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Characteristics of Emotion Recognition Ability among Primary School Children: Relationships with Peer Status and Friendship Quality

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Abstract

The present study explored the characteristics of children's emotion recognition ability, as well as its relationships with peer status and friendship quality. Participants were 308 Chinese primary school children in Grades 2 to 6 (54% boys; $M_{age} = 9.99$ years, $SD = 1.49$). Emotion recognition ability was measured by responses to multimodal videos covering eight emotions. Peer status and friendship quality were measured by peer nomination and questionnaire, respectively. Results indicated that: 1) Emotion recognition ability showed an overall upward trend as children age, with girls performing better than boys; 2) There were significant differences on the accuracy scores between emotion categories (ranked from high to low as: anger, sadness, joy, amusement, fear, irritation, pleasure, and interest), as well as a significant interaction between emotion category and grade; 3) Emotion recognition ability was positively related with both peer status and friendship quality, demonstrating its ties to children's interpersonal interactions. These results not only broaden understanding about the development of emotion recognition ability, but also evidence its importance as a sensitive indicator of children's social relationships.

Keywords Emotion recognition ability · Peer status · Friendship quality · Chinese primary school children

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Reading and interpreting others' emotional expressions plays a critical role in social interactions. We identify happiness from smiles, sadness from people's tears, anger from their yells, and so forth. As for children, the development of emotion recognition ability (ERA) is not only a foundation for acquiring competencies such as emotion understanding and emotion regulation (Joseph and Newman 2010), but also plays a critical role in establishing their early social networks and peer relations (see Trentacosta and Fine 2010 for a review). This appears to be especially true in collectivistic cultures, where emotion expressions are usually more implicit (Kang et al. 2003). Although abundant research has discussed the development and interpersonal functions of ERA, some critical gaps remain. Specifically, the knowledge about older children's recognition of different emotions is limited, existing measurement tools have not shown satisfying ecological validity, and there have been few investigations connecting ERA with multiple levels of peer relations, such as peer status and friendship quality. Therefore, the current study aimed to investigate the development of ERA among Chinese primary school children, as well as its links with peer processes.

1 Development of Children's ERA

Emotion recognition ability refers to the competence to "accurately perceive and interpret the emotional states of others in social intercourse" (Bänziger et al. 2009, p. 691). It has been repeatedly shown that infants as young as a few months can discriminate among certain basic emotions (see Nelson and de Haan 1997 for a review), which refer to psychologically-irreducible emotions that exist in all cultures (Ortony and Turner 1990). The best recognized basic emotions typically include happiness, sadness, anger, and fear, with disgust and surprise also sometimes included. ERA is therefore widely acknowledged as an early-developing skill. Despite a large body of literature on emotion recognition in infancy and early childhood, there is relatively less knowledge about the continued development of ERA from childhood into adolescence (Lawrence et al. 2015). As primary school children are in the midst of this transition, investigations of this stage can complement our understanding of the continuing development of ERA, and thus provide guidance on detecting children who are slower to develop emotion recognition skills.

The Differentiation Model (Widen and Russell 2008; Widen 2013) suggests that children's understanding of facial expressions is a long path from broad categories to specific, discrete emotions. Recent studies have increasingly shown that the development of ERA is by no means stagnant after early childhood, but rather is an enduring process from infancy to adulthood (Burnett et al. 2009; Lawrence et al. 2015; McClure 2000; Rodger et al. 2015; Thomas et al. 2007; van Beek and Dubas 2008; Widen et al. 2015). For example, Thomas et al. (2007) reported continued improvement in sensitivity to morphed faces between groups of older children, adolescents, and adults. Rodger et al. (2015) further compared recognition thresholds for facial pictures expressing one of six basic emotions among participants aged 5 years up to adulthood: Sadness and surprise showed gradual improvements in recognition, while disgust and anger evidenced steep improvements. van Beek and Dubas (2008) tested the recognition of both basic and ambiguous (combined by two or more basic emotions) expressions in 9- to 15-year-old youth, but only found age differences in decoding ambiguous

faces. In summary, these previous studies have shown the continued development of ERA beyond early childhood. However, they were almost all limited by an exclusive focus on the basic emotions, and by the use of static pictures as the stimuli. Considering there are far more emotion categories that unfold in a dynamic, multimodal fashion in our daily interactions, more research is needed to broaden our knowledge of ERA among primary school children.

We extended prior research in this area in two important ways. First, in terms of emotion categories, we considered both categorical classifications (basic and complex emotions) and dimensional classifications (dividing emotions based on valence and arousal; Russel 1980) when including various emotions. As children begin their formal schooling, they are gradually exposed to more complex and subtle emotions (e.g., amusement, anxiety, and embarrassment), which have been shown to be even more frequently experienced in daily life than some basic emotions (Scherer et al. 2004). Nevertheless, it is still not clear how children gradually grasp these complex emotions. Additionally, since most basic emotions are negative in valence, this tendency also leads to a neglect of positive emotions, which similarly play a crucial role in personal development (Fredrickson and Branigan 2005). It has been emphasized that there are a number of positive affect states under the umbrella term "happiness", such as pride, amusement, and pleasure, which convey quite distinct feelings and have discrete signals (Sauter 2010). Therefore, it is necessary to include various positive emotions to measure ERA more comprehensively. The practice of including only one positive emotion may also inflate the accuracy rate of happiness, due to its obvious differences with other options. Previous research has largely shown that happiness is the earliest and best recognized emotion, followed by anger and sadness, then by fear and other emotions (see Widen 2013 for a review). It remains to be seen whether the order remains unchanged after including additional complex and positive emotions. In the current study, we respectively selected two emotions from each of the four quadrants divided by valence and arousal, which included both basic and complex emotions. Thus, we were able to test the age differences of ERA more comprehensively, as well as compare accuracies of different emotions.

Second, in terms of the expressive stimuli used, we replaced static facial pictures with dynamic, multimodal videos. The recognition of emotions in everyday life is a complicated process that involves multi-channel cues. Besides facial expressions, vocal cues, gestures, and body language can all affect emotion-related judgments (Hawk et al. 2009; Wieser and Brosch 2012). ERA tests including the face, voice, and body were found to be more highly correlated with other measures of interpersonal accuracy than tests using only single-channel cues, suggesting that they capture ERA in a more comprehensive way (Schlegel et al. 2017a). Additionally, using still pictures rather than dynamic stimuli also reduces ecological validity to a large extent. Although it is still controversial whether dynamic information improves emotion recognition accuracy (see Krumhuber et al. 2013 for a review), such stimuli are undeniably closer to the emotion expressions observed in daily life and could evoke stronger emotional arousal (Krumhuber et al. 2013). Therefore, to explore emotion recognition as it occurs in the natural flow of analog information, stimuli are required that reflect the dynamic unfolding of expressions in multiple modalities (Bänziger et al. 2012). In the current study, we utilized short videos of emotional expressions developed by Bänziger et al. (2012) that simultaneously present facial, vocal, and bodily emotional cues.

2 Links between ERA, Peer Status, and Friendship Quality

It is widely acknowledged that emotions serve social functions (Fischer and Manstead 2008). Several theoretical models, such as the expanded social information processing model (Lemerise and Arsenio 2000), the emotions as social information (EASI) model (van Kleef 2009), and the affective social competence model (Halberstadt et al. 2001), have proposed that accurate reading or successful interpretation of others' emotions is a vital aspect of social interaction. At the practical level, some intervention programs, such as RULER (A social and emotional learning curriculum teaching children how to recognize, understand, label, express, and regulate emotions) and INTEMO (A training program targeted on emotional intelligence), have shown that integrating lessons and practices about ERA and other emotion skills into school curricula improved children's social adjustment over subsequent academic years (Brackett et al. 2012; Ruiz-Aranda et al. 2012). Summarily, we infer others' internal thoughts and attitudes from their external emotion expressions, so as to adjust our own responses accordingly. This is a foundation upon which individuals of all ages construct good interpersonal relationships. As for children, peer relation is one of the most important components among their interpersonal networks.

Generally, peer relation has been conceptualized on two levels (Gifford-Smith and Brownell 2003): group-based peer relations (i.e., peer status) and dyadic peer relations (i.e., friendships). Peer status is a unilateral construct from the group toward individuals, reflecting the view the group has of a specific member. It is usually measured by nominations of peer acceptance and peer rejection, which respectively refer to the degree to which a child is liked and disliked by peers (Bukowski et al. 1996). Friendship, however, is a bilateral construct between individuals, reflecting mutual, voluntary, and lasting intimacy among peers (Zou 1998). Peer status and friendship are closely related; low peer status is usually considered to set the stage for poor friendships because it blocks children's possibility to socialize and make friends (Bukowski et al. 1996; Pedersen et al. 2007). However, they still reflect quite different aspects of peer relations and may influence children's psychosocial adjustment in different ways (Gifford-Smith and Brownell 2003). A generally unpopular child is also likely to have several close friends, while being widely accepted in a group does not guarantee high friendship quality. Therefore, when it comes to the link between ERA and peer relations, it is necessary to explore both constructs.

Existing literature has mainly focused on how ERA relates to peer status, with substantial research evidencing their positive association (see Halberstadt et al. 2001 for a review). Among school-age children, several studies have shown that children's ability to recognize facial or vocal emotional expressions was positively related to their peer acceptance and negatively related to peer rejection (e.g. Edwards et al. 1984; Leppänen and Hietanen 2001; Mostow et al. 2002; Nowicki and Duke 1992). Additionally, even after controlling for the effects of other affective components, such as emotion expressivity (Arsenio et al. 2000) and emotional vocabulary knowledge (Miller et al. 2005), children's ERA remains a strong predictor of peer status.

In contrast, research concerning ERA and friendship is relatively rare. After children enter primary school, their understandings of friendships undergo

significant changes as they begin to learn the reciprocal nature of this special relationship (Marcone et al. 2015). The quality of friendship becomes increasingly important to children's development (Gifford-Smith and Brownell 2003), which makes it necessary to further examine the relationship between ERA and children's friendships. A few studies provide some evidence for this link. For example, Dunsmore and Noguchi (2008) demonstrated that preschoolers with reciprocal friendships had higher ability to send and receive emotional information. A study by Zou et al. (2008) demonstrated the positive relationship between self-reported emotion awareness and friendship quality among Chinese adolescents. In fact, ERA might be particularly important to multiple levels of peer relationships in collectivistic cultures. In a cross-cultural study, Kang et al. (2003) have found that ERA significantly predicted relationship quality among Korean, Chinese, and Asian American college students, but not for Euro-American students. Although participants were emerging adults, this study provides some initial insights into associations between ERA and interpersonal relationships in collectivistic societies. Within such contexts, children are usually socialized to control their emotional expressions because of display rules that favor inhibition and suppression (Oyserman et al. 2002). This could presumably lead to greater difficulty in recognizing others' emotions, compared to individualistic cultures. High ERA enables children to be sensitive to more subtle forms of expression, and therefore promotes correct understanding and appropriate responses to a large extent. The current study was conducted in China, a typically collectivistic country in which ERA might be especially crucial for both peer status and more intimate friendships.

3 The Present Study

The present study was designed to provide some in-depth insights into children's emotion recognition ability, which is a fundamental component of emotional competence and an important indicator of child adjustment. Specifically, we aimed to investigate the age differences and characteristics of ERA, as well as its interpersonal functions among Chinese primary school children. For the first aim, we extended earlier research regarding emotion categories and the ecological validity of stimuli. Using multimodal videos depicting eight basic and complex emotions, we studied children's ERA more comprehensively, including the overall age trends, comparisons between emotion categories, the interaction between emotions and grade, and response bias analysis. We hypothesized that, generally, children's ERA would increase with age (H1) and participants would score higher on basic emotions (H2). Given that the recognition ability on basic emotions usually develops early, we expected that accuracies on complex emotions would show larger grade differences among primary school children (H3). For the second aim, we tested the correlations between ERA and children's peer relations. Two different aspects of peer relations were included, namely peer status and friendship quality. Based on previous theories and studies, we hypothesized that ERA would be positively correlated with both other-rated peer status and self-reported friendship quality (H4). In other words, greater ERA was expected to predict better peer relations.

4 Methods

4.1 Participants

Participants ($N = 317$) were recruited from two public primary schools (one school of high achievement level and one of average level) in Beijing. We randomly selected one class in each grade (grade 1 was excluded because of inability to complete self-report questionnaires) of these two schools and invited the students to participate in our study on the premise of parental or guardian permission. Data of nine children were excluded because of obviously random responding. Thus, there remained 308 valid participants, aged between 7 and 14 ($M_{age} = 9.99$ years, $SD = 1.49$). There were 167 boys and 141 girls, respectively from grade 2 ($N = 66$; $M_{age} = 8.05$ years, $SD = 0.31$), grade 3 ($N = 65$; $M_{age} = 9.02$ years, $SD = 0.45$), grade 4 ($N = 56$; $M_{age} = 10.03$ years, $SD = 0.38$), grade 5 ($N = 67$; $M_{age} = 11.17$ years, $SD = 0.46$), and grade 6 ($N = 54$; $M_{age} = 12.01$ years, $SD = 0.59$) of primary schools.

4.2 Selection of Video Stimuli

The video stimuli were taken from The Geneva Multimodal Emotion Portrayals (GEMEP; Bänziger et al. 2012), which contains 1260 video clips of 18 emotions (12 emotions selected from the four quadrants in the emotional valence-arousal space, and six additional ones). The video clips (duration = 1–4 s) were produced by 10 professional adult actors in an interactive recording procedure. In each video clip, the actors are visible from their upper torso upwards (conveying facial and postural/gestural emotional cues) and pronounce a sentence made up of syllables without semantic meaning (conveying emotional cues through their voice). Schlegel et al. (2014) have used 14 emotions out of the GEMEP to develop The Geneva Emotion Recognition Test (GERT), which is a standardized and well-validated ERA test for adults. This further showed the utility of these emotions to measure individual differences on ERA. However, to date no test exists based on the GEMEP with a difficulty level adapted to children.

In order to create an ERA measure suitable for primary school children, we began by considering only the 12 emotions that Bänziger et al. (2012) mapped onto the valence-arousal space. They are 1) Pleasant & high arousal: joy, amusement, pride; 2) Pleasant & low arousal: pleasure, relief, interest; 3) Unpleasant & high arousal: anger, fear, despair; 4) Unpleasant & low arousal: irritation, anxiety, sadness. Three pre-studies were conducted to determine the final material to measure ERA. As a starting point, pre-study 1 first selected the emotion categories that would be used in the formal test. A sample of 70 children (38 boys, 32 girls; $M_{age} = 9.71$ years, $SD = 0.79$) in grades 3 and 4 of primary school were asked to assess their familiarity with the 12 emotion labels, from 1 = *not familiar at all* to 4 = *very familiar*, on a simple questionnaire. As the first step to narrow down the number of stimuli, only two emotions with relatively higher mean scores on this assessment were selected on every quadrant: joy, amusement, pleasure, interest, sadness, irritation, anger, and fear. This initial pretest insured that ERA scores would not be biased by unfamiliarity with the emotion labels presented to participants.

Since the number of videos in the original corpus was rather large, we only considered portrayals that were included in the 145-item Core Set of the GEMEP (Bänziger et al. 2012) and the 83 items of the GERT (Schlegel et al. 2014), which added up to 106 video clips under these eight emotions. In pre-study 2, we tested these videos among 37 (13 males, 24 females; $M_{age} = 23.62$ years, $SD = 2.17$) undergraduates and graduates from a university in Beijing. Participants were asked to select the most appropriate word from eight options to label the emotion of the actor in the video they just watched for all 106 videos. We assumed that if a specific video could not be recognized by most adults, it may be unsuitable to serve as a stimulus in a children's ERA test. Therefore, 11 videos with quite low accuracy (below 50%) were deleted. Among the remaining ones, we selected six to seven videos under each emotion category whose accuracy scores were evenly distributed from 50 to 100%. A total of 55 video clips were selected in this pre-study.

Pre-study 3 then measured these selected videos among our target population. A sample of 143 primary school children (71 boys, 70 girls; $M_{age} = 9.73$ years, $SD = 1.39$) in Grade 2 to 6 was invited to participate. Based on analyses of item difficulty and discrimination, we excluded seven video clips that either 1) did not obtain the highest percentage of responses on the target emotion, or 2) had a discrimination value below .30. We further made some adjustments to guarantee the approximate equality of video clip quantities between different emotions, as well as to avoid heavy imbalances in actor gender for every emotion. Finally, 43 videos were selected, with five or six clips under each emotion category.

4.3 Other Measures

Peer Status Peer nomination techniques were used to assess peer status. Participants were asked to tick the names of three classmates they liked most, and circle three they liked least on a class list. The numbers of nominations that children received on the two items were first standardized within class to mean = 0 and $SD = 1$, which were defined as peer acceptance and peer rejection respectively. Peer status was then computed by subtracting the peer rejection score from the peer acceptance score for each child.

Friendship Quality Parker and Asher (1993)'s Friendship Quality Questionnaire (FQQ) was used. This scale was initially designed for children and has been widely used among primary school students (e.g., Grotpeter and Crick 1996; Zhou et al. 2005). Items ask children to indicate how true a particular statement is with regard to their relationships with a best friend, on a 5-point Likert scale (1 = *not at all true* to 5 = *really true*). The Chinese version adapted by Zou (1998) includes 38 items and five dimensions (trust and support, companionship and recreation, validation, intimate exchange, conflict and betrayal). In order to make the number of items more appropriate for young children, we selected four items with relatively high loadings within each dimension, which added up to 20 items. Sample items read: "He/she cares about my feelings", "We always play together at recess", "He/she tells me I am pretty smart". The latent friendship quality variable was constructed by the average score of each dimension. The internal consistencies of five dimensions and the total scale were $\alpha = .72$, .65, .76, .70, .70, and .82 respectively.

4.4 Procedure

Data were collected in the middle of the fall term. Participants were tested in groups in a quiet classroom, equipped with a computer and a pair of headphones at every desk. At least three trained instructors with psychology degrees followed and supervised the process. Children were first asked to complete the ERA test on computers, which was programmed and displayed via E-prime 2.0. Instructors explained the operation methods and notes in detail before start. Participants then put on headphones and completed the test independently. The 43 video clips were displayed in a random order. After each one, the eight emotion labels (joy, amusement, pleasure, interest, sadness, irritation, anger, and fear) were presented on the screen, and children were asked to select the most appropriate option to match the video they just watched by clicking that label with the computer mouse. Children's answers were recorded automatically by E-prime and then transformed into binary variables with 0 = incorrect, 1 = correct (corresponding to the target emotion that the actor had been instructed to portray). Following the ERA test, participants were asked to complete the printed questionnaires. For some children in Grade 2 who were still unable to read by themselves, instructors explained the items one by one.

4.5 Data Analysis

The classic accuracy score (i.e. the ratio of answers on the correct option) on the ERA test was computed as the core variable. Basic characteristics of children's ERA were explored mainly with SPSS 20.0. In terms of the associations between ERA and peer relations, SPSS 20.0 was used to explore correlations between main variables and the regression model was then tested through SEM procedures in Mplus 7.0. The fit of model was considered acceptable when the Comparative Fit Index (CFI) and Tucker Lewis Index (TLI) values were at or above .90, and Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) values were at or below .08 (Kline 2011).

5 Results

5.1 Grade and Gender Differences on ERA

Mean accuracy scores and standard deviations on the ERA test are presented in Table 1. A 5 (Grade) × 2 (Gender) between-subjects ANOVA showed significant grade [F (4, 298) = 15.40, $p < .001$, $\eta^2 = .171$] and gender [F (1, 298) = 8.26, $p = .004$, $\eta^2 = .027$] main effects on ERA, but no significant interaction between the two [F (4, 298) = 0.17, $p = .953$, $\eta^2 = .002$]. The post hoc test indicated that 2nd graders scored significantly lower than the other four grades (all ps < .001); children in Grades 3 and 4 also had significantly lower accuracy than Grades 5 and 6 (3 vs. 5: $p = .014$; 3 vs. 6: $p < .001$; 4 vs. 5: $p = .048$; 4 vs. 6: $p = .001$); there were no significant differences either between

Table 1 Mean accuracies and standard deviations on the ERA test among primary school children

		Gender		Grade					Total
		Boys	Girls	2	3	4	5	6	
	n	167	141	66	65	56	67	54	308
Accuracy	*M*	.62	.66	.56	.63	.64	.68	.71	.64
	SD	.12	.12	.11	.12	.11	.10	.09	.12
	F	8.26**		15.40***					

* $p < .05$, ** $p < .01$, *** $p < .001$. Same as below

Grades 3 and 4 ($p = .698$), or between Grades 5 and 6 ($p = .157$).[1] Girls scored significantly higher than boys.

5.2 Accuracy Differences between Emotions

Significant differences in accuracy between emotion categories were found through the repeated-measures ANOVA [F (7, 2149) = 66.64, $p < .001$, $\eta^2 = .178$]. Ranked in descending order according to the mean accuracy scores were: anger, sadness, joy, amusement, fear, irritation, pleasure, and interest. Results of pairwise comparisons revealed that the accuracy for anger (76%) was significantly higher than all the rest; next were sadness, joy, amusement, and fear, which did not differ significantly on accuracy (around 70%); the relatively difficult emotions were irritation, pleasure, and interest, respectively, with only 40 to 60% participants answering correctly. The mean differences of accuracy between emotion categories were summarized in Table 2.

A 2 (between-subject: gender) × 8 (within-subject: emotion category) mixed-design ANOVA showed no significant interaction between gender and emotion category [F (7, 2142) = 0.54, $p = .802$, $\eta^2 = .002$]. Therefore, the accuracy differences between emotion categories were similar between boys and girls.

A 5 (between-subject: grade) × 8 (within-subject: emotion category) mixed-design ANOVA showed that the interaction between grade and emotion category was significant [F (28, 2121) = 2.15, $p < .001$, $\eta^2 = .028$]. The mean accuracy scores on each emotion category across different grades are depicted in Table 3. Results of one-way ANOVA showed that there were no significant grade differences on the recognition of joy [F (4, 303) = 1.21, $p = .306$], sadness [F (4, 303) = 2.36, $p = .053$], or anger [F (4, 303) = 1.29, $p = .276$]. However, older students scored significantly higher than younger students on the recognition of amusement [F (4, 303) = 5.02, $p = .001$], fear [F (4, 303) = 6.64, $p < .001$], irritation [F (4, 303) = 10.14, $p < .001$], pleasure [F (4, 303) = 6.77, $p < .001$], and interest [F (4, 303) = 4.50, $p = .002$]. To better display the interaction effect, participants were divided into three groups (grade 2, grade 3 & 4, grade 5 & 6) according to the overall ER developmental trend. The interaction is shown in Fig. 1.

[1] In case that the improvement on accuracy with age was due to longer attention span, we tested the accuracy differences between the first half and second half of ERA test. Results indicated that children in grade 5 and 6 scored higher in the second half (p = .021 and .042 respectively), which might indicate a practice effect; for children in grade 2 to 4, there were no significant differences between the two halves (p = .328, .492, and .559), suggesting that even younger children could maintain their attention through the whole test.

Table 2 Comparing mean accuracy scores across different emotions (I-J)

Emotion (J)	*M*	*SD*	Emotion (I)							
			joy	amusement	pleasure	interest	sadness	irritation	anger	fear
joy	.69	.24	–							
amusement	.69	.27	.00	–						
pleasure	.59	.29	.11***	.10***	–					
interest	.40	.28	.29***	.29***	.19***	–				
sadness	.70	.22	−.01	−.01	−.12***	−.30***	–			
irritation	.62	.23	.07***	.07***	−.04*	−.22***	.08***	–		
anger	.76	.21	−.06***	−.07**	−.17***	−.36***	−.05**	−.13***	–	
fear	.66	.26	.04	.03	−.07***	−.26***	.04*	−.04*	.10***	–

5.3 Response Bias Analysis

To further explore the characteristics of ERA among primary school children, the distribution of errors was analyzed. Table 4 displays a confusion matrix of both correct and incorrect responses, which visualizes the proportion of each option being selected for all emotion categories. Joy and amusement were often interchanged; pleasure was mostly misidentified as joy; sadness was sometimes recognized as irritation, as they are both negative and low-arousal emotions; irritation and anger, which only differed on intensity, were frequently confused; for fear, incorrect answers were mainly distributed on anger and sadness. Thus, for most emotions, participants' incorrect answers centered on same-valence options. The only exception is interest, for which answers on irritation occupied nearly one-third. Although the two emotions differ on valence, they share some common features such as "frowning". Therefore, generally the closer the alternative was to the answer, the possibility it was chosen incorrectly was higher.

Table 3 The mean accuracy scores on each emotion category of children in different grades

		joy	amusement	pleasure	interest	sadness	irritation	anger	fear
Grade 2	*M*	.65	.58	.46	.29	.66	.50	.75	.58
	SD	.26	.31	.29	.26	.21	.22	.22	.27
Grade 3	*M*	.71	.72	.54	.38	.67	.62	.78	.60
	SD	.23	.26	.30	.28	.23	.24	.19	.25
Grade 4	*M*	.73	.65	.60	.43	.70	.60	.76	.62
	SD	.20	.23	.31	.28	.22	.22	.20	.27
Grade 5	*M*	.68	.73	.65	.44	.72	.67	.78	.76
	SD	.25	.26	.27	.27	.23	.20	.19	.22
Grade 6	*M*	.72	.77	.70	.49	.77	.73	.70	.74
	SD	.21	.22	.21	.29	.21	.19	.24	.23
Total	*M*	.69	.69	.59	.40	.70	.62	.76	.66
	SD	.24	.27	.29	.28	.22	.23	.21	.26

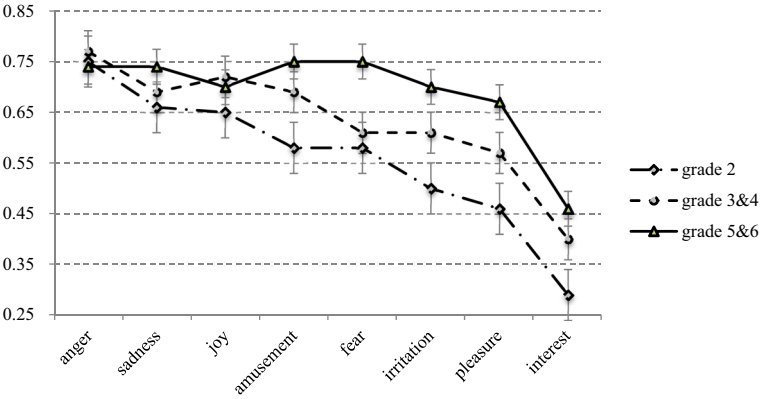

Fig. 1 The interaction diagram between emotion category and grade. The vertical axis displays participants' mean accuracy score on ERA test. Emotion categories are arranged on the horizontal axis. Three curves represent grade 2, grade 3&4, grade 5&6, respectively

5.4 Relationships between ERA, Peer Status and Friendship Quality

Descriptive Statistics and Correlations The descriptive statistics and correlations of ERA with peer status and different dimensions of friendship quality are presented in Table 5. ERA of primary school children was positively correlated with peer status and four positive dimensions of friendship quality, and negatively correlated with the negative dimension of friendship quality.

Measurement Model The confirmatory factor analysis (CFA) conducted on friendship quality showed that the standardized factor loadings for its five dimensions were .73, .77, .83, .72, and − .32 respectively. Since the absolute value of the loading on conflict and betrayal was below the threshold of .40, this dimension was deleted to guarantee the validity of this questionnaire.[2] Potential gender and grade differences on the measurement model of friendship quality were then tested by χ^2 difference tests. Again, according to the overall ER developmental trend, five grades were divided into three groups. Neither freeing the factor loadings across gender [$\Delta\chi^2(3) = 0.53$, $p = .913$] nor grade [$\Delta\chi^2$ (3) = 1.38, $p = .711$] caused a significant change in model fit, suggesting the measurement invariance of friendship quality as functions of gender and grade. Therefore, the measurement model was estimated as a single group, and revealed a satisfactory fit: $\chi^2(2) = 5.42$, $p = .067$, CFI = .99, TLI = .98, RMSEA = .08, SRMR = .02.

Structural Model Next, the structural model was constructed with ERA as the predictor, peer status and friendship quality as dependent variables. The effects of participant school (dummy-coded as 0 for high-achievement-level school and 1 for average-achievement-level school), gender (dummy-coded as 0 for girls and 1 for boys), and age were also controlled. Analyses suggested a good fit: $\chi^2(17) = 33.95$, $p = .009$, CFI = .97, TLI = .95, RMSEA = .06, SRMR = .03. Specific path coefficients are

[2] The results of the regression model were basically the same whether or not the last dimension was included on the latent factor of friendship quality.

Table 4 The distribution of participants' answers on each emotion category (Percentage)

		Correct options							
		joy	amusement	pleasure	interest	sadness	irritation	anger	fear
Participant answers	joy	**.69**	.26	.18	.06	.00	.02	.00	.00
	amusement	.13	**.69**	.06	.01	.00	.01	.00	.00
	pleasure	.07	.02	**.59**	.11	.03	.05	.00	.00
	interest	.06	.01	.11	**.40**	.01	.06	.01	.01
	sadness	.01	.01	.02	.06	**.70**	.07	.01	.12
	irritation	.01	.00	.04	.29	.18	**.62**	.20	.09
	anger	.01	.00	.00	.01	.00	.11	**.76**	.11
	fear	.02	.00	.01	.06	.06	.05	.02	**.66**

The table demonstrates the percentage of each option being selected. Bold numbers represent correct answers; Underlined numbers represent incorrect answers being selected most frequently

depicted in Fig. 2. Results showed significant gender (Girls scored higher than boys; $\beta = -.15$, $SE = .05$, $p = .003$), age ($\beta = .40$, $SE = .05$, $p < .001$), and school differences ($\beta = -.15$, $SE = .05$, $p = .003$) on ERA, which were consistent with the ANOVA results. There were also significant gender differences on peer status ($\beta = -.13$, $SE = .06$, $p = .020$). The effects of gender, age, and school on friendship quality, as well as the effects of school and age on peer status, were not significant (all ps $> .06$). Peer status and friendship quality were moderately correlated with each other ($r = .31$, $SE = .06$, $p < .001$), suggesting that the two constructs were distinct but interrelated. Consistent with our expectation, ERA was positively related with both peer status ($\beta = .25$, $SE = .06$, $p < .001$) and friendship quality ($\beta = .22$, $SE = .07$, $p = .001$), showing the strong interpersonal functions of ERA.[3]

6 Discussion

The present study investigated age differences in ERA and its interpersonal correlates among Chinese primary school children. Results demonstrated an overall upward trend on ERA as children age, with girls performing better than boys. We further found significant differences on the accuracy scores between emotion categories, as well as a significant interaction between emotion category and grade. Both findings suggest that children's recognition of different emotions may follow distinct developing paths.

[3] We also used multi-group models to further test whether the correlations between ERA and peer relations differed across gender and grade (five grades were divided into three groups according to the ER development trend: grade 2, grade 3 & 4, grade 5 & 6). The constrained model, where paths were set equal across gender/grade, was compared with the unconstrained model where paths were free to vary. The result showed non-significant chi-square differences either for gender [$\Delta\chi^2(2) = 2.41$, $p = .300$] or for grade [$\Delta\chi^2(4) = 3.79$, $p = .436$]. Thus, the model could be supposed as invariable across gender and grade.

Table 5 The mean scores on ERA, peer status, different dimensions of friendship quality, and their correlations

	M	*SD*	1	2	3	4	5	6	7
1 ERA	0.64	0.12	1						
2 PS	0.02	1.64	.22***	1					
3 FQ1	4.07	0.86	.22***	.27***	1				
4 FQ2	4.19	0.79	.24***	.24***	.58***	1			
5 FQ3	3.50	1.03	.16**	.30***	.57***	.64***	1		
6 FQ4	3.40	1.08	.17**	.23***	.52***	.53***	.63***	1	
7 FQ5	1.77	0.87	−.13*	−.28***	−.34***	−.24***	−.27***	−.14*	1

PS = peer status; FQ1 = trust and support; FQ2 = companionship and recreation; FQ3 = validation; FQ4 = intimate exchange; FQ5 = conflict and betrayal

Additionally, ERA was positively related to both peer status and friendship quality, demonstrating its ties to children's interpersonal interactions.

6.1 Characteristics and Development of Children's ERA

In general, older children scored significantly higher than younger children on the ERA test (H1). Although previous literature has repeatedly demonstrated that ERA is an early-developing skill (e.g., Herba and Phillips 2004), we still found significant grade differences among primary school children after increasing the difficulty of the ERA test by including more complex emotion categories. This is in line with the Differential Model proposed by Widen and Russell (2008), again suggesting that the development of ERA is a gradual process that continues beyond the pre-school stage. The fact that girls had higher ERA than boys is consistent with previous studies (McClure 2000), which can be explained by various factors. Girls usually develop faster with regard to emotion-related brain regions (Nelson and de Haan 1997), which determine their early advantages. Distinct parental emotion socialization practices towards girls and boys

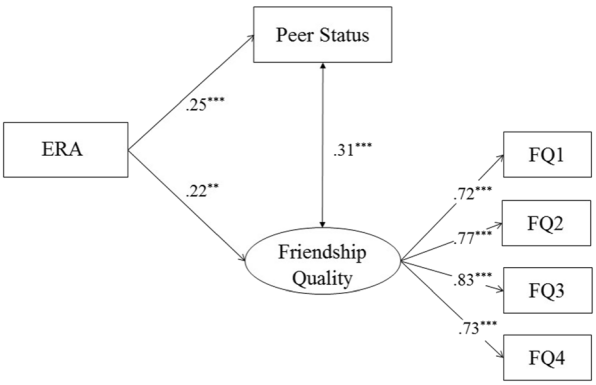

Fig. 2 The regression model between ERA, peer status and friendship quality. Standard coefficients are reported. Participant gender, school, and age were included as covariates, but not depicted in the figure for parsimony

further broaden this gap. For example, parents may talk about emotions more with girls, and are more accepting of girls' expressions of negative emotions (Garside and Klimes-Dougan 2002).

Children significantly differed on the recognition of different emotion categories. As expected (H2), primary school children generally performed better on the recognition of basic emotions (joy, anger, sadness, and fear) than the remaining, more complex emotions. The interaction analysis between emotion and grade further revealed that children's recognition accuracies on anger, joy, and sadness did not significantly differ between grades, while for the remaining five emotions (fear, amusement, pleasure, interest, and irritation), older students scored significantly higher than younger students (H3). These two results together indicate that children have grasped most basic emotions by the primary school stage, and the improvement on ERA mainly stems from gradually deeper understanding of more complex emotions. The response bias analysis further revealed that children were more likely to confuse similar emotions, so the recognition on different emotions were not completely independent. Just as Widen (2013) suggested, emotion recognition is a broad-to-specific process. Children's definition of each basic emotion is initially quite broad, from which they gradually differentiate various complex emotions; the definition of each emotion category also becomes narrower and more accurate. Therefore, to better explore individual differences in ERA of older children, related tasks should contain at least several complex emotions. Previous ceiling effects observed for some emotional sets among school children (e.g. Bruce et al. 2000) are potentially due to a mismatch between measurement tools and participants' abilities.

It is noteworthy that the sequence of recognition accuracies across basic emotions was not identical to prior research. Studies concerning four to six basic emotions have fairly consistently found that children's recognition of joy or happiness is the most accurate and develops earliest, regardless of whether assessments consist of matching or labeling tasks (see Widen 2013 for a review). In contrast, after expanding the number of emotion categories, the present study found that children obtained the highest recognition accuracy for anger. This is probably because joy, as the only positive emotion in most studies, is obviously different from other emotions (Widen and Russell 2008). Thus, children could easily exclude other alternatives when judging joy, which might improve its accuracy rates to a large extent. The present study included the same number of positive and negative emotions, so children were no longer able to distinguish joy merely according to valence. Moreover, it has been found that anger and disgust are often confused with each other (Widen 2013; Hawk et al. 2009). The present study did not include the option of disgust, which might drive up the accuracy of anger. Another possible reason is that the additional information from acoustic and bodily channels may facilitate the recognition of certain emotions. For example, prior research has shown that nonlinguistic affect vocalizations show superiority on the recognition of anger, sadness, and fear, compared to facial expressions, but facial expressions had more advantages when decoding joy (Hawk et al. 2009). Therefore, the use of multimodal videos may mainly contribute to the recognition of these three negative basic emotions but not to the recognition of joy. This result suggests that any notion about the development of ERA is very likely to be restricted by measurement methods or limited emotion categories. More research on a wider range of emotions and different emotion cues is needed before drawing any final conclusions.

6.2 Links between ERA, Peer Status, and Friendship Quality

To explore the interpersonal correlates of ERA, we analyzed its relationships with two levels of peer relations: peer status and friendship quality. Path analysis revealed that ERA positively predicted both constructs (H4), which reflects predictions of previous theories that emphasize the social functions of emotion (Halberstadt et al. 2001; Lemerise and Arsenio 2000; van Kleef 2009). Identifying affective messages, as one basic component of affective social competence, is essential on maintaining successful interpersonal relationships (Halberstadt et al. 2001). One of the most important roles of emotional expression is to act as a social signal in interpersonal interactions (Fischer and Manstead 2008). Therefore, children who can accurately recognize these emotional signals are more likely to understand peers' true feelings or intentions, and accordingly adjust their own responses and behaviors (Miller et al. 2005). This is the foundation for making a good impression in a group, as well as maintaining close friendships. For example, high ERA could help children to choose the acceptable time and occasion to make statements about their own interests without annoying others; this is also the premise of both empathy and subsequent prosocial behaviors (Izard et al. 2001). Conversely, failing to decode others' emotion expressions could sometimes result in improper responses, such as acting playful and happy when friends are in a bad mood, or persisting in a discussion when peers have lost interest; these behaviors could easily give rise to peers' antipathy and jeopardize one's social relationships. Generally, peer status and friendship quality are closely related with each other, and thus both shared positive links with ERA. According to previous studies (e.g. Bukowski et al. 1996; Pedersen et al. 2007; Izard et al. 2001), peer status determines children's social circles to some extent, which then influences children's chances to establish intimate friendships. As our cross-sectional design rendered any tests of such mediating effect, we chose to examine these two factors as simultaneous dependent variables in order to examine the unique relationship that ERA held with each, when controlling for the other. Future research may use longitudinal design to test the mediation model from ERA to peer status, and then to friendship quality.

Multi-group analyses found that the regression model did not differ across gender and grade (see Footnote 3). That is, ERA predicted peer relations equally for both boys and girls, and across different grades of primary school. This finding differs somewhat from previous studies. For example, Leppänen and Hietanen (2001) found that emotion recognition ability was related to social adjustment for 7–10-year-old girls, but not for boys. Rowsell et al. (2014) also demonstrated that self-reported emotion identification skills in early adolescence only predicted friendships for females in late adolescence. This inconsistency may potentially be due to cultural differences. Both of the aforementioned studies were conducted in western countries (Finland and Australia, respectively), where ERA might have less importance for interpersonal relationships in comparison to collectivistic cultures (Kang et al. 2003). In this case, the effect of ERA might have only been pronounced for girls because they are more oriented toward interpersonal relationships (Leppänen and Hietanen 2001). However, in collectivistic countries such as China, where people tend to express their emotions in a more implicit and indirect way, high ERA might be more necessary for knowing others' true feelings, regardless of gender.

6.3 Implications and Limitations

The results of the present study provide insight into the age-related characteristics of ERA, which are particularly instructive for helping educators to detect children with delayed development on ERA and to enact timely interventions. Previous research has indicated that short-term, computer-based ERA training, which contained an instruction component and a practice-with-feedback component, led to lasting improvements on facial, vocal, and audiovisual emotion recognition among young and middle-aged adults (Schlegel et al. 2017b). Such an intervention program might be adapted to school or family settings, to help children who experience difficulties in ERA. Based on the age-related characteristics of ERA found in the present study, it seems important for such interventions to put more emphasis on the recognition of complex emotions in the primary school stage.

Moreover, our study associated ERA with two indices of peer relations. The positive links between ERA and both other-rated peer status and self-reported friendship quality suggest the necessity for teachers and parents to pay more attention to this skill for the benefit of children's social interactions. Low ERA should be taken into consideration when analyzing the reasons for children's relationship problems. These results also support the value of social and emotional learning programs such as RULER, which can be adopted more widely to assist in improving children's overall adjustment.

Some limitations of our research should also be noted. First, the present study focused on primary school children. Although it addressed gaps in the literature regarding the continued development of ERA, the extension of our conclusions was still restricted by our sampling approach. For example, since we did not include younger preschool children in the present study, the order in which children grasp different emotions still remains unclear. Therefore, future research should extend the age range of participants upward and downward, to describe the development of ERA as completely as possible.

Second, the video stimuli in the ERA test were acted by models of another ethnicity. Even though we excluded videos that were not well recognized among Chinese adults, to minimize potential cultural influences or overly-difficult stimuli, outgroup bias might still be unavoidable, especially for the recognition of more complex emotions (van der Schalk et al. 2011). In this case, children's ERA may have been underestimated, compared to if they had been exposed to Chinese models. Likewise, the mismatch between participants' and models' ages may also increase the difficulty of recognition. Additionally, the collectivistic background of the present study may restrict the generalization of our results, to some extent. Future research might investigate whether there are cultural differences in the development of ERA or its social functions, using strictly-designed cross-cultural studies.

Third, the correlational and cross-sectional design of our study impedes inferences about developmental processes or casual relationships. In addition to the influence of ERA on peer processes, the reverse impact should also be considered. Long-term social exclusion could greatly tax cognitive resources that are necessary for emotion recognition (Baumeister et al. 2005), and may also deprive children of good opportunities to get real-life training and experience in their ERA. Longitudinal and experimental research is thus needed to explore the potential bi-directional links between ERA and

peer relations. The possibility that peer status mediates a link between ERA and friendship quality also calls for longitudinal research.

Fourth, accurate emotion recognition should be a necessary condition of good interpersonal relationships, but not a sufficient condition. Besides ERA, some other abilities are also needed to respond adaptively in social interactions, such as dispositional empathy and emotion regulation ability. Future studies could investigate the moderating effects of such elements in the link between ERA and peer relations. Moreover, it is important for future research to control for the effects of possible confounding variables, such as socio-economic status and personality characteristics, which could facilitate the generalization of our conclusions.

7 Conclusion

Our research provides detailed investigations into the characteristics of emotion recognition ability among primary school children, as well as its links with peer status and friendship quality. The use of multimodal videos across a larger number of emotions than past studies offers some novel insights about the later development of ERA; the recognition of most basic emotions has reached maturity in primary school stage, but the ability to recognize more complex emotions continues to improve. Our findings additionally imply that children's ERA might not only predict peers' attitudes towards them, but also their own perceptions of friendship quality. Theoretically, this model builds a bridge between ERA and two levels of peer relations. Practically, this result highlights the importance of ERA and suggests a possible intervention direction for children's interpersonal problems.

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