodes attached to the teacher's chest and a recorder in a belt on their waist to ensure mobility. The various measures were synchronized by using the marker option of the heart rate device. At the end of the lesson, teachers completed a paper-and-pencil questionnaire on positive and negative emotions experienced during and after the lesson they had just taught.

Due to technical failure, videos were missing for four lessons and physiological data was missing for one teacher. For the remaining 75 teachers, moment-to-moment data on interpersonal behavior and physiology was available for on average 41 min 43 s per lesson ( $SD = 13$  min 12 s).

### 2.3. Measures

#### 2.3.1. Teacher interpersonal behavior

We used Continuous Assessment of Interpersonal Dynamics (CAID; Lizdek, Sadler, Woody, Ethier, & Malet, 2012; Sadler et al., 2009) to capture teachers' interpersonal behavior in terms of agency and communion. CAID uses the interpersonal circle (see Fig. 1) as an underlying coding scheme with both the vertical (i.e., agency) and horizontal (i.e., communion) axes ranging from  $-1000$  to  $1000$  to ensure a fine-grained tracking of interpersonal behavior. Coders watched the video recording of the lesson on the left side of their monitor and captured changes in teacher behavior with a joystick device directly on the interpersonal circle displayed on the right side of their screen. Changes in agency were coded by moving the joystick forward or backward and changes in communion were simultaneously recorded by moving left or right. That is, the joystick could be moved freely over the entire circle and agency



**Table 1**  
Cronbach's alpha, means, and standard deviations of the nine emotion subscales.

	$\alpha$	$M$	$SD$
Emotions during the lesson			
Relaxation	.87 <sup>b</sup>	3.81	0.82
Enjoyment	.89 <sup>a</sup>	3.78	0.74
Boredom	.73 <sup>c</sup>	1.94	0.85
Anger	.91 <sup>b</sup>	1.79	0.84
Anxiety	.79 <sup>a</sup>	2.08	0.84
Emotions after the lesson			
Relief	.78 <sup>a</sup>	2.01	0.96
Pride	.70 <sup>a</sup>	3.66	0.65
Disappointment	.87 <sup>b</sup>	1.52	0.69
Shame	.68 <sup>a</sup>	1.60	0.54

<sup>a</sup>  $n = 80$ .

<sup>b</sup>  $n = 79$ .

<sup>c</sup>  $n = 78$ .

and communion were not rated separately but in an integrated way. Both the nature of behavior (i.e., direction of movement of the joystick) as well as the intensity (i.e., distance from the center of the circle) were coded (see also Ross et al., 2017). In line with interpersonal theory, agency and communion were coded simultaneously as many behaviors represent a blend of both dimensions, but the joymon software saved the coordinates on agency and communion axes separately (per 0.5 s; Lizdek et al., 2012).

Each video was coded by three trained coders. Training was based on Lizdek et al. (2012) and lasted approximately ten hours, including homework exercises and group discussion. Each coder rated the videos in a randomized order to prevent order effects. The teacher videos were split in fragments of 15 min to minimize coder fatigue. Fragments belonging to one teacher were coded consecutively. Fragments with low reliability (i.e., ICC < 0.60; 8.41% of all fragments) were re-coded by the coder with the lowest overlap with the other coders or by a fourth independent coder when there was lack of correlation between all three coders. The 0.5 s codes of the three coders with the highest reliability were averaged per 5 s, resulting in approximately 500 data-points (i.e., 5 s intervals) per teacher depending on the length of their lesson ( $SD = 158$ ). The final overall intra-class correlation (ICC; two-way random effects, consistency, three raters; Koo & Li, 2016) was 0.71 for agency ( $SD = 0.12$ ) and 0.63 for communion ( $SD = 0.13$ ). These reliability values are comparable to previous studies (Dermoddy, Thomas, Hopwood, Durbin, & Wright, 2017; Sadler et al., 2009; Thomas, Hopwood, Woody, Ethier, & Sadler, 2014) and indicate strong to moderate agreement, respectively (LeBreton & Senter, 2008). Fragments with low ICCs for communion were included in the final dataset, based on the notion that the relatively low variability of teachers' moment-to-moment levels of communion made small discrepancies very influential on the ICC-calculations, while their effect on the final, averaged score was minimal.

### 2.3.2. Physiological arousal

Teachers' heart rate was monitored continuously during the lesson with the VU University – Ambulatory Monitoring System (VU-AMS; Willemsen, De Geus, Klaver, Van Doornen, & Carrofl, 1996). Seven electrodes were positioned on the chest to measure the impedance cardiogram (ICG), the electrocardiogram (ECG), as well as physical activity. Signal quality was checked before the lesson. During the lesson, teachers wore the device in a belt on their waist to enable mobility. After the lesson, the physiological signal was stored and imported into the VU-AMS software. The software provided an automated check for potential outliers and artefacts and the first author and two trained assistants evaluated all proposed revisions and made corrections when necessary (less than 1% of the data). The corrected heart rate signal was exported per 5 s. We controlled for physical activity

with the Additional Heart Rate approach (based on Myrtek, 2004; see Donker et al., 2018). This was done for each teacher individually, as the association between physical activity and heart rate might be affected by age, gender, and physical fitness (Houtveen & De Geus, 2009; Kreibitz, Gendolla, & Scherer, 2012; Myrtek, 2004; Wang & Maxwell, 2015). The resulting data that was used in the analyses represents teachers' affective arousal, that is, a measure of teachers' heart rate beyond the level that could be expected based on their physical activity.

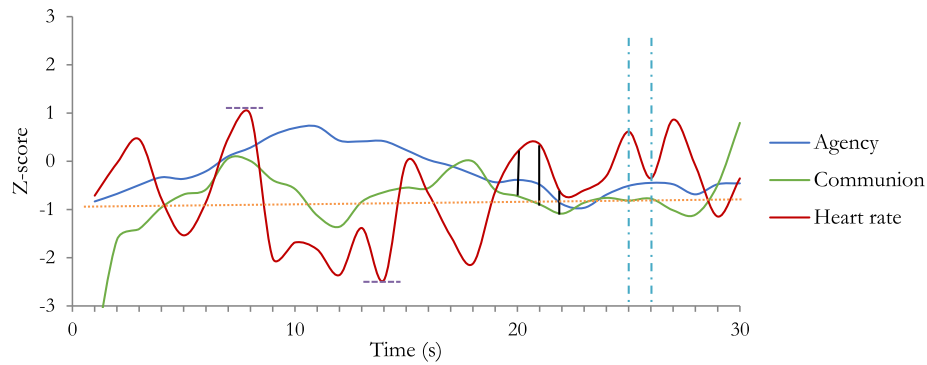
### 2.3.3. Teacher emotions

Teachers' lesson-focused, self-reported emotions were measured after the lesson with 33 items based on the Achievement Emotions Questionnaire (AEQ; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011) and the Teacher Emotions Scales (TES; Frenzel et al., 2016), see Appendix A for an overview of all items. Both the AEQ and the TES have been associated with teacher and student outcomes (Frenzel et al., 2016; Pekrun et al., 2011). In line with Pekrun's taxonomy of achievement emotions (Pekrun, Elliot, & Maier, 2006; Pekrun, Goetz, Titz, & Perry, 2002), we incorporated positive and negative, and activating and deactivating emotions (9 emotions in total; see Table 1). The items were either focused on feelings during the lesson (i.e., activity focus; 'During this lesson, I felt...') or were retrospective and focused on emotions experienced now the lesson was over (i.e., outcome focus; 'When I think of the past lesson, I feel...'). Each subscale included three or four items. Items were translated to Dutch with forward-backward translation and we made items shorter and less context-dependent (e.g., 'I was bored' instead of 'Because the time drags I frequently look at my watch'). In line with the original AEQ, answer options ranged from 1 (disagree) to 5 (agree). Based on reliability analyses we omitted two items of the 'Boredom' scale (see Appendix A). The reliability of the 'Shame' scale was 0.68, but deleting items did not improve its reliability and thus we decided to keep the original scale in order to be able to explore associations with a wide range of emotions. Confirmatory Factor Analysis (CFA) of the model with nine discrete emotions showed similar fit to the original TES,  $\chi^2(398) = 626.66$ ,  $p < .001$ , CFI = 0.87, RMSEA = 0.09, SRMR = 0.08.

### 2.4. Data analysis

We used the moment-to-moment agency, communion, and heart rate data to calculate statistical indicators at the teacher level with SPSS version 25.0: mean level, range, instability, and intra-individual cross-correlations (see Fig. 3 for an illustration). Mean levels represented the average score of a time series over the course of the lesson and reflected teachers' habitual position during the lesson. Range was calculated as the difference between the maximum and minimum value of each time series and thus taps into the extremeness of teacher behavior shown during the lesson. Instability was operationalized as the Mean Square Successive Difference (MSSD), which gives insight in the consistency and predictability of teachers' behavior by taking into account the sequential order of events and the amplitude of moment-to-moment changes (Jahng, Wood, & Trull, 2008). The cross-correlation between two time series within individuals for agency-communion, agency-heart rate, and communion-heart rate was calculated as an indication of the direction and strength of the connectedness between teachers' interpersonal behavior and physiological arousal.

We tested the association between these statistical indicators and teachers' emotional outcomes with a multivariate multiple regression analysis in Mplus version 8.1 using robust maximum likelihood estimation (Muthén & Muthén, 2017). The strength of the pathways was indicated using standardized regression coefficients, which represent change in standard deviation units. An alpha of 0.05 was used for all tests of statistical significance.



Line	Measure	Calculation	Possible range
.....	Mean level	Average of all data points	-1000 to 1000
-----	Range	Difference between highest and lowest score	0 to 2000
-.-.-.-	Instability	Mean of the squared difference between two adjacent points	0 to 4000000
————	Association	Individual cross-correlation between two variables	-1 to 1

Fig. 3. Illustration of the different statistical indicators computed in the current study. (The reader is referred to the web version of this article for a colored version of this figure.)

3. Results

3.1. Data screening

Inspection of the data and variables revealed violation of the assumption of normality for communion range, heart rate instability, and all emotion scales except enjoyment. Because of the expected relatively rare occurrence of certain emotions (i.e., many teachers scored 1 on boredom, anger, relief, and disappointment; see also Pekrun et al., 2011), we decided not to transform the variables, but use Spearman correlations in our descriptive analyses and the MLR estimator in Mplus. We checked all values against z-scores to identify outliers. One outlier for communion instability was found and transformed into the mean + 2SD. No multivariate outliers were identified.

3.2. Descriptive statistics

Teachers differed largely in their mean level, range, and instability

of agency, communion, and heart rate (see Table 2). As expected based on earlier studies (Pennings et al., 2018; Pennings, Brekelmans, et al., 2014), most teachers showed positive mean levels of agency ( $M = 278, SD = 135$ ) and communion ( $M = 332, SD = 92$ ) during their lesson. Teachers showed a wider range in agency ( $M = 891, SD = 155$ ) compared to communion ( $M = 587, SD = 156$ ), and relatively low levels of instability for agency ( $M = 1667, SD = 450$ ) as well as communion ( $M = 1265, SD = 505$ ). To illustrate the meaning of high versus low instability, Fig. 4 shows the moment-to-moment communion scores for the two teachers with the highest versus the lowest instability. It can be seen that the teacher with the highest instability score in our sample (solid line) covered a wider range of the communion dimension and changed a lot from moment to moment.

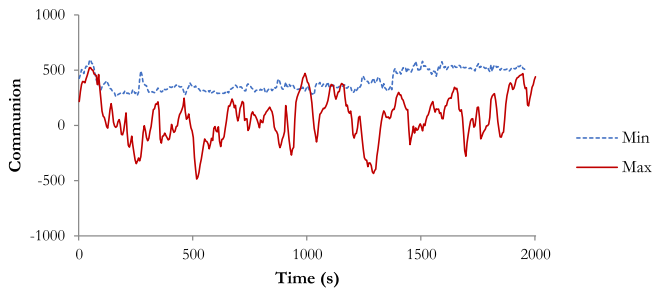
Regarding the *intra-individual association between agency, communion, and heart rate*, we found a wide range of positive and negative cross-correlation values indicating that these associations are highly teacher- (and possibly lesson-) specific. Fig. 5 displays histograms of the range of cross-correlations that were found in our study. On average

Table 2

Descriptive statistics of and spearman correlations between mean, range, instability and cross-correlations of agency, communion and heart rate (N = 75).

	Descriptive Statistics				Correlations											
	Mean	SD	Min	Max	Mean			Range			Instability			Cross-Correlation		
					Ag	Com	Hr	Ag	Com	Hr	Ag	Com	Hr	Ag-Com	Ag-Hr	Com-Hr
Mean																
Ag	278	135	-77	559	-											
Com	332	92	79	536	0.06	-										
Hr	91	14	60	136	-0.10	-0.22	-									
Range																
Ag	891	155	525	1255	-0.10	-0.13	-0.04	-								
Com	587	156	332	1103	-0.11	-0.20	-0.07	<b>0.37</b>	-							
Hr	43	11	20	82	-0.21	-0.20	<b>0.52</b>	0.20	-0.01	-						
Instability																
Ag	1667	450	658	3157	-0.09	<b>-0.30</b>	-0.05	-0.19	0.05	0.07	-					
Com	1242	409	525	2275	<b>-0.33</b>	<b>-0.39</b>	0.12	-0.19	<b>0.36</b>	0.04	<b>0.57</b>	-				
Hr	58	42	3	184	0.04	-0.08	<b>0.28</b>	0.05	-0.01	<b>0.63</b>	0.02	0.02	-			
Cross-correlation																
Ag-Com	-0.16	0.35	-0.84	0.85	<b>0.23</b>	<b>-0.34</b>	-0.10	0.10	-0.03	-0.03	0.18	-0.05	-0.02	-		
Ag-Hr	0.17	0.25	-0.43	0.68	<b>-0.23</b>	0.00	<b>0.29</b>	0.03	-0.20	0.15	0.01	0.06	0.07	-0.13	-	
Com-Hr	-0.08	0.21	-0.65	0.51	0.07	<b>-0.30</b>	-0.10	0.05	0.10	-0.05	0.10	0.06	0.09	<b>0.32</b>	-0.09	-

Note. Ag = agency, Com = communion, Hr = heart rate. Bold coefficients were significant at  $p < .05$ .



**Fig. 4.** Time series of the teacher with the most unstable (maximum MSSD; solid red line) and most stable (minimum MSSD; dotted blue line) communion. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

agency and communion were negatively associated from moment to moment ( $r = -0.16$ ,  $SD = 0.35$ ). This suggests that teachers on average were less communal in situations where they displayed high agency and/or were less agentic when they showed high levels of communion. Thus, being both warm and demanding may reflect the ideal of many teachers and students but does not seem to be the standard behavior for teachers in real-life classroom situations. Further, both relatively high levels of agency and low levels of communion tended on average to go together with a high heart rate ( $r = 0.17$  and  $r = -0.08$ , respectively), but again, the ranges of these intra-individual correlations were large ( $SD = 0.25$  for agency and  $0.21$  for communion). Thus, while some teachers were more likely to have an elevated heart rate in situations with low agency or communion, other teachers were much more likely to exhibit a reverse pattern. Fig. 6 illustrates these findings by showing the observed behavior of two teachers plotted on the interpersonal circle with similar agency-heart rate associations, but opposite agency-communion and communion heart rate cross-correlations. The darker a dot, the higher the heart rate at that moment, relative to this teacher's mean. For example, the clustering of dark dots in the upper-right corner of the interpersonal circle for the teacher on the right indicates that high agency and high communion (i.e., being warm and demanding at the same time) went along with a relatively high heart rate, compared to this teacher's average heart rate.

### 3.3. Correlations between the statistical indicators

The correlations between the statistical indicators are presented in Table 2. Mean levels of agency and communion were not correlated. So overall, a certain level of teacher agency did not tend to go together with a certain level of communion, which is in line with central assumptions of interpersonal theory (Horowitz & Strack, 2011) and previous empirical findings (Mainhard et al., 2012; Pennings et al., 2018). Teachers' range of agency and communion and their instability in the two interpersonal dimensions were significantly correlated, which suggests that teachers who covered a wide range of agentic behaviors were likely to also display a broader range of communal behavior, and teachers who were relatively unstable on one dimension usually were

also less stable on the other dimension of interpersonal behavior.

Teachers with a higher mean agency level were on average less instable on communion and had a stronger negative agency-heart rate correlation indicating that these teachers were less likely to show physiological arousal in situations with high agency, but were more likely to have an elevated heart rate in situations with lower agency levels. Higher communion mean levels were associated with less instability for both agency and communion. Moreover, teachers with high communion mean levels had a more negative agency-communion cross-correlation and a more negative communion-heart rate cross-correlation. This indicates that these teachers were more likely to show elevated levels of agency and heart rate in situations with low levels of communion. In line with this, we found that teachers' agency-communion cross-correlation and their communion-heart rate cross-correlation were positively associated.

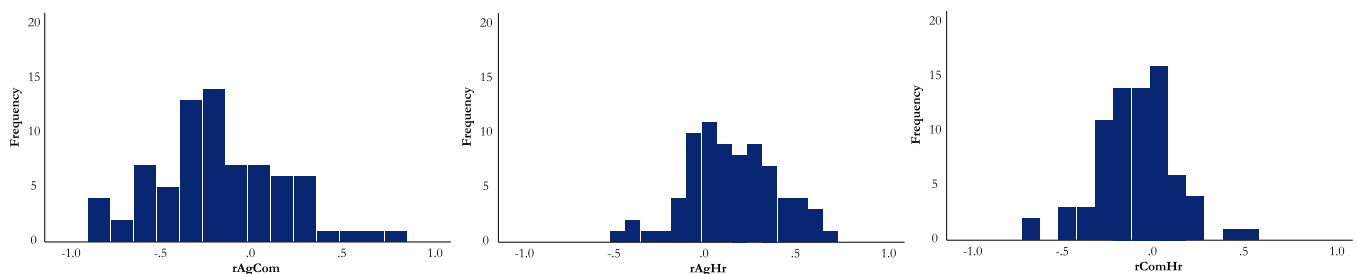
Regarding *physiological arousal*, we found significant positive correlations between mean, range, and instability of heart rate (i.e., people with a higher mean heart rate tended to have also a larger range and more instability). This confirms that absolute heart rate values as such might have little predictive value for emotions, because their mean levels might be mainly due to physiological factors such as teachers' age or fitness (Berntson, Quigley, Norman, & Lozano, 2016; Myrtek, 2004). Therefore, we included only the cross-correlations of heart rate with agency and communion (which were controlled for physical activity with an individual correction; see Methods) in our further analyses.

### 3.4. Associations between the statistical indicators and teacher emotions

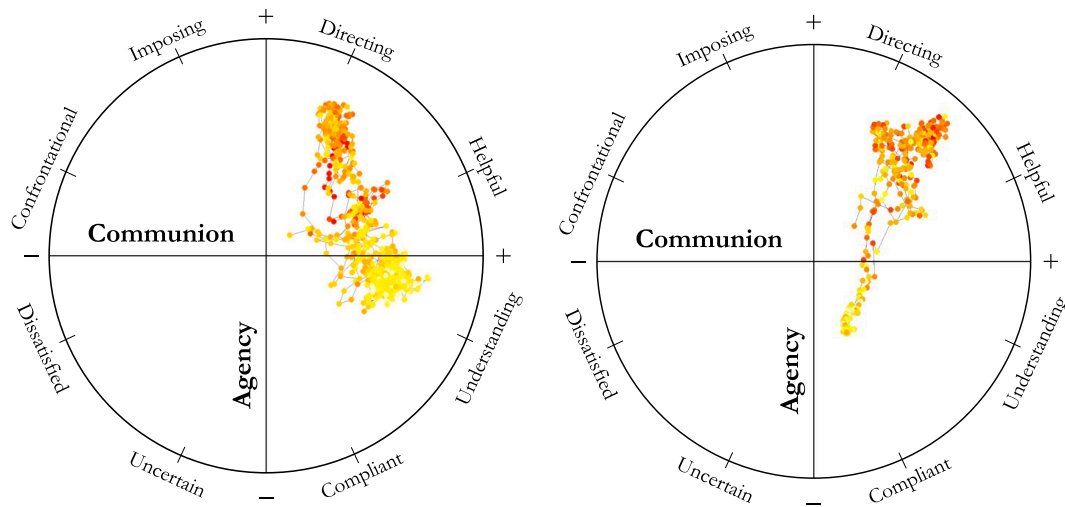
Teachers differed in their self-reported emotions (see Table 1). On average, teachers scored highest on relaxation and enjoyment experienced during the lesson and lowest on disappointment and shame after the lesson. Table 3 shows that the statistical indicators of the moment-to-moment data together explained a moderate to large amount of variance in teachers' self-reported emotions (ranging from 8% for boredom to 35% for disappointment), thereby highlighting the relevance of moment-to-moment processes for teachers' emotional outcomes.

Regarding *teachers' interpersonal behavior*, we found that especially high mean levels of agency were associated with relatively higher levels of positive emotions (specifically enjoyment and pride) and lower levels of negative emotions (i.e., anxiety, disappointment, and shame). Teachers' mean level of communion was negatively associated with self-reported anger during the lesson. Teachers' range and instability of behavior occurred not to be very relevant predictors of emotional outcomes, with only one significant positive association between teachers' agency range and relief.

The *intra-individual associations between agency, communion, and heart rate* were relatively strong predictors of emotions, beyond the effect of mean levels of agency and communion. Both a negative agency-communion cross-correlation (i.e., a strong negative coupling) as well as a positive communion-heart rate cross-correlation (i.e., a relatively higher heart rate in situations with high communion) were



**Fig. 5.** Distribution of the cross-correlations in the sample.  $rAgCom$  = cross-correlation between agency and communion,  $rAgHr$  = cross-correlation between agency and heart rate,  $rComHr$  = cross-correlation between communion and heart rate.



**Fig. 6.** Illustration of the behavioral pattern and corresponding heart rate values of two teachers with similar intra-individual cross-correlations for agency with heart rate (resp. 0.68 and 0.56), but different cross-correlations for agency with communion (resp. -0.82 and 0.85) and communion with heart rate (-0.65 and 0.51). The darker the dot, the higher the heart rate at that moment, relative to this teacher's mean. (The reader is referred to the web version of this article for a colored version of this figure.)

associated with less positive emotions (i.e., relaxation) and more negative emotions (i.e., anger, relief, and disappointment). Furthermore, teachers reported higher levels of enjoyment when heart rate and agency were positively associated (i.e., high heart rate in situations with high agency).

#### 4. Discussion

The aim of the present study was to explore how teachers differed in terms of interpersonal behavior and physiological arousal during teaching a real-life lesson and to examine the predictive value of statistical indicators of the moment-to-moment data for teachers' emotional outcomes. Together, our statistical indicators accounted for a substantial amount of variability between teachers in their emotional outcomes. This confirmed the relevance of interpersonal aspects of teaching, as well as of the nature of their coupling with teachers' moment-to-moment physiological arousal during teaching, for teachers' lesson-focused emotions (Becker et al., 2015; Butler, 2015; Chang, 2009; Fischer & Van Kleef, 2010). The large range and instability of teachers' interpersonal behavior showed that their behaviors differed substantially from moment-to-moment during a lesson (Mainhard et al., 2012; Pennings et al., 2018; Pennings, Brekelmans, et al., 2014),

although range and instability of behavior were not predictive of teacher's self-reported lesson-focused emotions.

Regarding agency, we found on average positive levels of teacher agency in the observed lessons and teachers with a higher mean level of agency reported more positive and less negative emotions after the lesson. This is in line with findings from previous research showing that it is important for teachers' emotional well-being to provide general leadership and structure in class (i.e., high mean levels of agency; Doumen, Verschuere, & Buyse, 2009; Frenzel et al., 2009; Wubbels et al., 2012) and that high levels of agency may function as teachers' ideal in secondary education (Veldman et al., 2016; Wubbels & Brekelmans, 2005). Yet, for some teachers showing high levels of agency went together with increased physiological arousal. Interestingly, these teachers were more likely to report positive emotions after the lesson. In line with Blascovich's biopsychosocial model (2008), these teachers might have interpreted enacting agency as a positive challenge, thereby enabling their body to work more efficiently and to provide them with the extra energy needed through an elevated heart rate (Scheepers et al., 2012; Seery, 2011). Meeting this challenge might reflect a mastery experience for teachers and may therefore result in positive emotional outcomes (cf. Spilt et al., 2011).

Regarding communion, many have considered it to be important for

**Table 3**

Results of multivariate multiple regression analyses of the association between the statistical indicators and teacher emotions at the between-teacher level (N = 75).

	Relaxation		Enjoyment		Boredom		Anger		Anxiety		Relief		Pride		Disappointment		Shame		
	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	
Mean																			
Ag	0.13	0.10	<b>0.25</b>	<b>0.11</b>	-0.12	0.12	-0.05	0.10	<b>-0.25</b>	<b>0.12</b>	-0.07	0.11	<b>0.32</b>	<b>0.12</b>	<b>-0.31</b>	<b>0.09</b>	<b>-0.34</b>	<b>0.12</b>	
Com	0.15	0.12	0.06	0.13	0.09	0.14	<b>-0.28</b>	<b>0.11</b>	-0.07	0.12	-0.09	0.11	0.11	0.12	-0.02	0.12	-0.01	0.13	
Range																			
Ag	-0.09	0.12	0.03	0.11	0.15	0.13	0.11	0.11	0.21	0.14	<b>0.23</b>	<b>0.12</b>	0.05	0.11	0.12	0.11	0.15	0.13	
Com	0.09	0.16	0.05	0.13	0.00	0.15	0.08	0.16	-0.10	0.22	-0.01	0.17	-0.12	0.11	0.01	0.15	0.06	0.17	
Instability																			
Ag	0.16	0.16	-0.14	0.16	0.06	0.16	-0.06	0.14	-0.13	0.15	0.03	0.14	-0.28	0.16	-0.05	0.17	0.09	0.15	
Com	-0.29	0.23	-0.15	0.24	0.11	0.17	0.18	0.22	0.22	0.22	0.23	0.19	0.16	0.18	0.30	0.20	0.00	0.18	
Cross-correlation																			
Ag-Com	<b>0.23</b>	<b>0.10</b>	0.13	0.11	0.10	0.16	<b>-0.29</b>	<b>0.09</b>	-0.10	0.09	<b>-0.38</b>	<b>0.10</b>	0.11	0.11	<b>-0.25</b>	<b>0.10</b>	-0.08	0.12	
Ag-Hr	0.07	0.12	<b>0.23</b>	<b>0.11</b>	-0.17	0.13	0.06	0.10	0.02	0.11	-0.01	0.11	0.14	0.10	-0.12	0.10	-0.12	0.10	
Com-Hr	<b>-0.23</b>	<b>0.11</b>	-0.04	0.11	0.03	0.11	<b>0.32</b>	<b>0.10</b>	0.22	0.12	<b>0.30</b>	<b>0.11</b>	-0.11	0.12	<b>0.32</b>	<b>0.08</b>	0.14	0.11	
R <sup>2</sup>	0.19		0.21		0.08		0.32		0.20		0.27		0.20		0.35		0.19		

Note. Ag = agency, Com = communion, Hr = heart rate. Bold coefficients were significant at  $p < .05$ .



teachers to engage in warm and caring interaction (i.e., high levels of communion; Irvine & Fraser, 1998; Roorda et al., 2017; Wubbels & Brekelmans, 2005; Wubbels et al., 2006). Although a higher mean level of teacher communion during a lesson was only associated with less self-reported anger, teachers reported less positive and more negative emotions when high levels of communal behavior went together with elevated heart rates. These findings show that using *inter*-individual associations between mean levels to draw conclusions regarding *intra*-individual processes could have resulted in misleading conclusions (Fisher et al., 2018; Murayama et al., 2017). That is, while habitually showing communion in class was indicative of lower levels of anger, being aroused while exhibiting communion made it more likely that a teacher reported higher levels of anger experienced during the lesson. In this case, physiological arousal may thus be an indicator of teachers' emotional labor: displaying communal behavior (i.e., high observed levels of communion) while in fact being angry and thus faking or forcing friendly behavior (reflected by the high heart rate; Gross, 1998; Taxer & Frenzel, 2015). Emotional labor has been linked to negative emotions and lower well-being in the long run (Barber et al., 2011; Xanthopoulou, Bakker, Oerlemans, & Koszucka, 2018). It might be valuable to design interventions for teachers to help them employ more effective emotion regulation strategies, such as cognitive reappraisal (Mauss, Cook, Cheng, & Gross, 2007).

We found large differences between teachers in how they combined their interpersonal agency and communion. The more teachers showed high levels of agency and communion simultaneously (i.e., reflecting a warm demander), the more likely they were to report more positive and less negative emotions after the lesson. This in line with previous studies where it was shown that high levels of both agency and communion are preferable (Irvine & Fraser, 1998; Wubbels et al., 2006). In our study however we also found that on average many teachers tended to combine more agentic with less communal behavior (and vice versa), thus being inclined to get more imposing or confrontational when increasing agency rather than directing or helpful (see Fig. 1). This may indicate that being a warm demander can be hard and thus may need more attention in teacher education and professionalization.

Finally, we conclude that using physiological measures in combination with observed behavior may help researchers and teachers to get insight into individual teachers' *action tendencies* (i.e., repeated associations between interpersonal behavior and physiological arousal; Arnold, 1960, in Frijda, Kuipers, & Ter Schure, 1989). Especially the cross-correlations between agency/communion and heart rate in the current study might reflect these action tendencies (cf. Frijda, 2010). Such action tendencies may give insight in teachers' affective arousal to displaying certain behaviors in class and, given that they are associated with emotional outcomes, could be used to design more personalized teacher training and interventions.

#### 4.1. Limitations and future directions

Given that the use of moment-to-moment observational and physiological data in research on real-life teaching is in its infancy, this study has some limitations, which may also serve as directions for future research. First, the reliability of our coding of teacher communion was relatively low, and although this is in line with other studies (Dermody et al., 2017; Sadler et al., 2009; Thomas et al., 2014), further research should investigate how to increase the ICC-values for communion. One of the main reasons that it is very hard to increase the ICC for communion is that people are usually quite stable in their level of communion (see also the low instability value in Table 2), which makes the coding procedure very sensitive to very small changes in behavior that must nevertheless be detected and interpreted in similar ways by the coders. Especially when there is very small variability in teacher communion, it is very hard to get high ICC values of the codings. To the best of our knowledge, there is no statistical procedure available to correct for this issue.

Second, our results could be elaborated by including observations of student behavior to further contextualize teacher behavior and to disentangle the role of student behaviors in teachers' physiological arousal. Also, more specific information on students (beyond gender and age), such as their achievement or engagement levels, would help to contextualize our findings. Moreover, including more lessons per teacher might answer the open question to what degree interpersonal behavior and the associations with physiology vary over lessons or classes (e.g., classes with low achievement levels, younger students, or classes with an overall poor classroom social climate). Having more data available per teacher might also yield a more robust estimate of teachers' habitual reaction patterns and might lower the potential effect of being observed on teachers' experienced emotions (Praetorius, McIntyre, & Klassen, 2017). Nonetheless, we should also note that most previous studies using these intensive coding methods only coded 10 min of classroom interaction (Pennings et al., 2018; Pennings, Van Tartwijk, et al., 2014; Sadler et al., 2009), while we included entire lessons. In addition, it has been found that, depending on the construct under investigation, observing just one lesson can already give a reliable insight in teachers' classroom management quality and personal learning support (cf. Praetorius, Pauli, Reusser, Rakoczy, & Klieme, 2014).

Third, we calculated the statistical indicators (mean level, range, stability, and cross-correlations) first and tested their association with self-reported emotions in a separate analysis. Computing inter-individual statistical indicators based on moment-to-moment data allowed us to use intra-individual information while at the same time exploring their associations with higher-level outcomes such as emotions and burnout, and thereby moving beyond the case study design of many studies using moment-to-moment data (e.g., Donker et al., 2018). Although some recently developed applications allow for analyzing inter- and intra-individual associations in one model (e.g., Dynamic Structural Equation Modeling; Hamaker, Asparouhov, Brose, Schmiedek, & Muthén, 2018), the high auto-correlations of our variables prevented us from using these methods. On the other hand, due to the intensive nature of our moment-to-moment data (i.e., several hundred data points per teacher), the cross-correlations presented can be considered rather robust and estimates based on statistical modeling are unlikely to further reduce the standard errors.

Finally, although the present study highlights some concrete starting points for further research, it is certainly necessary to replicate our findings. Also, it would be interesting, for example, to use physiological indicators to identify specific lesson sequences and to use these in video stimulated recall interviews with teachers to get better grip on their subjective appraisals (see for example Ahmed, Van der Werf, & Minnaert, 2010; Schepens, Aelterman, & Van Keer, 2007).

#### 4.2. Conclusion and practical implications

This study showed that it is worthwhile to move beyond the use of solely self-reported and cross-sectional data and towards the inclusion of moment-to-moment data to get a better understanding of the processes underlying teachers' emotional outcomes. In line with the emphasis that is put on interpersonal processes for emotions and well-being in general (Fischer & Van Kleef, 2010), and for teachers in particular (Wubbels et al., 2006), our findings indicated that a coupling of certain interpersonal behaviors with physiological arousal could be a relevant personal antecedent of teacher emotions tied to specific lessons. Using moment-to-moment data of interpersonal behavior and physiological arousal does not only help to draw ecologically valid conclusions on what might be personally relevant for teachers during teaching, but may also help individual teachers to reflect in more specific ways on their teaching (Fisher & Boswell, 2016; Pennings & Mainhard, 2016; Van Vondel, Steenbeek, Van Dijk, & Van Geert, 2017). The identification of individual difficulties and teacher idiosyncrasies of how their interpersonal behavior in class and their physiological

arousal are connected might point to possible areas of improvement and individualized interventions to help teachers to cope with and better enjoy their important job.

**Acknowledgement**

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**Appendix A**

*Teacher emotion questionnaire*

Questions have been translated and adapted from the Achievement Emotions Questionnaire (Pekrun et al., 2011) and the Teacher Emotions Scales (Frenzel et al., 2016). Questions were asked in a randomized order. Answer options ranged from 1 (oneens [disagree]) to 5 (eens [agree]).

Instruction: De volgende vragen gaan over hoe u de afgelopen les hebt ervaren. [The next questions ask how you experienced the past lesson.]

	Dutch (original)	English (translated)
	<b>Tijdens deze les ...</b>	<b>During this lesson ...</b>
Relaxation	... voelde ik me rustig ... voelde ik me relaxed ... voelde ik me op mijn gemak	... I felt calm ... I felt relaxed ... I felt comfortable
Enjoyment	... was ik ontspannen ... had ik plezier ... was ik enthousiast ... heb ik genoten	... I was relaxed ... I had fun ... I was enthusiastic ... I enjoyed it
Boredom	... vond ik het leuk ... vond ik het saai ... verveelde ik me ... dwaalden mijn gedachten af*	... I liked it ... I found it boring ... I was bored ... my thoughts drifted away*
Anger	... wilde ik dat de les voorbij was* ... voelde ik me boos ... was ik gefrustreerd ... voelde ik irritatie	... I wanted the class to be over* ... I felt angry ... I was frustrated ... I was irritated
Anxiety	... ergerde ik me ... maakte ik me zorgen ... was ik nerveus ... voelde ik me gespannen	... I was annoyed ... I worried ... I was nervous ... I felt tense

\*These items have been deleted after reliability analysis.

Instruction: De volgende vragen gaan over hoe u zich op dit moment voelt als u terug kijkt op de afgelopen les. [The next questions are about how you feel at this moment when you look back at the past lesson.]

	Dutch (original)	English (translated)
	<b>Als ik terugkijk op de afgelopen les ...</b>	<b>When I think of the past lesson ...</b>
Relief	... ben ik blij dat deze les afgelopen is ... voel ik me beter dan tijdens de les	... I am glad the lesson is over ... I feel better than during the lesson
Pride	... voel ik opluchting dat het voorbij is ... vind ik dat ik het goed heb gedaan ... ben ik tevreden over mezelf ... ben ik trots op mezelf	... I am relieved that it is over ... I think I did a good job ... I am content with myself ... I am proud of myself
Disappointment	... ben ik teleurgesteld in mezelf ... valt het me tegen hoe ik het heb gedaan ... voelt het alsof ik gefaald heb	... I am disappointed in myself ... I am disappointed with how I did ... I feel like I failed
Shame	... voel ik me terneergeslagen ... heb ik een schuldgevoel ... schaam ik mij ... had ik de les anders willen doen ... heb ik spijt van dingen die ik heb gedaan	... I feel down ... I feel guilty ... I am ashamed ... I wanted to do the lesson differently ... I regret the things that I did

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