



# Our teacher likes you, so I like you: A social network approach to social referencing

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## ABSTRACT

A teacher is a social referent for peer liking and disliking when students adjust their evaluations of a peer based on their perceptions of teacher liking and disliking for this peer. The present study investigated social referencing as an intra-individual process that occurs over time, using stochastic actor-oriented modeling with RSiena. The co-evolution of peer-perceived teacher liking and disliking networks with peer liking and disliking networks was analyzed in 52 fifth-grade classes in the Netherlands, with 1370 students ( $M_{\text{age}} = 10.60$ ). Results showed that when a student viewed the teacher to like a peer, this student would also like this peer. Regarding disliking, there was a stronger effect in the opposite direction, indicating that students' disliking a peer increased the likelihood that they would view the peer as disliked by the teacher as well. In sum, partial evidence for social referencing as an intra-individual process was found. For teachers this implies that the cues they provide regarding their liking of a student, and not necessarily their disliking, may affect individual peers' liking of this student.

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## 1. Introduction

The classroom is a primary context for peer interactions and for the development of peer relationships (McAuliffe, Hubbard, & Romano, 2009; Rubin, Bukowski, & Parker, 2006). In addition to students' interactions with their teachers, peer interactions and relationships are considered important determinants of social and academic adjustment (Ladd, Kochenderfer-Ladd, Visconti, & Ettekal, 2012; Rubin et al., 2006; Wentzel, 2005). Connecting these two influential agents of child development, a growing body of research has focused on how teachers influence children's development indirectly via peer relationships (e.g., Chang et al., 2007; Hughes, Cavell, & Willson, 2001; McAuliffe et al., 2009). More specifically, one branch of research has viewed the teacher as a *social referent* for affective peer evaluations – that is, students are hypothesized to use social cues from how the teacher interacts with a peer as information about the likeability of the peer (Hughes et al., 2001; McAuliffe et al., 2009). Because the teacher is the main focal point in the classroom, students have ample opportunity to witness teacher behavior and to develop ideas about whether the teacher likes or dislikes each of their peers. Students can use this information in their own affective evaluations of their classmates (Hughes et al., 2001; Hughes, Im, & Wehrly, 2014). When teachers indeed are social referents for peer liking

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and disliking, teachers can put this mechanism to use and strategically interact with a student in such a positive manner that will improve peers' views of the student (McAuliffe et al., 2009). In this way, teachers can exert their "invisible hand" (Farmer, McAuliffe, & Hamm, 2011), and affect not only students' academic adjustment but also their social development.

Since social referencing relies on individual students to develop an idea about teacher liking for a peer, and then to adapt their own view of the peer accordingly, social referencing implies an intra-individual process. Research thus far (e.g., Hughes et al., 2001) has only inferred this intra-individual process based on analyses of classroom-level reputation or status. The present study extended the existing research in three ways. First, to directly test social referencing as an intra-individual process, individual students' tendencies to adjust their liking and disliking of a peer, based on their individual perceptions of the teacher's like or dislike of this particular peer, were investigated. Second, to conduct a further test of social referencing as the mechanism that drives the associations between teacher and peer (dis)liking, possible effects in the opposite direction were studied, specifically whether peer (dis)like also affects students' perceptions of teacher (dis)like. Finally, we examined whether students' likeliness to follow their teacher's affective evaluations of their peers depended on the students' perceptions of the teacher's warmth. Together, these additions to the existing knowledge base will provide more insight into how social referencing actually works within individual students' minds and will make room for directions for teachers that are even better grounded in empirical findings.

### 1.1. The teacher as a social referent for peer liking and disliking

According to social referencing theory, children look to their caregivers for social cues regarding how to respond to novel or startling situations (Feinman, 1982; Walden & Ogan, 1988). Hughes et al. (2001) extended this theory to the classroom and hypothesized that students refer to their teachers' interactions with their peers for cues regarding how to evaluate these classroom peers. Most researchers interested in the impact of teachers on peer liking and disliking relationships in primary schools (first to sixth grade) have focused on how observable teacher behavior (e.g., McAuliffe et al., 2009), teacher-rated preference or affect for students (e.g., Chang et al., 2007; Kiuru et al., 2015), or teacher-rated support and conflict in the teacher-student relationship (e.g., De Laet et al., 2014; Hughes & Im, 2016) are related to peer liking and disliking status. In agreement with social referencing theory, these studies have generally found that children who have positive rather than negative relationships with their teachers are liked more by their classmates. However, based on the nature of these studies, the active role of students who developed an image of how the teacher liked or disliked a peer and accordingly liked or disliked the peer themselves could only be assumed because student perceptions of teacher liking for their peers were not considered.

Hughes and colleagues (Hughes et al., 2001, 2014; Hughes, Zhang, & Hill, 2006) extended the existing research by focusing on how students' perceptions of the teacher-student relationship in primary schools are related to students' peer liking and disliking status. They found, in accordance with social referencing theory, that students who were viewed by their classmates as having a supportive relationship with the teacher were liked by more of their peers, whereas students who were perceived to be in frequent conflict with the teacher were disliked by more of their peers. To the contrary, research in Belgian secondary schools (Engels et al., 2016; Mage = 13.79 years) found no significant correlation between peer-perceived teacher-student relationships and peer liking. Thus, it might seem that teachers function as a social referent for students' peer liking and disliking particularly in primary schools.

#### 1.1.1. Social referencing as an intra-individual process

Engels et al. (2016) and Hughes et al. (2001, 2006, 2014) investigated peer perceptions as the classroom-averaged reputation or status. Thus, all nominations a student received from any of his or her peers were aggregated into the student's reputation score. Reputations are valuable representations of the valence of a group's sentiment toward a peer (Hughes et al., 2014), and it is not unlikely that a positive association between teacher and peer liking reputation indicates social referencing. However, this is not conclusive evidence for an intra-individual process, so conclusions and implications based on existing research must still be formulated with a certain degree of caution. In the present study, we explicitly focused on the intra-individual processes and studied whether for individual students, thinking that the teacher likes or dislikes a peer would make it more likely that this particular student would come to like or dislike this particular peer as well. For instance, if Ann thinks the teacher likes her classmate Beth, Ann would come to like Beth as well. On the other hand, if Ann thinks the teacher dislikes Beth, Ann will take this as a cue to come to dislike Beth as well. In other words, we investigated whether teacher (dis)liking ties lead to peer (dis)liking ties, where a tie refers to a relationship of any kind between two actors in a social network (Borgatti, Everett, & Johnson, 2013), the social network in this case being a class of students. Note that we refer to a student viewing that the teacher likes a peer as a teacher liking tie, although it is not a tie in terms of an emotional relationship between two people, such as a friendship or a liking tie. Rather, it is a social cognition tie (Babad, 2009; Cillessen, 2009) in the sense that a student identifies those peers whom they believe are liked by the teacher.

### 1.2. Effects of prior peer evaluations on perceived teacher liking and disliking

Up to this point, associations between peer-perceived teacher (dis)liking and peer (dis)liking have been mainly explained as students following their teacher's affective evaluations of their peers. This explanation corresponds to the dominant conceptualization of the teacher as a socializing agent who affects peer relations (Farmer et al., 2011). However, students' perception formation might not be such a straightforward process, and effects of peer liking and disliking ties on peer-perceived teacher liking and disliking could also underlie the previously found correlations. When a student likes a peer, the student could be more likely to

view the teacher to like this peer accordingly, possibly because confirmation bias (Hymel, Wagner, & Butler, 1990; Nickerson, 1998) plays a role. Confirmation bias refers to students mainly attending to information that corresponds to their already existing evaluation of something (in this case a peer) and disregarding incoherent information. Such a bias is known to affect how students evaluate their peers' personalities and behaviors (Hymel, 1986; Hymel et al., 1990). Translating this bias to the effects of peer (dis)liking on students' perceptions of teacher (dis)liking, it might, for instance, lead Ann, who already likes her classmate Beth, to believe that the teacher also likes Beth because she consistently evaluates interactions between the teacher and Beth as positive and disregards any possible negative interaction. Thus, although associations between peer-perceived teacher liking and disliking and peers' own liking and disliking are often viewed as driven by students' perceptions of teacher evaluations, students' prior affect for the peer might also drive the associations.

Thus far, little research has been conducted that connects primary school students' perceptions of peers to later perceptions of how teachers view these peers. Only in the study by Engels et al. (2016) in secondary education were such effects included; however, neither peer likeability status nor peer popularity status was associated with later peer-perceived positive and negative teacher-student relationships. By focusing on how peer (dis)liking ties and student perceptions of teacher (dis)liking ties between students developed across three measurement moments across one school year, in the present study we were able to disentangle the effects of each type of tie on the other.

### 1.3. Model competence: the moderating role of teacher warmth

Beyond investigating social referencing as an intra-individual process and assessing the direction of effects between teacher and peer (dis)liking ties, the present study also aimed to provide further insight into the conditions under which social referencing might occur. We pursued this goal by examining whether the social referencing effect might be moderated by the amount of teacher warmth that the student perceives. In the process of social referencing, teachers have been theorized to convey information through affective modeling (Bandura, 1992) because the teacher models a positive or negative affect for a certain student. Research on modeling in terms of observational learning has shown that the extent to which the modeled behavior or attitude is learned by students depends on, among other factors, the perceived competence of the model (Schunk, 2004). We propose that, in the case of the teacher modeling social preferences, a relevant teacher characteristic that could add to the perceived model competence of a teacher might be the ability to establish relationships characterized by warmth and positive affect (see Judd, James-Hawkins, Yzerbyt, & Kashima, 2005; Sabol & Pianta, 2012). The more teacher warmth the student perceives, the more relevant and credible the teacher might become as a model for peer liking. In other words, perceived teacher warmth could moderate the extent to which students are inclined to refer to their teacher for information regarding how to evaluate their peers.

This proposition is in agreement with social balance theory (Heider, 1946), which conceptualizes consistency in positive and negative social relationships as a driver of positive and negative attitudes. That is, if Ann likes Beth, and Beth likes Chris, to create balance, Ann will like Chris as well. In contrast, if Ann dislikes Beth, and Beth likes Chris, Ann disliking Chris also creates a balanced situation. To illustrate how this principle might relate to social referencing Fig. 1, represents three situations of social relationships among a student (Ann), a teacher (Mrs. Baker), and a peer (Chris). In the left diagram, there are no tensions in the positive and negative associations among the actors. Ann likes the teacher, and in accordance with Mrs. Baker's evaluation of Chris, Ann likes Chris as well. The middle diagram represents an imbalanced situation, because Ann has a positive relationship in common with someone she dislikes. In this situation, Ann could come to dislike Chris because the teacher likes him (right diagram in Fig. 1). Because Ann dislikes Mrs. Baker, she will be less likely to accept her as a model. Thus, social referencing could depend on how Ann values Mrs. Baker. In the present study, the student's perception of teacher warmth was considered to represent the extent to which a student values the teacher, although it is not a direct measure of the student's liking versus disliking of the teacher.

### 1.4. The present study

Existing research on social referencing has provided important indications that this mechanism plays a role in students' affective evaluations of their peers. However, the studies conducted so far have focused on peer liking and disliking status as classroom reputation and have not investigated whether social referencing occurs as an intra-individual process. Furthermore, the existing

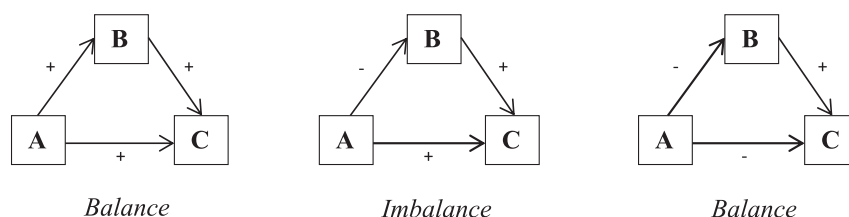


Fig. 1. Social balance and imbalance in relationships. Pluses represent liking relationships, minuses represent disliking relationships.

research has rarely employed longitudinal designs, so development over time and the directionality of effects have yet to be examined. In the present study, the focus was on social referencing as an intra-individual process and on changes in students' views of each other over three time points within one school year. Moreover, to incorporate model competence and thereby provide further insight in the conditions under which social referencing might occur, it was examined whether students' perceptions of teacher warmth moderated the effects of perceived teacher (dis)liking on peer ties.

To investigate social referencing at the intra-individual level, stochastic actor-oriented modeling (Snijders, 2001) was applied. This social network analysis technique evaluates how ties within social networks develop over time. In the present study, the development of four networks of ties among students was investigated: a peer liking network, a peer disliking network, a peer perception of teacher liking network, and a peer perception of teacher disliking network. Using stochastic actor-oriented modeling for the analysis of the co-evolution of multiple social networks (Snijders, Lomi, & Torló, 2013), we could test the main social referencing hypotheses that reflect network change as a result of intra-individual processes from one time point to the next:

**Hypothesis 1a.** A teacher liking tie leads to the existence of a peer liking tie and the non-existence of a peer disliking tie.

**Hypothesis 1b.** A teacher disliking tie leads to the existence of a peer disliking tie and the non-existence of a peer liking tie.

As indicated in the section about social referencing as an individual process, a teacher liking or disliking tie between a student and a peer refers to the situation in which the student indicates that the teacher likes or dislikes the peer. As an alternative process that might account for the previously found correlations at the group level, the confirmation bias effect is expressed in the second set of hypotheses:

**Hypothesis 2a.** A peer liking tie leads to the existence of a teacher liking tie and the non-existence of a teacher disliking tie.

**Hypothesis 2b.** A peer disliking tie leads to the existence of a teacher disliking tie and the non-existence of a teacher liking tie.

The third hypothesis focused on model competence in terms of teacher warmth:

**Hypothesis 3.** The extent to which a teacher liking or disliking tie leads to a peer liking or disliking tie depends on the student's perception of teacher warmth.

The hypotheses were tested while controlling for basic tendencies in network development and for gender because students tend to like same-sex classmates and to dislike opposite-sex classmates (e.g., Dijkstra, Lindenberg, & Veenstra, 2007; Rose & Smith, 2009), and girls often have more supportive and less conflicting relationships with teachers than boys (e.g., McCormick & O'Connor, 2015).

## 2. Method

### 2.1. Participants

As part of a larger study of classroom climate in the fifth grade of elementary education in the Netherlands, 52 fifth-grade classes with 52 teachers and their 1370 students participated in three waves of data collection (fall – winter – spring).<sup>1</sup> Only students for whom informed parental consent was provided participated (1351, 98.6% of the total number of students). During the first wave, 1309 students participated (eight had not yet joined the classes, and 34 were absent); during the second wave, 1284 students participated (three had not yet joined, ten had left the classes, and 54 were absent); and during the third wave, 1285 students participated (14 had left the classes, and 53 were absent). There were 1197 students who participated in all three waves (88.6% of all consented students). The students' mean age during the first wave was 10.60 years old ( $SD = 0.50$ ), and 52.6% of them were male. According to the classification of Statistics Netherlands (2012), 83.8% were Dutch (both parents born in the Netherlands), 5.7% were Western immigrants (at least one parent born in another Western country), and 10.5% were non-Western immigrants (at least one parent born in a non-Western country). The class size was, on average, 26.17 pupils ( $SD = 3.87$ , range 18 to 34). In 86.5% of the classes in our sample, the composition of the group was, to a large extent, the same as the year before, with only a few students joining or leaving a group, which is quite common in the Netherlands.

In the Netherlands, as opposed to the group composition, teachers do generally change every year. Students have either a single teacher (12 classes, 23.1%), or two teachers who each work part-time (40 classes, 76.9%). In the case of two teachers, the teacher who spent more time in the classroom participated in our study; in total 32 of all participating teachers (61.5%) taught at least 4 days a week. The teachers were 41.40 years old on average (range 24.51 to 62.47,  $SD = 11.83$ ); the teachers' mean experience was 14.96 years (range 1 to 39,  $SD = 10.82$ ), and 33 teachers were female (63.5%).

<sup>1</sup> In total, 59 classes participated in this larger project. Four classes were omitted from the analyses because, over the course of the study, four substitute teachers participated due to an illness, maternity leave or travel of the primary teacher, one class was omitted from the analyses because it did not participate in all three waves, one was omitted because of the permanent presence of two teachers who served an exceptionally large class size of 42 students at wave 1 and 44 at waves 2 and 3, and one was omitted because of a deviation in the data collection procedure at waves 2 and 3.

## 2.2. Instruments

### 2.2.1. Network data

On each measurement occasion, two peer nomination items were used to measure dyadic peer liking and disliking ties: “Which classmates do you like most?” and “Which classmates do you like least?” Also on each measurement occasion, the students were asked to nominate which of their classmates they thought were liked most and liked least by their teacher: “Which classmates are liked most by ...?” and “Which classmates are liked least by ...?” Each item included the name of the teacher involved. Same- and opposite-sex nominations were allowed and nominations were unlimited. The students were asked to nominate at least one of their classmates. Apart from themselves, the students could nominate any classmate, whether or not present and whether or not consented. Nominations given to non-consented students were excluded from the dataset. Thus, the primary sample of 1309, 1284, and 1285 students who were present and consented at the three time points indicated to have ties with a larger sample of 1343, 1338, and 1337 students who were consented and belonged to the class at a certain time point.

The primary sample of students nominated their classmates from a list. To avoid sequence effects (Poulin & Dishion, 2008), the order of the classmates' names on this list was random and thus different for each participant on each measurement occasion. This nomination procedure resulted in four directed network matrices per class (peer liking and disliking, and peer-perceived teacher liking and disliking).

### 2.2.2. Teacher warmth

Student perceptions of teacher warmth at the first and second time point were included to predict the development of the peer liking and disliking networks from the first to second and second to third waves. The students evaluated their teachers by completing the Questionnaire on Teacher Interaction for Primary Education (QTI-PE; see Hendrickx, Mainhard, Boor-Klip, Cillessen, & Brekelmans, 2016). The QTI-PE is based on the QTI as developed for secondary education (Brekelmans, Mainhard, Den Brok, & Wubbels, 2011; Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006; Wubbels et al., 2012), and in the present study, it was used to measure a student's perceived teacher warmth. The questionnaire consists of 16 items, each of which reflects a certain degree of warmth. The item “This teacher is friendly”, for example, reflects a high degree of warmth, and the items such as “This teacher yells” and “This teacher is impatient” reflect a low level of teacher warmth. The items again included the name of the teacher involved. A 5-point Likert scale was used, ranging from 1 (*almost never*) to 5 (*almost always*). Following standard procedures (see Wubbels et al., 2012), each item was weighted for the amount of warmth, and the sixteen weighted item scores were averaged, resulting in a single score, ranging between –1 and 1. The Cronbach's alpha values were 0.82 and 0.86 for the first and second waves, respectively.

## 2.3. Procedure

The data were collected in 2012/2013, with the first wave starting at least one month after the start of the school year. The waves were 13–15 weeks (wave 1–wave 2) and 9–11 weeks (wave 2–wave 3) apart. Schools located in the middle, south, and east of the Netherlands were recruited to participate. After a school's principal and the classroom teacher agreed to participate, parents received information about the goals of the study and were asked for consent for their child to participate. All students for whom informed consent was granted completed the questionnaires on netbook computers in their own classrooms. The students were seated separately, and the netbooks were flanked by partition screens to prevent distractions and to increase privacy. Standard instructions were provided in which voluntary participation was assured, and it was explained that the answers provided would be handled confidentially. After all data were collected, the teachers received a summary of the findings for their classrooms.

## 2.4. Analysis

### 2.4.1. Social network analysis

The data were analyzed using stochastic actor-oriented modeling with SIENA (Simulation Investigation for Empirical Network Analysis; Ripley, Boitmanis & Snijders, 2015), a statistical package applied in R software (R Core Team, 2015) and therefore referred to as RSiena. RSiena is dedicated to the longitudinal analysis of social networks, and it simulates how a network at a certain point in time has developed from a network at an earlier time point (Ripley, Snijders, Boda, Vörös & Preciado, 2015). It does so by decomposing all network changes into so-called microsteps, in which one student (the actor, ego) has the opportunity to create or terminate one outgoing tie toward a classroom peer (alter). Then, it tests whether ego's changes follow certain tendencies or behavioral rules, which are predefined by the researcher (Ripley, Snijders et al., 2015) to test specific hypotheses. A reciprocity effect is an example of such a tendency: if ego is liked by alter, ego will reciprocate this liking tie and thus like alter as well. RSiena yields parameter estimates ( $\beta$ ) for each given effect, which can be tested by referring the t-ratio (parameter estimate divided by its standard error) to a standard normal distribution (Snijders, van de Bunt, & Steglich, 2010). Parameter estimates can be either positive, when a tendency is present in the data, or negative, when the opposite of the tendency is present. As parameter estimates refer to multinomial logit models, they can be interpreted in terms of odds ratios. That is, if a parameter estimate  $\beta$  was obtained in the analysis, then  $\exp(\beta)$  gives the odds of an actor making a network change in which the effect statistic increases by one unit versus making a change in which this statistic does not change (see Ripley, Snijders et al., 2015).



In addition to examining changes within single networks, RSiena can also be used to study the co-evolution of two or more networks, in which the ties in one network lead to changes in ties in the other network (Snijders et al., 2013). Using this analysis technique, we tested whether our hypotheses regarding the co-evolution of peer-perceived teacher liking and disliking with peer liking and disliking indeed represented tendencies that explained network change. For instance, we tested the rule “If ego thinks the teacher likes alter, ego will like alter as well” (i.e., [Hypothesis 1a](#): a teacher liking tie leads to a peer liking tie).

#### 2.4.2. Parameter estimation

Estimation was performed using the Method of Moments (Snijders, 2001), and all of the analyses were performed with 3000 iterations and were repeated until convergence was attained, as indicated by an overall maximum convergence ratio lower than 0.25 (as advised in the RSiena manual; Ripley, Snijders et al., 2015). As indicated in the Participants section, not all students participated in all three waves of data collection, which induced missing values. RSiena can take into account missing values up to 20%, which are treated in such a way to minimize their impact on the estimation results (Ripley, Snijders et al., 2015). That is, missing data is handled in two steps. First, to enable meaningful simulation on complete data, missing values are imputed. For missing observations at the first measurement moment, the value 0 (no tie, for instance Ann has not indicated to like Beth) is imputed, because in general network data are sparse, so “no tie” is the value that occurs most often. For missing observations at the second or third measurement moment, the prior value, if available, is considered most informative and therefore this value is imputed. As a second step, in order to ensure a minimal impact of imputed missing values on the results and to avoid bias in the parameter estimates, the calculation of the target statistics uses only non-missing data (see Huisman & Steglich, 2008; Ripley, Snijders et al., 2015).

#### 2.4.3. Nested data

Measurement occasions were nested within students who were nested within classes. At the lower level of nesting, that of time points within students, the unit of analysis is a period of change from one network at a certain moment to another at the next moment. In our case there are two periods; one from T1 to T2 and one from T2 to T3. RSiena assumes that the time dynamics is homogeneous, which will lead to smooth trajectories of the main statistics from wave to wave (Snijders et al., 2010). Based on the theory regarding social referencing, we did not have reasons to assume differences in the effects across these periods, which was empirically supported by initial exploration of time heterogeneity.

The RSiena approach to account for the nesting of students within classes is to model effects in two steps. First, the models are run for each class separately, which in our case resulted in 52 separate model runs. Next, the results of those model runs are combined across classes in a meta-analysis (Snijders & Baerveldt, 2003). We used this technique to generate mean parameter estimates that reflected the extent to which each hypothesized effect indeed represented a tendency that was present in the entire sample. Next to overall mean parameter estimates and tests of their significance, the meta-analysis also yields a standard deviation and significance test for each effect. These results were used to evaluate whether the parameter estimates differed across classes.

#### 2.4.4. Analytical plan

Data analysis of the effects per class proceeded in two steps: first for the evolution of separate networks and then for the co-evolution of teacher and peer networks (see Huitsing, Snijders, Van Duijn, & Veenstra, 2014).

**2.4.4.1. Evolution of separate networks.** In the first analysis step, to control for predominant within-network development effects, we modeled the development of peer liking, peer disliking, teacher liking, and teacher disliking separately. We included the basic effects that have been found in, for instance, friendship networks and other network types (e.g., Ellwardt, Steglich, & Wittek, 2012; see also Snijders, 2001): out-degree (the balance between creating and terminating ties), reciprocity (the extent to which ties are reciprocated), transitivity (the tendency to like those who are liked by the people you like), out-degree activity (the extent to which being nominated by many peers leads to being nominated by more peers), in-degree popularity (the extent to which nominating many peers leads to nominating more peers), and out-degree popularity (the extent to which nominating many peers leads to being nominated by more peers). Further information on the effects and their statistical expressions can be found in the RSiena manual (Ripley, Snijders et al., 2015). For the development of peer disliking, transitivity was not included because we did not assume that when, for instance, Ann disliked Beth and Beth disliked Chris, Ann would become to dislike Chris as well. The peer-perceived teacher liking and teacher disliking networks are networks of social cognition rather than networks of social relationships (see Babad, 2009; Cillessen, 2009). Therefore, we did not expect many of the standard network effects to occur. For instance, just as with peer disliking we did not expect transitivity; that is, when Ann thought Beth was liked by the teacher and Beth thought Chris was liked by the teacher, we had no reason to expect that Ann would be more likely to think that the teacher liked Chris merely because of the other relationships in this triad. Therefore, only the very basic effects of out-degree, reciprocity, and in-degree popularity were included in the analyses of the teacher networks.

In addition to these within-network effects, gender was included as a control variable. For the liking and disliking networks, we included gender similarity to reflect a tendency to like same-sex classmates and to dislike opposite-sex classmates. For the teacher liking and disliking networks, we included gender of the alter because girls were hypothesized to be more likely to be viewed by their classmates to be liked by the teacher and less likely to be viewed as disliked by the teacher, due to a general tendency of girls to have more supportive and less conflicted relationships with teachers than boys (McCormick & O'Connor, 2015).

**2.4.4.2. Co-evolution of teacher and peer networks.** In the second analysis step, we modeled the co-evolution of two networks at a time (Snijders et al., 2013), combining a teacher network with a peer network. With two teacher networks and two peer networks, this technique resulted in a total of four combinations that were modeled for each class. Two types of intra-individual (dyadic) effects were tested: the social referencing effects of the teacher ties on the peer ties (the extent to which ego thinking the teacher likes or dislikes alter leads to ego liking or disliking alter; [Hypotheses 1a and 1b](#)), and the confirmation bias effects of the peer ties on teacher ties (the extent to which ego liking or disliking alter leads to ego thinking the teacher likes or dislikes alter; [Hypotheses 2a and 2b](#)). [Hypothesis 3](#), regarding the role of teacher warmth as a moderator of social referencing, was tested using an interaction effect of the students' perception of teacher warmth with the dyadic effect of a student's perception of teacher liking or disliking on the peer tie. Students' perceptions of teacher warmth were centered around the group mean, so values represent individual deviations relative to the class's average perception of the teacher's warmth (see [Enders & Tofghi, 2007](#)). Because these analyses are performed for each class separately, the group mean is per analysis the only available mean (see [Ripley, Snijders et al., 2015](#)). In addition to the effects that directly examined our three hypotheses, popularity effects were tested to compare the intra-individual effects with the effects from reputation-based results (the extent to which being perceived by many to be (dis)liked by the teacher leads to being (dis)liked by many peers and the extent to which being (dis)liked by many peers leads to being perceived by many to be (dis)liked by the teacher; see [Hughes et al., 2001, 2014](#)).<sup>2</sup>

**2.4.4.3. Supplementary analyses.** If a dyadic effect of peer-perceived teacher liking or disliking ties on peer liking or disliking ([Hypothesis 1a and 1b](#)) co-occurred with a dyadic effect in the opposite direction ([Hypothesis 2a and 2b](#)), this would be informative regarding a correlation between Ann thinking the teacher likes Beth and her own liking for Beth, but would still be little informative regarding the source of this association. To delve further into the direction of effects and to determine whether there was more support for [Hypothesis 1a and 1b](#) or [2a and 2b](#), as an additional analysis, we ran the analyses anew, but split up the dyadic effects into a creation and endowment (also referred to as maintenance) function. To explain how these functions are used, we refer to [Table 1](#) in which effects from peer-perceived teacher liking on peer liking are disentangled. The table presents four situations. In each of these situations, at T1, a teacher tie existed (Ann thought that the teacher liked Beth; second column). Before doing this analysis, we tested whether this tie at T1 co-occurred with a peer tie during the next wave (Ann liked Beth at T2; right-most column), without considering whether this was an old or a new situation, so whether Ann already liked Beth at T1 (middle column). In other words, Situations 1 and 2 were compared to Situations 3 and 4. Therefore, a creation function tested whether a *new* peer tie would come to exist so that Ann would come to like Beth (comparing Situation 2 to Situation 4), and an endowment function tested whether Ann was more likely to continue to like Beth when she thought the teacher liked her at T1 (comparing Situation 1 to Situation 3).

### 3. Results

#### 3.1. Descriptive statistics

In [Table 2](#), descriptive statistics of the four networks for the three time points are presented; in particular, the average densities (number of nominations expressed as a proportion of the maximum number possible), degrees (average number of given or received nominations by an individual), and Jaccard coefficients (the degree of similarity between the networks at subsequent time points [Snijders et al., 2010](#)) are provided. As seen in this table, the densities and average degrees were higher for peer liking than for peer disliking, indicating that students reported more positive than negative relationships. Furthermore, the students nominated more peers to be liked than disliked by the teacher. For the Jaccard coefficients, with a possible range of 0 (no ties remained the same) to 1 (all ties remained the same), a minimum of 0.20 is recommended for a model based on a gradual change process to be reasonable ([Snijders et al., 2010](#)). On average, the Jaccard coefficients in our study ranged from 0.25 to 0.45 for the different networks. Thus, in general, the networks met the requirements of gradual change. All four networks remained more stable during the second period (wave 2–wave 3) than the first (wave 1–wave 2).

[Table 3](#) shows how teacher liking and disliking ties co-occurred with peer liking and disliking ties among dyads at the same time point. In all four combinations of teacher and peer networks, the majority of dyads had no ties, neither a teacher (dis)liking nor a peer (dis)liking tie (55.3% to 82.4% of the dyads in the four network combinations). As seen in the columns reading “both ties,” peer-perceived teacher liking co-occurred more often with peer liking than with peer disliking, whereas peer-perceived teacher disliking more often co-occurred with peer disliking than with peer liking.

#### 3.2. Evolution of separate networks

[Table 4](#) shows the results of the RSiena meta-analyses of the basic within-network effects that were modeled to control for predominant effects within each separate network. For all four networks, there was a negative out-degree effect. This is quite a common finding ([Snijders et al., 2010](#)) and indicates that the networks were sparse rather than dense in nature. As expected,

<sup>2</sup> As part of the aforementioned study of classroom climate in fifth-grade classrooms, after the first wave an intervention occurred in 23 of the classes, aimed at increasing the teachers' awareness of their classrooms' peer systems and ameliorating teacher-student and peer relationships (for more information, see [Boor-Klip, Segers, Hendrickx, & Cillessen, 2016](#)). Results from a MANOVA showed that there were no differences between the conditions in the parameter estimates of the between-network effects; Wilk's  $\Lambda = 0.188$ ,  $F(8, 2) = 1.08$ ,  $p = 0.566$ . Therefore, we present the results for the sample as a whole.

**Table 1**

Situations that are compared using the creation and endowment functions.

| Situation | Ann thinks teacher likes Beth at T1 | Ann likes Beth at T1 | Ann likes Beth at T2 |
|-----------|-------------------------------------|----------------------|----------------------|
| 1         | Yes                                 | Yes                  | Yes                  |
| 2         | Yes                                 | No                   | Yes                  |
| 3         | Yes                                 | Yes                  | No                   |
| 4         | Yes                                 | No                   | No                   |

reciprocity effects were only found for peer liking and disliking. Thus, when a student indicated to (dis)like a peer, this peer was more likely to indicate to (dis)like the student as well. The transitivity effect showed that students had a tendency to close trip-lets; that is, if Ann liked Beth, and Beth liked Chris, Ann was likely to come to like Chris as well. In-degree popularity was significant for all networks, except for peer liking. In the other three networks, when a student was nominated by many classmates, this student was likely to be nominated by even more classmates at the next time point. Out-degree activity and out-degree popularity were only tested for the peer networks. Students who liked or disliked many at a certain time point were likely to nominate even more peers at the next time point (out-degree activity), and students who liked or disliked many others at a certain time point were less likely to be nominated themselves by many others during the next wave (out-degree popularity). Finally, gender effects were in the expected directions: girls were more likely than boys to be perceived as liked by the teacher and less likely to be perceived as disliked by the teacher, and students tended to like same-sex peers and dislike opposite-sex peers.

### 3.3. Co-evolution of teacher and peer networks

To test our hypotheses, social network analyses were performed of the co-evolution of peer-perceived teacher liking and disliking with peer liking and disliking networks in each class. The analyses reached convergence in 61.5% (peer-perceived teacher liking with peer liking network), 73.1% (peer-perceived teacher liking with peer disliking network), 59.6% (peer-perceived teacher disliking with peer liking network), and 67.3% (peer-perceived teacher disliking with peer disliking network). Non-convergence is not uncommon in research applying these social network techniques in multiple groups (see, for instance, Knecht, Burk, Weesie, & Steglich, 2010). Logistic regression analysis at the classroom level was performed to identify significant predictors of convergence. In correspondence with Knecht et al.'s (2010) study, we found that convergence was predicted by the amount of information available (in this case, the degree in the teacher networks, i.e., the average number of nominations, and the number of pupils in the classroom). In addition, convergence was predicted by greater stability (average Jaccard index). Surprisingly, in the network combinations that involved teacher liking ties, the effect of degree was negative, indicating that with more information available there was a smaller chance of convergence. This could be because in some classes many children nominated every other peer to be liked by the teacher ("Our teacher likes all of us"). This situation yielded limited dispersion of ties, which might have negatively affected convergence. In summary, because with more information and more variability comes greater analytical power, we argue that these results can still reasonably be generalized to the population.

Table 5 shows the results of the meta-analyses combining the results from all of the classes in which convergence was reached. The columns reading "Mean parameter" show the mean parameter estimates across all classes and indicate the extent to which each effect represented a tendency that was generally present in the data. The standard deviation indicates the extent to which a parameter estimate differed across classes. In the table, asterisks indicate two-sided *p*-values; in the remainder of this section, one-sided *p*-values are used when our hypotheses clearly indicated a positive or negative effect.

**Table 2**

Density, degree, and Jaccard coefficient of the four networks.

| Network           | Density<br>M (SD) | Degree<br>M (SD) | Jaccard coefficient<br>M (SD) |
|-------------------|-------------------|------------------|-------------------------------|
| Peer liking       |                   |                  |                               |
| T1                | 0.14 (.05)        | 3.51 (1.09)      | 0.32 (.06)                    |
| T2                | 0.19 (.05)        | 4.73 (1.31)      | 0.37 (.08)                    |
| T3                | 0.21 (.05)        | 5.12 (1.48)      |                               |
| Peer disliking    |                   |                  |                               |
| T1                | 0.10 (.03)        | 2.44 (0.73)      | 0.28 (.07)                    |
| T2                | 0.12 (.03)        | 3.01 (0.68)      | 0.32 (.07)                    |
| T3                | 0.12 (.03)        | 3.06 (0.83)      |                               |
| Teacher liking    |                   |                  |                               |
| T1                | 0.29 (.10)        | 7.28 (2.47)      | 0.34 (.11)                    |
| T2                | 0.33 (.12)        | 8.26 (3.14)      | 0.45 (.13)                    |
| T3                | 0.34 (.14)        | 8.55 (3.62)      |                               |
| Teacher disliking |                   |                  |                               |
| T1                | 0.12 (.04)        | 2.89 (0.90)      | 0.25 (.11)                    |
| T2                | 0.13 (.05)        | 3.31 (1.24)      | 0.32 (.13)                    |
| T3                | 0.14 (.06)        | 3.45 (1.43)      |                               |



**Table 3**

Co-occurrence of teacher and peer ties in percentages.

| Teacher network   | Peer network |               |                  |           |                |               |                  |           |
|-------------------|--------------|---------------|------------------|-----------|----------------|---------------|------------------|-----------|
|                   | Peer liking  |               |                  |           | Peer disliking |               |                  |           |
|                   | No ties      | Peer tie only | Teacher tie only | Both ties | No ties        | Peer tie only | Teacher tie only | Both ties |
| Teacher liking    |              |               |                  |           |                |               |                  |           |
| T1                | 64.2         | 7.3           | 22.1             | 6.4       | 64.2           | 7.3           | 26.2             | 2.3       |
| T2                | 57.0         | 10.4          | 24.5             | 8.1       | 59.2           | 8.2           | 28.9             | 3.7       |
| T3                | 55.3         | 11.2          | 24.6             | 8.9       | 58.3           | 8.2           | 29.6             | 3.9       |
| Teacher disliking |              |               |                  |           |                |               |                  |           |
| T1                | 76.2         | 12.5          | 10.1             | 1.2       | 82.4           | 6.3           | 8.1              | 3.3       |
| T2                | 70.3         | 16.7          | 10.9             | 1.9       | 79.2           | 7.8           | 9.0              | 4.1       |
| T3                | 68.6         | 17.8          | 11.3             | 2.3       | 78.1           | 8.3           | 9.8              | 3.8       |

Note. Mean amount of dyads per class from which these percentages are taken is 664 (Wave1), 650 (Wave2), and 650 (Wave3).

### 3.3.1. Peer liking

The left part of Table 5 shows the results of the meta-analyses involving the peer liking network. Following Hypothesis 1a, there was a between-network dyadic effect of peer-perceived teacher liking on peer liking;  $\beta = 0.33$ ,  $t = 3.02$ , one-sided  $p = 0.003$ , odds ratio = 1.39. Thus, when a student indicated that the teacher liked a peer, there was an increased chance of the student indicating liking this peer on the next measurement occasion. There was also a reverse effect, albeit smaller (Hypothesis 2a); when a student indicated to like a peer, there was an increased chance that the student would nominate this peer as someone who is liked by the teacher at the next measurement point;  $\beta = 0.28$ ,  $t = 3.33$ , one-sided  $p = 0.001$ , odds ratio = 1.32. Because these effects co-occurred, we further examined the direction of effects by re-running the analyses while dividing the tendencies into a creation and endowment part. In this supplementary analysis, only the effects of peer-perceived teacher liking on peer liking were significant. The parameter estimate for creating a new liking tie was 1.09 ( $t = 2.87$ , one-sided  $p = 0.004$ , odds ratio = 2.97), and for terminating an existing liking tie, it was  $-0.69$  ( $t = -2.65$ , one-sided  $p = 0.007$ , odds ratio = 0.50). Thus, when a student thought that the teacher liked a peer, this student was more likely to come to like the peer later and was less likely to stop liking the peer if he or she already did so. Both effects significantly differed across classes;  $\chi^2(25) = 64.16$ ,  $p < 0.001$  for the creation function, and  $\chi^2(27) = 42.08$ ,  $p = 0.032$  for the endowment function.

In contrast with our expectations as expressed in Hypotheses 1b and 2b, at the dyadic level, teacher disliking ties were not related to peer liking ties in either direction. Furthermore, no support for Hypothesis 3 was found: teacher warmth did not moderate the dyadic effects of peer-perceived teacher liking or disliking on peer liking ties.

At the actor level, resembling the effects tested in earlier studies (see Hughes et al., 2001, 2006, 2014), a higher teacher liking reputation was related to a higher peer liking reputation at the next time point;  $\beta = 0.02$ ,  $t = 2.40$ , one-sided  $p = 0.012$ , odds ratio = 1.02. Thus, when a student was perceived by many classmates to be liked by the teacher, there was a slightly increased chance that at the next time point many classmates would like this student. This effect was less strong than the dyadic, intra-individual effect. Again, the reverse was also true: a higher peer liking reputation led to higher teacher liking reputation;  $\beta = 0.02$ ,  $t = 1.88$ , one-sided  $p = 0.034$ , odds ratio = 1.02. A teacher disliking reputation was also related to a peer liking reputation in the expected direction. That is, when a student was perceived by many others to be disliked by the teacher, the student was somewhat less likely to be liked by others at the next time point;  $\beta = -0.03$ ,  $t = -4.62$ , one-sided  $p < 0.001$ , odds ratio = 0.97, and students who were liked by many others were somewhat less likely to be nominated by others as being disliked by the teacher;  $\beta = -0.04$ ,  $t = -3.10$ , one-sided  $p = 0.002$ , odds ratio = 0.96.

**Table 4**

Meta-analysis Results of the Separate Models for the Evolution of Peer Liking, Peer Disliking, Teacher Liking and Teacher Disliking Networks.

| Effect                    | Peer Liking<br>Estimate (SE) | Peer Disliking<br>Estimate (SE) | Teacher Liking<br>Estimate (SE) | Teacher Disliking<br>Estimate (SE) |
|---------------------------|------------------------------|---------------------------------|---------------------------------|------------------------------------|
| Out-degree                | -1.61 (0.07)**               | -2.35 (0.05)**                  | -0.58 (0.13)**                  | -1.60 (0.06)**                     |
| Reciprocity               | 1.15 (0.05)**                | 0.76 (0.06)**                   | -0.01 (0.03)                    | 0.06 (0.07)                        |
| Transitive triplets       | 0.48 (0.03)**                | -                               | -                               | -                                  |
| In-degree popularity      | -0.00 (0.01)                 | 0.16 (0.00)**                   | 0.02 (0.01)*                    | 0.11 (0.01)**                      |
| Out-degree activity       | 0.04 (0.00)**                | 0.08 (0.00)**                   | -                               | -                                  |
| Out-degree popularity     | -0.09 (0.01)**               | -0.05 (0.01)**                  | -                               | -                                  |
| Gender alter <sup>a</sup> | -                            | -                               | 0.20 (0.03)**                   | -0.37 (0.05)**                     |
| Gender similarity         | 0.57 (0.04)**                | -0.23 (0.06)**                  | -                               | -                                  |

<sup>a</sup> Gender was coded 0 for boys and 1 for girls.

\*  $p < .05$ .

\*\*  $p < .01$ .

**Table 5**

Meta-analysis results of the co-evolution of teacher and peer networks.

| Effect                           | Peer liking network        |                    |                    |    | Peer disliking network     |          |                    |    |
|----------------------------------|----------------------------|--------------------|--------------------|----|----------------------------|----------|--------------------|----|
|                                  | Mean parameter             |                    | Standard deviation |    | Mean parameter             |          | Standard deviation |    |
|                                  | Estimate (SE)              | Estimate           | $\chi^2$           | df | Estimate (SE)              | Estimate | $\chi^2$           | df |
| Social referencing effects       |                            |                    |                    |    |                            |          |                    |    |
| Teacher liking tie → peer tie    | 0.33 (0.11) <sup>††</sup>  | 0.61 <sup>**</sup> | 80.64              | 31 | 0.07 (0.07)                | 0.43     | 40.08              | 34 |
| Teacher disliking tie → peer tie | −0.08 (0.10)               | 0.53               | 22.48              | 26 | 0.26 (0.14) <sup>†</sup>   | 0.80     | 41.75              | 33 |
| Confirmation bias effects        |                            |                    |                    |    |                            |          |                    |    |
| Peer tie → teacher liking tie    | 0.28 (0.08) <sup>††</sup>  | 0.47 <sup>**</sup> | 84.37              | 31 | 0.22 (0.08)                | 0.46     | 43.65              | 36 |
| Peer tie → teacher disliking tie | 0.21 (0.12)                | 0.69 <sup>**</sup> | 75.39              | 30 | 0.47 (0.09) <sup>††</sup>  | 0.53     | 45.02              | 34 |
| Model competence effects         |                            |                    |                    |    |                            |          |                    |    |
| Teacher liking tie → peer tie    | −0.12 (0.41)               | 2.29 <sup>*</sup>  | 48.53              | 31 | −0.00 (0.30)               | 1.74     | 35.16              | 33 |
| Teacher disliking tie → peer tie | −0.39 (0.30)               | 1.49               | 21.59              | 24 | 0.43 (0.33)                | 1.79     | 30.96              | 28 |
| Reputation effects               |                            |                    |                    |    |                            |          |                    |    |
| Teacher liking rep → peer rep    | 0.02 (0.01) <sup>†</sup>   | 0.04               | 41.28              | 31 | −0.06 (0.01) <sup>††</sup> | 0.06     | 35.81              | 37 |
| Teacher disliking rep → peer rep | −0.03 (0.01) <sup>††</sup> | 0.03               | 24.12              | 30 | 0.03 (0.01) <sup>††</sup>  | 0.04     | 20.11              | 33 |
| Peer rep → teacher liking rep    | 0.02 (0.01) <sup>†</sup>   | 0.06               | 41.42              | 31 | −0.02 (0.01) <sup>††</sup> | 0.04     | 44.57              | 36 |
| Peer rep → teacher disliking rep | −0.04 (0.01) <sup>††</sup> | 0.07               | 42.17              | 30 | 0.01 (0.01)                | 0.04     | 32.96              | 33 |

Note. rep = reputation.

<sup>\*</sup>  $p < 0.05$ , two-tailed.<sup>\*\*</sup>  $p < 0.01$ , two-tailed.<sup>†</sup>  $p < 0.05$ , one-tailed.<sup>††</sup>  $p < 0.01$ , one-tailed.

### 3.3.2. Peer disliking

The right part of Table 5 shows the results of the meta-analyses involving the peer disliking network. In agreement with social referencing, when a teacher disliking tie existed, it was more likely that a peer disliking tie existed at the next time point (Hypothesis 1b;  $\beta = 0.26$ ,  $t = 1.91$ , one-sided  $p = 0.032$ , odds ratio = 1.30). However, support for the opposite effect (Hypothesis 2b) was stronger;  $\beta = 0.47$ ,  $t = 5.23$ , one-sided  $p < 0.001$ , odds ratio = 1.60. Because both dyadic effects co-occurred, these effects again were disentangled by separating the creation and endowment functions in a supplementary analysis. The result was that only the effect of peer disliking ties on the creation of teacher disliking ties existed;  $\beta = 0.76$ ,  $t = 4.72$ , one-sided  $p < 0.001$ , odds ratio = 2.14. Neither of the endowment functions was significant, so teacher disliking ties did not prevent the termination of a peer disliking tie, and peer disliking ties did not prevent the termination of teacher disliking ties.

The second part of Hypothesis 2b stated that if a peer disliking tie existed, there was a smaller chance of a teacher liking tie existing at the next time point. There was no support for this hypothesis. Actually, it seemed that when a student disliked a peer, this student was more likely, rather than less likely, to nominate this peer as being liked by the teacher at the next measurement occasion;  $\beta = 0.22$ ,  $t = 2.99$ , two-sided  $p = 0.005$ , odds ratio = 1.25.

Again, there was no support for Hypothesis 3: teacher warmth did not moderate the associations of peer-perceived teacher liking or disliking with peer disliking. At the actor level, both teacher liking and disliking reputation were significantly related to peer disliking reputation. When a student was perceived by many others to be liked by the teacher, this student was somewhat less likely to be disliked by many;  $\beta = -0.06$ ,  $t = -6.84$ , one-sided  $p < 0.001$ , odds ratio = 0.94. In contrast, when a student was perceived by many to be disliked by the teacher, the student was slightly more likely to be disliked by many others;  $\beta = 0.03$ ,  $t = 4.00$ , one-sided  $p < 0.001$ , odds ratio = 1.03. The effect in the opposite direction was also significant for teacher liking: students with higher peer disliking reputation were a little less likely to have high teacher liking reputation;  $\beta = 0.01$ ,  $t = -3.08$ , one-sided  $p = 0.002$ , odds ratio = 1.01.

## 4. Discussion

The hypothesis that teachers function as a social referent for peer liking and disliking describes how students refer to their teachers for cues regarding how to evaluate classroom peers. The aim of the present study was to provide evidence for social referencing as an intra-individual process that unfolds over time. Past studies have either not acknowledged the need to investigate students' perceptions of how their teachers relate to their peers (e.g., De Laet et al., 2014; McAuliffe et al., 2009), or, when they did focus on student perceptions, have examined social referencing in terms of associations between reputations at the group level (Engels et al., 2016; Hughes et al., 2001, 2006, 2014). Applying a multilevel social network approach to longitudinal data, we investigated whether for individual students, perceiving the teacher to like or dislike a classmate affected their future evaluations of that peer. To provide further evidence for social referencing, we tested effects in the opposite direction as well, and we finally examined whether model competence, in terms of teacher warmth, moderated the extent to which students indeed followed their teachers' affective evaluations of classmates. The present study provides partial support for social referencing as an intra-individual process because students who perceived the teacher to like a peer were more likely to come to like this peer themselves. However, for peer disliking, there was more support for an effect in the opposite direction – when a student disliked a peer first, the student was more likely to come to think that the teacher disliked the peer as well.

#### 4.1. *The teacher as a social referent*

In agreement with social referencing (Hughes et al., 2001; McAuliffe et al., 2009), our first set of hypotheses was (a) that students who thought the teacher *liked* a peer would be more likely to like this peer themselves and less likely to dislike this peer; and (b) that students who thought the teacher *disliked* a peer would be more likely to dislike this peer themselves and less likely to like this peer. Indeed, there was a tendency for students to come to like a classmate whom they perceived as being liked by the teacher and a tendency to come to dislike a classmate whom they perceived as being disliked by the teacher. These findings substantiated prior work on peer reputations in teacher-student relationships (e.g., Hughes et al., 2001, 2014) by showing that correlations between reputations of teacher and peer liking and disliking at the class level indeed are likely rooted in an intra-individual process.

In contrast with predictions based on social referencing, however, perceived teacher liking did not function as a protective factor against peer disliking. Possibly, for some students, perceiving a peer to be liked by the teacher had the negative connotation of a teacher's pet (Babad, 2009), which would lead them to dislike the peer because of the perceived teacher liking. When this process co-occurs with social referencing, the effects might negate each other. For future research, it would be interesting to delve further into the conditions under which the teacher's pet effect and the social referencing effect are present.

The results regarding reputations showed overall negative associations between classroom-level perceived teacher liking and peer disliking and between classroom-level perceived teacher disliking and peer liking, which is in agreement with the findings by Hughes et al. (2001). Thus, individuals who were generally viewed as liked versus disliked by the teacher were slightly less likely to be disliked versus liked by many of their classmates. Because these reputation-level associations were not reflected in dyadic-level associations, these were likely due to mechanisms beyond social referencing. Possibly, this occurred because of general likeable or dislikeable qualities of the student that would result in some students' liking or disliking and others' perceptions of teacher liking or disliking. Likeable qualities could include a tendency to help others, share, or display other prosocial behavior, whereas dislikeable qualities might include aggression or bullying (Asher & McDonald, 2009).

#### 4.2. *Effects of prior peer evaluations on perceived teacher liking and disliking*

The second set of hypotheses that was tested in this study was that students (dis)liking a peer might also lead to thinking that the teacher (dis)likes that peer, for example, because students' prior liking and disliking for a peer biases their views on how positively or negatively the teacher interacts with that peer. For peer liking, effects in this direction were found, but these effects were less strong than the effects in line with social referencing. Thus, although there was some evidence for bidirectional associations between teacher and peer liking, the teacher seemed to be the engine in this process. For disliking, however, there was more support for an effect of disliking a peer on perceiving the teacher to dislike the peer as well. Apparently, for peer disliking more so than for peer liking, the personal affect that a student had for a peer guided his or her perception of teacher disliking for this peer. This seems to indicate that students who dislike a peer are inclined to assume that the teacher dislikes the peer as well, perhaps because – due to confirmation bias – they predominantly pay attention to negative teacher behavior toward this peer. These differences between findings for peer liking and disliking are in agreement with Hughes and Im's (2016) conclusion that it is important to separate these two aspects of peer evaluations, which are very often analyzed together as peer status (see Coie, Dodge, & Coppotelli, 1982).

Surprisingly, when a student disliked a peer, this seemed to increase the likelihood of the student thinking the teacher liked the peer. That is, when a student disliked a peer, this student became more, instead of less, likely to view the teacher liking that peer. A possible explanation is that teachers notice that a certain student is disliked by his or her peers and therefore try to compensate by increasing the amount of positive interaction that they have with the student (see McAuliffe et al., 2009). When peers pick up on this positivity, they might come to think that the teacher likes the student. Alternatively, a student who dislikes a peer might view any positive teacher behavior toward the peer as unwarranted or unfair, which could lead to the student becoming more aware of and sensitive to any sign that the teacher might like the peer. Because teachers generally develop more supportive than conflicted relationships with their students (e.g., De Laet et al., 2014; Hughes & Im, 2016), it is likely that such signs are present for every student at some point. Thus, when a student is more sensitive to teacher positivity toward a certain peer whom he or she dislikes, he or she could become more likely to nominate the peer as someone who is liked by the teacher.

#### 4.3. *Model competence: the moderating role of teacher warmth*

Based on the idea of model competence and consistent with principles of social balance, our third hypothesis was that students would be more likely to follow the teacher's affective evaluation of a peer when they perceived more teacher warmth. However, our findings did not indicate that such an effect existed. An explanation could be that there was relatively little power to detect such complicated tendencies. Although > 1400 students participated in this study, these analyses were performed on each class separately. Because the classes consisted of only approximately 25 students, it was difficult to find support for complex moderating effects. It is also possible that we failed to capture an effect of teacher warmth because we only investigated students' personal deviations from the class mean perception of teacher warmth. So, we examined differences between students within classes, in which all students assessed the same teacher's warmth. As shown by intra-class correlations of 0.21 and 0.26 for the two waves, respectively, a substantial part of the total variance in teacher warmth was due to differences between

teachers. Because the classes differed in the extent to which social referencing played a role, it seems relevant to investigate why certain teachers were stronger social referents than others, and if model competence was important at this level.

#### 4.4. Limitations and directions for future research

The study results must be interpreted in light of some limitations. First, in the present study, associations between teacher and peer liking and disliking were investigated. However, both are related to multiple characteristics of the student, such as his or her behavior or academic achievement (e.g., Asher & McDonald, 2009; Cillessen & Mayeux, 2004; Hughes et al., 2001). Because of the already complex nature of the analyses, it was necessary to focus on teacher and peer ties and to omit these actor-level variables. To control to some degree for these effects, we incorporated the basic network effects of in-degree popularity, out-degree popularity, and out-degree activity (see Ripley, Snijders et al., 2015), and we included effects of gender to at least capture that aspect. This approach was not perfect, and it might be the case that the study results would be affected if some other student variables were controlled for.

Second, whereas this study addressed an important assumption underlying research on social referencing, one aspect of this mechanism was not incorporated: actual teacher behavior. In social referencing theory, students witness teacher behavior toward their peers and, based on their perceptions of this behavior, develop an idea of how the teacher evaluates each peer. Some studies have shown that students from a very young age are able to see differences in teacher behavior directed toward their classmates and based on these differences, make correct inferences regarding the teacher's affective evaluations of these classmates (e.g., Babad, 1993, 2009; Kuklinski & Weinstein, 2001). Research is needed that connects teacher behavior toward a classmate with students' perceptions of teacher liking and disliking of this classmate.

Finally, in the present study, we did not find indications that perceived teacher warmth affected the extent to which social referencing occurred. Nevertheless, social referencing is likely to differ across students, peers, and dyads, and there are multiple other possible variables that could moderate the social referencing process. For instance, some students' opinions might in general be more malleable than others', and some students might more readily accept the teacher as a model. Target peers' characteristics, affecting the extent to which social referencing applies to them, could include popularity and prosocial or aggressive behaviors. The relevant features of the dyad might include whether the student and peer share the same neighborhood or hobbies, whether there is animosity, and how close in space to each other they are within the classroom (see Van den Berg & Cillessen, 2015). For future research, it might be fruitful to delve into these more or less subtle processes to further deepen the understanding of when and how social referencing occurs in class.

#### 4.5. Implications

The present study substantiated social referencing as a truly intra-individual process. Research focusing on how individuals alter their views about peers is more suitable when conclusions are to be drawn about what occurs within students' minds than research that uses peer reputations within the classroom group. For future research regarding social referencing and other social-cognitive processes in the classroom, it is important to be aware of possible discrepancies between theories about intra-individual processes and the employed statistical analyses. Unless data analysis is performed on how dyadic ties are formed, there will always be some uncertainty regarding whether the intended mechanisms actually occur. Therefore, although the stochastic actor-oriented modeling technique that we employed is fairly complex – particularly with a large multi-leveled sample such as the present one – we strongly recommend future research to consider applying this technique as well.

For teachers, interacting with their students is a major feature of their profession, which can have an impact on more aspects of students' development than teachers anticipate. If future research is able to empirically relate teacher behavior to students' perceptions of teacher liking for their peers, this may hold implications for teachers. If teachers knew that students might refer to them for information regarding other students in the class, they could deliberately model their interactions with certain students with the aim of affecting how peers view this student. Several studies have shown that interventions based on altering teacher interaction with some of their students indeed affected teacher behavior and peer perceptions of students (e.g., Mikami et al., 2013; Spilt, Koomen, Thijs, & Van der Leij, 2012). In order to adapt their teaching, teachers first need to be aware of students' social standing with their peers. However, in general this awareness appears to be limited (Gest, 2006; Neal, Cappella, Wagner, & Atkins, 2011). Therefore, teacher training and in-service professional development programs would likely benefit from paying greater attention to the social dynamics of the classroom, how teachers can get attuned to peers' views of each other, and how teachers could interact with certain students to boost their peer relationships.

### 5. Conclusion

In conclusion, the application of stochastic actor-oriented modeling of social networks as they develop over time has further illuminated how individual students change their minds about individual peers. Consistent with social referencing, this study has shown that individual students are more likely to come to like a peer when they think that their teacher likes this peer. However, in the case of negative peer evaluations, it seems that disliking a peer informs the view that the teacher must dislike this peer as well, more so than the other way around. For future research, it is important to align the level at which analyses are performed with the level at which hypotheses are formulated and thereby to draw valid conclusions about processes occurring in the individual mind.



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