RESEARCH PAPER

Culture shapes preschoolers' emotion recognition but not emotion comprehension: a cross-cultural study in Germany and Singapore

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Abstract Contemporary approaches suggest that emotions are shaped by culture. Children growing up in different cultures experience culture-specific emotion socialization practices. As a result, children growing up in Western societies (e.g., US or UK) rely on explicit, semantic information, whereas children from East Asian cultures (e.g., China or Japan) are more sensitive towards implicit, contextual cues when confronted with others' emotions. The aim of the present study was to investigate two aspects of preschoolers' emotion understanding (emotion recognition and emotion comprehension) in a cross-cultural setting. To this end, Singaporean and German preschoolers were tested with an emotion recognition task employing European-American and East Asian child's faces and the Test of Emotion Comprehension (TEC; Pons et al., 2004). In total, 129 German and Singaporean preschoolers (mean age 5.34 years) participated. Results indicate that preschoolers were able to recognize emotions of child's faces above chance level. In line with previous findings, Singaporean preschoolers were more accurate in recognizing emotions from facial stimuli compared to German

preschoolers. Accordingly, Singaporean preschoolers outperformed German preschoolers in the Recognition component of the TEC. The overall performance in TEC did not differ between the two samples. Findings of this study provide further evidence that emotion understanding is culturally shaped in accordance with culture-specific emotion socialization practices.

Keywords Emotion development · Culture · TEC · Facial expression · Emotion comprehension

Emotion understanding refers to an individual's ability to identify, explain and predict own and others' emotions based on facial, bodily, or vocal cues, and within social contexts (Harris et al., 2016; Pons & Harris, 2019). According to the conceptual framework of Castro et al. (2016), emotion understanding consists of two facets: emotion recognition and emotion comprehension (also referred to as emotion knowledge). *Emotion recognition* is defined as the fundamental ability to perceive and label visual and/or auditory cues while using relevant contextual cues. *Emotion comprehension* on the other hand describes a complex set of skills enabling individuals to understand the internal and external causes of emotions (e.g., receiving a gift), qualities of emotions (e.g., decrease in intensity over time), functions and consequences of emotions (e.g., sympathy), cultural norms (e.g., cultural scripts), and management of emotions (e.g., self-

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regulating strategies). Previous research has shown that emotion understanding is crucial for children's psychosocial development as it is positively associated with beneficial outcomes such as social competence, school readiness, or academic achievement (Curby et al., 2015; Franco et al., 2017; Voltmer & von Salisch, 2017), and negatively related to maladaptive outcomes such as behavioral problems (i.e., internalizing behavior such as anxiety or social withdrawal, or externalizing behavior such as aggressive behavior) (Göbel et al., 2016; Trentacosta & Fine, 2010). However, these results mainly derive from research in Western societies, and only most recently, studies suggest that children's emotion understanding (Tang et al., 2018; Yang et al., 2021) and its association to developmental outcomes (Doan & Wang, 2018) is moderated by culture. Against this background, this study investigated the two aspects of preschoolers' emotion understanding, namely emotion recognition and emotion comprehension, in a cross-cultural context.

Emotion in culture

Although emotions are a universal phenomenon across different species and cultures (Darwin, 1965; Ekman & Friesen, 1971), contemporary approaches suggest that many aspects of emotion processing are shaped by culture (Elfenbein et al., 2007; Matsumoto, 2009; Matsumoto & Hwang, 2012; Mesquita et al., 2016). People from different cultures hold different views about the values of emotions (Markus & Kitayama, 1991), and culture-specific display rules determine the frequency, intensity, and appropriateness of expressed emotions in social interactions (Hareli et al., 2015). For example, in Western cultures (e.g., US or Germany), where independence and autonomy are emphasized, emotions are regarded as unique to the individual and as a manifestation of the self. Thus, emotion expression and an explicit communication of emotions is encouraged. Accordingly, people in Western cultures frequently express and verbalize emotional states (Markus & Kitayama, 1991; Mesquita & Frijda, 1992). In contrast, in East Asian cultures (e.g., China or Japan), people emphasize group harmony and relatedness, and therefore, an explicit expression or communication of emotions is considered as impeding social harmony. Thus,

members of East Asian cultures rather express emotions in a more implicit and indirect manner (Matsumoto, 2009). These differences in culture-specific communication are outlined in Hall's (1976) framework in which cultures are classified into *low-context* and *high-context* cultures according to their preferred communication styles. Accordingly, members of low-context cultures (e.g., US or Germany) are characterized by a preference for explicit, verbal communication when conveying information (e.g., verbal expression of emotional states), whereas a smaller proportion of information is communicated in terms of contextual cues (e.g., vocal tone or gestures). In contrast, members of high-context cultures (e.g., China or Japan) rather communicate in terms of implicit, contextual cues (e.g., vocal tone, facial expressions, gestures), whereas explicit verbal statements constitute a smaller proportion in communication.

Children growing up in different cultures frequently experience these culture-specific verbal and non-verbal emotion behaviors, which steadily shape their emotion development (Camras et al., 2014; Chen et al., 2011; Mesquita et al., 2016; Yang & Wang, 2019). Parents and other caretakers play an important role in transmitting cultural values and norms about emotions (Castro et al., 2015), and research has demonstrated that parents indeed successfully scaffold emotional behaviors of infants and young children in line with their cultural standards (Halberstadt & Lozada, 2011; Morelen & Thomassin, 2013). For instance, parents in Western cultures frequently teach and discuss emotions and emphasize the importance of emotion comprehension in the developing child (Gottman et al., 1997). In contrast, East Asian parents do not directly support their children's emotion comprehension. Instead, they focus on teaching display rules, fostering sensitivity towards others' emotions and emphasizing appropriate reactions towards emotions (Doan & Wang, 2010; Wang & Fivush, 2005). Although cross-cultural studies investigating children's emotion understanding are still relatively scarce, the aforementioned variations in emotion socialization strategies are suspected to have important consequences for children's emotion recognition and emotion comprehension.

Children's emotion recognition across cultures

Emotion recognition is one aspect of emotion understanding and refers to the ability to identify emotions from facial expressions, gestures, or vocal cues in speech. It has been shown that emotion recognition develops linearly throughout childhood with 3- to 6-year-olds being less accurate than 7- to 10-year-olds, and the latter age group being less accurate than adults (Chronaki et al., 2015; Durand et al., 2007; Juen et al., 2012; Lawrence et al., 2015). Moreover, a large body of research provides evidence that children and adults recognize happy faces best, whereas disgust and fear are usually most difficult to identify (Durand et al., 2007; Gagnon et al., 2010; Griffiths et al., 2015; Juen et al., 2012; Lawrence et al., 2015; Prado et al., 2014; Widen & Russell, 2003).

Evidence for cross-cultural differences in emotion recognition of facial expressions mainly comes from studies with adults. For instance, previous studies found that adults were better at identifying emotions expressed by members of their own cultural background than from other cultural backgrounds, referred to as an in-group advantage of emotion recognition (Dailey et al., 2010; Elfenbein & Ambady, 2002; Wickline et al., 2009; Yan et al., 2016). However, a mutual in-group advantage seems to disappear when people are acculturated in a new culture or live in diverse societies (Elfenbein & Ambady, 2003b; Prado et al., 2014; Reyes et al., 2018). Cross-cultural research on children's emotion recognition is still sparse, and to date, there is just slight evidence for a cultural in-group advantage in children (Crivelli et al., 2016; Markham & Wang, 1996). Markham and Wang (1996) investigated 4-, 6-, and 8-year-old Chinese and Australian children's emotion recognition with two tasks' employing facial expressions of six basic emotions posed by Asian and European-American models. Results revealed that Australian children were significantly better at labeling emotions in European-American faces compared to Asian faces, whereas Chinese children were slightly better (though not significantly) at identifying emotions from Asian faces compared to European-American faces. Nevertheless, Chinese children outperformed Australian children for all emotions except happiness when comparing children's overall emotion recognition scores averaged across both emotion recognition tasks and expresser ethnicities. In line with the latter finding, a handful of studies demonstrated that Chinese or Japanese children were better at recognizing emotions from faces or vocal tones than Dutch or American children (Kawahara et al., 2021; Matsumoto & Kishimoto, 1983; Yang et al., 2021). For instance, Kawahara et al. (2021) investigated 5- to 12-year-old Dutch and Japanese children by means of facial and vocal emotion recognition tasks. Results demonstrated that Japanese children across all age groups outperformed Dutch children on both the vocal and facial emotion recognition tasks. In line with these findings, two further recent studies investigated children's sensitivity to implicit (i.e., *how* something is said) or explicit (i.e., *what* is said) emotional cues in spoken words. Results revealed that Japanese and Chinese children paid more attention to implicit emotional cues than to explicit emotional cues, whereas their U.S. American counterparts showed the opposite pattern (Ikeda et al., 2021; Yang et al., 2021).

Taken together, these findings demonstrate that culture has an important impact on the development of emotion recognition. In accordance with Hall's (1997) context theory, East Asian children seem to rely more on implicit cues, and thus, have an advantage in recognizing emotions from facial or vocal expressions compared to children growing up in Western cultures.

Children's emotion comprehension across cultures

Emotion comprehension refers to the ability to understand the nature, causes, and consequences of own and others' emotions, and how to manage emotions in everyday life. The development of emotion comprehension has been extensively studied in Western societies (Cavioni et al., 2020; Göbel et al., 2016; Molina et al., 2014; Pons et al., 2003, 2004; Voltmer & von Salisch, 2017) demonstrating that children progress through a series of landmarks of emotion comprehension between 3 and 11 years. Accordingly, Pons et al. (2004) identified nine successive components of emotion comprehension, which can be assessed by the Test of Emotion Comprehension (TEC; Pons et al., 2004): component I (*Recognition*) reflects the ability to recognize and label basic emotions from facial expressions; component II (*External*) describes the ability to understand that emotions can be triggered by external events; component III (*Desire*) represents the capacity to

understand that due to different desires individuals may experience different emotions in the same situation; component IV (*Belief*) reflects the ability to understand that different beliefs may cause different emotions in a situation; component V (*Reminder*) describes the ability to understand that memories can trigger emotional reactions; component VI (*Regulation*) represents the ability to understand that emotional states can be managed by regulation strategies; component VII (*Hiding*) describes the capacity to understand the discrepancy between felt and displayed emotions; component VIII (*Mixed*) represents the ability to understand that an individual can experience ambivalent emotions in a situation; component IX (*Moral*) describes the ability to understand that immoral behaviors cause negative emotions. Pons et al. (2004) investigated the psychometric structure of the TEC and identified three key developmental periods (external, mental, reflexive), each characterized by the emergence of three components. A recent study replicated TEC's factorial structure and measurement invariance across age and gender groups (Cavioni et al., 2020), indicating that TEC is a robust instrument for assessing emotion understanding in children between 3 and 10 years.

Meanwhile, an increasing number of studies addressed the question to what extent the development of emotion comprehension is culturally shaped (Doan & Wang, 2018; Molina et al., 2014; Tang et al., 2018; Tenenbaum et al., 2004). To date, there is evidence that East Asian children's and Western children's emotion comprehension differs. For instance, 3- to 6-year-old Chinese preschoolers have been found to be less likely to correctly identify the emotions of protagonists in stories compared to American preschoolers (Wang, 2003), and show a disadvantage in the comprehension of emotional words compared to their British counterparts (Li & Yu, 2015). Moreover, 3- to 4-year-old Chinese preschoolers performed worse in understanding causes of emotions (Wang, 2008). Nevertheless, it seems that Asian children catch up on their emotion comprehension as suggested by a study showing that 7- to 10-year-old Chinese immigrant children did not differ from European American children in their emotion knowledge (Yang & Wang, 2016).

Of particular importance for the present research, a recently published study investigated 3- to 6-year-old Chinese preschoolers' emotion comprehension

means of the TEC (Pons et al., 2004). Results revealed that Chinese preschoolers acquired the skills corresponding to the nine TEC components in the same order as Western European samples. Nevertheless, Chinese preschoolers showed a better performance in the *Hiding* component than British and German children, whereas the two latter groups performed better on the *Reminder* component (Tang et al., 2018). The authors interpreted these findings in terms of culture-specific emotion socialization: since Chinese parents emphasize group harmony, Chinese children may be expected to hide their emotions, hence, fostering their understanding of the *Hiding* component. In contrast, European American parents frequently discuss emotions when referring to past events (Wang et al., 2000), which in turn may facilitate Western children's understanding of the *Reminder* component. Taken together, these findings suggest that East Asian and Western children show culture-specific differences in several aspects of emotion comprehension. In line with Hall's (1976) context theory, East Asian children seem to lag behind in acquiring aspects of emotion comprehension involving the explicit communication of emotional states. In contrast, Western children seem to have greater difficulties in understanding hidden emotions. This makes sense, as this aspect of emotion comprehension is at odds with the explicit mode of communication in low-context cultures.

Aims of the present study

To our knowledge, there is no study investigating both aspects of emotion understanding, emotion recognition and emotion comprehension, in preschoolers within a cross-cultural setting. To this end, the present study aimed to fill this gap and extend previous findings by investigating the effect of culture on the development of emotion recognition and emotion comprehension in a high-context and low-context culture with comparable socioeconomic backgrounds: Singapore and Germany.

In the present study, Singapore was chosen as a high-context culture with a high percentage (76.8%) of Chinese inhabitants. Singapore is a Southeast Asian city state comparable to Hong Kong in terms of cultural background, history, and economy. Just like Hong Kong, Singapore as a former British colony was

influenced by western culture, and yet Chinese habits and traditions play a crucial role in the daily routine regarding politeness behavior, family structures, and a distinct emphasis on competition, achievement, and success. This is reflected in highly comparable patterns in the six dimensions of national culture proposed by Hofstede (2001, 2011) between Singapore (SG), Mainland China (CH) and Hong Kong (HK). In particular, all three jurisdictions show almost identical values (CH 20; HK 25; SG 20) on the individualism/collectivism dimension [which corresponds to Hall's (1976) context dimension]. Accordingly, Mainland China, Hong Kong and Singapore are considered as collectivist societies (Hofstede Insights, 2021) with people preferring an indirect communication, avoiding open conflicts, and maintaining group harmony (Hall, 1976; Hofstede, 2011; Markus & Kitayama, 1991). In addition, all three jurisdictions show high values on the power distance dimension (CH 80; HK 68; SG 74) indicating that individuals living in these societies are not equal, and that this inequality is widely accepted.

In contrast, Germany (GER) was chosen as a low-context culture comparable to the United States (US) or the United Kingdom (UK). These three countries demonstrate high values on Hofstede's individualism/collectivism dimension (US 91; UK 89; GER 67), and thus, are considered as individualist cultures. Therefore, individuals of these countries prefer an explicit communication and emphasize self-actualization (Hall, 1976; Hofstede, 2011; Markus & Kitayama, 1991). In contrast to the Asian jurisdictions, Germany, the United States, and the United Kingdom show lower values on the power distance dimension (US 40; UK 35; GER 35) indicating that these societies value equality and participation of their individuals.

Accordingly, Germany and Singapore are suitable representatives for low-context and high-context cultures, respectively. For the present study it was intended that, besides the cultural distinction, both countries feature a comparable socioeconomic background as differences in socioeconomic status have previously been reported to influence children's development of social cognitive skills (e.g., Ebert et al., 2017). As indicated by the Human Development Index (HDI), Singapore (HDI = 0.94) and Germany (HDI = 0.95) have a comparable socioeconomic status (Human Development Report, 2020).

The first major aim of the present study was to investigate Singaporean and German 4- to 6-year-old preschoolers' emotion recognition by means of a facial emotion recognition task employing six basic emotions (i.e., happiness, sadness, anger, fear, surprise, disgust). In line with Hall's (1976) context theory and previous findings demonstrating that Asian children were better at recognizing emotions from faces or vocal information (Kawahara et al., 2021; Yang et al., 2021), we expected Singaporean preschoolers to outperform German preschoolers in the emotion recognition task.

Moreover, we aimed to investigate a potential in-group advantage of emotion recognition as suggested by studies with adults (e.g., Dailey et al., 2010; Yan et al., 2016). To date, evidence for an in-group advantage in children is still scarce and ambiguous (Crivelli et al., 2016; Markham & Wang, 1996). Thus, we exploratively investigated whether German and Singaporean children demonstrate a mutual in-group advantage.

In line with studies reporting better emotion recognizing with increasing age (e.g., Chronaki et al., 2015), we assumed that preschoolers in the present study would perform better on the emotion recognition task with increasing age.

The second major aim of the current work was to investigate German and Singaporean children's emotion comprehension by means of the Test of Emotion comprehension (TEC; Pons et al., 2004). According to previous findings demonstrating a delay in Chinese children's emotion comprehension (Wang, 2003, 2008), we expected German preschoolers to show higher mean global TEC scores than Singaporean preschoolers. Nevertheless, in line with the study by Tang et al. (2018), we assumed that Singaporean preschoolers would show higher passing rates on the Hiding (VII) component of the TEC, whereas German preschoolers were expected to show higher passing rates on the Reminder (V) component of the TEC. Moreover, due to its similarity with the emotion recognition task, we expected that Singaporean preschoolers would outperform German preschoolers on the Recognition (I) component. In line with previous findings indicating a developmental progression in the TEC with increasing age (e.g., Cavioni et al., 2020; Pons et al., 2004), we expected that preschoolers in the current work would obtain higher global TEC scores with increasing age.

Method

Participants

An a priori power analysis using MorePower 6.0.4. with the following specifications was applied: One between-subjects factor with two levels (*country*: Singapore/Germany) and two repeated measures factors with two (*stimulus ethnicity*: Asian American/ European American) and six (*emotion*: happy, anger, etc.) levels. Alpha was set to 0.05, power to 0.95, and an expected effect size of $\eta^2 = 0.2$ (in accordance with previous studies reporting small to medium effect sizes; e.g., Yan et al., 2016). The effects of interest were the main effect of *country* to investigate potential differences in emotion understanding between Singaporean and German preschoolers and the interaction between *country* and *stimulus ethnicity* for the detection of a possible in-group advantage. The analysis returned a total sample size of $N = 56$. The final sample consisted of 65 (34 males) Singaporean preschoolers with a mean age of 5.34 years (SD = 0.75; range = 3.92–6.67) and 64 (34 males) German preschoolers with a mean age of 5.33 years (SD = 0.75; range = 4.00–6.58). There was no significant age difference between the groups ($t(126) = 0.059$, $p = .953$, $d = 0.01$). Singaporean children came from homes geographically distributed across the whole city state of Singapore, were of Chinese descent and were recruited and tested at their respective preschools (seven preschools). German children lived in a middle-sized city in Germany, were of German family origin and were recruited and tested either at their respective preschools ($n = 59$, six preschools), or at the Developmental Psychology Unit at Saarland University ($n = 5$). One additional Singaporean preschooler was tested but not considered for analyses due to having too many missing values caused by shyness ($n = 1$). One additional German preschooler was tested but discarded from analyses because of uncooperative behavior during data collection ($n = 1$). Moreover, $n = 3$ Singaporean preschoolers and $n = 4$ German preschoolers did not complete the emotion comprehension task and were therefore only considered for analyses regarding the emotion recognition task. Table 1 summarizes sample descriptions for both countries. Parental socioeconomic status (SES) is based on information from parents on their current occupation and highest educational qualification as suggested by Hollingshead (1975). Moreover, we received information about their monthly net income. Comparisons of socioeconomic statuses and maternal and paternal net income indicate that German and Singaporean preschoolers had a comparable socioeconomic background. Parents of all children gave their informed written consent prior to participation.

Materials

Emotion recognition task

Stimuli were gathered from a recently published dataset (Child Affective Facial Expression set (CAFE); LoBue et al., 2017; LoBue & Thrasher, 2015) featuring a collection of pictures of 2- to 8-year-old children of varying ethnicities posing six basic emotional facial expressions (happiness, sadness, anger, fear, disgust, surprise). For the present study, pictures of European American (EA) children and Asian American (AA) children expressing highly stereotypical facial expressions (taken from subset A; for further information see LoBue & Thrasher, 2015) with validity scores of $\geq 60\%$ were selected ($M = 84.4\%$, SD = 0.11; range 61–97%). Due to our criterion and the inclusion of two specific ethnicities, not all stimulus categories could be filled by the CAFE set. Hence, eight pictures had to be gathered from other sources (e.g., from the online stock photography database http://www.shutterstock.com). Colors and white balance of all additional pictures were adjusted in Photoshop (CS6) to guarantee maximal congruence with the CAFE stimuli. 43 Singaporean adults (23 males; $M_{age} = 28.2$ years) and 79 German adults (22 males; $M_{age} = 23.4$ years) rated the selected stimuli. Results revealed satisfying validity scores of $M = 0.82$ (SD = 0.15) and $M = 0.87$ (SD = 0.16) for the Singaporean and German sample, respectively.

A stimulus book was created, consisting of 50 color-printed, laminated pages (2 practice pages and 48 test pages) with each page showing six upright pictures (9 cm × 6 cm) of either EA or AA child's faces aligned in two columns and three rows (see Fig. 1). On each page, six children of the same ethnicity and gender expressed six basic emotions. Positions of emotions were randomized per page. The order of pages alternated between EA and AA faces and was randomized for gender and target emotion. In

Table 1 Description and comparison of the German and Singaporean samples

Variable	German (N = 64) M (SD)	Singapore (N = 65)	t-test (2-tailed)
Mean number of siblings	0.90 (0.62)	1.18 (0.83)	$t(117) = 2.05, p = .042$*
Maternal age	37.44 (5.13)	37.81 (4.93)	$t(114) = 0.391, p = .697$
Paternal age	40.18 (6.69)	40.18 (6.18)	$t(112) = 0.311, p = .756$
SES (Hollingshead-revised[a])	43.88 (12.24)	45.93 (12.24)	$t(113) = 0.880, p = .380$
	Mdn (range)		Mann–Whitney-U-test
Categorized[b] maternal net income (in US $)	2 (1–4)	2 (1–4)	$U = 1444, p = .810, r = .02$
Categorized[b] paternal net income (in US $)	3 (1–4)	4 (1–4)	$U = 1238, p = .275, r = .11$

[a]Family socioeconomic status (SES) was transformed according to the conventions supposed by Hollingshead (1975). Hollingshead four factor index of social status ranges from 8–66. A score between 40–54 reflects a SES of medium business owners, minor professionals, or technical specialists

[b]Paternal and maternal net income was converted to US dollars for both countries and categorized into 4 categories: 1 = 0–1.520 US Dollars, 2 = 1.520–2.460 US Dollars, 3 = 2.460–3.700 US Dollars, 4 ≥ 3.700 US Dollars

total, each emotion category was presented eight times, resulting in 48 test trials. For each page, children were requested to point to the target picture on each page by asking them "Could you please show me the boy/girl who feels … (e.g. angry)?". No feedback was given for correct or incorrect responses.

Test of emotion comprehension

In the present study, the English (Pons et al., 2004) and German version (Janke, 2006) of the Test of Emotion Comprehension (TEC) were administered to the Singaporean and German sample, respectively. The TEC is a picture book, which comprises 23 cartoon scenario boards assessing nine components of emotion comprehension emerging between 3 and 11 years. The first component requires children to point to one cartoon face from among four alternatives corresponding to the target emotion asked by the experimenter (e.g., "happy", "scared", "angry", "sad"). Thus, this component is comparable with the emotion recognition task administered in the present study. The remaining eight components are assessed by means of stories with increasing complexity. The stories are illustrated by cartoon pictures positioned on top of the page showing the protagonist in a certain context (e.g., receiving a birthday gift; stealing cookies from a jar). Crucially, the protagonist's face has been left blank, and based on the respective story, children are asked to

select the appropriate emotional cartoon face from among four choices located at the bottom of the page.

Procedure

Preschoolers were tested individually in a separate room by a trained English- and Chinese-speaking experimenter in Singapore and by three trained German-speaking experimenters in Germany. For all children, the emotion recognition task was administered first, followed by the TEC. In the emotion recognition task, children were familiarized with the picture book and asked to help the experimenter with finding the correct faces for different emotions. Children were briefed that they should carefully look at all six pictures before pointing to a certain face. Two practice pages were administered to assure that all children understood the task correctly. Experimenters were trained to administer the instructions in a standardized manner by keeping a neutral voice and not giving facial cues. Moreover, experimenters were trained to protocol children's responses on a score sheet. The administration of the emotion recognition task took about 10 min. The TEC was administered according to the recommendations given in the manual (Janke, 2006; Pons et al., 2004), with experimenters reading out the stories in an emotionally neutral tone, following the original wording of the test, not giving any feedback or suggestions for correct and incorrect

Fig. 1 Examples of two test pages showing European American and Asian American stimuli based on the Child Affective Facial Expression set (LoBue & Thrasher, 2015)

responses, and immediate coding of children's responses on a score sheet. The administration of the TEC took about 20 min, and children received a small gift after participation.

Coding and statistical analyses

On the emotion recognition task, children could achieve 1 (correct) or 0 (incorrect) points for each target emotion, resulting in a maximum of 8 points per emotion category and a maximum of 24 points for each stimulus ethnicity. Mean unbiased hit rates (H_u; see Wagner, 1993 for further information) were calculated separately for each emotion category and stimulus ethnicity. H_u corrects for potential response biases and is calculated as the product of two conditional probabilities: (1) that an emotion category

is correctly identified under the condition that it is presented to the rater at all, and (2) that a response is correctly given under the condition that the response is used at all by the rater (Armistead, 2013; Wagner, 1993). H_u is calculated as follows:

$$H_u = \frac{A^2}{B \times C}$$

A represents the number of times a specific emotion category (e.g., happiness) was correctly identified, B represents the number of times that an emotion category was presented, and C represents the number of times the response category was used. H_u values range from 0 to 1, with 0 indicating that an emotion category was judged incorrectly on all trials, and that a response category is constantly used incorrectly. In

contrast, a value of 1 indicates that a specific emotion category was judged correctly on all trials, and that no confusion errors occurred for this specific category.

The scoring procedure of the TEC followed the recommendations given in the manual (Janke, 2006; Pons et al., 2004). For each component, children could achieve either 0 (fail) or 1 (pass) point. The first (*Recognition*) and second (*External*) component comprise five items each, and the components were passed when children responded correctly to at least four of these five items. The third component (*Desire*) was passed when children were correct on all four questions. The ninth component (*Moral*) was passed when children gave correct answers for both questions. The remaining five components (*Hiding*, *Belief*, *Reminder*, *Regulation* and *Mixed*) encompass one test question each and were passed when children responded correctly. The global TEC score (ranging from 0 to 9 points) was obtained by summing up the scores of the nine components.

Data were analyzed using IBM SPSS Statistics (version 27). The level for significance was set at α = 0.05 and effect sizes were calculated using Cohen's *d* for independent-samples *t*-tests, Cohen's *dz* for dependent-samples *t*-tests, and partial eta-squared (η_p^2) values for ANOVAs. In case the assumption of sphericity was violated, a Greenhouse–Geisser-correction was applied.

Results

Emotion recognition

On average, the Singaporean sample had a mean unbiased hit rate of H_u = 0.59, SD = 0.16, and the German sample of H_u = 0.46, SD = 0.15, when collapsed across emotion categories and stimulus ethnicities.

We ran a 2 × 2 × 6 ANCOVA with *country* (Singapore vs. Germany) as a between-subject factor, and *stimulus ethnicity* (European American (EA) vs. Asian American (AA) faces) and *emotion* (happiness, sadness, anger, disgust, fear, surprise) as within-subject factors on mean unbiased hit rates controlling for *age* as a covariate.
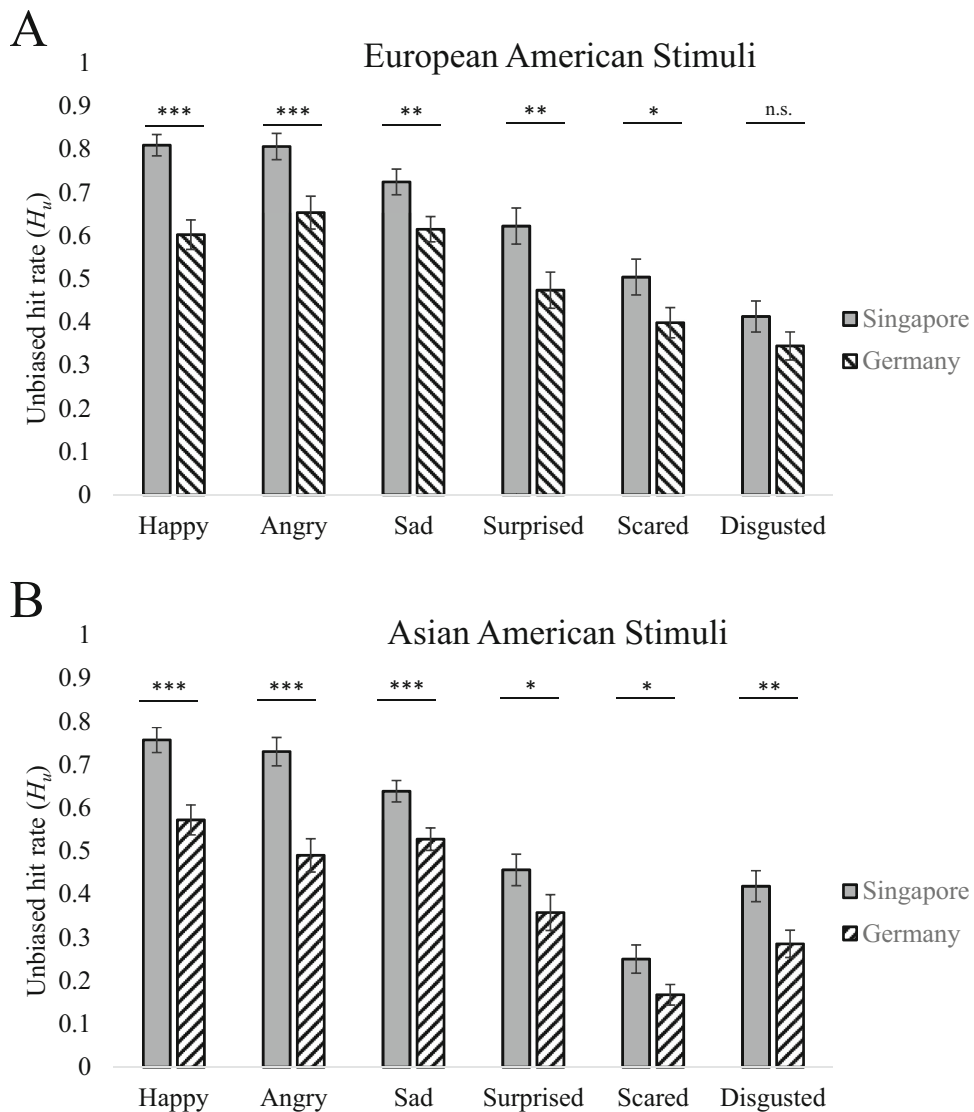
In line with our hypothesis that Singaporean preschoolers (high-context culture) would outperform German preschoolers (low-context culture) on the emotion recognition task, the analysis revealed a significant main effect of *country*, $F(1, 126) = 32.9$, $p < .001$, $\eta_p^2 = 0.207$. Singaporean preschoolers (M = 0.59, SD = 0.16) showed significantly higher mean unbiased hit rates than German preschoolers (M = 0.46, SD = 0.15). Planned comparisons (one-tailed) revealed that Singaporean preschoolers recognized all emotions in both EA and AA faces (except for disgust in EA faces) significantly better than German preschoolers (all $ts \geq 1.79$, all $ps \leq .038$, all $ds \geq 0.31$, see Fig. 2).

Moreover, a significant main effect for *stimulus ethnicity* ($F(1, 126) = 5.20$, $p = .024$, $\eta_p^2 = 0.040$) indicated that preschoolers showed higher unbiased hit rates when judging EA faces (M = 0.59, SD = 0.17) compared to AA faces, (M = 0.48, SD = 0.17). Bonferroni-adjusted post-hoc analyses revealed that recognition of EA faces was significantly more accurate for all emotions (all $ts \geq 4.16$, all $ps \leq .001$) with the exception of disgust ($t(128) = 1.03$, $p = 1.00$) and happiness ($t(128) = 2.17$, $p = .192$).

With regard to the explorative question whether Singaporean and German preschoolers show a cultural in-group advantage of emotion recognition, the analysis revealed no significant interaction between *country* and *stimulus ethnicity* ($F(1, 126) = 0.240$, $p = .625$, $\eta_p^2 = 0.002$), indicating that there was no mutual in-group advantage for own ethnicity.

Further, a significant main effect for *emotion* was yielded, ($F(3.79, 477.6) = 3.13$, $p = .016$, $\eta_p^2 = 0.024$) with preschoolers performing best on happy faces (M = 0.70, SD = 0.23), followed by angry (M = 0.68, SD = 0.24), sad (M = 0.63, SD = 0.18), surprised (M = 0.49, SD = 0.29), disgusted (M = 0.37, SD = 0.23), and finally scared faces (M = 0.34, SD = 0.23).

Finally, in accordance with our hypothesis that emotion recognition improves with increasing age, the analysis revealed a significant effect of the covariate *age* ($F(1, 126) = 38.4$, $p < .001$, $\eta_p^2 = 0.234$). Bonferroni-corrected post-hoc tests revealed that 6-year-olds (M = 0.63, SD = 0.14) performed significantly better than 5-year-olds ($p = .003$; M = 0.52, SD = 0.14), and 4-year-olds ($p < .001$; M = 0.46, SD =

A

European American Stimuli

B

Asian American Stimuli

Fig. 2 Mean unbiased hit rates (H_u) for German and Singaporean preschoolers judging (**A**) European American stimuli and (**B**) Asian American stimuli. Vertical bars indicate between-subject standard errors, *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

0.14). All other interactions were non-significant (all Fs ≤ 1.86, all ps $\geq .121$).

Emotion comprehension

Global TEC scores ranged from 0 to 9 ($M = 4.48$, SD = 1.70, $n = 62$) in the Singaporean sample and from 1 to 8 ($M = 4.42$, SD = 1.72, $n = 60$) in the German sample. To test the hypothesis that German preschoolers outperform Singaporean preschoolers on the TEC, a 2 *country* (Singapore/Germany) ANOVA with

country as a between-subject factor and *age* as a covariate was conducted on the global TEC scores. In contrast to our hypothesis, there was no significant main effect of *country* ($F(1, 119) = 0.064$, $p = .801$, $\eta_p^2 = 0.001$), with German preschoolers and Singaporean preschoolers showing comparable global TEC scores. However, in line with our hypothesis that emotion comprehension improves with increasing age, the analysis revealed a significant effect of the covariate *age* ($F(1, 122) = 38.6$, $p < .001$, $\eta_p^2 = 0.245$). Post-hoc Bonferroni-corrected

comparisons revealed that 5-year-olds and 6-year-olds outperformed 4-year-olds significantly (both p-values < .001), whereas there was no significant difference between 5- and 6-year-old preschoolers (p = .143).

A series of Chi-square tests was conducted to assess differences in the frequency of passing or failing a TEC component between Singaporean and German preschoolers. In line with our hypothesis that Singaporean preschoolers should outperform German preschoolers on the first component (*Recognition*), the analyses revealed a significant difference for the *Recognition* component (χ^2(122) = 7.31, p < .01; see Table 2) indicating that more Singaporean children passed the recognition task than German children. No significant differences were found for the remaining eight components (all χ^2 < 1.28), disconfirming our hypothesis that Singaporean and German preschoolers would differ on the *Hiding* and *Reminder* components.

Discussion

The aim of the present study was to extend previous findings by investigating two aspects of emotion understanding in a Southeast Asian and Western European culture with comparable socio-economic status. Specifically, the current work aimed to investigate potential differences in the development of emotion recognition and emotion comprehension in Singaporean and German preschoolers aged 4 to 6 years. To this end, all preschoolers completed an emotion recognition task and the Test of Emotion Comprehension (TEC, Pons et al., 2004).

Overall, the results of the current work demonstrate that preschoolers' emotion recognition was influenced by culture, whereas emotion comprehension was comparable between Singapore and Germany. Moreover, preschoolers of both countries performed better on both tasks with increasing age.

Emotion recognition

Results indicated that Singaporean preschoolers were better at identifying all six emotions (except disgust in European-American faces) than German preschoolers. This finding is in line with the theoretical notion that people in high-context cultures like China or Singapore express and detect emotions through implicit, contextual cues (Hall, 1976). Children growing up in this cultural context become more sensitive towards subtle cues, which is supported by previous studies indicating that Chinese children were better at recognizing emotions from faces (Markham & Wang, 1996) or vocal cues (Yang et al., 2021) than Western children. In contrast, people in low-context cultures like the US or Germany explicitly express and discuss emotional states (Camras et al., 2014; Hall, 1976; Wang, 2003) making it less relevant for them to rely on facial cues. Thus, our study provides further evidence that culture-specific emotion socialization affects already preschoolers' emotion recognition.

However, there was no mutual in-group advantage as supposed by studies with adults (Wickline et al., 2009; Yan et al., 2016). In contrast, both Singaporean and German preschoolers were better at recognizing emotions in European American faces. There is

Table 2 Percentage correct and rank order of each TEC component for German and Singaporean preschoolers

TEC component	German n = 60 M_{age} = 5.36		Singaporean n = 62 M_{age} = 5.37		χ^2 (df = 1)
	Rank	Pass (%)	Rank	Pass (%)	
I (Recognition)	1	82	1	95	7.31**
II (External)	3	68	3	76	1.28
III (Desire)	2	76	2	79	0.29
IV (Belief)	8	27	8	21	0.55
V (Reminder)	4	52	5	41	1.16
VI (Regulation)	5/6	44	6	37	0.49
VII (Hiding)	5/6	44	4	51	0.53
VIII (Mixed)	9	20	9	13	1.12
IX (Moral)	7	34	7	29	0.26

**p <.01. Chi-square tests for each component are based on the two factors culture (Singapore/ Germany) × success (pass/fail)

evidence that European American children express emotions more frequently and more intensively compared to East Asian children (Camras et al., 2006; Louie et al., 2014). Accordingly, Singaporean and German children may be more familiar with emotional expressions of European American faces, and thus, be more proficient in identifying emotions in European American children's faces. Moreover, previous studies have shown, that exposure to different cultures or living in diverse societies reduces an in-group advantage in emotion recognition (Elfenbein & Ambady, 2003a; Prado et al., 2014; Reyes et al., 2018). Thus, due to Singapore's multi-cultural society, Singaporean children are frequently confronted with children of varying cultural backgrounds, probably allowing them to identify emotions in a broad variety of cultures.

In line with previous research, results suggest that both Singaporean and German preschoolers' emotion recognition improved with age (Chronaki et al., 2015; Durand et al., 2007; Juen et al., 2012). Moreover, consistent with the literature, recognition rates of happy faces were highest (Durand et al., 2007; Juen et al., 2012; Lawrence et al., 2015), whereas recognition rates of disgusted and scared faces were lowest in both samples. This result is in accordance with previous findings showing that disgust and fear develop gradually throughout preschool years (Gagnon et al., 2010; Widen & Russell, 2003, 2004), and that facial emotion displays of similar valence and arousal are often confused (e.g. anger and disgust; fear and surprise) (Langner et al., 2010; Recio et al., 2013; Russell & Bullock, 1986).

Overall, results from the emotion recognition task in this study support the notion of cultural differences between Singaporean and German preschoolers. Importantly, the current study extends previous research by investigating children's emotion recognition by means of child's faces. Future research should further investigate these differences by means of dynamic or spontaneously posed emotions.

Emotion comprehension

Results regarding the Test of Emotion Comprehension (TEC) suggest that the overall developmental pattern was comparable between Singaporean and German preschoolers. This finding is consistent with previous findings showing improvements in TEC with increasing age and similar rank orders and for Italian (Molina

et al., 2014), Chinese (Tang et al., 2018), British (Pons et al., 2003), and German (Molina et al., 2014) children. Nevertheless, Singaporean preschoolers performed significantly better (95%) on the first component (Recognition) than German (82%) preschoolers. In the Recognition component, children are required to select the correct facial expression among four alternatives, hence, this finding is consistent with the pattern found in the emotion recognition task. Accordingly, Tang et al. (2018) and Molina et al. (2014) reported similar passing rates for the Recognition component in 4 to 6-year-old Chinese (92%), and 3 to 6-year-old German preschoolers (76%), respectively. Moreover, the passing rates for the Recognition component in Italian (72%) and British (73%) children were comparable to those of German children (Molina et al., 2014; Pons et al., 2003). These findings reflect once more, that East Asian children have an advantage in identifying implicit facial cues compared to Western European children as suggested by research on emotion recognition (Markham & Wang, 1996; Yang et al., 2021).

In contrast to our findings, Tang et al. (2018) reported that Chinese preschoolers outperformed British and German preschoolers on the Hiding component, and that the latter groups outperformed Chinese preschoolers on the Reminder component. Although trends in the expected directions are apparent in our data, Singaporean preschoolers performed statistically comparable to their German counterparts in the Hiding component (SG 51% vs. GER 44%) and in the Reminder component (SG 41% vs. GER 52%). One possible reason for this finding may be that compared to Mainland China, Singapore's culture is increasingly exposed to Western culture. For instance, Singaporean preschools underwent a post-millennial trend to incorporate child-centered western pedagogy into early childhood classrooms. As a result, an increasing number of preschools implemented new curricula and targeted to employ westernized teaching routines emphasizing the importance of individual needs and strengths (Bull & Bautista, 2018; Li et al., 2012; Luke et al., 2005). Therefore, Singaporean preschoolers likely received more opportunities to engage in mental state discussion than preschoolers growing up in Mainland China, which in turn might have boosted their emotion comprehension ability. Moreover, as stated before, growing up in diverse societies may also foster children's emotion

comprehension. At this point, it is important to note, that culture is not static but an everchanging dynamic system (Greenfield, 2018). Due to globalization, immigration and access to social media, cultural norms, values, and habits get altered over time. Thus, even though Singapore and Mainland China still share many cultural values and habits, they also developed in their own directions. While Singaporean Chinese children on the one hand experience Chinese socialization practices in their families, on the other hand they frequently engage with children and adults of different cultural backgrounds shaping their social cognition in unique ways. Nevertheless, even though Singapore seems to play a unique role among Asian jurisdictions, it still shares key cultural values and traditions with Mainland China and Hong Kong, which is reflected by our findings. Future work is needed to further investigate Singapore's unique cultural composition.

Limitations and future work

There are certain caveats and limitations that could direct future work in this area. First, although many aspects of emotion understanding develop in preschool age, several components emerge in later childhood. Since previous studies suggest that Asian and European American children's emotion understanding seems to approximate in later childhood, future studies should involve a wider age range of children to trace developmental courses. Second, it will be important to assess cultural differences in developmental outcomes of emotion understanding. There is first evidence for culture-specific associations between children's emotion understanding and internalizing behavior (e.g., Doan & Wang, 2018), and future research needs to identify how emotion understanding is related to beneficial and maladaptive outcomes in different cultures to develop culture-appropriate training programs. Third, upcoming research needs to address micro-cultural differences within cultural boundaries by taking parents' culture identity and child rearing strategies into account, or by assessing minority samples. This is particularly important, as most Asian countries comprise a variety of ethnic groups and share a history of colonization. However, most studies including the current work compared Eastern and Western cultures mainly in terms of broad cultural differences. Yet, in the case of Singapore, it would be worthy to study and compare children with Chinese, Malay, Indian or Indonesian family backgrounds to disentangle micro-cultural influences. Moreover, most studies investigating children's social cognitive skills were carried out in Mainland China, Japan, or Hong Kong, while to date there is no evidence for other Asian countries such as Thailand or Vietnam. This issue needs to be addressed by future research to shed light on cultural values that might be shared by a variety of Asian cultures, but also to identify factors causing unique cultural differences. In accordance with this claim, the source of cultural influence needs to be identified. Accordingly, it is important to assess parents' and teachers' six dimensions of national culture as supposed by Hofstede (2011). To date, most studies interpret culture differences in terms of the individualism/collectivism dimension. Nevertheless, cultural differences may also occur due to variations on the remaining five dimensions of national culture. Finally, due to globalization and immigration, cultures are increasingly influenced by cultural exchange. Future studies should address this by investigating the influence of cultural exposure on children's emotion understanding.

Availability of data and material Data archiving is not mandated but data will be made available on reasonable request.

Code availability Not applicable.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethics approval The present study was part of a research project entitled "Cross-cultural differences in the development of social cognition between German and Singaporean preschoolers" which was approved by the ethic committee of the Faculty for Human and Business Sciences of Saarland University (Protocol number 17-05), Germany, and by the NTU institutional review board (Protocol number IRB-2017-07-015), Singapore.

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