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Emotion recognition abilities and behavior problem dimensions in preschoolers: Evidence for a specific role for childhood hyperactivity.

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Abstract

Facial emotion recognition difficulties have been reported in school-aged children with behavior problems; little is known however about either this association in preschool children or with regard to vocal emotion recognition. The current study explored the association between facial and vocal emotion recognition and behavior problems in a sample of 3 to 6 year old children. A sample of fifty seven children enriched for risk of behavior problems (forty one were recruited from the general population while 16 had been referred for behavior problems to local clinics) were each presented with a series of vocal and facial stimuli expressing different emotions (i.e., angry, happy and sad) of low and high intensity. Parents rated children's externalizing and internalizing behavior problems. Vocal and facial emotion recognition accuracy was negatively correlated with externalizing, but not internalizing behavior problems independent of emotion type. The effects with the externalizing domain were independently associated with hyperactivity rather than conduct problems. The results highlight the importance of using vocal, as well as facial stimuli when studying the relationship between emotion recognition and behavior problems. Future studies should test the hypothesis that difficulties in responding to adult instructions and commands seen in children with Attention Deficit/Hyperactivity Disorder (ADHD) may be due to deficits in the processing of vocal emotions.

Keywords: Emotion recognition, vocal, facial, preschoolers, hyperactivity

Introduction

The ability to interpret others' emotions through facial and vocal expressions is argued to be fundamental to the development of effective social interaction and social adjustment (Saarni, 1999). Denham (1998), for example, showed that 3-5-year-old children who were better able to understand non-verbal emotional cues in social interactions developed better social skills and formed more positive relationships over time. Similarly, impairments in the recognition of emotional expressions have been linked to both externalizing and internalizing symptoms in childhood and adolescence. Increased symptoms of hyperactivity in 6-12-year-old children, for example, have been linked to difficulties recognising both positive (happy) and negative (anger, sadness, fear) facial expressions of emotion (Boakes, Chapman, Houghton, & West, 2008; Corbett & Glidden, 2000; Pelc, Kornreich, Foisy, & Dan, 2006; Sinzig, Morsch, & Lehmkuhl, 2008). In addition, children and adolescents with conduct problems showed increased errors detecting negative (sad, angry and fearful) facial expressions (Blair, Colledge, Murray, & Mitchell, 2001; Fairchild, Stobbe, Van Goozen, Calder, & Goodyer, 2010) and a hostility bias - a tendency to attribute anger to facial expressions of emotion (Dodge, Bates, & Pettit, 1990; Schultz, Izard, & Bear, 2004). Further research has found that elevated anxiety symptoms in children aged 10-11 years were also linked to increased attributions of anger to facial expressions with low intensity happiness (Richards, French, Nash, Hadwin, & Donnelly, 2007).

Researchers have argued that the preschool years constitute a landmark period for the development of emotion understanding and that the acquisition of emotional knowledge in this stage of development has significant implications for children's long-term social competence (Denham et al., 2003; Izard et al., 2001). Consistent with research in middle childhood and adolescence, several studies have found links between behavior problems and emotional processing in preschoolers. Nowicki and Mitchell (1998), for example, used the Diagnostic Analysis of Nonverbal Accuracy (DANVA) test to measure facial emotion recognition (angry, happy, sad, fearful) at "high" and "low" intensities. This study also included child and adult voices as well as faces. Here, they considered links between recognition of adult and child emotional faces with internalizing (i.e., anxious/depressed) and externalizing (i.e., aggressive) symptoms in 3-5-year-olds. The results showed that (irrespective of verbal ability) externalizing symptoms in girls were positively associated with identification errors for angry, sad and fearful child faces at high intensity. In addition, internalizing symptoms in girls were associated with more identification errors for angry and sad child faces and angry adult faces at high

intensity. Similarly, a study with 3-5-year-old preschoolers, who viewed a series of drawn faces (angry, happy, sad and fearful) and were asked to place on a puppet the face that depicted the puppet's feeling in a story, showed that decreased accuracy to recognize sadness was associated with externalizing (i.e. aggressive) symptoms (Martin, Boekamp, McConville, & Wheeler, 2010). Preschoolers aged 3-5 years with elevated levels of teacher-rated aggression were also more likely to label a story protagonist as experiencing anger (versus happiness, sadness and fear), in a task that required matching emotion labels to the feelings of a protagonist in a story context, indicating links between aggression and an anger bias in this age group (Schultz, Izard, & Ackerman, 2000). Similarly, higher levels of dependency on the teacher in 3-5-year olds were positively associated with bias to angry faces in a forced-choice recognition task using angry, happy, sad, surprised, fearful and neutral child faces (Barth & Bastiani, 1997).

Longitudinal research demonstrated that difficulties in verbal labeling of facial emotional expressions at age 3 and 4 predicted classroom anger and aggression at 5 to 6 years (Denham et al., 2002). Difficulties in labeling the emotion of a protagonist in stories at 3 years predicted social withdrawal at 5 years (Schultz, Izard, Ackerman, & Youngstrom, 2001). The same study found that hyperactivity and attention problems at 3 years were negatively associated with children's emotion situation knowledge at 5 years even after verbal ability was taken into account. These findings highlight the importance of understanding links between emotional information processing and behavior problems early in development; where findings can inform early preventive interventions aimed to accelerate the development of emotional knowledge in young children and reduce symptoms of psychopathology (Izard et al., 2008). Difficulties in emotion recognition in children with externalizing and internalizing symptoms might be understood more clearly by exploring emotional processing difficulties evident during this early stage of development.

Research to-date has typically focused on individual differences and understanding of facial emotion processing in preschoolers. Fewer studies have, however, looked at potential difficulties in vocal emotion processing in preschoolers with behavior problems. The relative lack of evidence with regard to vocal emotion and individual differences in behavior is surprising given links between vocal emotion processing and social competence in the preschool years (Goonan, 1995; Nowicki & Mitchell, 1998; Verbeek, 1996). Nowicki and Mitchell (1998), for example, using the DANVA voices test (Baum & Nowicki, 1998) in 3-5-year-olds found that teacher-rated aggressive behavior and internalizing

symptoms in girls were associated with more errors in recognizing happy, sad and fearful child voices, irrespective of a child's verbal ability. In a similar study, Maxim and Nowicki (2003) found that lower social competence (i.e., 'ability to maintain satisfactory relationships with adults) was associated with more errors identifying negative emotions in adult voices (i.e., angry and sad adult voices in girls and boys respectively) in 4-6-year-olds. In particular, girls made more errors identifying high intensity voices (Maxim & Nowicki, 2003). Similarly, Maxim and Nowicki (1998) showed that 5-year-olds boys' ability to 'get along with' teachers and peers (as rated by teachers) was positively linked with higher accuracy to recognize emotion (in this case fear) from child voices. In a similar study, Verbeek (1996) observed 3-5-year olds children's social behavior over a three month period in the playground and found that more errors identifying happy and angry child voices at the DANVA test were positively linked with greater involvement in conflict with peers.

While associations have been demonstrated between emotional processing skills and behavioral difficulties in preschoolers, current research has not considered the independent contribution of different dimensions of externalizing (i.e. conduct problems and hyperactivity) or internalizing (emotional) symptoms in facial and vocal emotion processing in this age group. In addition, previous studies have typically utilized the DANVA voices test (DANVA-Adult Paralanguage). One limitation with this stimulus set is that it contains only American child and adult voices which may not be appropriate for other English speaking countries.

The present study aimed to extend current knowledge to examine the developmental origins of difficulties in emotion processing in very young children with symptoms of externalizing and internalizing behavior problems. In addition, it aimed to examine the independent contribution of the different dimensions of child behavior problems to emotion recognition in this age range. The study extended previous research (Nowicki & Mitchell, 1998) to examine the modality specificity (i.e., face and voice) of emotion processing using a specially designed battery of vocal stimuli with a UK voice. The voice stimuli created here, using one female adult model, were based on the DANVA test. An equivalent female adult model stimulus set was utilized from an established set of facial stimuli (Ekman & Friesen, 1976). The inclusion of one adult female allowed some focus in the current study on emotional expression as reflected in mother-child interaction. Following the DANVA test, we also utilized different levels of intensity of emotional faces and voices in order to identify patterns of emotion recognition in preschoolers. Researchers have argued that stimuli that vary in intensity have

stronger ecological validity because every day social interactions require reading emotional messages that have different levels of intensity. Moreover, it has been suggested that variation of stimulus intensity might reflect different non-verbal processing problems and impact children's social competence differently (Nowicki & Carton, 1993). For example, some children with low social competence had difficulty identifying emotions of low but not high intensity (Verbeek, 1996) whereas other children with behavior problems had difficulty identifying high intensity emotions (Nowicki & Mitchell, 1998).

The present study investigated emotion processing in angry, happy and sad faces and voices across two levels of emotional intensity in young children. In addition, it considered associations between emotion processing with symptoms of externalizing and internalizing behaviors. We predicted that conduct problems would be positively associated with difficulties identifying negative emotions across faces and voices (especially anger), whereas symptoms of hyperactivity would be positively linked to broader difficulties in emotion recognition for faces and voices (anger, sadness and happiness). This prediction was based on past findings that conduct problems were associated with increased errors (Fairchild et al., 2010) and biases (Schultz et al., 2000) in regards to negative expressions, whereas hyperactivity was associated with general difficulties identifying both positive and negative expressions (Corbett & Glidden, 2000, Sinzig et al., 2008). In addition, it was hypothesized that elevated internalizing symptoms would be associated with a bias to angry facial expressions. This prediction was based on research in school-aged children (Richards et al., 2007) and preschoolers (Barth & Bastiani, 1997) linking internalizing symptoms with a bias to angry expressions. Further exploratory analyses considered the relative contributions of behavioral symptoms (hyperactive, conduct and emotional symptoms) to emotion processing difficulties in preschoolers'.

Methods

Participants

Forty one children (mean age = 4 years 2 months, *SD* =0.74 years, range = 2 years 6 months - 5 years 8 months, 21 boys) with English as their first language participated in this study along with their birthmothers. Mothers' age ranged from 20 to 43 years (*M*=32.86, *SD*=5.68). Of the 65 children

initially approached, 41 were recruited via nursery schools. The sample was enriched for potential behavior problems with a further 16 children (mean age = 5 years 2 months, *SD* =0.89 years, range = 3 years - 6 years 3 months, 12 boys), out of 32 initially approached, recruited through contacts at local clinics. These children had been referred by doctors and health visitors as being at risk of emotional and/or behavior problems but had no confirmed diagnosis at the time of the study and were added to increase the potential range of severity of emotional and behavior problems so as to add statistical power to detect associations between emotion recognition and problems. The research protocol was approved by the Psychology and NHS Ethics Committees. All parents gave informed written consent on behalf of their children to take part in the study.

Materials

Facial expression stimuli. The material used for the assessment of facial emotion recognition consisted of standardized pictures of emotional facial expressions (Ekman & Friesen, 1976; Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002). A set of 3 (emotion: angry, happy, sad) x 2 (intensity: low and high) facial expressions of the same female model were used. The study employed expressions of a low (50%) and high (75%) intensity level per emotion type and a neutral (e.g., 0% emotion) expression. Each facial expression was displayed to the child across the two intensities leading to 6 different emotion x intensity conditions plus one neutral condition.

Vocal expression stimuli. UK vocal stimuli were created for the purposes of the present study. We patterned our English accent vocal emotion recognition test to the American accent DANVA-Adult Paralanguage test (Baum & Nowicki, 1998). An English native speaker actress was asked to say the neutral sentence *'I am going out of the room now but I'll be back later'* in standard UK accent in response to vignettes of emotional situations. This sentence has been rated as neutral by 90% of adults (Maitland, 1977). The actress was asked to produce expressions to approximate low and high intensities. The actress produced 6 trials for low and 6 trials for high intensity per emotion type (angry, happy and sad) and 10 neutral expressions. Eighteen 20- to 52-year-old undergraduate students, English native speakers, (mean age=27.05, *SD*=8.68, 15 females) listened to each one of the 46 vocal stimuli produced by the actress and judged whether it was 'angry', 'happy', 'sad', or 'neutral'. After selecting one (emotion) word per vocal item, judges were asked to indicate how intense the emotion they had chosen (e.g., angry) was on an eight point scale from 'not at all angry' to 'extremely angry'. Because the main goal of the test was to present stimuli to children that would be recognized

by most as communicating a particular emotion, a relatively high percentage of inter-judge agreement was used for item selection. Seven stimuli were selected from the original sample of 46 stimuli based on the means (*SD*) of the judges' ratings on the eight point scale: High intensity: Angry: *M*=6.38, *SD*=2.00, Happy: *M*=5.72, *SD*=1.74, Sad: *M*=6.33, *SD*=1.78; Low intensity: Angry: *M*=4.55, *SD*=2.82, Happy: *M*=3.77, *SD*=2.36, Sad: *M*=4.11, *SD*=2.58 and Neutral: *M*=4.88, *SD*=2.13. Overall agreement between judges on how representative the seven vocal items were of each emotion category was as follows: High intensity: Angry: 94.4%, Happy: 100%, Sad: 94%; Low intensity: Angry: 88.9%, Happy: 83.3%, Sad: 77.8% and Neutral: 94.4%. This high percentage agreement among judges is similar to the American DANVA-Adult Paralanguage test (Baum & Nowicki, 1998)**.** In summary, the vocal stimulus material consisted of 3 (emotion: angry, happy, sad) x 2 (intensity: low and high) expressions plus a neutral expression from the same actress. An equal number of low and high intensity levels for each emotion were represented in the test. Each item was displayed to the child across two levels (low and high intensity) leading to 6 different emotion x intensity conditions plus one neutral condition. Further, in this study we aimed to gather construct validity information to support the test's use. One way to establish construct validity for the DANVA test is to show that it is related to social competence (Nowicki, 2008). We tested the proposition that higher accuracy to recognize emotion in voices would be associated with lower levels of externalizing and internalizing problems in preschoolers.

Experimental Task Design

Children took part in an emotional expression identification task across two modalities (face, voice). Both tasks had four response options (angry, happy, sad and neutral/'okay'), and were made up of 70 experimental trials (10 trials per emotion x intensity condition, plus a neutral expression) presented in two blocks of 35 trials each. At the beginning of each task children participated in 7 practice trials identical to those in the experimental trials (one per emotion x intensity condition, plus a neutral trial). The researcher asked the children to identify the emotion in the face/voice and give a verbal response. Each trial began with the presentation of a central fixation cross (500 ms) followed by the presentation of the stimulus (3000 ms for faces and voices) followed by a blank screen until the children gave a verbal response. The inter-trial interval was 1000 ms. Stimuli were presented on a computer monitor or via speakers and stimulus order was randomized.

Procedure

Children were tested individually in a quiet room. The task was introduced to the children as a game. They were told, 'Children can tell how adults feel by looking at their faces and listening to their voice. Today we are going to play a game about feelings. Feelings are like when you feel happy or sad. Do you know what these words mean? Do you ever feel happy? What makes you happy?' This was repeated for all emotions used in the study. Two children whose performance was not perfect on all emotions were not tested in this study. For all the remainder children, performance was perfect on all emotions. This way we ensured that children understood the meaning of all emotion labels before taking part in the main task. Following this introduction to emotions, children participated in 7 practice trials (see above) before continuing to the main task. All children successfully completed the practice trials. The following instructions were given to the children prior to the practice trials and the main task: 'Now I am going to show you some people's faces/play an audio tape with some people's voices saying the sentence 'I am going out of the room now, but I'll be back later' and I want you to look at the faces/listen to the voices and tell me if the person is happy, angry, sad or okay'. Immediately after presentation of the stimulus, the experimenter asked the child 'Is this person angry, happy, sad or okay? The presentation of the face and voice tasks was counterbalanced across participants. The experimenter read out the emotion words in counterbalanced order across trials. This was facilitated by the use of 24 script cards (6 possible combinations of emotion words x 4 emotions). The same female experimenter read out the response words to all children in a neutral tone of voice and did not provide any prompts or other cues to the answer. Stimuli were presented and responses logged in via Inquisit software (www.millisecond.com). After each block of 35 trials lasting about 5 minutes, children were given the opportunity to have a short break. Children were reminded to pay attention throughout the task and were given a sticker at the end of each block. Total testing time was about 20 minutes (10 minutes per task). At the end of the study children were given a certificate as a small thank you gift.

Questionnaire Measures

Child hyperactivity, conduct problems and emotional symptoms. The Strengths and Difficulties Questionnaire (SDQ) is a 25-item behavioral screening questionnaire for 3 to 16 year olds with good psychometric properties (ά=0.85) (Goodman, 1997). It includes sub-scales measuring

emotional symptoms, hyperactivity, conduct problems, peers problems and pro-social behavior each containing five items. The current study used the hyperactivity, conduct problem and emotional symptoms sub-scales. Each item is scored on a scale from 0 (not true) to 2 (certainly true). The five items generate a range of scores from 0-10. Cronbach's alphas in the present study were .66, .86 and .84 for the emotional symptoms, hyperactivity and conduct problems sub-scale respectively.

Data Analysis

Discrimination accuracy. Raw data were transformed into measures of accuracy according to the 2HT (two high threshold) model (Corwin, 1994). Discrimination accuracy (Pr) was computed for each target emotion using 'hits' (e.g., number of angry, happy, or sad expressions classified correctly), according to the following formula: Pr = ((number of hits + 0.5) / (number of targets + 1)) – ((number of false alarms + 0.5) / (number of distractors + 1)). Pr scores take values which tend to 1, 0 and -1 for accuracy reflecting better than chance, close to chance and worse than chance levels respectively. For example, in a task with 10 trials of each of the 7 conditions: angry, happy and sad at two intensity levels (low, high) per condition plus one neutral condition, if a child classified 9 angry faces as angry but he/she also classified as angry 7 neutral faces, 4 happy faces (low intensity), 3 happy faces (high intensity), 4 sad faces (low intensity), and 5 sad faces (high intensity), then his/her accuracy for angry faces would be: ((9 + 0.5) / (10+1)) – ((7+4+3+4+5+ 0.5) / (50+1))=0.40, suggesting that accuracy is better than chance.

Response bias. Measures of discrimination accuracy were used to compute scores of response bias (Br), defined as a participant's propensity to classify an emotional expression as angry, happy, sad or neutral, according to the following formula: Br= ((number of false alarms + 0.5) / (number of distractors + 1)) / (1-Pr). Values that tend to 1 indicate the presence of a systematic bias whereas values that tend to zero (0) indicate the absence of a systematic bias. For example, in the same example given above, if a child had an accuracy score (Pr) of 0.40 for angry faces (combined Pr scores for angry high and low intensity) and also classified as angry 7 neutral faces, 4 happy faces, 3 happy faces, 4 sad faces and 5 sad faces, then his/her response bias score for angry faces would be as follows: ((7+4+3+4+5+0.5)/ (50+1)) / (1-0.40)=0.76, suggesting an elevated bias to angry faces.

Accuracy (Pr) and bias (Br) scores were entered in a repeated measures analysis of variance (ANOVA) with emotion type and modality as the within-subject factor. Pearson's correlations were used to explore the relationship between child symptoms of psychopathology and discrimination

accuracy (Pr) and response bias (Br). Regression analyses examined the independent contribution of child symptoms in predicting emotion recognition accuracy.

Results

Table 1 displays means and standard deviations of parental ratings of child behavior problems in the whole sample. Although the SDQ scores were used as continuous variables in this study, we also examined the proportion of children in the 'atypical' range for symptoms using the recommended cut-offs of 7, 4 and 5 or more out of a total of 10 symptoms for hyperactivity, conduct and emotional symptoms respectively (Goodman, 1997).

---------- Please, insert Table 1 here ----------

Emotion Identification Performance

Figure 1 shows the mean accuracy (Pr) and bias (Br) scores for faces and voices by emotion. Children performed above chance (with chance defined a score of zero) for high and low intensity angry, happy, sad and neutral facial and vocal expressions [*t*'s (56) > 2.38, *p's* <.05]. There was no significant difference in accuracy between males and females for facial [*t* (55) =-.77, *p* >.05] or vocal [*t* (55) =.09, *p* >.05] expressions. Child age was associated with accuracy for facial (*r* =.43, *p* <.001) and vocal (*r* =.41, *p* <.001) expressions collapsed across emotion. Repeated measures ANOVA with intensity (low, high) as the within subject factor and child age as a covariate examined the main effect of emotion intensity on accuracy. Results showed no main effect of intensity on accuracy for facial and vocal expressions (*F* (1, 55) =2.93, *p* >.05, η^2_p =.051). Therefore, subsequent analyses did not include intensity as a factor.

Accuracy (Pr) scores were entered into a 2 (modality: face vs. voice) x 4 (emotion: angry vs. happy vs. sad vs. neutral) ANOVA. Child age was entered as a covariate in the model. Children were significantly more accurate in discriminating facial than vocal expressions (m's= .53 vs. .34 respectively; *F* (1, 55) =5.75, *p* <.05, η^2_p =.09). There was a significant main effect of emotion on accuracy (*F* (3,165) = 6.78, *p* <.001, η^2_p =.11). Post-hoc pairwise comparisons indicated that children were more accurate in discriminating angry compared to happy, sad and neutral expressions. They were also more accurate in discriminating happy compared to neutral and sad compared to neutral expressions (*p* <.001; see Figure 1). There was no significant emotion x modality interaction effect for

discrimination accuracy (F (3,165) = 2.57, p >.05, η^2_p =.04).

With respect to the bias analyses, there was no significant differences in bias between males and females to facial [t (55) =1.14, p >.05] or vocal [t (55) =.19, p >.05] expressions. In addition, child age was not associated with response bias to facial or vocal expressions (p > .05). Analysis of response bias data (2 [modality] x 4 [emotion] ANOVA of Br scores) revealed a main effect of emotion (F (3,168) = 7.64, p <.001, η^2_p =.12). Post-hoc pairwise comparisons indicated that children presented higher response bias to sad compared to angry, happy (p <.05) and neutral (p<.001), suggesting a higher tendency to attribute sadness to facial and vocal expressions (see Figure 1). There was no significant main effect of modality on response bias (F (1, 56) = 2.50, p >.05, η^2_p =.04). Results also showed a significant emotion x modality interaction effect on response bias (F (3, 168) =5.34, p <.01, η^2_p =.09). When comparing bias scores for faces and voices for each emotion separately, participants showed a higher bias to anger for voices compared to faces (p <.01) and a higher bias to happiness for faces compared to voices (p <.05**,** see Figure 1).

----------Please, insert Figure 1 here----------

Emotion Processing and Behavior Problems

Discrimination accuracy for facial (Pearson's r in the range of .76 to.79, p <.001) and vocal (Pearson's r in the range of .61 to.86, p <.001) expressions across the two intensity levels were highly correlated. Running the main analyses for the two intensity levels separately did not change the results. Therefore, aggregated scores of accuracy ('Pr' score) and bias ('Br' score) for each emotion per modality was used for subsequent analyses.

Correlations were used to explore the relationships between parent ratings of emotional and behavioral problems and discrimination accuracy (Pr) and response bias (Br) scores. Because age was positively correlated with accuracy it was controlled for in this analysis. Results showed that higher hyperactivity scores were negatively associated with accuracy to identify anger and happiness in faces (p < .05). In addition, higher hyperactivity scores were negatively associated with discrimination accuracy to angry, happy and sad vocal expressions (p <.01). Conduct problems were also negatively associated with discrimination accuracy to angry, happy (p <.05) and sad (p <.01) vocal expressions (see Table 2). No significant associations emerged between discrimination

accuracy and emotional problems and between response bias with hyperactivity, conduct problems or emotional problems (p >.05).

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Multiple regression analyses examined the independent contribution of the different dimensions of child behavior problems to emotion recognition: Emotion recognition was the dependent variable and age and child behavior problem dimension (hyperactivity, conduct problems and emotional problems) were the independent variables. Analyses were conducted separately for each emotion x modality condition (i.e., angry face). Hyperactivity was significantly negatively associated with the children's recognition of angry (p <.05, see Table 3) and happy (p=.05) faces. There was also a statistical trend for a negative association between hyperactivity and children's recognition of angry voices (p=.07). Neither conduct problems nor emotional symptoms were significantly associated with children's recognition of emotion. These results indicated that the negative association between emotion recognition and externalizing psychopathology reflected individual differences in hyperactivity and not conduct problems.

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Discussion

The present study explored preschoolers' processing of emotions as expressed in faces and voices. In addition, it considered associations between emotion processing and parent reports of childhood behavior symptoms. The current findings showed that preschoolers were able to label angry, happy and sad facial expressions at two levels of intensity at above chance levels and performance increased with age. Preschoolers were more accurate at recognizing faces compared with voices, and angry compared to happy, sad and neutral expressions. We also found negative associations between emotion recognition and symptoms of hyperactivity that were consistent across facial and vocal modalities.

In relation to emotion processing bias, the current study found that preschoolers showed a higher bias to attribute sadness to both facial and vocal expressions. When comparing bias scores for faces and voices, preschoolers were more likely to attribute anger to vocal compared to facial

expressions and more likely to attribute happiness to facial compared to vocal expressions. A developmental pattern in bias was not evident and nor were any gender differences found.

In the current study, preschoolers identified facial expressions more accurately than vocal expressions consistent with research with primary school-aged children (Nowicki & Duke, 1994). Moreover, recognition accuracy using the newly developed UK voice stimuli were similar to accuracy rates obtained using the American DANVA voice test in preschoolers (Maxim & Nowicki, 2003). The age-related increase in emotion recognition accuracy for both facial and vocal modalities was also consistent with previous findings (Nowicki, 2008; Rosenqvist, Lahti-Nuuttila, Laasonen, & Korkman, 2013; Rothman & Nowicki, 2004). Furthermore, the finding that preschoolers were more accurate at recognizing and labelling angry, compared with happy and sad expressions is largely consistent with previous research (Hortacsu & Ekinci, 1992). The finding that happy vocal expressions were more difficult to recognize compared to angry is also generally consistent with previous research and indicates that, although happiness is more easily recognizable from facial expressions (Ekman, 1994), it is more difficult to identify in vocal expressions (Elfenbein & Ambady, 2002; Scherer, 2003). Increased biases for sadness found in the current study are also consistent with previous research in preschoolers (Martin et al., 2010). The lack of any age differences in bias indicates that bias is more stable compared to accuracy over time (see also Barth & Bastiani, 1997).

A key finding of the present study was the negative association between different aspects of externalizing behaviors and children's accuracy for facial and vocal emotional expressions (i.e., sadness and anger), that did not extend to internalizing problems. While correlational analyses suggested a role for both aspects of externalizing behavior, further examination indicated that increased hyperactivity symptoms, (and not conduct problems), were more clearly associated with poor recognition for angry faces**.** Reduced sensitivity to facial anger and sadness has been reported previously in primary school-aged children (Corbett & Glidden, 2000; Kats-Gold, Besser, & Priel, 2007; Pelc et al., 2006) and preschoolers (Martin et al., 2010) with hyperactivity. The results raise the possibility that anger might play an important role in the emotion regulation deficits seen in children with hyperactivity. The fact that preschoolers with hyperactivity presented lower recognition accuracy for anger further suggests some difficulty in perceiving signals of threat (i.e., anger) in adult expressions.

The finding that reduced sensitivity to facial anger in preschoolers was linked to hyperactivity, but not conduct problems, raises important questions regarding distinct emotion processing profiles in children with different types of externalizing behavior problems and their developmental origins. For example, it is possible that emotion processing difficulties take different forms in children with different forms of psychopathology early in development. Previous studies in emotion processing in preschoolers with conduct problems have not measured or controlled for hyperactivity symptoms. Consistent with current theory (Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2004) and research in older children (Yuill & Lyon, 2007), accuracy deficits may be more readily observed in children with hyperactivity due to an impulsive, inattentive style of processing emotional information in these children. In addition, general difficulties in attending to emotional information or inhibiting responses might further interact with social-cognitive processes to hinder successful social interactions in children with hyperactivity (Yuill & Lyon, 2007).

The finding that emotion processing difficulties found in school-aged children with externalizing symptoms are already present in the preschool years has important implications for early preventive intervention efforts aiming to promote emotional competence in children. The pre-school years represent the developmental period laying the foundations for later emotional and social competence (Denham et al., 2003). Findings from the current study highlight the importance of understanding the relationship between emotion processing difficulties and externalizing behavior problems early in development. The majority of existing social and emotional skills programmes typically target children with conduct problems (Webster-Stratton, Reid, & Hammond, 2001). Knowledge from the current study can inform emotion-centred preventive intervention programmes that are especially tailored to the specific needs of the children with hyperactivity. Intervening early can help children with hyperactivity to foster the development of social-cognitive processes linked to emotional understanding, to facilitate effective social skills and reduce the risk of problem behaviors.

The current study demonstrated emotion recognition deficits in both modalities linked to hyperactivity symptoms. Previous work with preschoolers has linked vocal emotion processing difficulties with externalizing symptoms (i.e. aggressive behavior, Nowicki & Mitchel, 1998). The present work extends the existing literature by constructing and validating an emotion identification test for native English-speaking children and by examining links between emotion recognition and different dimensions of preschooler's behavior problems (hyperactivity and conduct problems).

Findings of the present study are consistent with Shapiro and colleagues (1993; see also Norvilitis et al., 2000) who found deficits in vocal expression recognition in a group of primary school-aged children with hyperactivity. These findings highlight the importance of incorporating vocal as well as facial modalities in future studies with preschoolers. Vocal modalities may represent separate processes underlying recognition of emotion in preschoolers with behavior problems and these processes may be distinct from visual modalities.

A bias toward anger reported in primary school-aged children with externalizing or internalizing symptoms was not evident in this study (Richards et al., 2007; Schultz et al., 2004). Previous studies in children with conduct and internalizing difficulties have utilized tasks measuring children's hostile attribution in ambiguous situations. The task employed in this study may be sensitive to different aspects of biases than those related to hostile attribution. Alternatively, the stimuli used in the current study (i.e., 50% intensity) may not be sufficiently ambiguous to allow for individual differences in response bias to emerge. For example, Richards et al., (2007) demonstrated associations between an angry interpretation bias and trait anxiety in late childhood with very low levels of emotional expression (i.e., 10%). Previous work linking emotion processing biases with internalizing symptoms has focused on primary school aged children and adolescents. It is possible that recognition biases are not yet evident in this sample of young children and that they develop across childhood. Alternatively, the association between processing biases and internalizing symptoms might reflect the emotion subscale used in this study. Although previous work has shown that emotional symptoms in the SDQ are associated with other standardized measures of trait anxiety (Goodman, 2001) this scale was less reliable and less variable compared to the hyperactivity and conduct problems subscale in this study. Evidence of associations with internalizing symptoms might be more readily observed in samples recruited from services specialising in internalizing disorders.

The current study was able to replicate and extend previous research to indicate that preschoolers with elevated hyperactivity symptoms present difficulties in identifying negative emotions from non-verbal cues. There were, however, a number of limitations. It is not clear whether low accuracy for vocal expressions reflects emotion-specific effects or properties of the stimuli used (e.g., word stimuli). In addition, neither verbal nor performance IQ data were available in this study. IQ data would be beneficial because preschool children who show early signs of externalizing problems may have disorders that are associated with a broader range of dysfunctional social, emotional and

cognitive behaviors. It is possible, for example, that children with poor verbal abilities may be at a disadvantage in performing tasks that rely on verbal responses. Previous research suggests that poor verbal ability may play a role in the facial emotion recognition difficulties seen in preschoolers with externalizing symptoms (Hughes, Dunn, & White, 1998) and future research should include verbal ability measures in emotion recognition tasks that rely on verbal responses. The stimuli used in the current study might also account for the pattern of results. Ekman facial stimuli consist of grayscale images which are unecological relative to coloured facial stimuli encountered in real-life social interactions. In addition, facial stimuli which are designed within an empirical-normative (i.e. DANVA; Nowicki & Duke, 1994) rather than an anatomical framework (Ekman & Friesen, 1976) may be more sensitive to capture emotional expressions as they unfold in real-life situations. The present research would therefore have benefited from a more varied stimulus set that included both male and female facial and vocal stimuli. The current research highlighted associations between symptoms of psychopathology and emotional processing; however, it did not address causal links between these variables. Emotion identification difficulties may contribute to social problems in children (Lipton & Nowicki, 2009) but also disorders themselves may lead to emotional identification difficulties. Alternatively, a third, unknown factor could cause both lower emotion recognition and higher externalizing problems (Lancelot & Nowicki, 1997). The current analysis focused only on the associations of dimensions of behavior problems and emotion recognition and despite including participants referred to clinics for such problems no children with diagnosed Attention Deficit Hyperactivity Disorder (ADHD), conduct problems or emotional problems were included. Future studies should extend our findings from problem dimensions to diagnostic categories.

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The authors declare the following conflict of interest: Professor Edmund Sonuga-Barke: Recent speaker board: Shire, UCB Pharma, Current & recent consultancy: UCB Pharma, Shire, Current & recent research support: Janssen Cilag, Shire, Qbtech, Flynn Pharma, Advisory Board: Shire, Flynn Pharma, UCB Pharma, Astra Zeneca, Conference support: Shire. Dr. Margaret Thompson: Recent speaker board: Janssen Cilag, Current & recent consultancy: Shire, Current & recent research support: Janssen Cilag, Shire, Advisory Board: Shire. Dr. Matt Garner: Recent research support: Pfizer and Lundbeck.

Table 1

Means and standard deviations for child symptoms in the whole sample and proportion of children in the atypical range (N=57)

	Mean	SD	% atypical range
SDQ			
Hyperactivity	4.52	3.00	28.1%
Emotional problems	2.15	2.01	17.5%
Conduct problems	3.24	2.75	38.6%

Note: SDQ: Strengths and Difficulties Questionnaire

Table 2

Partial Pearson's correlations between accuracy and child symptoms controlling for child age in the whole sample (N=57)

	Hyperactivity	Conduct Problems	Emotional Problems
Face			
Angry	-.31*	-.16	-.14
Happy	-.31*	-.19	-.18
Sad	-.21	-.19	-.17
Neutral	-.16	-.10	-.03
Voice			
Angry	-.38**	-.30*	-.14
Happy	-.30*	-.29*	.00
Sad	-.39**	-.36**	-.07
Neutral	-.22	-.15	-.10

Note: *p < .05, **p < .01

Table 3.

Regression analyses examining the independent contribution of child symptoms to children's recognition of angry faces in the whole sample.

	B	*SE*B	β
Step 1			
Constant	.29	.16	
Age	.00	.00	.30
Step 2			
Constant	.29	.16	
Age	.01	.00	.41
Hyperactivity	-.04	.02	-.46*
Conduct Problems	.02	.02	.24
Emotional Problems	-.01	.02	.09

*Note: R^2 =.09 for Step 1, ΔR^2 = .11 for Step 2, *p < .05*

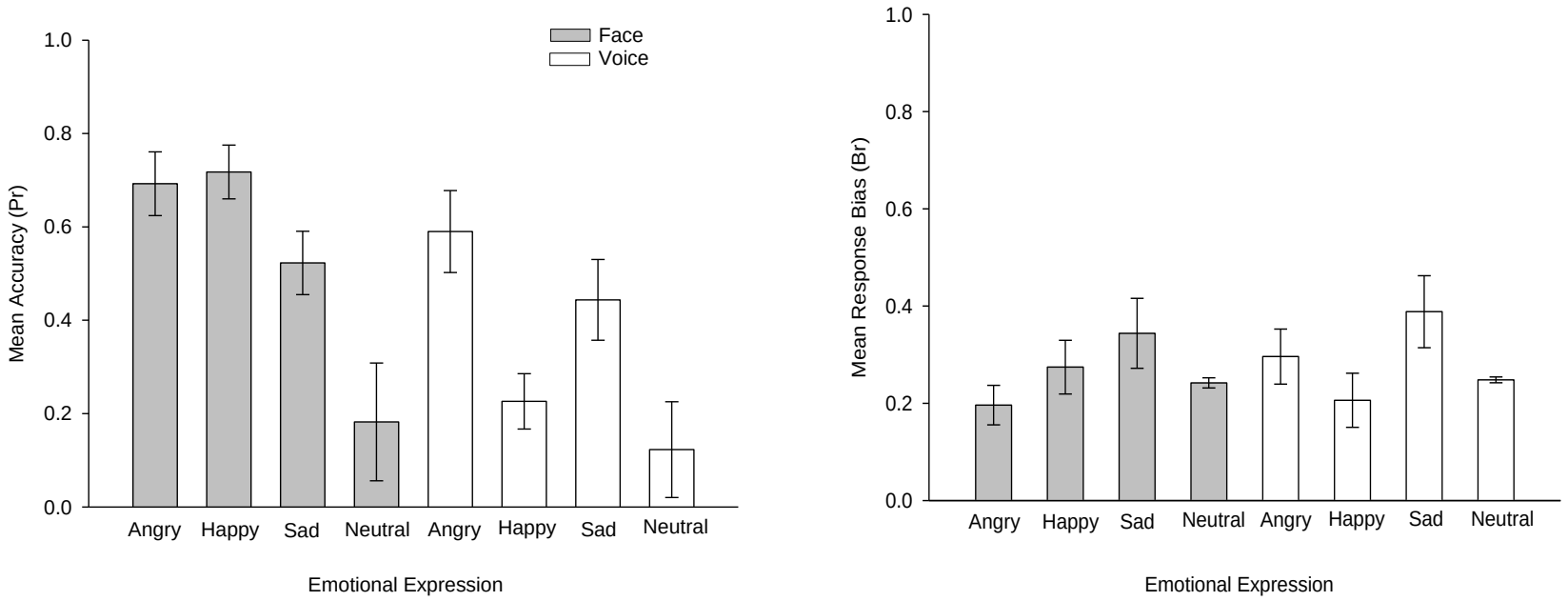

Figure 1. 95% confidence interval bar charts with error bars for mean accuracy (Pr) and response bias (Br) scores for faces and voices per emotion.