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Associations between friends, academic emotions and achievement: Individual differences in enjoyment and boredom

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1. Introduction

Based on theoretical assumptions and empirical evidence, academic emotions (e.g., Pekrun, 2006) are considered important preconditions for learning and achievement. Previous research findings have consistently emphasized the positive effects of enjoyment (e.g., Pekrun, Goetz, Titz, & Perry, 2002) and the negative effects of boredom on learning behavior and outcomes (e.g., Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010; for an overview see: Schutz, & Pekrun, 2007). The contradictory effects of these two emotions may be rooted in their inverse characteristics in terms of valence and arousal: Whereas enjoyment is defined as a pleasant and activating emotion, boredom is defined as a negative and deactivating emotion (Pekrun, 2006).

Despite the undoubted importance of emotions for learning and achievement, the lack of research on how students' emotional experiences are influenced by social contexts is surprising. Some empirical results indicate that teachers (e.g., Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009) and parents (e.g., Gniewosz & Noack, 2012) have an impact on students' academic emotions. Particularly little attention has been paid to the peer group – although peers have been identified as an important context for socialization in many other respects (e.g., Brown & Larson, 2009). Adolescence is characterized by a strong peer orientation (Berndt, 1979) – taken together with the fact that the average total time spent by students in formal classroom settings is 3.034 hours during lower secondary school (OECD, 2013), best friends

in class might not only be a source of school related values and beliefs (e.g., Altermatt & Pomerantz, 2003), but also academic emotions. Accordingly, this study focuses on the associations regarding enjoyment and boredom (in different academic domains) between the best friend (which plays a significant role in a student's peer group) and the student. To enhance our understanding of best friendships we focus on reciprocal as well as unilateral friendships, assuming that unilateral friendships also have developmental significance for students (Bot, Engels, Knibbe, & Meeus, 2005). Furthermore, we investigated how these associations are connected to academic achievement. Hence, focusing on both a beneficial and a detrimental academic emotion in the scholastic context, we investigated whether the best friend can be identified as a resource or a risk factor, or maybe even both, with regard to the socialization of academic emotions in the classroom. The large-scale design allows us to test the indirect influences of the best friend's academic emotions on a student's achievement through the academic emotions of the student.

1.1. Academic emotions

Academic emotions are generally defined as emotions related to learning/achievement situations and outcomes (Goetz, Zirngibl, Pekrun, & Hall, 2003). By this definition, academic emotions include achievement emotions experienced in school, but go beyond emotions related to success and failure by also addressing, for example, emotions

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associated with instruction or the process of studying (Pekrun et al., 2002). Expanding earlier conceptualizations of emotions (e.g., Russell, 1980; Schlosberg, 1954), Pekrun (1992) suggested a three-way taxonomy of academic emotions in terms of their focus, valence, and activation (for an overview see Pekrun, Frenzel, Goetz, & Perry, 2007). With respect to their object focus, two types of academic or achievement emotions can be distinguished: activity emotions pertaining to ongoing achievement related activities, and outcome emotions pertaining to the outcomes of these activities (Pekrun, 2006). In addition, both activity emotions and outcome emotions can be grouped according to their valence (positive vs. negative or pleasant vs. unpleasant) as well as their level of activation (activating vs. deactivating). Quite recently, research on students' distinct emotions in academic settings has addressed activity emotions such as enjoyment (a positive activating emotion, for an overview see Ainley & Hidi, 2014) and boredom (a negative, deactivating emotion, for an overview see Goetz & Hall, 2014). Generally, it is assumed that positive activating emotions have positive effects on achievement, whereas negative deactivating emotions have negative effects on achievement and learning behavior. Empirical findings support this assumption (e.g., Frenzel, Thrash, Pekrun, & Goetz, 2007; Pekrun et al., 2002; Pekrun, Hall, Goetz, & Perry, 2014).

There is growing empirical evidence that academic enjoyment and boredom are organized in a domain-specific manner (e.g., Goetz, Frenzel, Hall, & Pekrun, 2008). For example, Goetz, Frenzel, Pekrun, and Hall (2006) found that enjoyment shows the strongest degree of domain specificity among different emotions assessed in six subject domains (see also Goetz, Pekrun, Hall, & Haag, 2006). Results obtained by Goetz (2004) showed that the relations between emotions in different subjects are relatively small, indicating that adolescents experience enjoyment and boredom on different levels in different subjects. However, although there is growing evidence of the domain specificity of academic emotions, only few studies have investigated the underlying mechanisms (for an exception see Goetz, Lüdtke, Nett, Keller, & Lipnevich, 2013). Thus, we focused on the possible influence of friends in this study.

1.2. Relevance of enjoyment and boredom

The positive effects of students' enjoyment on achievement (e.g., Pekrun et al., 2002), and the detrimental effects of boredom on achievement across scholastic domains (e.g., Daniels et al., 2009; Pekrun et al., 2010), have been documented by a number of studies. Theoretical explanations depict a mediation through motivation, (meta-) cognitive activities, and cognitive resources. In this sense, enjoyment has been found to be positively, and boredom to be negatively, associated with students' mastery goals, interest, intrinsic motivation, attention, effort investment, self-regulation, elaboration and the use of metacognitive strategies (Pekrun et al., 2002; Pekrun, Elliot, & Maier, 2006) and, in turn, achievement (Goetz, 2004).

Enjoyment and boredom have been found to be among the most frequently reported emotions in the scholastic context (Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Pekrun & Linnenbrink-Garcia, 2012). Due to their prevalence in academic settings and their contrary effects on learning and achievement, as well as their salience across academic domains (e.g., Goetz et al., 2007), we addressed these two emotions in the current study.

1.3. Friends' influences on students' academic emotions

Previously, when predicting students' academic emotions through social environments, researchers have primarily focused on parents and teachers observing, respectively, their expectancies and characteristics of their instructional or educational practices. Pekrun (2006), for instance, argued that individual sources of emotions (i.e., control- and value-related appraisals) are influenced by parents' and teachers'

achievement expectations and interaction structures (e.g., feedback practices, established goal structures, autonomy support vs. control). Other theoretical models specifically underpin the relevance of social influences on students' enjoyment and boredom. For example, Robinson's (1975) model of academic boredom explicitly considers social environment as a third type of antecedent, asserting that teachers, parents, and peers (in terms of valuing the subject domain) may impact students' experiences of academic boredom. The present study adopts this perspective and applies it to the friendship context.

In the context of the present study we define friendship as a voluntary, dyadic relationship between two individuals (e.g., Hartup, 1996). We also explicitly include perceived best friendships in terms of unilateral friendships in our definition (e.g., Bot et al., 2005), thus focusing on reciprocal as well as unilateral best friendships. Neglecting the restriction of reciprocity is justified by the assumption that unilateral friendships are also subject to developmental influences (here, in terms of adopting academic emotions). It can be assumed that a student's motivation to develop a mutual best friendship may result in a large-scale adoption of the other individual's academic emotions (and attitudes, values etc.), in that an expression of great similarity may heighten the probability that the unilateral friendship will develop into a mutual best friendship. When focusing on friendships in the school context, we have to keep in mind that classmates remain constant across school subjects in many school systems (as in the German school system). Therefore, the best friend is expected to have an influence on a student's academic emotions in all domains.

Empirical evidence shows that individuals can pick up emotions from partners while interacting (Coviello et al., 2014; Fowler & Christakis, 2008) and, consequently, their emotions become similar to those of their friends (e.g., for school related values see Shin & Ryan, 2014). One theoretical explanation can be derived from the emotional contagion theory (Hatfield, Cacioppo, & Rapson, 1994): Students can adopt the emotions of their best friends through face to face interactions. More specifically, this theory provides a framework to explain why particularly close relationships, such as dyadic friendships, provide conditions which facilitate the adoption of emotions from one another. This process comprises two steps: The first step is derived from the hypothesis that individuals mimic the emotions of their counterparts. Regarding classroom relationships, the intention to mimic the emotions of one another is more likely to develop between best friends because the empathy created by exhibiting the same emotions strengthens intimate reciprocal friendships (or it might form the basis for an intimate friendship). As a result, the counterpart feels understood by his/her best friend. In addition—and particularly relevant in the school context where instructional methods and the classroom climate can restrain students from openly expressing their emotions—students can perceive the emotional reactions of their best friends through verbal expressions, such as “Math is fun” (cf. Hatfield et al., 1994). Findings in a study by Wild, Enzle, Nix, and Deci (1997) point out that information about emotional experiences can be an important source for perceiving another person's emotions. Back to emotional contagion theory, the second step is based on the facial feedback hypothesis, which aims to explain why individuals really do feel the same way their interaction partner feels: The central nervous system is responsible for emotional experiences. Thus, feedback via facial expressions, such as enjoyment or boredom, is transmitted to the central nervous system. Consequently, a person experiences the same emotion as his/her counterpart. For best friends in the same classroom, verbal, mimic and facial feedback processes seem to be highly responsible for the expression of similar domain-specific emotions between friends. With respect to intrinsic value, a motivational aspect that is closely related to enjoyment, empirical findings underpin this assumption with regard to the long-term adoption of friends' values (Berndt & Keefe, 1995; Molloy, Gest, & Rulison, 2010; Ryan, 2001; Shin & Ryan, 2014). For example, Shin and Ryan (2014) analyzed relationships among 6th graders, looking for links between students' intrinsic values and their (best) friends' intrinsic

values. The results suggest that the friends' intrinsic values influence students' intrinsic values over the course of a single school year. However, studies that focus on students' academic enjoyment or boredom are missing.

1.4. Present study

Given the well documented relevance of enjoyment for learning and achievement, and the consistently negative effects of boredom, little is known about the proximal social antecedents of these academic emotions. Despite a growing awareness of the importance of friends in adolescence, educational research has neither sufficiently investigated dyadic friendships in classrooms, nor has it analyzed them with respect to students' domain-specific emotions and indirect effects on achievement. In the present study, we did not address the characteristics or processes of adolescent friendships. Instead, we focused on similarity in students' school-related, domain-specific emotions in order to broaden our understanding of the socialization contexts of academic emotions. Identifying associations between the academic emotions of best friends would be an important step in research on the socialization of academic emotions (in addition to the roles of parents and teachers). We assume that both reciprocal, as well as unilateral, best friendship dyads have developmental significance for emotions as well as achievement. With this in mind, we formulated identical hypotheses for reciprocal and unilateral best friendships in the current study (conducted in two school subjects, mathematics and English as a foreign language):

H1.1. Best friends' enjoyment positively predicts enjoyment (in mathematics and English) among adolescents.

H1.2. Best friends' boredom positively predicts boredom (in mathematics and English) among adolescents.

Based on theoretical considerations (Pekrun, 2006), as well as empirical evidence, we expected associations between adolescents' emotions and achievement. According to these expected relationships, we assumed that friends would indirectly affect students' academic achievement through their role as models for academic emotions. Therefore, we formulated the following hypotheses:

H2.1. Best friends' enjoyment indirectly and positively predicts students' achievement through the students' enjoyment (in mathematics and English).

H2.2. Best friends' boredom indirectly and negatively predicts students' achievement through students' boredom (in mathematics and English).

This study goes beyond existing literature in several regards. First, the best friends' role in the interplay of academic emotions has rarely been investigated. Therefore, we focused on the associations between the academic emotions of the student's best friend and the student him or herself. Second, we investigated influences of the best friend on academic emotions in a domain-specific manner in order to resonate with the current state of research on academic emotions. Third, we analyzed unilateral as well as mutual best friendships, arguing that it is not the reciprocity, but rather the cognitive representation of an existent friendship, that is relevant for adopting emotions. Finally, the best friends' emotions were measured directly (using self-reports by the best friends). In contrast to student reports on the perceived emotions of their best friends, this method prevents inflated within-friendship-dyads-correlations resulting from students projecting their own emotions onto their friends (Ryan, 2000).

2. Method

2.1. Participants and procedure

In addressing the present research objectives, we drew on data collected in a larger German study. The participants were 700 public

secondary students in grades 5 through 7. Measurements were taken approximately two months after the start of the school year. To test our hypotheses, we included only those students whose nominated best friends (mutual or unilateral nomination) also took part in the study.¹ Thus, the final sample was based on 419 friendship dyads. One-hundred and thirty-five of these dyads (mean age = 11.08; *SD* = 0.96) were reciprocal best friendships, so-called *indistinguishable dyads* (dyad member A nominated dyad member B as first best friend, and vice versa). This group consisted of 79 female dyads (reciprocal friendship between two girls) and 56 male dyads (reciprocal friendship between two boys); more detailed, 78 dyads attended a higher scholastic track and 57 dyads attended a lower scholastic track.² In contrast, 284 dyads were unilateral best friendships (dyad member A nominated dyad member B as first best friend, but not vice versa), resulting in 284 *distinguishable dyads* (mean age = 11.85; *SD* = 0.93). This group consisted of 167 female dyads and 117 male dyads; furthermore, 148 of these dyads attended a higher scholastic track and 136 dyads attended a lower scholastic track. The Ministry of Education of the federal State of Baden-Württemberg approved and supported the study. Moreover, the study was conducted in accordance with ethical standards of the Declaration of Helsinki (World Medical Association, 2013). Informed consent for participation in the study was given by the school principals, teachers, and parents. Participation was completely voluntary and data collection was conducted by trained research assistants.

2.2. Measures

2.2.1. Friendship dyads

Friendship dyads were identified through peer-nominations (Bukowski, Hoza, & Boivin, 1994). Adolescents were asked to nominate three best friends within the same classroom in ranking order. The first nomination on the list of three was considered the student's best friend in class. Each adolescent was matched to his/her best friend in the data set by identification numbers. For this purpose, class by class, each student was accorded a unique identification number which was shown along with a list of names. To ensure anonymity, students were asked to report the identification numbers instead of the names of their three best friends.

2.2.2. Academic emotions

Enjoyment and boredom were assessed using the German version of a standardized questionnaire (AEQ, Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). A multi-matrix design was used (Munger & Loyd, 1988) with test booklets in which all items were presented for one school subject and anchor items were presented for the other subject. Test booklets were randomly distributed in each classroom. This method provides results similar to those obtained with complete datasets (Smits & Vorst, 2007). Due to the fact that this study was part of a larger study, we applied this method as an economic, within-schools assessment method. Enjoyment (anchor item: "I have fun doing [subject]") and boredom (anchor item: "I get bored doing [subject]") were each rated with three items, repeatedly in reference to a specific subject (mathematics or English, here a foreign language). All items were rated on a six-point scale, ranging from 1 (*completely not true*) to 6 (*completely true*). Internal consistencies were satisfactory and are depicted in Table 1. Assuring invariant constructs across the both subgroups of

¹ The excluded students also nominated other students as best friends, but these best friends (*n* = 188) were not included in the sample. Therefore, we had no information about reciprocity, and no information about the structure of the friendship dyad. Hence, 556 students reported at least an unilateral friendship. Because of missing values in all emotion and achievement variables, we excluded two more students. Thus, the final sample consisted of 554 students.

² In German secondary school education, students are assigned to one of three school tracks according to ability: Either to a higher, college-bound school track (Gymnasium), or one of the more vocationally oriented lower school tracks (Realschule and Hauptschule).

Table 1
Summary statistics.

	Indistinguishable dyads			Distinguishable dyads		
	M	SD	Rho	M	SD	Rho
Enjoyment mathematics	3.99	1.36	0.90	4.14	1.50	0.91
Enjoyment english	4.18	1.24	0.91	4.27	1.25	0.90
Boredom mathematics	2.62	1.35	0.82	2.49	1.47	0.80
Boredom english	2.44	1.28	0.71	2.52	1.36	0.82
Achievement mathematics	4.47	0.99	–	4.55	0.98	–
Achievement english	4.56	0.95	–	4.55	0.98	–
Enjoyment mathematics best friend	3.99	1.36	0.90	3.95	1.41	0.92
Enjoyment english best friend	4.17	1.24	0.91	4.20	1.30	0.91
Boredom mathematics best friend	2.62	1.35	0.82	2.64	1.45	0.79
Boredom english best friend	2.44	1.28	0.71	2.45	1.27	0.82
Achievement mathematics best friend	4.48	0.99	–	4.57	0.87	–
Achievement english best friend	4.56	0.96	–	4.66	0.89	–

Note. Rho: Construct reliability (Jöreskog's rho).

reciprocated and unilateral friendships the dimensions were tested for their invariance along three steps (Cheung & Rensvold, 2002). The first step tested the configural invariance. Therefore, a multigroup-model with 2 (emotions) \times 2 (school subjects) were tested. This model showed a good fit, χ^2 (84, $n = 554$) = 200.54, $p < .001$, RMSEA = .07, SRMR = 0.06, CFI = 0.95, TLI = 0.91, indicating configural invariance. The second step, metric invariance across subgroups, was tested by restricting the factor loadings to be equal across groups. The comparison between the configural and the metric model showed no systematic difference, TRd^3 ($df = 8$) = 12.24, $p = .14$, indicating metric invariance. In the third step, scalar invariance was tested by fixing the manifest intercepts to be equal across groups additional to the fixed factor loadings. As compared to the metric model, these restrictions did not lead to a worse model fit, TRd^3 ($df = 8$) = 7.80, $p = .45$, which points to scalar invariance. Thus, the requirements of invariant constructs across groups are met.

2.2.3. Achievement

Self-reported report card grades in mathematics and English were used as an indicator of academic achievement. The reported grades referred to students' school marks for their most recent exam in mathematics and English, respectively. The grades were coded so that higher values represent higher achievement.

2.3. Analyses

All models were estimated using Mplus 8 (Muthén & Muthén, 2017). Missing values due to item nonresponse (8.10%) proved to be completely at random, Little's MCAR test: χ^2 ($n = 554$) = 742.70, $p = .15$. The multi-matrix design necessitates the application of a MAR assumption regarding missing values controlled by the researcher. In this case we were able to use an MLR estimator (which is comparable with the full information maximum likelihood estimator). Thus all model parameters were estimated based on the available data, resulting in reduced biased results compared to list-wise deletion techniques (e.g., Arbuckle, 1996). The data were collected classroom-wise, thus the data structure was nested. This resulted in a violation of the independence of observation assumption for standard SEM, and ignoring the data structure would lead to biased estimations of the standard errors (Raudenbush & Bryk, 2002). Therefore, the MLR estimator engaged the pseudo maximum likelihood (PML) covariance matrix (Asparouhov, 2005) to correct for the effects of observation dependencies within classrooms.

To test the hypotheses, we estimated Actor-Partner-Interdependence

Models (APIM) as structural equation models (Olsen & Kenny, 2006), separately for the emotions enjoyment and boredom in mathematics and English. Taking the specific data structure into account – i.e. that some friendships are reciprocal, resulting in indistinguishable dyads, and some friendships are unilateral (“perceived friendships”) and produce distinguishable dyads – we analyzed the two groups separately in accord with Olsen and Kenny (2006). Following their suggestions, we considered several restrictions regarding the measurement model that resulted from the latent specification of the emotions enjoyment and boredom as well as the specification of the paths in the APIM. The items representing enjoyment and boredom in the model served as manifest indicators of the related latent constructs. Preventing an overestimation of the assumed associations within indistinguishable dyads (the student is at the same time a best friend) the factor loadings (a and b), the factor variance (p), the three item intercepts (c , d , and e), and the three item measurement error variances (f , g , and h) were set to be equal (see Fig. 1). For distinguishable dyads, all parameters were freely estimated. Regarding the final APIM, actor and partner effects were included. Actor effects describe the effect of the friend's emotion on his/her own achievement as well as the effect of the student's emotion on his/her own achievement. In contrast, partner effects imply the effect of the friend's emotion on the student's achievement, and the effect of the student's emotion on his/her friend's achievement. For indistinguishable dyads also the actor effects ($I1$ and $I2$), partner effects ($m1$ and $m2$), outcome intercepts ($o1$ and $o2$) and residual variances ($q1$ and $q2$) were restricted (Fig. 1, Kenny, Kashy, & Cook, 2006; Olsen & Kenny, 2006). Because we used a pairwise arrangement for the data resulting in a doubled inclusion of each dyad in the indistinguishable subsample, we used a case weight option of 0.5 implemented in Mplus (Olsen & Kenny, 2006) to prevent an overestimation of the assumed effects. Regarding the unilateral friendship dyads, it was possible that one student was nominated more than once. In order to control for this, we also used a case weight option based on the number of nominations of each student in the dataset. As with the measurement model, the final APIM also does not include restrictions for the distinguishable dyads. Some hypotheses were formulated as indirect effects (i.e., the best friend's emotions predict the student's emotions and subsequently achievement). Thus, the factor intra-class covariance was included as a direct path, i.e. the emotion of the friend is regressed onto the emotion of the student (path r).

Testing the indirect hypotheses, we estimated the indirect effects of the friends' emotions on the students' achievement through his/her respective emotions by applying the MODEL INDIRECT option in Mplus. For indistinguishable dyads, actor as well as partner mediation effects should be identical due to the structure of the data (student and best friend are indistinguishable). Since no causal mediation hypotheses were formulated, the total effects (achievement predicted by the

³ Differences are based on a scaled χ^2 (TRd) because of the fit statistics obtained by the MLR-estimator in Mplus (Satorra, 2000; Satorra & Bentler, 2001).

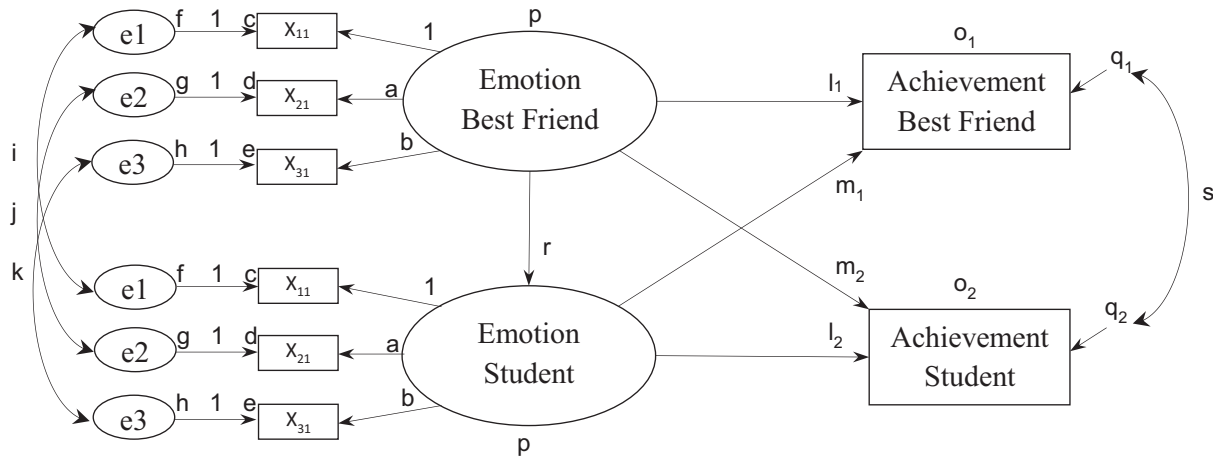


Fig. 1. The Actor-Partner-Interdependence Model with latent emotion variables and manifest achievement variables (based on Olsen & Kenny, 2006). The parameters for the latent measurement model of the emotion variables include two estimated factor loadings (a and b), the factor variance (p), the factor intra-class covariance as a direct path (r), the three item intercepts (c , d , and e), the three item measurement error variances (f , g , and h), and the three item intra-class error covariances (i , j , and k). The parameters for the Actor-Partner-Interdependence model additionally include the actor effects (l_1 and l_2), partner effects (m_1 and m_2), outcome intercepts (o_1 and o_2), residual variances (q_1 and q_2), and the residual covariances (s). Identical labels are set to be equal for indistinguishable dyads.

friend's emotion, without considering the mediator) do not have to be statistically significant (MacKinnon, Krull, & Lockwood, 2000; Preacher & Hayes, 2008; Zhao, Lynch, & Chen, 2010).⁴ In order to test the indirect effects on statistical significance in APIM, bootstrapping (500 resamplings) was used, which has proven to be an adequate method (Ledermann, Macho, & Kenny, 2011; MacKinnon, 2008). This technique estimates the standard errors for statistical significance based on a 95% confidence limit. If null is not included in this interval, the indirect effects are considered to be statistically significant.

3. Results: indistinguishable dyads

3.1. Descriptive results

Enjoyment was experienced at a higher level in comparison to boredom (see Table 1). Correlational results indicated moderate to high domain-specific relations between each emotion (enjoyment or boredom). Associations between the emotions of a student and his/her friend were significant for enjoyment as well as for boredom, for both mathematics and English, also the associations between the two friends' grades were moderately significant. The results are depicted in Table 2.

3.2. Main results – direct effects

The final models for enjoyment in each of the two school subjects showed a good fit to the data (see Table 3). As expected, the best friend's level of enjoyment was related to the level of the student's enjoyment in mathematics, $\beta = 0.41$, $SE = 0.11$, $p < .001$, and English, $\beta = 0.39$, $SE = 0.07$, $p < .001$ (see Fig. 2). The more domain-specific enjoyment reported by the best friend, the more domain-specific enjoyment was reported by the student. In line with our expectations, a student's enjoyment predicted his/her achievement in mathematics, $\beta = 0.28$, $SE = 0.06$, $p < .001$, and English, $\beta = 0.21$, $SE = 0.05$, $p < .001$ (actor effect): The higher the self-reported enjoyment for a subject, the better the achievement in this subject. The direct effects of friends' enjoyment on students' grades (partner effect) were not significant in mathematics, $\beta = 0.01$, $SE = 0.06$, $p = .42$, but they reached significance in English, $\beta = 0.08$, $SE = 0.04$, $p = .03$.

The final models for boredom also showed a good fit (Table 3). As

expected, a within-dyad-link was also found for boredom in both domains (see Fig. 3), indicating that the more boredom reported by the best friend, the more boredom was reported by the student (mathematics: $\beta = 0.24$, $SE = 0.14$, $p = .04$, English: $\beta = 0.43$, $SE = 0.14$, $p < .01$). Also consistent with our expectations, a student's boredom predicted his/her achievement in mathematics, $\beta = -0.22$, $SE = 0.07$, $p < .001$, and English, $\beta = -0.31$, $SE = 0.12$, $p < .01$ (actor effect): The higher the self-reported boredom for a subject, the lower the achievement in this subject. The direct effects of friends' boredom on students' grades (partner effects) were significant for boredom in mathematics, $\beta = -0.14$, $SE = 0.08$, $p = .04$, and English, $\beta = -0.20$, $SE = 0.08$, $p < .01$.

3.3. Main results - indirect effects

In a final step, indirect effects were estimated. We could validate the hypothesized indirect effects of the best friend's enjoyment on the student's achievement mediated by the student's enjoyment in mathematics ($\beta = 0.15$; $CI = [0.043; 0.223]$) as well as in English ($\beta = 0.10$; $CI = [0.046; 0.144]$). We could also demonstrate the hypothesized indirect effect of the best friend's boredom on the student's achievement mediated by the student's boredom in English ($\beta = -0.10$; $CI = [-0.353; -0.042]$), but not in mathematics ($\beta = -0.06$; $CI = [-0.157; 0.008]$). Thus, the best friend's boredom was associated with the student's achievement, mediated by the student's boredom, but only in the school subject of English.

4. Results: distinguishable dyads

4.1. Descriptive results

The descriptive results for distinguishable dyads also indicated that enjoyment was experienced at a higher level in comparison to boredom (Table 1). Correlational results indicated moderate to high links for each emotion (enjoyment or boredom) between domains. Associations between a student's and his/her friend's emotions were significant for enjoyment as well as for boredom in mathematics and for enjoyment in English. Associations in achievement between friends were significant in English but not in mathematics. The results are presented in Table 2.

4.2. Main results – direct effects

The final enjoyment-models showed a good fit to the data (Table 3).

⁴ Additional information about the direct effects can be taken from the correlational results.

Table 2
Correlations.

	1	2	3	4	5	6	7	8	9	10	11	12
1 Enjoyment mathematics	—	0.35**	−0.87**	−0.20*	0.39**	0.02	0.30**	0.08	−0.21**	−0.03	0.13	0.10
2 Enjoyment english	0.15*	—	−0.33**	−0.85**	0.04	0.24**	0.14	0.13*	−0.15*	−0.11	0.07	0.11*
3 Boredom mathematics	−0.87**	−0.22*	—	0.32**	−0.30**	−0.03	−0.29**	−0.06	0.29**	0.08	−0.20**	0.02
4 Boredom english	−0.31**	−0.90**	0.45**	—	0.02	−0.11	−0.10	−0.05	0.19*	0.08	−0.14*	0.08
5 Achievement mathematics	0.38**	0.02	−0.24**	0.07	—	0.31**	0.02	−0.08	0.11	0.08	0.16	0.08
6 Achievement english	0.02	0.31**	0.02	−0.26**	0.26**	—	0.01	0.10	0.02	−0.11	0.17*	0.20**
7 Enjoyment mathematics best friend	0.39**	0.12	−0.30**	−0.21**	0.13	0.01	—	0.27*	−0.85**	−0.20	0.26**	0.06
8 Enjoyment english best friend	0.12	0.36**	−0.18*	−0.37**	0.06	0.21**	0.15*	—	−0.25*	−0.83**	0.07	0.33**
9 Boredom mathematics best friend	−0.30**	−0.18**	0.26**	0.28**	−0.16	0.00	−0.87**	−0.22*	—	0.34**	−0.16*	0.02
10 Boredom english best friend	−0.21**	−0.37**	0.29**	0.46**	−0.08	−0.23**	−0.31**	−0.90**	0.45**	—	0.05	−0.28**
11 Achievement mathematics best friend	0.13	0.06	−0.16	−0.08	0.26*	0.15	0.38**	0.02	−0.24**	0.07	—	0.33**
12 Achievement english best friend	−0.01	0.21*	0.00	−0.23**	0.15	0.40**	0.02	0.31**	0.02	−0.26**	0.26**	—

Note. Correlations below the diagonal are for indistinguishable dyads and represent intra-class correlations; correlations above the diagonal are for distinguishable dyads and represent Pearson correlations.

* $p < .05$.

** $p < .01$.

Table 3
Fit indices.

	χ^2	df	p	CFI	RMSEA	SRMR
Indistinguishable dyads						
Mathematics enjoyment	35.33	25	0.08	0.98	0.04	0.05
English enjoyment	13.36	25	0.97	1.00	0.00	0.04
Mathematics boredom	39.35	25	0.03	0.96	0.05	0.05
English boredom	18.32	25	0.83	1.00	0.00	0.04
Distinguishable dyads						
Mathematics enjoyment	16.10	13	0.24	1.00	0.03	0.03
English enjoyment	9.22	13	0.75	1.00	0.00	0.02
Mathematics boredom	21.73	13	0.06	0.97	0.05	0.04
English boredom	18.99	13	0.12	0.99	0.04	0.03

Note. The calculated models for the indistinguishable dyads are the I-SAT-Models described by Olsen and Kenny (2006) resulting in no further adjustments to the chi-square test statistic and model fit indices; CFI = comparative fit index; RMSEA = Root-mean-square error of approximation; SRMR = Standardized root-mean-square residual.

As expected, the best friend's level of enjoyment was related to the level of the student's enjoyment in mathematics, $\beta = 0.33$, $SE = 0.09$, $p < .001$, and English, $\beta = 0.15$, $SE = 0.08$, $p = .03$ (see Fig. 4). The more enjoyment reported by the best friend, the more enjoyment regarding mathematics, as well as English, was reported by the student. Supporting our expectations, a student's enjoyment predicted his/her achievement in mathematics, $\beta = 0.27$, $SE = 0.05$, $p < .001$, and English, $\beta = 0.17$, $SE = 0.05$, $p < .001$ (actor effect): The higher the self-reported enjoyment for a subject, the better his/her achievement in this subject. The direct effect of the perceived friend's enjoyment on a student's grade (partner effect) was neither significant in mathematics,

$\beta = -0.07$, $SE = 0.05$, $p = .07$, nor in English, $\beta = 0.06$, $SE = 0.06$, $p = .13$.

The within-dyad-link for boredom was confirmed in mathematics, $\beta = 0.33$, $SE = 0.08$, $p < .001$, but not in English, $\beta = 0.04$, $SE = 0.11$, $p = .36$ (see Fig. 5). Furthermore, students' boredom negatively predicted achievement in mathematics, $\beta = -0.23$, $SE = 0.07$, $p < .001$, but not in English, $\beta = -0.08$, $SE = -0.07$, $p = .14$, indicating that higher levels of student boredom diminish achievement in mathematics (actor effect). Similar to the results found for enjoyment, the direct effect of the friend's boredom on a student's grade (partner effect) was neither significant in mathematics, $\beta = -0.02$, $SE = 0.07$, $p = .46$, nor in English, $\beta = -0.15$, $SE = 0.10$, $p = .06$.

4.3. Main results - indirect effects

In a final step, indirect effects were estimated. We could verify the hypothesized indirect effects of the best friend's enjoyment on the student's achievement mediated by the student's enjoyment in mathematics ($\beta = 0.12$; $CI = [0.035; 0.197]$). This indirect effect was also found for boredom in mathematics ($\beta = -0.09$; $CI = [-0.155; -0.030]$). Thus, the best friend's emotions—enjoyment and boredom—were associated with the student's achievement, mediated by the student's emotions.

In the school subject of English, we found an indirect effect for enjoyment ($\beta = 0.03$; $CI = [0.006; 0.084]$). Due to the non-significant within-dyad effect regarding boredom in English, we didn't calculate any indirect effect for this emotion.

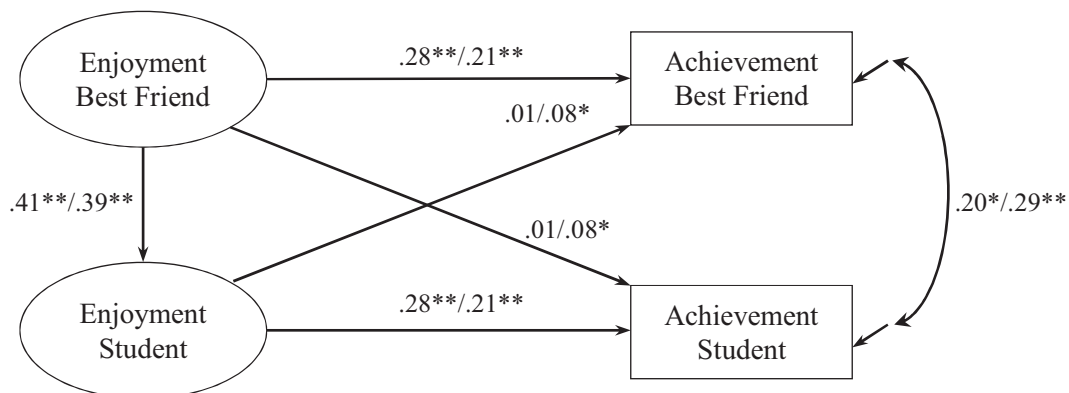


Fig. 2. Final structural equation model for indistinguishable dyads on enjoyment; coefficients (mathematics/English) represent unstandardized estimates.

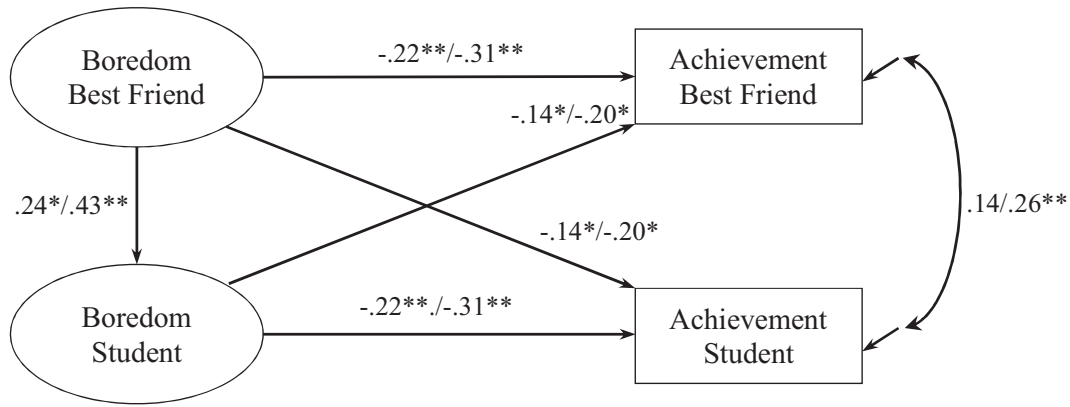


Fig. 3. Final structural equation model for indistinguishable dyads on boredom; coefficients (mathematics/English) represent unstandardized estimates.

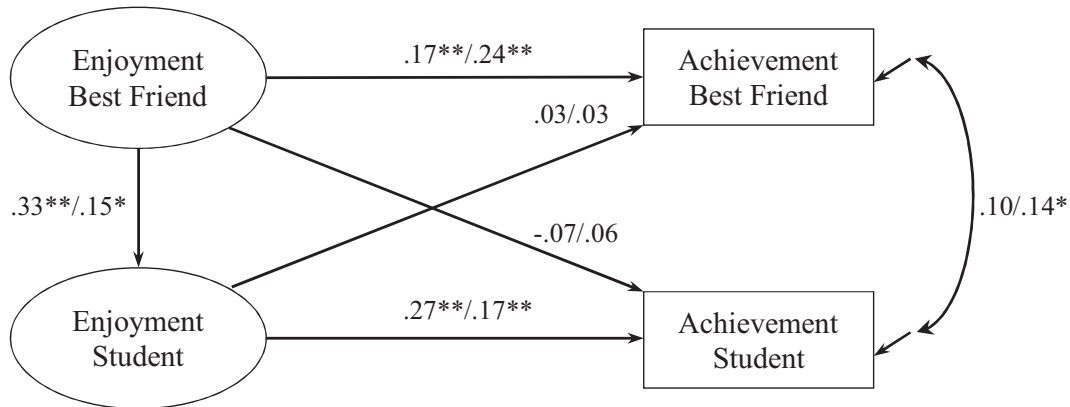


Fig. 4. Final structural equation model for distinguishable dyads on enjoyment; coefficients (mathematics/English) represent unstandardized estimates.

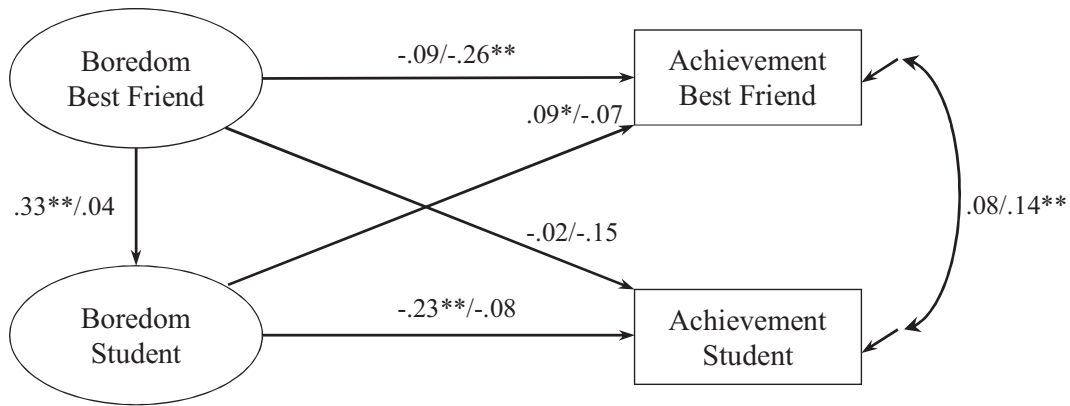


Fig. 5. Final structural equation model for distinguishable dyads on boredom; coefficients (mathematics/English) represent unstandardized estimates.

5. Discussion

Based on emotional contagion theory (e.g. Hatfield et al., 1994), this study focused on within-friendship-associations in enjoyment and boredom and, in turn, their associations with students' achievement in mathematics and English. First, in line with prior results (Daniels et al., 2009; Pekrun et al., 2002; Pekrun et al., 2010), we could show a significant link between academic emotions and achievement: Enjoyment as a positive, activating emotion was linked to better achievement, whereas boredom as a negative, deactivating emotion was associated with lower achievement in both domains (in nearly all models). These results underpin the assumed effects of emotions on academic achievement (e.g., Pekrun, 2006), and emphasize the importance of understanding the developmental conditions of these two emotions.

In line with previous findings regarding the associations of intrinsic values between friends (Berndt & Keefe, 1995; Molloy et al., 2010; Ryan, 2001; Shin & Ryan, 2014), we found significant relationships between students' enjoyment and their best friends' enjoyment in reciprocal friendship dyads as well as in unilateral, perceived friendship dyads. The domain-specific focus extends our understanding concerning the associations of academic emotions between friends and their importance for achievement. Regarding mathematics and English, a friend's high academic enjoyment can be seen as a resource for an individual's level of enjoyment. Furthermore, the significant indirect effects (in nearly all models) of best friends' enjoyment on students' achievement (in mutual and unilateral friendship dyads) underpin the relevance of best friends within classes for academic learning and achievement.

The within-dyad-link was also found for boredom in both domains for reciprocal friends. For unilateral perceived friendship dyads the effect was only found in mathematics and not in English. Focusing on unilateral friendships, the smaller effects regarding boredom, compared to enjoyment, can be discussed as follows: Both emotions can be perceived by an individual via small hints made by a best friend concerning his/her emotions. Thus, the source of information regarding such hints should not differ between the two emotions. However, with respect to observational processes, it would be harder to observe boredom than enjoyment through facial expressions. Theoretical explanations and empirical results support this assumption (see [Ortony & Turner, 1990](#)). Specifically, enjoyment is classified as a basic emotion which can be clearly identified by facial expressions. In contrast, boredom is not classified as a basic emotion and this emotion is likely to be less clearly expressed because, among other things, this emotion is less acceptable in the classroom. Assuming that, in unilateral friendship dyads, friendship quality is lower and intimate communication is less likely, the possibility for perceiving such a negative emotion through a clear expression combined with expressed hints would be diminished.

Comparing the effects of reciprocal friendship dyads and unilateral friendship dyads, relationship quality could also explain the stronger associations within reciprocal best friendships than those seen in unilateral best friendships. Assuming that, in reciprocal friendships, intimate conversations about emotions may occur more often than in unilateral friendship dyads, the latter might be more dependent on observational processes, such as facial expressions, than on small hints. This could make it more difficult to perceive the emotions of the friend, resulting in lower or no effects (regarding boredom in English) compared to reciprocal friendships. Nonetheless, the effects within unilateral friendship dyads affirm the developmental significance, also for a perceived best friendship.

Regarding the similarity of friends concerning emotions and grades, we assume that in reciprocal friendships the direction of influence corresponded to our assumptions in nearly all models, e.g. friends' emotions had an effect on students' emotions and, in turn, on their achievement. This assumption should be more likely than the opposite direction, e.g. friends' grades affected students' grades and, in turn, their emotions. One explanation could be that, in reciprocal friendships, intimate communication about one another's emotional states is more important, and more likely, than perception of and communication about structural indicators like grades. There is evidence supporting the converse influence, i.e. that of grades on emotions ([Pekrun, Lichtenfeld, Marsh, Murayama, & Goetz, 2017](#)). Based on our results concerning reciprocal friendship dyads, we would expect that best friends are more likely to influence this bidirectional development through their emotions than their grades. Regarding unilateral friendships, it can be assumed that students who nominated someone as a best friend were influenced by his/her emotions or grades to increase the similarity between the two of them in the other variable. From our point of view this indicates that, in unilateral friendship dyads, a socialization process transpires with the aim of building the unilateral best friendship into a reciprocal best friendship.

However, due to the cross-sectional design, we cannot differentiate whether friend selections were based on similarity regarding the same level of enjoyment (for mathematics and English), or if this similarity was an effect of socialization processes within the friendship. Based on earlier findings by [Shin and Ryan \(2014\)](#), we assume that in reciprocal friendships the socialization effect would be stronger—they only observed socialization effects within one school year for intrinsic value—similar to the emotion enjoyment. For the distinguishable dyads, it could be assumed that perceived friends influence students regarding their emotions in mathematics and their grades in English, resulting in a higher similarity going forward. Due to positive associations between best friends' grades (i.e., significant residual covariances) selection and/

or socialization effects on the basis of grades or on the basis of other third variables, especially in the school subject of English, were indicated. We assume that in unilateral friendship dyads students pick up friends similar in one dimension—emotions or grades (see also [Gremmen, Dijkstra, Steglich, & Veenstra, 2017](#); [Shin & Ryan, 2014](#))—and get more similar during the friendship creating the precondition that the perceived best friend will also pick the student as his/her best friend as well.

Due to some significant direct partner effects in the APIM, e.g. the effect of friends' enjoyment and boredom on students' achievement in English for reciprocal friendship dyads, we should take further mediators into consideration (e.g., [Zhao et al., 2010](#)). A possible mediator could be that, due to boredom, the learning activities of the students were reduced and thus responsible for their lower achievement.

Going beyond the dyadic perspective, it is important to consider larger friendship networks as well. Thus, the friendship network can serve as normative basis for what is accepted as a valuable aim and, in turn, a "good" emotional reaction to a subject (e.g., [Ajzen & Fishbein, 1980](#)). Future studies should address the issue of larger friendship networks via social network analysis.

Finally, from an ecological perspective in which students participate in multiple socialization contexts, future studies might incorporate friend-, teacher- and family-contexts. In that friendships increasingly gain in importance as adolescents mature, it would be interesting to investigate whether friends replace family members over the course of adolescence as models for the adoption of academic emotions.

The present study has some limitations that one should bear in mind when interpreting the results. First, we assessed emotions retrospectively in a paper-pencil questionnaire. Therefore, the ecological validity is limited (e.g., [Bronfenbrenner & Morris, 2006](#)). However, the predicted associations with achievement point to solid construct validity.

Second, we did only focus on students who reported at least one unilateral best friendship in class, based on their first nomination in a list of three. However, there was a small subgroup of 32 dyads, where member A nominated member B as 'first best friend', but member B nominated member A as 'second' or 'third best friend'. Keeping in mind that adolescent friendships change over time ([Poulin & Chan, 2010](#)), it can be assumed that there is a higher likelihood that these relationships may change to mutual friendships compared to completely unilateral nominations.

In former studies unilateral friendships without any reciprocal nomination were often characterized as friendlessness. However, it would be interesting to investigate whether students without any nominated friend in the classroom—even not a unilateral friendship—are also influenced by their classmates (in our study every student nominated a best friend in the classroom), or if these students are rather influenced by their teachers' emotions. As we explicitly focused on reciprocal and unilateral best friendships in our study those students were not a relevant group but to gain a more sophisticated understanding of peer group effects, future studies should additionally investigate students with no friends in class.

Despite these limitations, the present study provides evidence for the important role that friends play in the experience of academic enjoyment. The study points to social learning processes for domain-specific emotions, and its results underline the importance of friends as a resource, as well as a risk factor, for learning and achievement. In addition to results in the behavioral context (where friends were identified as a risk factor for health, e.g., smoking or drinking, e.g. [Popp, Laursen, Kerr, Stattin, & Burk, 2008](#)), we found influences on positive as well as negative emotions. In sum, it seems reasonable to assume that peers can also indirectly (mediated through enjoyment and boredom) facilitate students' levels of achievement.

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