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The Development of Early Emotion Understanding: Investigating the Role of Language

Author
Ogren, Marissa

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The Development of Early Emotion Understanding: Investigating the Role of Language

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by

Marissa Lynn Ogren

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ABSTRACT OF THE DISSERTATION

The Development of Early Emotion Understanding:

Investigating the Role of Language

by

Marissa Lynn Ogren
Doctor of Philosophy in Psychology
University of California, Los Angeles, 2021
Professor Scott P. Johnson, Chair

Learning to understand others' emotions from an early age is crucial for long-term social-cognitive development. However, much remains unknown regarding potential mechanisms behind the development of early emotion understanding. Some theoretical work has proposed that language may facilitate the development of emotion understanding (e.g., Barrett, 2017), while other theoretical work argues that language should not be crucial for such development (e.g., Ekman & Cordaro, 2011). Thus, to better understand *how* children learn to understand emotions, what may explain some of the large individual differences observed in early emotion understanding, and what theoretical perspective may best explain early emotion understanding development, it is important to further examine the role of language in early emotion understanding development. The present studies use a novel approach to examining the relation between language and emotion understanding across early development using 1) Eye tracking, 2) Corpus analysis, and 3) Live action assessment of emotion category learning methodologies.

Study 1 examined whether infant performance on a completely non-linguistic emotion categorization task related to infant language abilities. Participants were 50 infants between 15- and 18-months of age who completed the emotion categorization task using an eye tracker and whose parents provided the infants' vocabularies. Results from this study revealed that non-linguistic emotion categorization related to vocabulary size for girls, but not for boys, providing some evidence that language may begin to relate to early emotion categorization abilities in infancy.

Study 2 investigated young children's natural language environments and how this environment relates to children's propensity to talk about emotion words. Nearly 2,000 transcripts of natural interactions between mothers and their 15- to 47-month-old child were drawn from the CHILDES (MacWhinney, 2000) database. Findings from this study revealed that child use of emotion language was significantly predicted by their age and their mother's use of emotion language, but not by the child or mother's general language complexity. These results suggest that exposure to emotion language, but not necessarily general language, may be important for children's developing ability to talk about and understand emotions.

Study 3 evaluated whether exposure to specific emotion words would causally influence children's ability to learn about new, complex emotions. Across two experiments, 72 3-year-old children took part in a pre-test post-test emotion category learning assessment where they were tasked with identifying which face best matched how a character would feel in a scenario. Between pre-test and post-test, children saw a face paired with a scenario and either heard an explicit emotion label, a vague emotion label, or irrelevant information. Results revealed that children learned the face-scenario associations better when given an explicit emotion label versus irrelevant information (Study 1), but vague emotion labels did not provide any advantage over

irrelevant information (Study 2). Taken together, these results suggest that explicit emotion labels may be particularly important for helping young children learn about emotions.

In sum, these three studies provide some evidence that language may be important for the development of early emotion understanding. However, the strength of this evidence varied by study, suggesting that other factors such as the particular methodology being used, child age, and use of emotion language versus general language, may play important roles in understanding this relation. Altogether, these results present evidence that may be useful for more comprehensively understanding the potential mechanistic role of language in the early development of emotion understanding.

The dissertation of Marissa Lynn Ogren is approved.

Catherine M. Sandhofer

Jennifer Silvers

Jennie Grammer

Scott P. Johnson, Committee Chair

University of California, Los Angeles

2021

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VITA

EDUCATION

M.A. Psychology, University of California, Los Angeles 12/2016
Committee: Scott P. Johnson, Ph.D. (Chair), Catherine M. Sandhofer, Ph.D.

B.S. Psychology, University of Washington 06/2012
Graduated Magna Cum Laude
Philosophy Minor

A.A., Everett Community College 06/2010
Graduated with High Honors

GRANTS & FELLOWSHIPS

Dissertation Year Fellowship ($20,000), UCLA Graduate Division 2020 - 2021

F31 Grant Number 1F31HD100067 ($73,568), NICHD 2019 - 2021
The Development of Early Emotion Understanding: Investigating the Role of Language
Role: PI

Graduate Summer Research Mentorship ($6,000), UCLA Graduate Division 2017

Graduate Summer Research Mentorship ($6,000), UCLA Graduate Division 2016

Distinguished University Fellowship ($21,000), UCLA Department of Psychology 2015 - 2016

SELECTED PUBLICATIONS

Ogren, M., & Johnson, S. P. (2021). Primary caregiver emotional expressiveness relates to toddler emotion understanding. *Infant Behavior and Development, 62,* 101508.

Ogren, M., & Johnson, S. P. (2020). Factors facilitating early emotion understanding development: Contributions to individual differences. *Human Development, 64,* 108-118.

Ogren, M., & Johnson, S. P. (2020). Intermodal emotion matching at 15 months, but not 9 or 21 months, predicts early childhood emotion understanding: A longitudinal investigation. *Cognition and Emotion, 34,* 1343-1356.

Ogren, M., Baranowski, T., Lowry, S. J., & Mendoza, J. A. (2020). Model of Goal Directed Behavior for limiting Latino preschoolers' television viewing: Validity and reliability. *BMC Public Health, 20,* 185.

Ogren, M., Kaplan, B., Peng, Y., Johnson, K. L., & Johnson, S. P. (2019). Motion or emotion: Infants discriminate emotional biological motion based on low-level visual information. *Infant Behavior and Development, 57,* 101324.

Ogren, M., Burling, J. M., & Johnson, S. P. (2018). Family expressiveness relates to happy emotion matching among 9-month-old infants. *Journal of Experimental Child Psychology, 174,* 29-40.

Tsang, T., **Ogren, M.**, Peng, Y., Nguyen, B., Johnson, K. L., & Johnson, S. P. (2018). Infant perception of sex differences in biological motion displays. *Journal of Experimental Child Psychology, 173,* 338-350.

SELECTED PRESENTATIONS

INVITED TALKS

Ogren, M. (2021, January). *Learning about emotions in infancy and early childhood: The role of developmental, social, and cognitive factors.* The Learning & Brain Development Lab, Northeastern University, Boston, MA.

Ogren, M. (2020, October). *How do children learn to understand others' emotions?* Social Cognition and Learning Lab, University of California San Diego, San Diego, CA.

CONFERENCE TALKS

Ogren, M., & Johnson, S. P. (2020, April). *Emotion understanding in early childhood and emotional expressiveness in the environment.* Talk presented at the 2020 Society for Affective Science Annual Conference, Virtual.

Ogren, M., & Johnson, S. P. (2019, July). *The relation between infant emotion matching and early childhood emotion understanding.* Talk presented at the 2019 International Society for Research on Emotion Conference, Amsterdam, Netherlands.

Ogren, M., & Johnson, S. P. (2019, June). *Primary caregiver emotional expressiveness relates to early childhood emotion understanding.* Talk presented at the 14th Annual Symposium on Cognitive and Language Development, Los Angeles, CA.

Ogren, M., & Johnson, S. P. (2019, March). *Infant emotion matching and preschool emotion understanding: Distinct developmental skills?* Talk presented at the 2019 Society for Research in Child Development Biennial Meeting, Baltimore, MD.

Ogren, M. (2019, March). *The development of emotion understanding from infancy through early childhood.* Symposium chaired and organized for the 2019 Society for Research in Child Development Biennial Meeting, Baltimore, MD.

General Introduction

The ability to infer emotional meaning from others' expressions and reactions, commonly referred to as emotion understanding, is a crucial aspect of healthy development. It is important for successful social interaction, as it allows us to predict the likely behaviors of others (Hesse & Cicchetti, 1982; Olson, Astington & Harris, 1988). This may be because understanding emotions grants insight into others' goals and behaviors (Reschke, Walle, & Dukes, 2017), which ultimately gives us the opportunity to react appropriately to those around us and thereby to maintain interpersonal relationships. Although emotion understanding is a complex social skill involving an integration of information across multiple domains (e.g., facial expression, tone of voice, contextual information), it begins to develop early in life (Denham, 1986), and early emotion understanding has long-term implications for an individual's healthy social development (Fabes, Eisenberg, Hanish, & Spinrad, 2001; Izard et al., 2001). A substantial body of research has investigated how emotion understanding may impact future development. However, fewer studies have attempted to understand factors that predict emotion understanding. Considering the significance of early emotion understanding, it is crucial to identify factors that contribute to individual differences in its functioning, and thereby mechanisms behind its development. The present experiments focus on one such factor, language, and how it relates to emotion understanding development across the first four years after birth.

By the time children are only 3 years old, their emotion understanding abilities already have substantial predictive power for various aspects of later development. Preschool emotion understanding relates to later academic success (Denham et al., 2012; Voltmer & Von Salisch, 2017), moral reasoning (Dunn et al., 1995; Lane, Wellman, Olson, LaBounty, & Kerr, 2010), peer acceptance (Cassidy, Parke, Butkovsky, & Braungart, 1992), social competence (Atzil, Gao,

Fradkin, & Barrett, 2018; Denham et al., 2003), and sympathy (Eggum et al., 2011). Taken together, this body of research indicates that early childhood emotion understanding is predictive of several key components of overall healthy development. Additionally, early emotion understanding abilities are highly variable (Denham, 1986). Thus, it is important to better understand what factors influence the substantial individual differences observed in emotion understanding within the first few years of life.

Across infancy and the preschool years, substantial development in children's understanding of emotion categories occurs. Within the first year after birth, infants can typically discriminate between various facial expressions such as happy versus angry or neutral (LaBabera, Izard, Vietze, & Parisi, 1976) and fear versus sadness (Schwartz, Izard, & Ansul, 1985). Young infants can also match emotional information across domains- identifying the face that matches a particular tone of voice- (Walker, 1982), and can even match emotions across face and voice when the bottom third of the face is occluded (Walker-Andrews, 1986). Near infants' first birthday, they begin to match facial expressions to preceding emotional events (Ruba & Repacholi, 2019), and by roughly 15 months infants begin to adjust their behavior based on someone else's emotional reaction (Walle & Campos, 2012). At approximately 18 months, infants may begin to produce emotion labels (Ridgeway, Waters, & Kuczaj, 1985). Further, by age 2 children begin to map emotion labels to multiple stereotypical facial expressions and also match these expressions to the way that a puppet would feel in various scenarios (Denham, 1986). Although this is a typical developmental trajectory, there is substantial variability in performance on emotion understanding tasks at early ages (Pons & Harris, 2019). Considering the notable changes in emotion understanding that occur across the first few years after birth,

examining early emotion understanding development with the intent of understanding individual differences and factors that may influence them is of great importance.

To date, several theories have proposed various factors and mechanisms which may explain the development of emotion understanding. Basic Emotions Theory suggests that emotions and emotion understanding have a strong evolutionary and biological basis (Ekman, 1992). That is, the ability to experience, identify, and interpret facial expressions of emotion are thought to be more strongly influenced by evolutionary history than by an individual's environment and experiences (Ekman, 1999). In line with this framework, Basic Emotions Theory holds that perception of emotion is very similar cross-culturally. Additionally, this theory suggests that language is a communication device for labeling emotions, but is not crucial for developing an understanding of these emotions (Ekman & Cordaro, 2011). In contrast, the Theory of Constructed Emotion (Barrett, 2017) proposes that emotion concepts are fundamentally constructed through contexts and experiences. This theory states that because emotions are abstract concepts, language may provide crucial structure for forming cognitive representations of these concepts.

Emotions are abstract concepts. This means that emotions do not have any single, defining, concrete form. Emotional expressions are highly variable within the same category (e.g., 'fear' can be expressed both by freezing and remaining still and by screaming and jumping backwards- two notably visually distinct reactions). Additionally, the same emotional information can take on multiple meanings (e.g., a person can scowl in anger or in concentration; Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019). Thus, learning to understand emotions represents a significant challenge, as different expressions can carry the same emotional meaning, and the same emotional expressions can have different meanings depending on the

context (Hoemann, Xu, & Barrett, 2019). This is even further complicated by the complex and dynamic nature of emotions (Hoemann, Gendron, & Barrett, 2017; Richmond & Zacks, 2017). Emotions can be conveyed through facial movements, body movements, tone of voice, and language, all of which change from moment to moment. Thus, learning emotion categories is complex, and the abstract nature of emotions may make language a key facilitator of early emotion understanding development.

Language is powerfully linked to human cognition, and influences category development for other abstract concepts. The link between language and cognition is thought to exist because words provide invitations to form categories (Brown, 1958), as words may highlight the commonalities among various category members. For example, colors are abstract concepts, and prior work has shown that children struggle to understand the concept of color until they learn color words (Sandhofer & Smith, 1999). Additionally, infants were able to learn an unfamiliar category (e.g., dinosaurs) when category exemplars were accompanied by a common label but did not learn the category when exemplars were paired with audio tones (Waxman & Markow, 1995). In fact, when 2-year-olds were provided with two labeled exemplars from a novel category, this provided the foundation for learning from later, unlabeled category exemplars (LaTourrette & Waxman, 2019), indicating that even limited exposure to exemplar labels can be beneficial for category learning and development. Because words facilitate category development in multiple domains (e.g., Balaban & Waxman, 1997; Fulkerson & Waxman, 2007), it has been theorized that language should similarly facilitate emotion category learning. However, the connection between language and early emotion understanding development remains largely unclear to date.

Research with adults has begun to investigate how language relates to emotion understanding and perception. Adults who engage in semantic satiation of emotion words, repeating the same emotion word 30 times in a row causing it to temporarily lose its meaning, show disrupted processing of relevant emotional faces (Gendron, Lindquist, Barsalou, & Barrett, 2012). Additionally, when instructed to identify whether two stimuli presented in quick succession represent the same emotion, adults are faster to respond and more accurate when a face is followed by an emotion word rather than followed by another face (Nook, Lindquist, & Zaki, 2015). Research with older adults who had semantic dementia, a disorder which impairs the ability to understand word meanings, found that these individuals did not create discrete emotion categories when asked to freely sort pictures of emotional faces into meaningful categories, whereas older adults without semantic dementia sorted the faces into stereotypical emotion categories (Lindquist, Gendron, Barrett, & Dickerson, 2014). Thus, research with adults suggests a relation between language and emotion perception. However, whether language is crucial to emotion understanding *development* remains less clear.

Among 4-year-olds, emotion understanding has been correlated with child language abilities (Cutting & Dunn, 1999). In fact, this study found that when associations were analyzed between emotion understanding and child age, family background, language, and false belief understanding, the child's language contributed the most unique variance. That is, of the four variables tested, language was the most significant predictor of emotion understanding. Emotion understanding and receptive language abilities have also been significantly correlated across the broader age range of 4-11 years (Pons, Lawson, Harris, & De Rosnay, 2003), and this correlation held when covarying for child age and gender. Further, covarying for language abilities when investigating emotion understanding in childhood has become common (e.g., Cook, Greenberg,

& Kusche, 1994; Denham, Zoller, & Couchoud, 1994; Steele, Steele, Croft, & Fonagy, 1999), indicating that researchers in the field generally recognize language as relating to emotion understanding. Despite this recognition, the mechanism behind this relation in early childhood remains nebulous.

There are three possible explanations for the relation between emotion understanding and language in childhood. First, it is possible that child language relates to emotion understanding because of the linguistic demands involved in common emotion understanding tasks. That is, children with more advanced language skills may outperform their peers on emotion understanding tasks simply because they are better at following spoken task instructions and/or verbalizing what they know. Common emotion understanding measures such as the Affective Knowledge Test (Denham, 1986) require children to label the emotions of felt faces, to point to the face that corresponds to an emotion label, and to point to the face that matches the emotion of a character in a story after listening to a brief vignette. Similarly, the Test of Emotion Comprehension (Pons et al., 2003) uses cartoon drawings of faces to assess children's emotion comprehension in tasks such as recognition of emotions, understanding causes of emotions, and understanding of mixed emotions. These emotion understanding tasks attempt to limit the requirement for verbal responses on the part of the child, but there are still linguistic comprehension demands imposed by the activities. Although this may explain the relation between emotion understanding and language, it is important to note that there are very similar associations between these two factors on the two tasks, which differ notably in the amount of language used. If the linguistic demands of the task were driving this relation, we would expect to see slightly different relations depending on the amount of language used in each task. An alternative possibility is that child language fundamentally relates to emotion understanding, as

proposed in the Theory of Constructed Emotion (Barrett, 2017), and this relation is task independent. That is, language may have a causal influence on the development of emotion understanding, regardless of what task is used to measure emotion understanding. Finally, it is possible that more domain-general cognitive skills may account for development in both areas (language and emotion understanding). Additional research is necessary to explore which of these possibilities best explains the relation between language and emotion understanding.

To date, the influence of language on emotion understanding development remains unclear. To address this, and to better understand the substantial individual differences observed in early emotion understanding development, the present experiments aimed to identify whether language influences emotion understanding development across the first 4 years after birth. It is crucial to investigate this question at such a young age, because stability has been observed in the trajectory for emotion understanding development from age 3 to 5 (Brown & Dunn, 1996) and from age 7 to 12 (Pons & Harris, 2005). Therefore, it is important to identify how language contributes to emotion understanding early in life, as substantial emotional development is occurring, in order to best identify its impact on individual differences and development.

To investigate the relation between emotion understanding and language, the current proposal uses a developmental approach. The present studies used eye tracking, corpus analysis, and live action experimental methodologies to assess how language and emotion understanding relate in children younger than 4 years of age. Both emotion understanding and language undergo substantial development between 15 and 47 months of age, so investigating this relation during this age window will provide important information regarding how this relation may or may not change as both skills gradually improve. Ultimately, the three studies outlined in this proposal will advance our understanding of specifically *how* this crucial skill develops and the

impact of language development on emotion understanding using multiple age-appropriate methodologies.

Study 1: Eye Tracking. Eye tracking tasks have frequently been used to assess emotion perception among infants and young children by measuring visual attention to particular emotional stimuli. As previously mentioned, eye tracking studies have provided evidence for infant discrimination of emotional faces (LaBabera, Izard, Vietze, & Parisi, 1976) and infant matching of emotion across face and voice (Vaillant-Molina, Bahrick, & Flom, 2013; Walker, 1982; Walker-Andrews, 1986). However, it remains unknown whether infants' developing language abilities are related to their performance on such eye tracking emotion perception tasks, which may be developmental precursors to emotion understanding (Ogren & Johnson, 2020). Thus, Study 1 examined the relation between productive language and emotion categorization in a non-linguistic eye tracking paradigm among 15- to 18-month-old infants.

Study 2: Corpus Analysis. Language input from parents relates to a child's later language abilities (Huttenlocher, 1998). Children's *emotion* language, however, has not been similarly explored. If the Theory of Constructed Emotion (Barrett, 2017) is correct in its proposal that language is crucial for emotion understanding development, then the development of emotion vocabulary, specifically, in early childhood warrants further attention. In particular, descriptive information regarding children's early emotion language environment and a clearer understanding of the development of emotion language across the first several years are crucial. Further, given the significant relation between parent vocabulary and child vocabulary (Huttenlocher, 1998), the role of parent language on child emotion vocabulary in a naturalistic environment should be investigated. Therefore, Study 2 used the Child Language Data Exchange System (CHILDES) parent-child interaction corpora to explore children's early emotion

language production, as well as whether specific patterns of parent and child language predicted 15- to 47-month-old children's emotion language production.

Study 3: Live Action Assessment of Emotion Category Learning. Language has been shown to significantly influence child categorization of novel stimuli such as animals and objects (Balaban & Waxman, 1997; Fulkerson & Waxman, 2007). If learning emotion categories relies on linguistic cues in a similar fashion to learning other categories, then children provided with clear linguistic labels for complex emotion categories should more efficiently learn those categories than children who are not provided with clear labels. To address this possibility, Study 3 investigated whether presentation of explicit emotion labels or vague emotion labels during emotion category learning aided learning of new emotion categories more effectively than irrelevant information for 3-year-old children.

Taken together, these three studies aimed to extend our knowledge of how language and emotion understanding relate to one another prior to children's 4th birthday. Study 1 and Study 2 aimed to identify whether the significant relation between emotion understanding and language extended to younger age groups in both laboratory tasks and naturalistic environments. Study 3 then addressed whether changes in language input causally influenced emotion understanding in a controlled, laboratory environment. These studies utilize a novel combination of eye tracking, corpus analysis, and live action assessments of emotion category learning to address this question from naturalistic and experimental perspectives. The specific methodologies used in each of these three studies will be addressed in turn.

Study 1

The ability to use others' emotional expressions and reactions to make inferences about their internal states and behavior is a crucial aspect of healthy social development. Understanding emotions is a complex social skill that develops early (Denham, 1986) and has long-term implications for an individual's social development (Fabes, Eisenberg, Hanish, & Spinrad, 2001; Izard et al., 2001). However, understanding emotions first relies on forming categories of emotional information that can then be extended to various people and situations. Considering the significance of early emotion understanding for healthy development, it is important to identify factors that contribute to individual differences in emotion categorization and mechanisms behind its development. The present study focuses on one such possible mechanism, language, and investigates how it may relate to individual differences in infant emotion categorization.

Two major theories have attempted to identify key mechanisms behind the development of emotion understanding and categorization. Basic Emotions theory suggests that emotions and emotion understanding have a strong evolutionary and biological basis (Ekman, 1992). Language is a device for labeling emotions but is not crucial for the development of emotion understanding or for the formation of emotion categories (Ekman & Cordaro, 2011). In contrast, the Theory of Constructed Emotion (Barrett, 2017) suggests that emotion categories are constructed through contexts and experiences. This theory proposes that emotions are abstract categories because emotions comprise highly variable instances that do not all look alike (e.g., one person may display fear by jumping backwards, widening their eyes, and gasping, while another person may freeze). The Theory of Constructed Emotion suggests that language may aid in creating cognitive representations of abstract emotion categories because applying labels to different examples of

the same emotion may facilitate recognizing the similarities among these instances (cf. Balaban & Waxman, 1997).

Many studies have investigated the emergence of emotion categorization, a crucial component of emotion understanding, as early as infancy (for a review, see Ruba & Repacholi, 2019). Such studies suggest that by 5 months of age infants can visually discriminate between happy and negative facial expressions such as fear (Bornstein & Arterberry, 2003), and by 10 months can form categories of emotional expressions such as disgust (Ruba, Johnson, Harris, & Wilbourn, 2017). Between 5 and 7 months infants begin to match emotional information across faces and voices (e.g., Walker, 1982), and by 10 months form expectations regarding the emotional expression that will follow an event (Hepach & Westermann, 2013; Skerry & Spelke, 2014). Thus, substantial emotion category development occurs during the first year after birth. However, the specific role of language in early emotion categorization remains unclear. Given that infants begin to understand the meanings of common words by 6 months of age (Bergelson & Swingley, 2012), language abilities may influence emotion categorization across a wide developmental period, including infancy. To fully understand this relation, it is crucial to identify how individual differences in language abilities relate to emotion categorization in early development.

It is important to draw a distinction between *general language abilities* and knowledge of emotion words, specifically, in emotion category development. This is because language and category development have been powerfully linked in other domains (e.g., Balaban & Waxman, 1997; Fulkerson & Waxman, 2007). Thus, if understanding emotions is not unique from understanding other categories, then general language abilities should similarly facilitate the development of emotion categories. Supporting this notion, research with 6- to 25-year-olds has

shown that the relation between age and a more mature conceptualization of emotions was mediated only by verbal ability (Nook, Sasse, Lambert, McLaughlin, & Somerville, 2017). This mediation was for *general* verbal language abilities and not emotion language. Additionally, although toddlers and preschoolers with general language impairments are capable of discriminating emotional stimuli, they are worse than their peers at emotion identification and attribution (Rieffe & Wiefferink, 2017). Together, these studies indicate that general language abilities may play a role in the development of emotion categories. However, to our knowledge there is no published research addressing this question in a manner that disentangles emotion understanding or categorization from the linguistic demands of the task. That is, there has not yet been a direct comparison of individual differences in children's language abilities and emotion categorization in a task that includes no language at all. Additionally, it is important to assess this relation early in life given previous suggestions that the influence of language on emotion understanding may be most pronounced within the first two to three years after birth, when basic language skills are rapidly developing (Eisenberg, Sadovsky, & Spinrad, 2005).

Assessing an understanding of emotion categories using a purely non-linguistic task would allow the role of language in emotion understanding to be directly addressed. One methodology that assesses potential precursors to emotion understanding without language is the facial emotion discrimination task, which simply measures whether infants spend more time looking to one emotional face than another. A consistent preference for one emotional face over another indicates that the infants can tell the two stimuli apart and prefer one over the other (e.g., LaBabera, Izard, Vietze, & Parisi, 1976; Schwartz, Izard, & Ansul, 1985). This is useful for determining when infants can distinguish between different facial expressions but provides little information about whether infants recognize differences in emotion beyond those specific

instances or understand emotion categories. Thus, in the present study we used an emotion categorization task, which tests for generalization of expressions across different individuals, to assess the early development of emotion categories. We reasoned that evidence from the emotion categorization task, alongside a measure of children's language abilities, will allow for a clearer answer to the question of how language relates to emotion categorization and, more broadly, to shed light on the development of emotion understanding in infancy.

The Present Study

In the present study, we assessed emotion category development in late infancy (15 to 18 months of age) using a nonlinguistic emotion categorization task. Late infancy is characterized by substantial variability in both language and emotion categorization, and we aimed to capitalize on this variability to address the question of how language relates to emotion category development. Due to the abstract nature of emotions, stronger language abilities may help some infants to identify similarities among various examples of the same emotion category as proposed by the Theory of Constructed Emotion (Barrett, 2017). For this reason, we hypothesized that individual differences in the vocabulary size of 15- to 18-month-olds would significantly relate to their performance on a nonlinguistic eye tracking emotion categorization task. Specifically, because previous research has indicated that infants demonstrate a novelty preference on tasks that are easier for them (Hunter & Ames, 1988) and a novelty preference on an emotion matching task at 15 months related to later emotion understanding (Ogren & Johnson, 2020) we predicted that infant vocabulary would relate to a novelty preference (i.e., a preference for the non-category member) on the present emotion categorization task.

Method

Participants

Fifty healthy, full-term infants (23 female) ranging in age from 15.05 to 18.50 months (M_{age}=16.54, SD_{age}=0.99) participated in the study. An additional 22 infants were excluded from the final dataset due to fussiness or crying (*N*=17), limited English exposure (less than 90% of the time; *N*=2), inconsistent eye track (*N*=1), or failure to meet data inclusion criteria as described below (*N*=2). This age range was selected to capture early infant language and emotion categorization abilities, while still providing substantial individual variability in both skills. A power analysis using correlations with 15-month-olds' eye-tracking performance on a similar task (Ogren & Johnson, 2020) indicated that a sample size of 39 would be necessary to achieve power of .8, which we increased to a sample size of 50 to ensure adequate power. Of the final sample, 45 infants had at least one parent who had completed four years of college. The ethnic/racial background of participants was as follows: White (N=31), Multiracial (N=10), African-American (N=5), Asian (N=1), Latino (N=1), Chose not to answer (N=2). Infants were recruited from lists of birth records and received a small gift (e.g., a T-shirt or toy) for their participation. The study was conducted in accordance with American Psychological Association ethical standards (University of California, Los Angeles IRB approval #10-000619).

Materials

Surveys. Parents provided written informed consent and completed a demographic questionnaire and the MacArthur Bates Communicative Development Inventory (MCDI; Fenson et al., 2007), a measure of early childhood vocabulary development. For this survey, parents were asked to check off every word that their child produces out of those provided. For the present study, the "Words and Sentences" version of the MCDI was utilized. Parents were only asked to identify their child's productive vocabulary, as it is less subjective than asking parents to make judgments about their child's receptive vocabulary. This version of the MCDI only

included four emotion words: Happy, Sad, Scared, and Mad. Only one parent in our sample reported that their child produced any emotion words, and so we did not assess relations to emotion-specific vocabulary in this study.

Stimulus creation. To create emotional stimuli for the eye tracking task, 29 undergraduate women were recruited. This allowed us to create a large set of faces from which we could use the most stereotypical category exemplars for our study. Infants raised primarily by their mothers show a preference for female faces (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002), and we reasoned that female faces as stimuli would facilitate infants' interest and performance. Each undergraduate was recorded from the shoulders up and stood in front of the same white background while wearing a black shirt. They were asked to think about a time when they felt a target emotion (anger, fear, happiness, and sadness) and to convey this through their facial expression while the camera recorded these expressions. Images were extracted from these video recordings at the peak intensity of each emotional expression. Images were edited such that the faces were all centered and approximately the same size. Additionally, pictures of unfamiliar objects were taken for control trials, as described subsequently.

Stimulus validation. A Qualtrics survey was conducted with adults to determine whether there was agreement regarding the emotion associated with the faces. Fifty-one adult raters (15 male) each viewed 116 images (29 women, 4 emotions per woman) and were asked which emotion (angry, fearful, happy, or sad) best described each image. Adults were then asked to rate how confident they were in each response (Likert scale 1-5 from "not at all confident" to "very confident"). Based on these responses, the 16 women who had the highest agreement regarding their expression of the 4 emotions were selected. On average for these images, the adult raters agreed on the intended emotion 94.6% of the time with average confidence ratings of 4.1

(Agreement ratings by emotion: Angry=94.9%; Fearful=91.8%; Happy=97.4%; Sad=94.5%. Confidence ratings by emotion: Angry=4.0; Fearful=3.6; Happy=4.4; Sad=4.1). No single selected image was agreed upon less than 70% of the time, which is substantially above chance ratings of 25%. Further, no single woman's average of the 4 expressions had lower than 85% agreement. Thus, we determined that the selected images were commonly viewed as appropriate representations of the four intended emotion categories.

Apparatus. An SR Research EyeLink 1000 eye tracker was used to collect information about infants' looking time to the stimuli. Infants viewed 36 trials, 24 of which included emotional faces as stimuli, and the remaining 12 contained unfamiliar objects for control trials. Infant eye movements were tracked for all trials. For each emotional trial, infants first viewed one woman depicting a particular emotional expression (e.g., Woman 1- Happiness) for 3 seconds (see Figure 1). After this, the image disappeared and was immediately replaced by new faces on the screen. The two new faces were both from the same woman (e.g., Woman 2) to control for any spontaneous preferences for one person over another. Woman 2 in one image displayed the same emotion as Woman 1 previously (in this case, happiness) and in the other image displayed a different emotion (e.g., fear). These images remained on the screen for 5 seconds. This design ensured that any emotion categorization was more than a simple perceptual match because infants had to generalize the emotion from one woman to another. Thus, this task involved more advanced emotion perception in that it required infants to categorize emotions across multiple identities. Twenty-four of these emotional trials were presented, with each emotion followed by a combination of that emotion and one of the three other emotions on two separate trials (e.g., anger followed by anger-sadness appeared twice per infant). Side of presentation for the stimulus that matched the category of the previous emotion was

counterbalanced, and the emotion that was presented alone for 3 seconds could not repeat for more than 2 trials in a row

Additionally, 12 control (nonsocial) trials were mixed in randomly among the emotional trials with the constraint that no more than two control trials were presented in a row. Stimuli for control trials consisted of novel objects (Figure 1). For control trials, one image of a novel object of a particular color was presented on the screen by itself for three seconds. Then, the image disappeared and was immediately replaced by two images of the same color (but different from the color of the original object). Of these two new objects, one matched the shape of the previous object and one did not. These two images remained on the screen for 5 seconds. In this way, the control trials mirrored the emotional trials without any emotional content. These control trials allowed us to determine each individual infant's ability to categorize non-emotional content and to account for general memory/categorization ability independent of emotional content. See Figure 1 for example images of how the emotional and control trials were presented to infants.

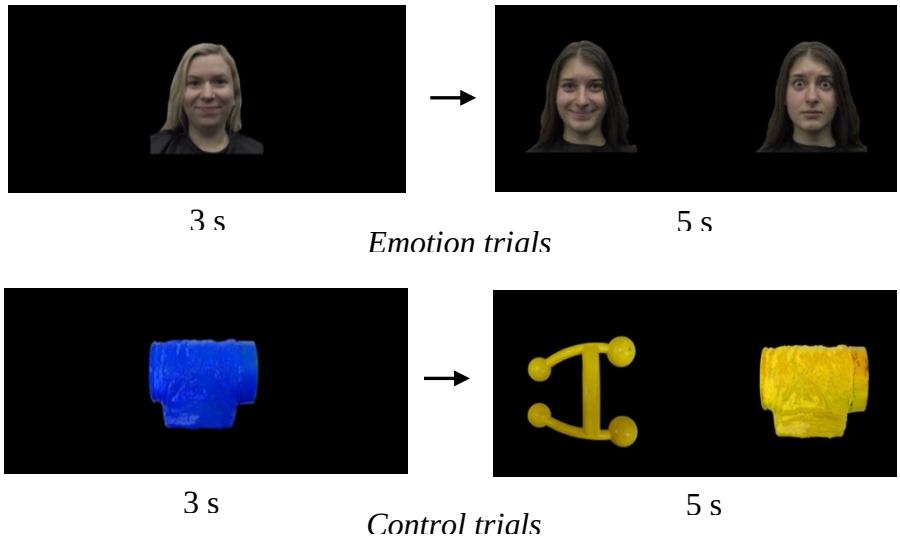

Figure 1. Example of possible emotional (top) and control (bottom) trials for Study 1.

Procedure

To participate in the eye tracking task, infants sat on a parent's lap approximately 60 cm from a 56-cm monitor. The eye tracker recorded infants' eye movements at 500 Hz. Prior to stimulus presentation, each infant's gaze was calibrated using the standard calibration routine provided by the eye tracker. After calibration, stimulus presentation began immediately. Each 8-second trial was preceded by an attention-getting stimulus in the center of the screen to re-center the child's gaze. Stimulus presentation continued until all 36 trials were complete. Parents were asked to hold their infants on their lap and not to interfere with the child's gaze or attention. During calibration and stimulus presentation, parents also wore sunglasses which had been painted black to ensure that the parents could not see the stimuli and inadvertently influence their child's looking behavior.

Results

Descriptive Statistics

Average vocabulary for our infant participants was 40.3 words (*SD*=66.9), which is comparable to previously reported norms for the 50th percentile at this age (Frank, Braginsky, Yurovsky, & Marchman, 2017). One infant had a vocabulary value that was more than 3 standard deviations above the mean. To reduce the influence of this outlier, we completed a 95% Winsorization of the data, replacing the lowest and highest vocabulary values with the next most extreme values. This process has been previously used to reduce the influence of outliers in data from a comparable infant age range (e.g., Crivello & Poulin-Dubois, 2019), and resulted in the final average vocabulary for our analyses of 36.0 words (*SD*=45.2).

For the eye tracking data, trials were removed if infants looked to the screen for less than 500 ms (out of 3000 ms possible) during the single-image presentation or less than 1000 ms (out of 5000 ms possible) during the paired-image presentation. Thus, trials were only included when

infants attended to *both* the first image and the subsequent pair of images. This process resulted in removal of 7.6 trials (*SD*=5.5) per participant on average: 2.4 control trials and 5.2 emotional trials. Additionally, we required that each participant provide at least 2 usable trials for each emotion (anger, fear, happiness, and sadness) and 4 usable control trials. This inclusion criterion resulted in removal of data from two participants.

Statistical Analyses

To assess emotion categorization, we analyzed visual attention during the portion of the task when two faces were presented side-by-side. We calculated the proportion of time that each infant spent looking to the emotion that was novel relative to the category of the previously displayed emotion out of the total time the infant spent looking to the two faces (out of 5s max) for each trial. Similarly, control categorization was calculated as the proportion of time that each infant spent looking to the object that belonged to the novel shape category relative to the previously displayed object. On average, infants spent 51.0% of the time looking to the novel face on emotion categorization trials (*SD*=4.6%). Infants spent a similar proportion of time looking to the novel object on the control trials (*M*=51.6%, *SD*=6.7%). Thus, we interpreted the present results to indicate that the two tasks were of comparable difficulty. When comparing to looking at chance level (0.5 to each face), infants did not demonstrate a statistically significant novelty preference for the emotional trials ($t(49)=1.51$, $p=.139$, $d= 0.21$) or for the control trials ($t(49)=1.73$, $p=.090$, $d= 0.24$), but there was notable variability in performance on both tasks. This was precisely as intended in order to allow for an examination of individual differences. Infant novelty preference did not significantly differ between the emotional and control trials ($t(49)=-0.52$, $p=.605$, $d=0.12$).

To analyze the relation between infant language and nonverbal emotion categorization, we used a multiple regression analysis. In the analysis, we included infant age, gender, and control categorization performance as covariates, because the relation between infant emotion categorization and language could be confounded by these variables. MCDI values were used to determine the effect of infant vocabulary on nonverbal emotion categorization over and above the effect of age, gender, and control categorization.

Vocabulary and Nonverbal Emotion Perception

A multiple regression analysis was used to address the relation between infant vocabulary and nonverbal emotion categorization. In this model, infant age did not significantly uniquely predict emotion categorization as measured by a preference for the novel face (β=-.01, p=.945), but child gender and control categorization did (Gender: β=.28, p=.046; Control categorization: β=.29, p=.044). Over and above the effect of infant age, gender, and control categorization, infant vocabulary did not significantly predict infant nonverbal emotion categorization (β=.15, p=.300). Thus, across all 15- to 18-month-old participants, vocabulary did not uniquely predict infant emotion categorization when accounting for other potential confounds.

Analyses Separated by Emotion

We conducted post-hoc analyses to investigate the possibility that infant vocabulary predicted nonverbal emotion categorization over and above age, gender, and control categorization for each of the four emotions independently. That is, perhaps infant vocabulary was related to categorization of one emotion in particular. Thus, we separated our emotion categorization outcome variable into four outcome variables based on the emotion presented during the first 3 seconds of the trial. Because of the post-hoc nature of this analysis, we adjusted

our alpha level to account for multiple comparisons. Thus, our new alpha level for these analyses was adjusted to .0125 rather than .05. Results revealed that there were no significant relations for any of the four emotional conditions- Anger: β=-.13, p=.392; Fear: β=.17, p=.263; Happiness: β=.15, p=.296; Sadness: β=.03, p=.830. That is, infant vocabulary also did not uniquely predict emotion categorization for any individual emotion category in isolation.

Gender Differences

Because we found that gender significantly predicted overall emotion categorization in our multiple regression model (consistent with previous reports of gender differences in child language and emotion understanding), we further analyzed our data for gender differences in vocabulary, control categorization, and emotion categorization. Results revealed no significant gender differences in our sample for vocabulary (t(48)=-0.65, p=.521, d=0.18) or control categorization (t(48)=-1.28, p=.208, d=0.36). However, there was a significant gender difference for emotion categorization (t(48)=-2.35, p=.023, d=0.67), such that the boys spent significantly more time looking to the novel face (M=0.52, SD=0.05) than did girls (M=0.49, SD=0.04).

Additionally, we ran two models separately for boys and girls predicting infant nonverbal emotion categorization from language ability over and above infant age and control categorization. Results revealed that for boys, neither age (β=.11, p=.607) nor control categorization (β=.10, p=.652) significantly uniquely predict emotion categorization. Over and above the effect of boys' age and control categorization, vocabulary did not significantly predict nonverbal emotion categorization (β=-.03, p=.901). In the same model for girls, age similarly did not uniquely predict nonverbal emotion categorization (β=.12, p=.459), but control categorization did (β=.69, p=.001). Additionally, over and above the effect of girls' age and

control categorization, vocabulary significantly predicted nonverbal emotion categorization (β=.42, p=.024).

Discussion

The present study investigated nonverbal emotion categorization and language abilities in late infancy. We found a significant relation between the two variables when accounting for age and control categorization, but only for girls. For the full sample, emotion categorization also related to infants' control categorization abilities. Further, we found that boys performed significantly better than girls on the nonverbal emotion categorization task. These results suggest that the relation between general language ability and emotion categorization is likely complex prior to 18 months of age, and modulated by multiple factors including child gender. Boys may see an early advantage in nonverbal emotion categorization due to the lack of language in the task, but girls with higher productive vocabularies may see an advantage over girls with lower vocabularies.

We observed a gender difference in the present study, such that boys had a significantly greater novelty preference in the emotion categorization task than girls. Some previous studies of emotion matching in infants (e.g., Palama, Malsert, & Gentaz, 2018) suggest that infants recognize intermodally-matched information by looking away from it and toward what is novel, and a recent study reported that a novelty preference on emotion matching tasks at 15-months predicts later emotion understanding (Ogren & Johnson, 2020). Thus, the pattern of results in the present study are novel in that they appear to indicate more advanced emotion categorization (i.e., a stronger novelty preference) among boys than girls.

Some prior work has shown that girls outperform boys on typical emotion understanding and perception tasks (e.g., Brown & Dunn, 1996; Caron, Caron, & Myers, 1982; Denham et al.,

2015; Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Ontai & Thompson, 2002) but other studies have analyzed for gender differences and found none (Dunn, Brown, & Beardsall, 1991; Fabes et al., 2001; Grazzani, Ornaghi, Agliati, & Brazzelli, 2016). However, our results indicate that under tested circumstances boys showed an advantage over girls in emotion categorization. This may be due to the nonverbal nature of our task, and possibly distinct pathways of processing emotional information for boys and girls. As young girls generally have improved language abilities over their same-age boy peers (Fenson et al., 1994), and typical emotion understanding tasks involve language (e.g., Denham, 1986), it is possible that the advantage for girls demonstrated in previous research has been driven by their language abilities. That is, perhaps girls rely on language more than boys for perceiving and processing emotion information. Although we did not observe any gender difference in language ability in our sample, it is possible that without any linguistic cues to guide their performance, girl infants may have not been able to process emotions as well. This pattern of results may suggest a difference in terms of pathways of processing emotional information in late infancy, with perhaps girls relying more on language when processing the input but boys relying more on visual information at this age. This aligns with results from our multiple regression analyses.

In our regression analyses, we observed a significant relation between infant language abilities and nonverbal emotion categorization for girls only. The contrasting findings for boys and girls are worthy of note. Recent theories have proposed that language should relate to the perception of emotion categories (e.g., Barrett, 2017) because language and words provide "invitations to form categories" (Brown, 1958). Our results with 15- to 18-month-old infants provide evidence that infant vocabulary size provides an advantage in categorizing emotions across different faces for girls, but not boys. This may be because, as suggested above, the girls

at this age may process emotion information using linguistic information more than boys, and therefore may have struggled more to complete the nonlinguistic emotion categorization task. This could be because girls tend to have larger receptive vocabularies than boys from young ages (Fenson et al., 1994), and thus may rely on receptive linguistic information more than boys to process emotional information. Thus, without language in the task, boys overall performed better, but were largely unaffected by their individual vocabularies (i.e., no significant relation between vocabulary and nonverbal emotion perception). In contrast, performance in girls (which was lower overall relative to boys) seems to have been more strongly influenced by individual differences in productive vocabulary. Further research is necessary to address how the role of language in processing emotion information may change for boys and girls across development.

Additionally, our results showed that for both genders combined, infant emotion categorization related to control categorization (although this result may have been driven by girls). Prior research has shown that general object categorization relates to language (e.g., Kowalski & Zimiles, 2006; Waxman & Markow, 1995), and our results suggest the possibility that language may influence general categorization abilities, which in turn may relate to later emotion categorization abilities. Therefore, it may be that a relation between language and emotion categorization development is complex (e.g., involving the mediation of more domain-general categorization abilities) and emerges over a wide developmental period. These possibilities could be investigated in the future with longitudinal research.

There is substantial variability among emotion displays within emotion categories (Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019). Not all expressions of anger, for example, look alike. Our emotional stimuli were validated by adults, yet it is possible that variability in emotions from one person to the next without the aid of any audio made this task

particularly challenging for infants. If this is the case, it remains possible that a relation between language and nonverbal emotion categorization for both boys and girls would be apparent among older age groups. This may be particularly important to investigate given that emotion words have been shown to influence emotion face categorization among 6-, 9-, and 12-year-olds (Vesker et al., 2018), but their effects in children older than 18 months but younger than 6 years remain largely unknown. This may also be important for teasing apart the role of general language abilities and emotion-specific vocabulary. In late infancy, emotion-specific vocabulary is low (as noted previously, only one out of the 50 participants in our sample produced any emotion words). However, previous work has suggested that by the preschool years learning emotion words may play an important role in learning an emotion concept (Widen & Russell, 2008). Perhaps as children get older and expand their emotional vocabulary (e.g., as toddlers), examining the role of emotion vocabulary versus general vocabulary will afford important insights into mechanisms behind emotion understanding development.

Additionally, we assessed the possibility that infant language relates to nonverbal emotion categorization for individual emotions, but we found no evidence in favor of this hypothesis. This pattern of results aligns with previous research that suggests that perception for a variety of emotions (not just one in isolation) is most predictive of later emotion understanding (Ogren & Johnson, 2020). Thus, for emotion categorization to relate to language abilities, we expect that it would be for the overall emotion categorization score rather than any individual emotion. However, it would be useful for future research to examine how perception of multiple emotions relates to infant language using additional nonverbal tasks. This will be valuable for determining whether the pattern of results observed in the present study extends to other paradigms (e.g.. matching tasks, violation of expectation paradigms), and thereby how robust the

relation between language and emotion categorization may be in late infancy, particularly for girls.

In conclusion, the present study assessed infant language abilities and nonverbal emotion categorization. For the full sample of infants, we did not find evidence that infant vocabulary size significantly predicted nonverbal emotion categorization when controlling for infant age, gender, and object perception abilities. That is, averaging across all participants, infant vocabulary was not a strong, unique predictor of emotion categorization. The same pattern held when separating the results by emotional condition, indicating that the relation between language and emotion perception did not change based on the particular emotion being perceived. However, a significant gender difference was identified, with boys demonstrating a significantly greater novelty preference than girls in the emotion categorization task. Further, when predicting nonverbal emotion categorization separately for boys and girls, vocabulary was a significant predictor when controlling for age and control categorization for girls only. This suggests that pathways of processing emotional information (particularly with regards to the role of language) may differ for boys and girls in late infancy.

Study 2

Understanding emotion categories is a crucial aspect of healthy social development (Hesse & Cicchetti, 1982; Olson, Astington, & Harris, 1988), and knowledge of emotion words plays an important role in developing emotion understanding. Not only are children with a larger emotion vocabulary more capable of talking about their own and others' emotions, but a recent theory suggests that emotion language actually fosters children's learning of emotion categories (Barrett, 2017). Considering the importance of emotion language for children's developing social

and emotional competence, it is crucial to better understand what emotion language children hear in their natural environment as well as what they produce. However, much remains unknown regarding the specific emotion words that children hear and produce in their natural language environment (Hoemann, Xu, & Barrett, 2019). To address this, the present study uses naturalistic corpus data to characterize the early emotion language environment.

Emotion words are challenging for children to learn because emotion categories are abstract. That is, although we treat emotions categorically, they are truly continuous gradients. There is not one distinct facial configuration that maps on to any given emotion and the same emotion category involves many diverse displays. In fact, emotion categories are expressed with substantial variability (Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019) and involve facial movements, tone of voice, body posture, and situation-specific information. Thus, children are faced with a challenging problem of integrating information across multiple domains and identifying how and where to draw category boundaries between various emotions (Hoemann, Xu, & Barrett, 2019). It has been proposed that learning emotion categories is similar to learning other types of categories or concepts (e.g., Rakison & Oakes, 2003), in that emotion categories are constructed from simpler precursors via learning and experience. In particular, children's emotion category learning may be aided by language, because it has been previously shown to influence category development for other abstract concepts such as relational concepts (Loewenstein & Gentner, 2005). This link between language and cognition is thought to exist because words invite children to form categories (Brown, 1958), and may highlight commonalities among category members. Further, it has been suggested that learning *emotion words* may be particularly helpful, as they provide a "powerful tool" for understanding emotions (Kopp, 1989). This may be because these emotion words allow children to link a variety of

emotional displays and events together via one label, such as “scared” (Lindquist & Gendron, 2013). In this way, emotion words may help children to organize and develop emotion concepts (Shablack & Lindquist, 2019). Thus, language (and more specifically emotion words) may help children to learn these abstract emotion categories.

Although emotion category learning appears challenging, most children begin to talk about emotions from a young age. By around 18 months of age, infants begin to produce emotion labels such as “happy” (Ridgeway, Waters, & Kuczaj, 1985), and by age 2 children begin to map emotion labels to stereotypical facial expressions and to scenarios (Denham, 1986). However, individual differences are marked in both children’s production of emotion words (Denham, 1986; Dunn, Brown, & Beardsall, 1991; Pons & Harris, 2019) as well as in their understanding of emotion categories (Cutting & Dunn, 1999; Pons, Lawson, Harris, & De Rosnay, 2003). Further, stability in individuals’ emotion understanding trajectories has been observed across the preschool years (Brown & Dunn, 1996) and middle childhood (Pons & Harris, 2005). Therefore, it is important to understand the mechanisms that underlie children’s early development of emotion categories and use of emotion words.

To understand children’s use of emotion words, it is crucial to first understand the emotional language environment in which children are embedded. Identifying the emotion words that children actually produce as well as what they regularly hear from their parents are vital pieces of information for ultimately understanding how children learn emotion categories. Looking at naturalistic language is necessary to answer these questions. This base knowledge will provide a foundation on which more nuanced questions about emotion category learning can be answered. Understanding children’s emotion word production across development is important, but the input that they receive from their parents is equally important, as it may offer

key insights into the information that children have access to and use to learn emotion categories. In other domains, the specific input that infants are exposed to is important for their attention and learning (Hurley & Oakes, 2015; Smith, Jayaraman, Clerkin, & Yu, 2018). Thus, if emotion category learning operates in a similar manner to other category learning, identifying the emotion words that children hear as input is crucial to more comprehensively understanding emotion category learning. However, surprisingly little research to date has addressed what specific emotion language is present in children's natural environments (Hoemann, Xu, & Barrett, 2019).

Additionally, it is important to understand what aspects of the linguistic environment may influence children's production of emotion words. Specifically, it is important to understand whether exposure to language *in general* or exposure to *emotion words* in particular is beneficial for children's ability to learn emotion categories and produce emotion words themselves. It may be the case that hearing more emotion words helps children to learn these words themselves and to conceptually organize emotion categories (Shablack & Lindquist, 2019). In contrast, exposure to more general language may be beneficial, as it may provide children with more information which they may then extend to emotion categories. Previous research has shown that the relation between age and a more mature conceptualization of emotions was mediated by *general* verbal abilities, but not by emotion language specifically across the age range of 6- to 25-years (Nook, Sasse, Lambert, McLaughlin, & Somerville, 2017). Further, young children with impairments in general language ability show deficits in emotion identification and attribution, even though they are capable of discriminating emotional stimuli (Rieffe & Wiefferink, 2017). Thus, it is possible that exposure to more language in general may facilitate children's learning about emotions and their propensity to talk about emotions. However, it is also possible that hearing emotion-specific language drives children to learn emotion categories and talk about them. Thus, examining the

language that children hear in their natural environment in terms of both emotion language and general language is of great importance.

Some studies have begun to answer questions regarding children's early emotion word production. Ridgeway, Waters, and Kuczaj (1985) identified norms for when young children begin to understand and produce emotion words, and others have investigated the development of emotion language production from age 2 to 5 among a sample of five children (Wellman, Harris, Banerjee, & Sinclair, 1995). Although this information is key for understanding how children begin to use emotion words, much remains unknown. In particular, the *specific emotion words* that children are exposed to and produce naturalistically remains poorly understood. Although the findings from Wellman and colleagues (1995) were valuable for identifying developmental trajectories, understanding what emotion language children naturally produce among larger samples of children is vital. Echoing this concern, Bretherton, Fritz, Zahn-Waxler, and Ridgeway (1986) stated "… the study of children's developing mastery of terms denoting and connoting emotion and the function of talking about emotions in naturally occurring interactions deserves far more attention than it has hitherto been accorded", and Hoemann, Xu, and Barrett (2019) have more recently expressed concerns that there is little evidence regarding how frequently parents explicitly label emotions when their young children are present. Thus, identifying basic characteristics of young children's emotion lexicon, including the frequency of naturalistic emotion talk among young children and their parents, the types of emotion words spoken, and factors that predict individual differences in child emotion word production, are crucial for furthering our knowledge of children's emotion category development.

The Present Study

In the present study, we addressed three key topics regarding children's naturalistic use of

emotion words: 1) Descriptive information regarding the frequency and type of emotion words that young children produce and hear, 2) Developmental trends in early emotion language production and exposure, and 3) Factors that predict children's production of emotion words. To do so, we analyzed transcripts from 15- to 47-month-old children in the Child Language Data Exchange System (CHILDES; MacWhinney, 2000) database. We coded parent and child production of emotion words and reported descriptive statistics, including the frequency and type of emotion word production by parents and children. Further, we explored developmental trends by looking at how emotion language production for children and parents changed with age, and how our naturalistic data compared to existing developmental norms. Finally, we investigated factors that predicted children's production of emotion words. Specifically, we assessed the effect of child age, parent and child general language complexity, parent emotion language, and parent emotion word priming.

Method

Participants

The transcripts of 15- to 47-month old children interacting with their parents were accessed from the CHILDES database (MacWhinney, 2000), a publicly available data set of conversational interactions with children. Transcripts in this database were collected from a variety of researchers interested in various aspects of language. Thus, none of the transcripts were collected with the intent of investigating emotion words, and therefore represent naturalistic depictions of emotion language production among families. The age range was selected because children over 15 months but under 4 years of age are typically verbal and demonstrate substantial variability in emotion language production (Ridgeway, Waters, & Kuczaj, 1985) as well as linguistic complexity (Fenson et al., 1994; Hoff, 2013). The final data set for the present study

included 181 children with an average age of 29.2 months (*SD*=7.4). The researchers did not collect any new data for this project and did not have access to any personally identifiable information regarding the participants, and thus this study was deemed exempt by the IRB at the University of California, Los Angeles, project title "CHILDES Investigations", and adheres to the American Psychological Association ethical standards. Participant demographic information (e.g., race, ethnicity, socioeconomic status) was not available for all participants due to the deidentified nature of the data, and thus is not reported in the present manuscript.

Transcript Selection

Transcripts included in the present study were selected based on several key criteria. All transcripts were in English and belonged to the English- North America collection of the CHILDES database. The target child of the transcript was always within the age range of 15- to 47-months. Additionally, mothers needed to be interacting directly with their child for the transcript to be included. As mothers are more likely to be primary caregivers and there were substantially fewer transcripts including fathers, we only included transcripts with mothers for the present analysis. Further, to assess naturalistic conversations between mothers and children, we removed transcripts where mothers or children were given an explicit task to complete during the session, such as reading a specific book or completing a delayed gratification task, as these assigned tasks might influence the conversations that mothers and children had. That is, if mothers were tasked with reading a specific book that included a substantial amount of emotional content, this might lead to more emotion word production than this particular mother and child may have had naturally. However, book reading was still included if it was the parent and/or child's choice to engage in this activity during free play. The key exclusion criterion was whether the task was explicitly assigned by an experimenter. Thus, the majority of selected

transcripts involved free play sessions between mothers and children (either in lab settings or at home), with additional transcripts provided from mealtime sessions, before bed, and other daily routine activities. Transcripts from the same child at multiple ages were included, although some children only provided a transcript at one time point. This resulted in a final sample of 1,987 transcripts from 181 children in 18 corpora which were accessed in December 2019. The final sample size was determined based on including all available transcripts that adhered to our selection criteria.

Emotion Talk

To assess emotion talk, we counted the number of times emotion words were produced by mothers and children in each transcript. To determine which words to include as emotion words we began by compiling a list based on two previous studies of emotion words (Baron-Cohen, Golan, Wheelwright, Granader, & Hill, 2010; Wellman, Harris, Banerjee, & Sinclair, 1995), lending over 300 potential emotion words in total. However, some of these words can be used to convey an emotion but are more frequently used to describe a non-emotion (e.g., "Absorbed" or "Broken") or are used to convey emotions in the United Kingdom but may not be expected to frequently convey emotion among a North American sample (e.g., "Merry"). To account for this and ensure that our study investigated words primarily used to convey emotions among our sample, we conducted a survey with undergraduate students.

Fourteen undergraduate students (12 female), all between the ages of 18 and 24 participated in this survey. Each undergraduate viewed all 351 words and was asked to answer two questions: 1) To identify whether or not each was an emotion word (yes or no), and 2) To approximate how frequently that word is used to convey an emotion (1=Always emotion word, 3=equally often emotion vs non-emotion, 5=Never emotion word). Based on these responses,

words were removed from our final emotion word list if they were identified as "yes" to being an emotion word by 50% or fewer of the undergraduate participants. This resulted in a final list of 141 emotion words used in the present study. Of these words, they were identified as "yes" to being emotion words by an average of 73.1% (*SD*=12.2) of participants. The average frequency of use as an emotion word score for the final word list was 2.5 (*SD*=0.5), indicating that they were perceived as more often used to indicate emotions than non-emotions. The final list of words can be found in Appendix A.

The childes-db r package version 0.1.2 (Sanchez et al., 2018) was used to identify emotion words within our selected transcripts. Using the get_types function, we counted how many times each emotion word from our list was produced by the mother or child within each transcript. We then summed across all emotion words to calculate the total number of emotion words produced by each speaker within each transcript.

General Language Complexity

To calculate the general language complexity of each speaker within each transcript, we also used the childes-db r package to determine each speaker's mean length of utterance (MLU). This value indicates the average number of morphemes (the smallest meaningful unit of language) for each speaker's utterances, and is frequently used as a measure of the complexity of productive language.

Results

Descriptive Information

First, we report basic descriptive characteristics of the emotion language produced in the naturalistic transcripts. These characteristics are key for understanding the nature of children's emotion language environments, as well as how variable these environments may be. To present

a comprehensive report of children's emotion language environment, we include descriptive statistics, the number of emotion words produced by mothers and children, the number of emotion word types versus tokens spoken, and gender differences.

Descriptive statistics. We first report the number of emotion words, emotion word frequency, and language complexity, as these are key basic characteristics for understanding children's emotion language environments and the information that they may be using to learn emotion categories. The average number of emotion words produced by children per transcript was 0.84 (*SD*=2.07). However, 1,396 of the 1,987 transcripts had 0 emotion words produced by a child, while the maximum was 29 emotion words produced by a child in one transcript. The average number of emotion words produced per transcript by mothers was 2.01 (*SD*=4.36). 1,230 transcripts had 0 emotion words produced by the mother, and the maximum number of emotion words produced in one transcript by mothers was 34. On average, children produced 180.45 (*SD*=210.47) utterances per transcript, indicating that children were producing approximately one emotion word per 215.87 utterances. Mothers on average produced 210.26 (*SD*=294.68) utterances per transcript, indicating approximately one emotion word per 104.58 utterances. The average child MLU across transcripts was 3.71 (*SD*=1.94), while the average mother MLU was 5.35 (*SD*=1.62). Thus, mothers produced both more complex language and more frequent emotion language than their children, but there was substantial variability in both factors and by both speakers.

Emotion word count. To understand how children learn about emotion categories, it is important to not only know how frequently emotion words are spoken in general, but also *which* emotion words children hear and produce. To address this, we investigated the specific emotion words that were produced by both mothers and children. Of the 141 possible emotion words

searched for in the transcripts, only 79 were spoken by a mother or target child. Children produced 47 unique emotion words and mothers produced 77. Figures depicting the frequencies separated by specific emotion words are presented separately for the target child (Figure 2) and mother (Figure 3). As the figures depict, some emotion words such as *happy*, *love*, *scared*, *sad*, *angry*, *mad*, *afraid*, and *glad* are produced relatively frequently by both speakers. However, other words such as *hate* and *surprised* are spoken frequently by one speaker but not the other. Additionally, for both mothers and children there were a few emotion words that were spoken with high frequency, followed by a sharp drop off with a high number of words spoken at very low frequencies. This provides valuable information regarding how hearing emotion words at high frequencies (e.g., *happy*) may allow children to consistently learn these emotion categories more readily and at younger ages than others, and why many other emotion categories which are spoken in their natural environments at lower frequencies (e.g., *disappointed* and *calm*) may take more time for children to learn. Why children produce some emotion words (e.g. *hate*) at higher frequencies compared to other emotion words relative to their mothers remains an important area for future research.

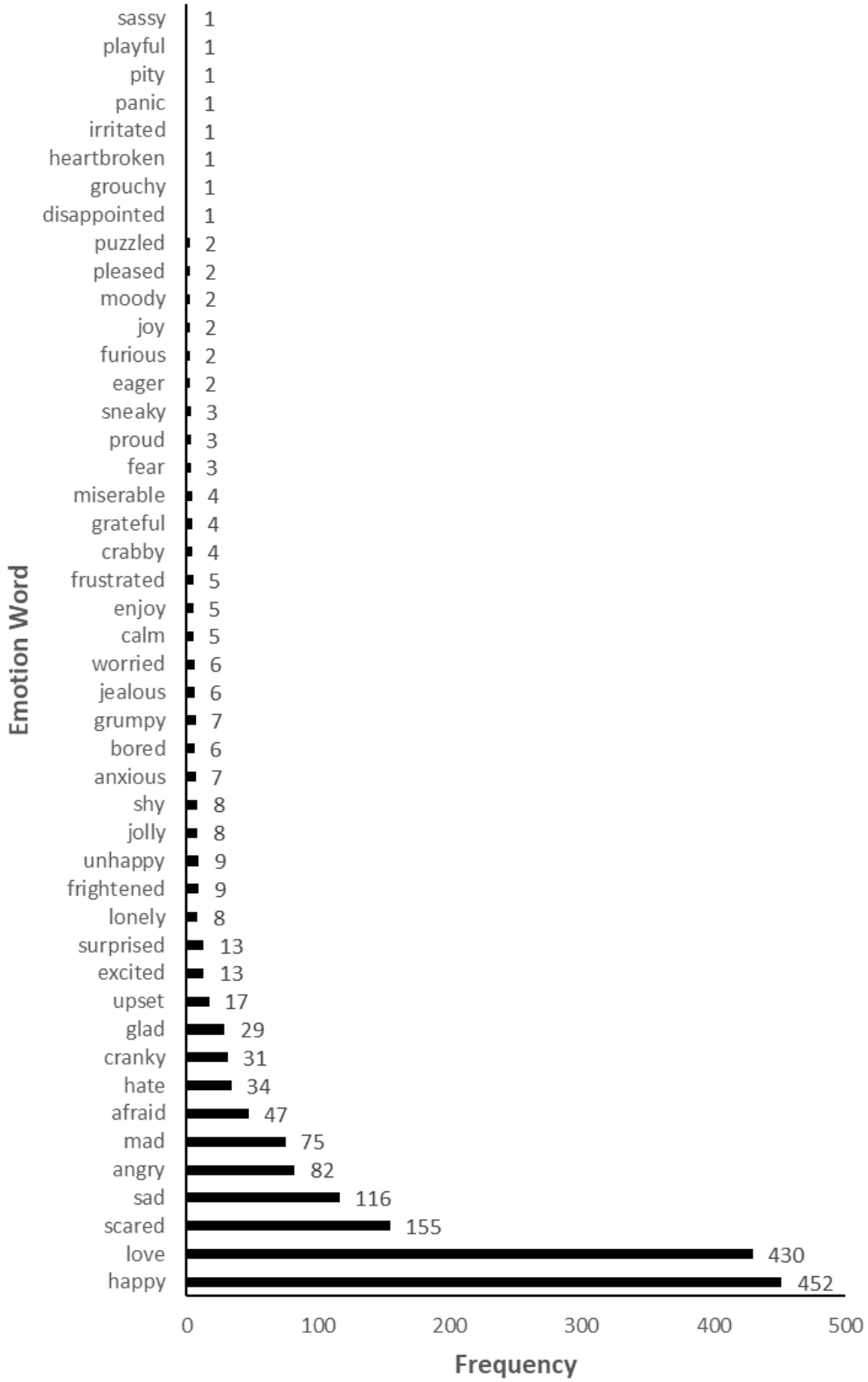

Figure 2. Frequency of emotion words spoken by the target child across all transcripts

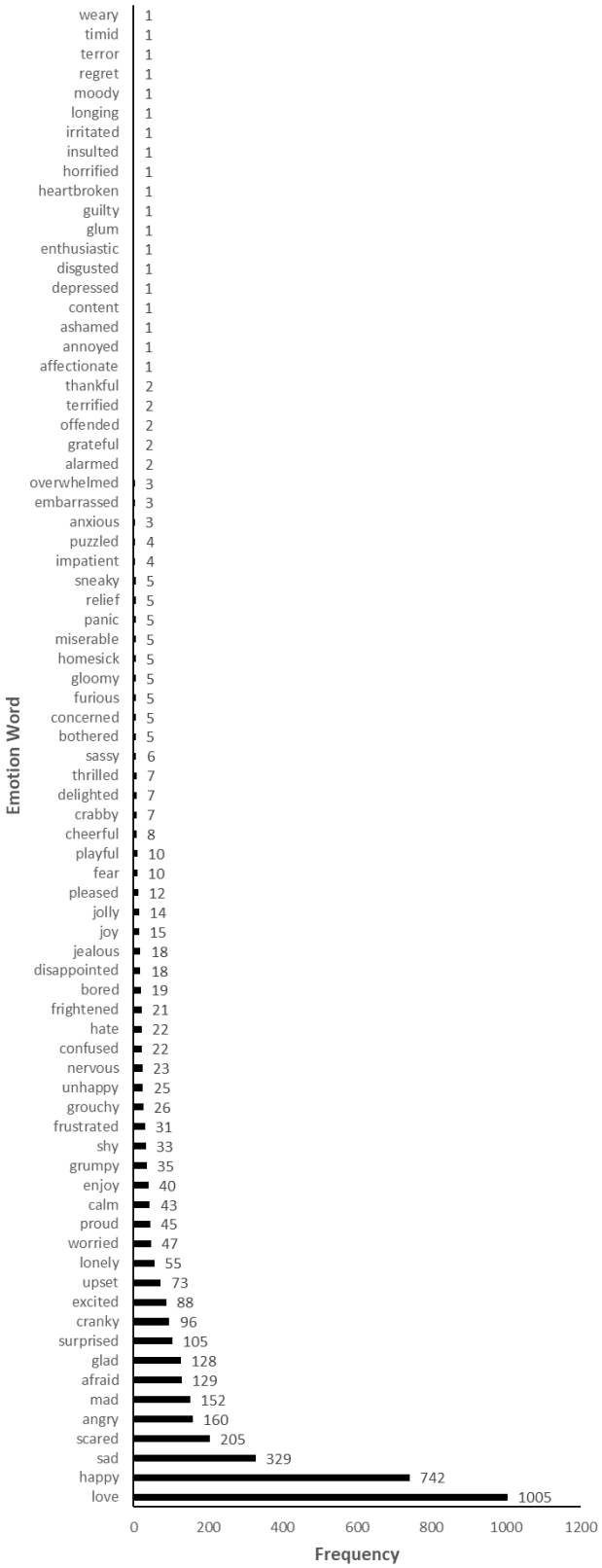

Figure 3. Frequency of emotion words spoken by the mother across all transcripts

Types vs tokens. In addition to understanding the specific emotion words being produced, the diversity of emotion words spoken by mothers and children is important to explore in order to understand how children are making sense of emotional information. As described above, children produced an average of 0.84 emotion words per transcript (1,678 emotion words across all transcripts) and mothers produced an average of 2.01 words per transcript (4,009 emotion words across all transcripts). However, these counts allow for individual speakers to be providing the same emotion word more than once within a given transcript. Thus, in addition to looking at the total number of emotion words spoken (tokens) we also investigated the number of unique emotion words produced by each speaker within each transcript (types). Results revealed that, across all transcripts, children produced 899 emotion word types (an average of 0.45 per transcript), indicating that the remaining 779 emotion words produced involved children repeating words they had already spoken earlier in the same transcript. Across all transcripts, mothers produced 2,021 emotion word types (an average of 1.01 per transcript), indicating that the remaining 1,988 emotion words produced involved mothers repeating words that they had already spoken earlier in the same transcript. Thus, both mothers and children repeated emotion words often, but parents still produced substantially more emotion word types than children on average. These results suggest that frequent repetition of the same emotion word by both mothers and children may be particularly important for children at this young age to learn emotion concepts.

Gender difference. We also analyzed for differences by child gender, as previous research has shown that parents tend to talk about emotions more with their preschool-aged daughters than sons (Denham, Bassett, & Wyatt, 2010) and that preschool-aged girls use more emotion language than boys (Kuebli, Butler, & Fivush, 1995). Thus, in our large sample of

transcripts we explored whether these patterns emerged in naturalistic speech. Of the 1,987 transcripts included, the majority (1,360) had a female target child. Of the remaining transcripts, 538 had a male target child and 89 did not specify the gender of the child in the transcript. Although there were substantially more female than male child transcripts, we conducted some basic analyses to assess gender differences. Results revealed that the average age of males (31.79 months) was significantly higher than that of females (27.91 months; $t(1896)=-10.51$, $p<.001$, $d=0.53$). Due to this difference in age, additional gender differences were assessed covarying for child age. Further analyses revealed that, accounting for child age, mother MLU was significantly higher for girls than for boys ($B=-.05$, $p=.022$), and child MLU was significantly higher for girls than for boys ($B=-.23$, $p<.001$). Additionally, when accounting for child age, mothers used more emotion language with boys than with girls ($B=.06$, $p=.009$) but boys and girls did not differ in their use of emotion language ($B=.02$, $p=.339$). Although these results should be interpreted with caution given the uneven gender breakdown, these findings suggest that when controlling for age, parents may provide more scaffolding to boys by speaking with more emotion words, but that ultimately boys and girls may not significantly differ in their use of emotion words.

Developmental Trends

In addition to characterizing the emotion language environment of young children, it is also crucial to understand how this changes with age. Because children's understanding of emotion categories improves substantially from infancy through age 3, it is of great importance to understand how their emotion language environment may (or may not) change across this age range to facilitate this development. To assess this, we investigated the effect of child age on both mother and child emotion language production. We also compared these naturalistic corpus

data to existing developmental norms in order to more comprehensively understand the development of emotion language in young children.

Age effects. How does children's emotion language environment change as children get older and begin to gradually understand more complex emotion concepts? To investigate this developmental change, we analyzed how children's emotion talk and the emotion words they hear from their mothers change with age. To do so, we binned transcripts into multiple age groups: Infants under 2 (N=547), 2-year-olds (N=1,017), and 3-year-olds (N=423). We then conducted two separate one-way ANOVAs (one for the emotion language of children and one for mothers) comparing emotion words produced across these 3 age groups. To control for potential changes in overall number of words spoken, we assessed whether the proportion of emotion words produced out of total words produced changed by age group. Results revealed that the proportion of emotion words produced significantly changed by age for children (F(2, 1984)=10.68, p<.001, η_p^2=.011) and mothers (F(2, 1984)=3.20, p=.041, η_p^2=.003), with the proportion of emotion words produced increasing with age as depicted in Figures 4 and 5. Thus, as children get older they are both producing more emotion words themselves, and hearing more emotion words produced by their mothers. Both this increasing input and production likely contribute to children's growing emotion understanding across this age range.

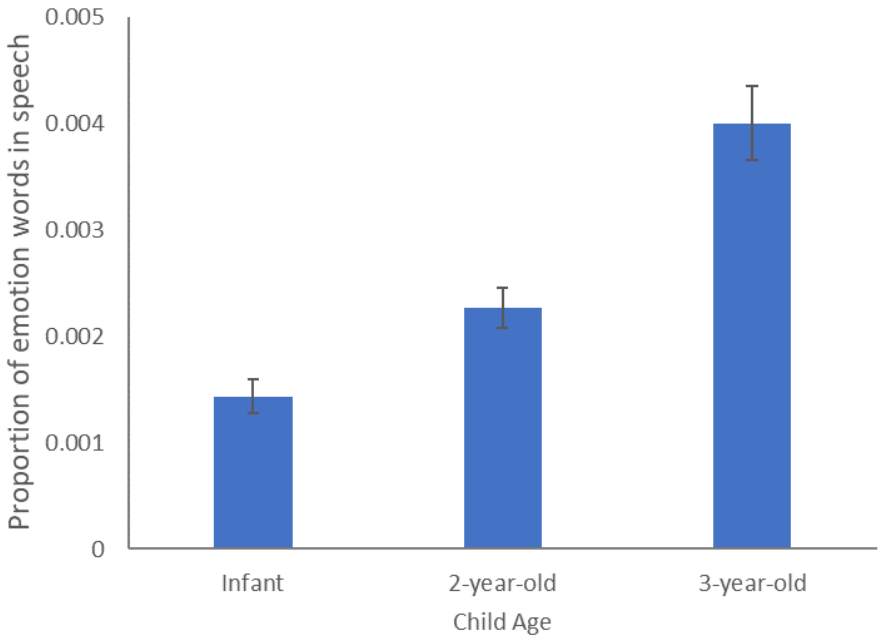

Figure 4. Proportion of emotion words produced by children in speech (out of total words spoken) by child age

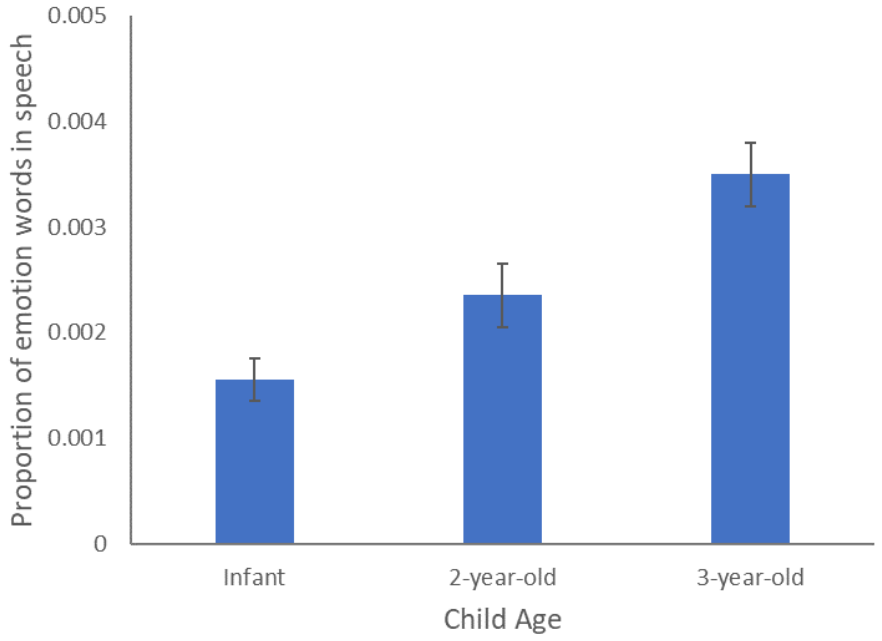

Figure 5. Proportion of emotion words produced by mothers in speech (out of total words spoken) by child age

Comparison to Existing Norms. Previous work has aimed to characterize changes in children's emotion language production across development by asking parents to report when their child produces various emotion words. To more comprehensively understand the development of children's emotion word production, we compared children's production of common emotion words to existing norms in order to assess how closely aligned parent reports were with children's natural production. Specifically, we compared the ages at which children in our naturalistic sample began producing common emotion words relative to norms provided by WordBank (Frank, Braginsky, Yurovsky, & Marchman, 2017), an open child vocabulary repository. Vocabulary norms presented in WordBank represent the ages at which parents report that their child *can* produce particular words. Here, we compare this with children's actual propensity to produce these words in their natural environment. We investigated the emotion word "happy", "sad", "mad", and "scared", as these are all included in the WordBank repository and are among the 6 most commonly produced emotion words in our sample. Wordbank data suggest that children at the 50th percentile can produce these words at approximately the following ages: Happy=23 months; Sad=27 months; Mad=28 months; Scared=26 months. For comparison, the mean age of children from our transcript analysis who produced each of the following words was as follows: Happy=31.18 months (*SD*=7.44); Sad=31.76 months (*SD*=6.79); Mad=35.48 months (*SD*=6.12); Scared=33.67 months (*SD*=6.81). Additionally, the 25th percentile for children's age in our sample who produced each emotion word were as follows: Happy=24.95 months (*SD*=7.44); Sad=27.86 months (*SD*=6.79); Mad=30.53 months (*SD*=6.12); Scared=28.78 months (*SD*=6.81), although the youngest children to produce each emotion word in our naturalistic sample were below 17 months of age with the exception of

"mad" (mad=24.76 months). Thus, the same general pattern of which words emerged at which ages was represented in the naturalistic transcript data (although children in the transcripts produced "scared" at later ages on average than "sad"). However, these data suggest that there may be a notable lag between when children are *capable* of producing these emotion words and when they actually do so consistently in naturalistic speech. See Figure 6 for the total frequencies with which these four words were produced per transcript among particular age groups. In line with the WordBank data, this figure demonstrates the later development of children's production of the word "mad" relative to "happy", "sad", and "scared". However, it is worth noting that children in our transcript analysis produced the synonyms "mad" and "angry" at comparable frequencies (see Figure 2), despite vocabulary norms frequently only including the word "mad". It may be useful, therefore, for future research to include both "mad" and "angry" when assessing young children's production of emotion words.

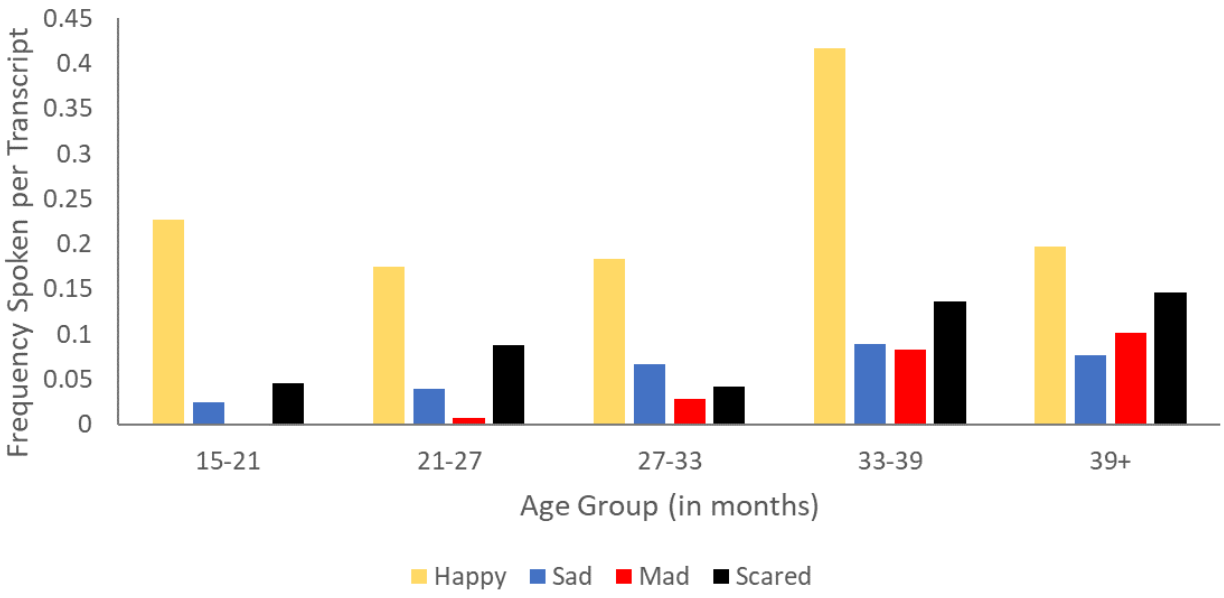

Figure 6. Total frequencies with which children produced the emotion words "happy", "sad", "mad", and "scared" per transcript across age groups beginning at 15-21 months and ending at 39-47 months.

In addition to comparing child emotion word production to existing norms, we looked at mother production of emotion words. In particular, we were interested in whether the emotion words more commonly produced by mothers in our transcripts aligned with the emergence of emotion word production over development from existing norms. WordBank data suggest that "happy" is the earliest learned emotion word. Across the age range of 16- to 30-months, WordBank data shows "sad" and "scared" emerging next, with "mad" emerging last. Our transcript data presented in Figure 3 show how often these words are produced by mothers. Importantly, "happy" is stated substantially more often by mothers than any of the other three emotion words, which aligns with WordBank data showing that children learn this word earliest. Additionally, mothers produce the word "mad" less often than any of the other three words. This aligns with existing WordBank data and suggests that because this word is less frequent in children's input, this may explain why it is produced later in development than the other three emotion words. These comparisons to existing norms provide important insights into how the production of emotion words in naturalistic speech aligns well with parent reports of when children are capable of producing emotion words, and how both natural production of these 4 emotion words and parent reports of production increase across the age range of 15-47 months.

Factors Predicting Child Emotion Talk

The previous results have provided key information regarding children's natural emotion language environments and how they may change with age. However, there are still notable individual differences in children's production of emotion words. To better understand the substantial individual differences in children's production of emotion words (and thereby their understanding of emotions more broadly), we investigated what linguistic factors would (or

would not) predict young children's production of emotion words. We assessed the role of multiple linguistic factors using multilevel models and descriptive reporting.

Statistical analyses. We assessed whether multiple aspects of children's emotion language environment were related to their emotion language production. Data for each transcript included child age, the MLU for mother and child, as well as a count of emotion words produced by the mother. A three-level multilevel linear mixed model was used to analyze the impact of these predictor variables and to control for the substantial variability in our outcome variable (child emotion word production) accounted for at each of these levels (Corpus: B=.37, SD=.61; Child: B=.19, SD=.44).

Predicting child emotion talk. We used our multilevel model to assess how well each of the following factors predicted child emotion language production: Child age, child MLU, mother MLU, and mother emotion language. When looking at each variable over and above the effect of the other variables in the model, results revealed that child age (β=.05, p<.001) and mother emotion talk (β=.21, p<.001) significantly predicted child emotion talk, but child MLU (β=.01, p=.690) and mother MLU (β=.00, p=.872) did not. Thus, age and emotion-specific language input appear closely related to child emotion language production, but not more general language complexity in the child's environment.

Priming. An additional factor that may influence children's production of emotion words is priming. That is, children may be more likely to produce emotion words that they have recently heard spoken. Thus, we investigated whether children's production of emotion words was related to priming by their mother. In other words, how often did children produce an emotion word when their mother had spoken that same emotion word earlier in the same transcript? To address this, we identified the emotion word types that children produced and

identified how frequently those emotion words had been produced by their mother earlier in the same transcript. Results revealed that of the 899 emotion word types produced by children, 502 (55.84%) were words that had been primed by mothers. Thus, mothers' production of a word does strongly relate to child production of the same specific word. Young children who naturalistically produce emotion words, therefore, are frequently, but not always, repeating a word that they had recently heard from their mother. Hearing someone produce an emotion word and then later repeating that same emotion word may be a beneficial learning mechanism for young children as they begin to understand emotion concepts.

Discussion

To our knowledge, this is the first study to investigate naturalistic emotion language production from late infancy through early childhood using a large sample including multiple corpora from the CHILDES database. Our results provide key descriptive information regarding the frequency and type of emotion words produced by parents and children, developmental trends, and linguistic factors that predict children's naturalistic production of emotion words. Notably, the general pattern of when emotion words emerged aligned with existing norms, providing further confidence in these results across multiple sources (i.e., parent report and naturalistic child language production). Further, results revealed that parent emotion language, but not parent or child MLU, predicted child emotion language production. These findings provide an important foundation for understanding children's daily emotional linguistic environment, including what sort of emotion language is naturally produced among young children and their parents and how emotion language production may change across development.

Identifying the frequency of emotion words produced by parents and children is important for understanding children's emotion language development. In particular, it should be noted that mothers produced more than twice as many emotion words per transcript as children, but there was substantial variability in the number of emotion words produced across transcripts. Additionally, over 50% of transcripts did not involve a child producing any emotion words, and over 50% of transcripts did not involve a mother producing any emotion words. Thus, emotion words may not be produced very frequently in natural mother-child conversations, but when they are produced they are produced by mothers substantially more often than children. This suggests, not surprisingly, that mothers' emotion language production may be an important source of information for children's developing emotion vocabulary. In an effort to improve child emotion understanding and emotion language, it may be important to create interventions to increase emotional language use by parents as has previously been successful in preschool settings (Grazzani & Ornaghi, 2011; Grazzani, Ornaghi, Agliati, & Brazzelli, 2016). Knowing the typical frequency of emotion language production and the types of emotion words commonly produced during these interactions, as presented here, may aid in the creation of such interventions.

An interesting pattern revealed in our results was that mothers' emotion language, but not mother or child MLU, predicted child emotion language. While this likely may indicate that children are learning emotion words from their parents, this result is in contrast to prior research showing that *general* language abilities are important for developing emotion concepts (Nook, Sasse, Lambert, McLaughlin, & Somerville, 2017). However, it is important to note that this previous study was conducted with 6- to 25-year-old participants, while our study was focused on children under the age of 4. Thus, we believe it is possible that early in development, hearing emotion words specifically may be helpful for children to gain this vocabulary and learn to begin

talking about and conceptualizing emotions. After this foundation is built, general language abilities may be useful for slightly older children to build on these existing emotion concepts. Exploring this possibility remains for future research. Additionally, it should be noted that the current study analyzed data from exclusively English-speaking participants. Whether or not there are differences in this pattern of results across a more diverse array of languages is an important question that may also be addressed in future research.

Results from the present analysis also revealed notable differences between young boys and girls. Specifically, we found greater language complexity (as measured by MLU) among girls than boys, which is in line with previously published literature (e.g., Bornstein & Haynes, 1998; Fenson et al., 1994). Further, we found that mother MLU was higher when they were with daughters than with sons, which aligns with prior research suggesting that parents adjust their language to be more complex as their child's language abilities are higher (van Dijk et al., 2013). However, an important limitation in these data is that they included substantially more girls than boys and on average older boys than girls, and thus these gender differences should be interpreted with caution. Additionally, we found no significant gender differences in terms of emotion language production from children, and that mothers provided emotion language more frequently to their sons than daughters. This appears in contrast to prior literature suggesting that girls tend to outperform boys in early emotion understanding and perception tasks (e.g., Brown & Dunn, 1996; Denham et al., 2015; Ontai & Thompson, 2002), and a recent meta-analysis identifying minimal differences in parenting of sons versus daughters (Endendijk, Groeneveld, Bakermans-Kranenburg, & Mesman, 2016). We posit that perhaps girls have improved language abilities (as indicated by higher MLU) and thus do not need as much emotion language input as their male counterparts in order to achieve the same level of emotion language production

themselves. However, we acknowledge that this is speculative, and future research would be necessary to explore this possibility.

The results from the present study provide key information that can inform theories of emotional development. In line with the Theory of Constructed Emotion (Barrett, 2017), our results suggest that mother's production of emotion words significantly predicts children's production of emotion words, which suggests that more frequently hearing emotion words may aid children in learning to talk about and construct emotion concepts. Importantly, the present results also provide key descriptive information regarding what emotion words young children commonly hear and produce, how this changes across development, and what linguistic factors do and do not predict children's emotion language production. This information may provide a crucial base for future research wishing to test which existing theory better explains children's emotion concept development. By more clearly characterizing children's early emotion language environments, the present study opens the door for future research to assess how children's early language environments may or may not influence their developing understanding of emotions.

Altogether, the present study moves the field of emotional development forward by clarifying the nature of children's early emotion language environment, how this changes across development, and what factors influence children's emotion language production. Learning to understand emotions represents a challenging problem, as children must integrate information across a variety of domains. Therefore, identifying what emotion language children are actually exposed to on a daily basis as they are developing these categories is a crucial first step to understanding how these categories are formed. Some previous work has begun to investigate children's early emotion language environments (Frank, Braginsky, Yurovsky, & Marchman, 2017; Ridgeway, Waters, and Kuczaj, 1985; Wellman, Harris, Banerjee, & Sinclair, 1995), but

the present study extends these findings to a large, naturalistic sample of children's actual emotion language production. Thus, these findings will provide a crucial base from which future research can examine more fine-grained questions regarding early emotion language development.

In conclusion, results from the present study provide valuable insight into the natural emotion language environment of young children. Knowing more about children's daily emotion language environments is beneficial for understanding how children come to develop emotion concepts, and what linguistic information may be at their disposal as they are in the early stages of learning such concepts. Ultimately, the information from the present study may be particularly useful when considering theories (e.g., Barrett, 2017) that suggest an important role of emotion language in the development of early emotion understanding.

Study 3

Understanding emotional information in the people around us is a crucial social skill. By making inferences about how others may be feeling, individuals can predict likely behaviors for others (e.g., Olson, Astington, & Harris, 1988) and adjust their behavior accordingly. Ultimately, this is beneficial for having successful social interactions (Izard et al., 2001). In line with this notion, research has shown that young children's ability to understand others' emotions relates to their peer acceptance (Cassidy, Parke, Butkovsky, & Braungart, 1992), likability among peers (Fabes, Eisenberg, Hanish, & Spinrad, 2001), and even academic success (Denham et al., 2012; Voltmer & Von Salisch, 2017). However, despite the importance of early development of this skill, learning to understand others' emotions is very complex. It involves integrating information across another person's facial expression, vocal tone, and body posture. Children

must also learn to incorporate information about the scenario, as well as their knowledge about this particular individual and how they have responded to emotional situations in the past. Considering the importance of early emotion understanding and its inherent complexity, it is important to understand what mechanisms may account for children's ability to learn about emotions from young ages. The present manuscript will focus on one potential mechanism, language, and how it may influence 3-year-olds' ability to learn about emotions.

Although understanding emotions is complex, children begin to perceive emotional information from young ages. Further, by the time children are only 3 years of age their emotion understanding already predicts their understanding of emotions at age 6 (Brown & Dunn, 1996), and similarly children's emotion understanding at age 7 predicts emotion understanding years later (Pons & Harris, 2005). Previous research has also shown that there are substantial individual differences in early emotion understanding (Denham, 1986; Pons & Harris, 2019). Given how early children begin to understand emotions, how predictive early emotion understanding is for later emotion understanding, and how stark individual differences are, it is important to investigate what factors may account for this substantial variability early in life.

Recent theoretical work suggests that language may be a key mechanism behind young children's ability to learn about emotions (Barrett, 2017). This is thought to be the case because language has been shown to aid category learning in other domains, as words may serve as "invitations to form categories" (Brown, 1958) by highlighting commonalities among category members. Prior research has shown that infants are capable of forming categories if category members are labeled, but not when another auditory stimulus (e.g., a tone) is paired with category members (Fulkerson & Waxman, 2007). Such evidence suggests that language may be crucially linked to human cognition and conceptual development (Ferguson & Waxman, 2016;

Perszyk & Waxman, 2018). In particular, language may aid children in learning abstract concepts, such as relational concepts (Loewenstein & Gentner, 2005). Emotions are also abstract concepts, as the same emotion can be displayed in a variety of ways (e.g., people may or may not scowl when angry; Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019). Thus, children are tasked with integrating information from multiple sources, and linking multiple diverse displays under the same emotion category and label (Lindquist & Gendron, 2013). If children learn emotions in the same way that they learn other abstract categories, language may help them to identify where to draw boundaries between different categories of emotion (Hoemann, Xu, & Barrett, 2019). Thus, theory suggests that language may facilitate emotion category learning in the same way that it does for other forms of abstract category learning.

Some evidence exists to support this theoretical position. Research with adults shows that reduced access to emotion words via semantic satiation, semantic dementia, or lack of emotion words in the task results in disrupted processing of emotional faces (Gendron, Lindquist, Barsalou, & Barrett, 2012; Lindquist, Gendron, Barrett, & Dickerson, 2014; Nook, Lindquist, & Zaki, 2015). Further research suggests a relation between emotion understanding and language in childhood. For example, emotion understanding is correlated with child language abilities at 4 years of age (Cutting & Dunn, 1999), and language contributed more unique variance to child emotion understanding than child age, family background or false belief understanding. Emotion understanding and receptive language are also correlated among a broader age range of children, from 4 to 11 years (Pons, Lawson, Harris, & De Rosnay, 2003). Thus, emotion understanding and language appear to be related in both adults and children.

Although the link between language and emotion understanding has become increasingly clear, previous research with children cannot address causality in these relations. That is,

previous research examining child emotion understanding and language has been correlational. Therefore, it is unclear whether the development of emotion understanding is influenced by language, whether language development is influenced by emotion understanding, whether the relation is bidirectional with both emotion understanding and language influencing one another over time, or whether some third variable accounts for change in both. Although theoretical work (e.g., Barrett, 2017) suggests that emotion words should causally facilitate the early development of emotion concepts, evidence to support this claim is currently limited. To address this, experimental work is necessary assessing whether changes in emotion language input lead to changes in young children's emotion understanding.

The Present Study

Across two experiments, we examined whether the presence of emotion words helps children to learn about emotions. To address this, we assessed the performance of 3-year-old children in an emotion understanding task using a pre-test post-test design. Specifically, at pre-test children heard brief vignettes in which a character experienced a complex emotion (annoyance, disgust, or nervousness) and were asked to select the face from an array that best matched how the character in the story would feel. Then, children observed learning trials where they heard the experimenter provide a vignette and label the character's emotional reaction using either an explicit emotion label or irrelevant information (Experiment 1), or a vague emotional label versus irrelevant information (Experiment 2). Then, children completed post-test trials which mirrored the pre-test trials but with new scenarios. We investigated whether changes in children's performance differed by labeling condition. We hypothesized that children would perform better in the explicit emotion label condition than the irrelevant condition, but that the vague label condition would not differ from the irrelevant condition, as theory suggests that

emotion words may be key for helping children to learn about abstract emotion categories (Barrett, 2017).

Experiment 1

To investigate whether explicit emotion labels may causally influence children's ability to learn about new emotion categories, we assessed whether presenting children with explicit emotion labels (vs irrelevant information) would impact knowledge of emotion categories in a pre-test post-test design.

Method

Participants

Thirty-six participants (25 female) ranging from 3.02 to 3.88 years of age (M_{age}=3.53 years, SD_{age}=0.22 years) participated in this study. Three additional children were excluded due to experimenter error (N=2) or failure to complete all trials (N=1). Participants were recruited from lists of birth records provided by Los Angeles County, and using the Children Helping Science website. Thus, participants were located across the United States. The ethnic/racial breakdown of participants was as follows: White (N=25), Multiracial (N=7), Asian (N=2), African-American (N=1), Chose not to respond (N=1). Parents provided informed consent prior to data collection, and received a $5 Amazon gift card for participating.

Materials

Stimuli for the present experiment included brief vignettes, neutral images related to the vignettes, and images of women depicting facial expressions. 24 vignettes were constructed to convey annoyed, disgusted, and nervous scenarios (8 vignettes per emotion; Appendix A). Each vignette involved a female character engaged in a brief scenario. Annoyed vignettes all involved characters experiencing something irritating occurring repeatedly. Disgust vignettes all involved

characters experiencing something gross or unpleasant. Nervous vignettes all involved characters experiencing something nerve wracking or uncertain. All vignettes involved distinct scenarios, but clearly adhered to these criteria. Additionally, a neutral image was included with each vignette. These images were provided as visual cues to help children remember the information from the vignette without providing clues to the emotion (e.g., For a vignette about a girl joining a new soccer team, the neutral image depicted a soccer ball in front of a goal). These neutral images were always depicted with their associated vignette.

To create the facial expression stimuli, 11 undergraduate women were recruited. Each undergraduate was recorded from the shoulders up as she stood in front of a solid white background. Undergraduates were asked to think about a time when they felt a target emotion (anger, annoyance, disgust, fear, happiness, nervousness, and sadness) and to convey this through her facial expression. The camera recorded these expressions, and the peak intensity of each emotional expression was extracted from these recordings. Images were edited such that the faces were all centered and approximately the same size.

Stimulus Validation

A Qualtrics survey was conducted to determine whether adults perceived the faces described above to belong to the intended emotional categories. Twenty-six adults (3 male) completed the survey. Each adult viewed 77 images (11 women, 7 emotions per woman) and were asked which emotion (afraid, angry, annoyed, disgusted, happy, nervous, or sad) best described each image. Adults were also asked to rate how confident they were for each response (Likert scale 1-5 from “not at all confident” to “very confident”). Based on these responses, the 9 women who had the highest agreement regarding their expression of the emotions were selected. On average for these images, the adult raters agreed on the intended emotion 84.1% of the time

with average confidence ratings of 3.8. Agreement ratings by emotion were as follows: Afraid=82.1%, Angry=82.1%, Annoyed=77.7%, Disgusted=94.6%, Happy=95.3%, Nervous=53.1%, Sad=93.6%. Considering that each emotion had a 1 in 7 (14.3%) chance of being selected for any given image, these ratings are all notably above chance levels. Confidence ratings by emotion were as follows: Afraid=3.4, Angry=3.8, Annoyed=3.9, Disgusted=4.0, Happy=4.2, Nervous=3.3, Sad=4.0. No single selected image was agreed upon by adults less than 50% of the time. Thus, we determined that the selected images were viewed by adults as appropriate representations of the seven intended emotion categories.

Procedure

A live-action pre-test post-test assessment of emotion category learning was administered online via a live interaction over Zoom. Participants were tested for their knowledge of three emotion categories which are typically challenging for children to recognize in this age range: Annoyed, Disgusted, and Nervous. Previously, parents have reported that their 3-year-old children were unlikely to use these emotion words (Ridgeway, Waters, & Kuczaj, 1985), as the percentages of children this age who produced these words were as follows: Annoyed: 23.3%, Disgusted: 18.4%, Nervous: 8.9%.

During the pre-test, the experimenter shared their screen over Zoom and the children heard 9 brief stories. For example, “Brittany went to the store with her mom. Outside, they walked past a big garbage can. The garbage was very stinky. Brittany did not like it.” The experimenter told the child each story in a neutral tone of voice without displaying any clear emotion through their facial expression. While the story was presented, the neutral image aligned with that story was presented in the center of the screen to remind the child of the story events. In the case of the story above, the neutral image was of a garbage can. After completion of the

story, the experimenter presented 4 emotional faces- one in each corner of the screen, with the neutral image still present in the center. The experimenter then asked "Which picture shows how Brittany feels?", and children were tasked with pointing to their choice on the screen. One of the pictures was the correct response (in this case, disgust), one was always a happy expression (in case children were not paying close attention and simply wanted the most positive image), and the other two pictures represented familiar, but incorrect response (e.g., sad and angry). Anger, sadness, and fear are typically known by 3-year-old children (Denham, 1986), and thus these negative emotions represented the potential familiar but incorrect choices. Children participated in nine pre-test trials (three for each target emotion), and their choices for each trial were recorded.

After the pre-test trials, children were randomly assigned to one of two learning trial conditions. Both conditions involved six total learning trials, with each target emotion represented twice. For children in the Explicit Label condition, they heard a new scenario, similar to the one described above, followed by an explicit label for the emotion (e.g., "Sally feels *disgusted*") while a picture of the appropriate emotional face was displayed. The experimenter then asked the child to point to the girl who felt that particular emotion label, and then asked the child to repeat the label. In the Irrelevant condition, children heard information that was irrelevant to the character's emotion after the story (e.g., "Sally *sits down*") while also viewing the emotional face and being asked to point to it and repeat what occurred.

Asking the child to point to the face and repeat what they had heard served the dual purposes of ensuring that children were paying attention and providing them with additional opportunities to learn the information. The Irrelevant condition served as a control to determine whether simply having additional exposure to emotional faces and scenarios without emotion

labeling boosted children's performance at post-test. In both learning trial conditions, the information paired with the categories of emotional faces was consistent (e.g., disgusted faces were always paired with either "Sally *feels disgusted* or *sits down*"). All six learning trials were presented in succession, in a randomized order for each participant.

Immediately following the learning trials, children participated in nine post-test trials. These trials mirrored the pre-test trials using different scenarios. The specific scenarios that were presented at pre-test vs post-test was randomized for each child. Each emotion category was included in three post-test trials. In all conditions, children's responses to the nine post-test trials were recorded.

Results

Descriptive Statistics

To be included in the present analyses, children had to provide a response for all 9 pre-test trials and all 9 post-test trials. As each trial presented children with 4 faces to choose from, we expected that by chance children would make 2.25 correct responses. Results revealed that on average (across both conditions) children made 2.69 correct choices at pre-test (SD=1.21). Because average pre-test trials were approximately at chance levels, we inferred that pairing annoyed, disgusted, and nervous scenarios with faces was challenging for children at this age. This aligns with previous research which suggests that 3-year-old children do not use these emotion words very often (Ridgeway, Waters, & Kuczaj, 1985). This was also precisely what we had intended, as we hoped to assess whether the presence of labels would change children's understanding of these scenarios and expressions given that they were initially challenging for 3-year-olds.

Statistical Analyses

To determine whether the language presented during the learning trials influenced children's ability to learn the relation between annoyed, disgusted, and nervous scenarios and faces, we compared children's performance across the two labeling conditions (Explicit Label and Irrelevant). Specifically, we conducted an independent samples t-test comparing the change scores (post-test – pre-test) across the two conditions.

Effect of Language

Average change score from pre-test to post-test by condition were as follows: Explicit Label=1.00 (*SD*=1.68); Irrelevant=-0.28 (*SD*=1.71) (See Figure 7). An independent samples t-test revealed that the change in responses from pre-test to post-test did significantly differ by labeling condition ($t(34)=2.26$, $p=.030$). Thus, overall child learning from pre-test to post-test was significantly greater in the explicit label compared to the irrelevant (control) condition.

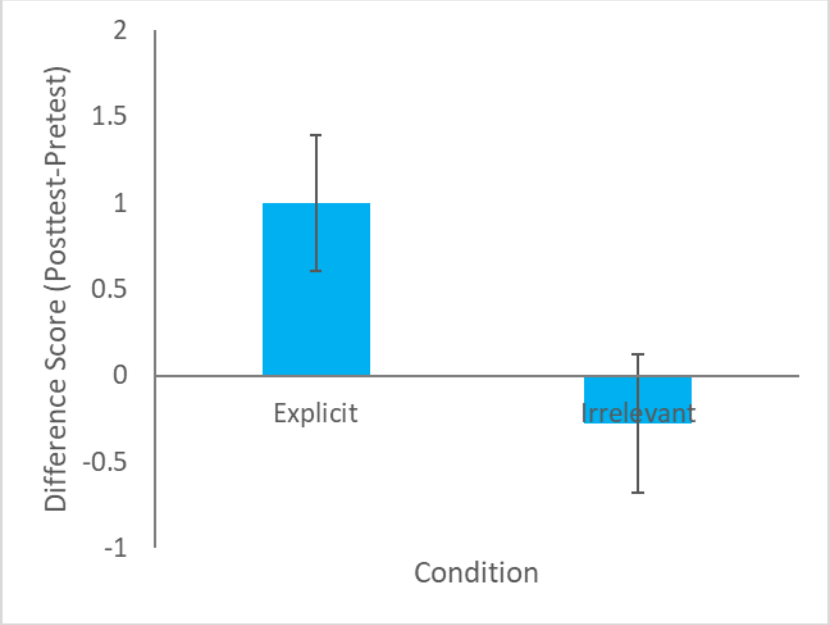

Figure 7. Change in number of correct responses from pre-test to post-test for the explicit label and irrelevant condition in Experiment 1. Error bars indicate standard error.

We further assessed whether performance in either condition was significantly different from what would be expected by chance (0 change from pre-test to post-test). One-sample t-test results revealed that the change score from pre-test to post-test was significantly different from chance in the Explicit Label condition ($t(17)=2.53$, $p=.022$), but was not different from chance in the Irrelevant condition ($t(17)=-0.69$, $p=.500$)

Follow-up Analyses

Considering the significant difference between the two conditions, we followed up with additional analyses to determine whether the effect of labeling may have been more prominent for some children than others. We first looked at gender differences. Overall, average change scores for girls ($M=0.56$, $SD=1.85$) and boys ($M=-0.09$, $SD=1.64$) did not significantly differ from one another ($t(34)=1.00$, $p=.322$). Additionally, there was no significant interaction between child gender and labeling condition for children's change scores ($F(1,32)=0.47$, $p=.693$).

We further investigated whether age might impact the influence of labeling on children's learning about complex emotions. Thus, we split the sample into children that were between 3.00-3.49 years of age (younger participants, $N=14$) and those that were between 3.50-3.99 years of age (older participants, $N=22$). Overall, average change scores for younger children ($M=0.36$, $SD=1.69$) and older children ($M=0.36$, $SD=1.89$) did not significantly differ from one another ($t(34)=0.10$, $p=.992$). Further, there was no significant interaction between child age group and labeling condition for their pre-test to post-test change scores ($F(1,32)=3.87$, $p=.058$).

Interim Discussion

The results from Experiment 1 indicate that children learned significantly more about the association between particular scenarios and facial expressions for complex emotions in the explicit label than in the irrelevant (control) condition. Further, there were no significant interactions between condition and child age or gender on performance. However, it remains possible that children simply needed any emotion-relevant information to help them learn in this task. That is, it may not have been the emotion words, specifically, that aided their performance, but rather any information indicating that emotional information should be attended to. To examine this possibility, we conducted Experiment 2.

Experiment 2

Following up on the significant findings from Experiment 1, we examined whether vague emotional information would similarly provide a benefit to children learning about emotions. To assess whether vague emotion labels may afford a similar advantage to children learning about new emotion categories, we conducted a study very similar to Experiment 1, but examining whether presenting children with vague emotion labels (vs irrelevant information) would also provide an advantage for young children learning new emotion categories.

Method

Participants

Thirty-six participants (24 female) ranging from 3.01 to 3.88 years of age (M_{age}=3.40 years, SD_{age}=0.26 years) participated in this study. Four additional children were excluded due to experimenter error (N=2) or failure to complete all trials (N=2). Participants were recruited in the same manner as Experiment 1, using lists of birth records provided by Los Angeles County, and

using the Children Helping Science website. The ethnic/racial breakdown of participants was as follows: White (*N*=20), Multiracial (*N*=14), Asian (*N*=1), African-American (*N*=1). Parents provided informed consent prior to data collection, and received a $5 Amazon gift card for participating.

Materials

The same materials were used in Experiment 2 as in Experiment 1. This included all vignettes, facial expression stimuli, and neutral images.

Procedure

The procedure for Experiment 2 was identical to Experiment 1, with the exception of the learning trial conditions. Half of the children were still randomly assigned to an irrelevant label condition, which was identical to that used in Experiment 1. However, the other half of children were presented with Vague Labels. In the Vague Label condition, during the learning trials children heard a nonspecific description of the emotion (e.g., "Sally feels *bad*"), also with a picture of the appropriate emotional face displayed as they listened to the vignette, and were asked to point to the girl and to repeat the label. All other procedures operated in the same manner as Experiment 1.

Results

Descriptive Statistics

As with Experiment 1, children had to provide a response for all 9 pre-test and post-test trials to be included in the analyses. On average (across both conditions) children made 2.58 correct choices at pre-test (*SD*=1.34). Thus, similar to Experiment 1, pre-test performance was close to chance and therefore the task was similarly challenging for children.

Statistical Analyses

An independent samples t-test was used to comparing the difference scores (post-test – pre-test) across the two conditions (Vague Label and Irrelevant).

Effect of Language

Average difference score from pre-test to post-test by condition were as follows: Vague=0.11 (*SD*=1.45); Irrelevant=-0.22 (*SD*=1.31) (See Figure 8). An independent samples t-test revealed that the change in responses from pre-test to post-test did not significantly differ by labeling condition ($t(34)=0.72$, $p=.474$). Thus, overall child learning from pre-test to post-test did not differ in the vague label compared to the irrelevant (control) condition.

As with Experiment 1, we assessed whether performance in either condition was significantly different from what would be expected by chance. One-sample t-test results revealed that the change score was not significantly different from chance in either the Vague Label condition ($t(17)=0.33$, $p=.749$) or the Irrelevant condition ($t(17)=-0.72$, $p=.481$).

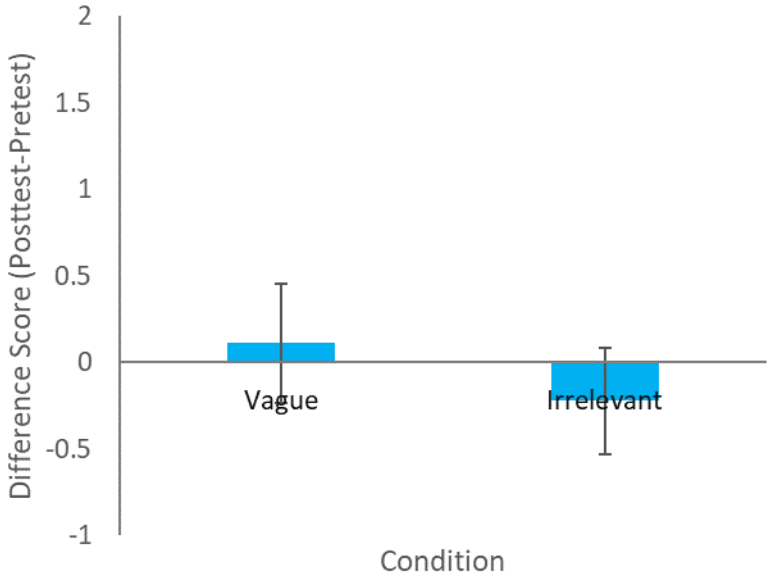

Figure 8. Change in number of correct responses from pre-test to post-test for the vague label and irrelevant condition in Experiment 2. Error bars indicate standard error.

Follow-up Analyses

To be consistent with Study 1, we followed up with additional analyses to determine whether the effect of vague versus irrelevant information may have been more prominent for some children than others. When examining gender differences, average change scores for girls (M=0.00, SD=1.18) and boys (M=-0.17, SD=1.75) did not significantly differ from one another (t(34)=0.34, p=.737). Further, there was no significant interaction between child gender and labeling condition for children's change scores (F(1,32)=0.25, p=.621). Similarly, average change scores for younger children (N=21; M=-0.24, SD=1.04) and older children (N=15; M=0.20, SD=1.74) did not significantly differ from one another (t(34)=0.94, p=.352). Further, there was no significant interaction between child age group and labeling condition for their pre-test to post-test change scores (F(1,32)=0.891, p=.352).

Interim Discussion

The results from Experiment 2 suggest that vague labels did not aid children in learning about complex emotions any more than irrelevant information, nor did they lead to children performing above chance levels. Thus, the benefit of labels for helping children learn the relation between emotional scenarios and facial expressions appears to be specific to explicit, non-vague emotion words.

Discussion

Across two experiments, the present study investigated whether emotion language would influence how 3-year-old children learned to associate facial expressions with complex

emotional scenarios. Results of Experiment 1 revealed that children in the Explicit Label condition performed significantly better than children in the Irrelevant condition. Study 2 followed up by identifying that children in the Vague condition performed comparably to the Irrelevant condition. Additionally, there was no significant effect of child age or gender on performance, and neither age nor gender significantly interacted with the labeling condition.

As hypothesized, we observed that children learned the association between complex emotional scenarios and facial expressions better when hearing an explicit emotional label than when given irrelevant information. However, this advantage did not extend to vague emotional information. It is important to note that in all conditions, children were always provided with consistent information across emotion types during the learning trials. That is, across both experiments all children hearing a "disgusted" learning trial scenario either heard that the character "feels disgusted", "feels bad", or "sits down". Thus, if children only needed consistent linguistic information to learn which face is associated with which type of scenario, they should have learned equally well across all three conditions. However, our findings suggest that consistent linguistic information was not enough in isolation to facilitate learning. Children performed significantly better when provided with explicit emotional labels than irrelevant information, and only the explicit label condition led to learning at above-chance rates from pre- to post-test. This suggests that *emotion words*, specifically, may play an important role in 3-year-olds' ability to learn about complex emotion categories, and that even vague emotion information (e.g., "she doesn't feel good") is not as informative for young children.

These findings hold important implications for theoretical work as well as interventions. These results support theoretical work that highlights the importance of language for children's developing understanding of emotions (e.g., Barrett, 2017; Lindquist, MacCormack, & Shablack,

2015). Specifically, by expanding beyond correlational research, this experimental design indicates that language (and more specifically emotion words) may play a causal role in children's ability to learn about emotions. With our experimental manipulation we were able to demonstrate that, even in a short task with only 6 learning trials, children were more successful at learning about complex emotions when presented with emotion words. These findings may also raise further questions for perspectives that language is simply a communication device for labeling emotions, but is not crucial for an understanding of emotions (e.g., Ekman & Cordaro, 2011), or that perception of emotion is very similar cross-culturally (e.g., Ekman, 1999), as our results suggest that language may in fact be important for emotion understanding and therefore that linguistic differences across cultures may lead to differences in emotion perception cross-culturally (Gendron, Roberson, van der Vyver, & Barrett, 2014). Further, we propose that these findings have important implications for interventions. Prior work has shown that emotion understanding interventions are promising (Sprung, Münch, Harris, Ebesutani, & Hofmann, 2015), but that there are many different approaches to such interventions. Our results suggest that perhaps targeting those around the child (e.g., parents) and increasing their use of specific emotion words may help improve children's developing understanding of emotion, as has been shown to be effective with preschool teachers (Grazzani & Ornaghi, 2011; Grazzani, Ornaghi, Agliati, & Brazzelli, 2016).

Interestingly, in both experiments we did not observe any significant interactions between children's learning in the task and either the child's gender or age. Some previous research has suggested that boys and girls differ in their understanding of emotion, typically with girls showing an advantage over boys (e.g., Denham et al., 2015; Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Ontai & Thompson, 2002). However, other studies have demonstrated no

significant differences in children's emotion understanding by gender (Dunn, Brown, & Beardsall, 1991; Grazzani, Ornaghi, Agliati, & Brazzelli, 2016). Our results align with those finding no gender differences, as we both observed no significant differences between boys and girls in their overall learning of emotions from pre-test to post-test, nor did we find any interaction between child gender and labeling condition in predicting learning about emotions. Thus, our results suggest that both boys and girls may see a similar benefit from hearing specific emotion words when learning about new emotions.

We also did not observe any significant differences between younger and older 3-year-olds in their learning from pre-test to post-test, nor was there any interaction between child age and language when predicting learning about emotions. It is important to note that our age range was relatively narrow (only 3-year-olds), and thus it is possible that an effect of age may be observed among a wider age group. These results also indicate that the impact of specific emotion labels on children's learning about emotions held across both younger and older 3-year-olds, which aligns with previous work suggesting that labels are helpful for the simpler task of categorizing emotional facial expressions across a wide age range in early childhood (Russell & Widen, 2002). Thus, the present findings indicate that emotion labels may be helpful for children's learning about new emotions regardless of gender or whether the child is a younger or older 3-year-old.

Although these results provide important information about how emotion labels may help children to link complex emotional events to facial expressions, there are still important questions that remain. Our study assessed children's knowledge of annoyed, disgusted, and nervous scenarios, as these emotions are typically challenging for 3-year-olds to understand. However, it is unclear whether these results would extend to additional complex emotions (e.g.,

disappointed or embarrassed). Further, it will be important for future research to investigate whether these results extend to older or younger age groups, which have more or less experience with emotions and language, respectively. Such research could help to identify whether there is a particular age window when language is particularly beneficial for helping children to link emotional scenarios and facial expressions, or whether particular emotions see a greater labeling advantage. Finally, these results were specific to faces and scenarios, but emotions are fundamentally complex and involve many other components (e.g., vocal tone, body posture). Future research may wish to examine whether emotion words are similarly beneficial for helping children to link other components of emotions together.

To conclude, across two experiments our results revealed that explicit emotion labels, but not vague emotional information, provided an advantage over irrelevant information for children learning about complex emotions. That is, children's learning about emotions significantly improved from pre-test to post-test when they were given explicit emotion labels, but not vague emotion information or irrelevant information. These results suggest that labels may causally influence children's learning about complex emotions from a young age, helping them to identify links between facial expressions and scenarios.

General Discussion

The goal of the present dissertation was to assess the role of language in the early development of emotion understanding. This was investigated using an eye tracking study of emotion categorization in infancy (Study 1), a corpus analysis of naturalistic parent-child interaction transcripts (Study 2), and a live action assessment of emotion category learning in early childhood (Study 3). Although the studies differed in the specific target age group and

methodology, the results converged on the conclusion that language likely does play a mechanistic role in early emotion understanding development.

Study 1 aimed to clarify the role of language in early emotion understanding development by presenting infants with an emotion categorization task that was completely devoid of language, and separately measuring infant language abilities. Participants were 50 15- to 18-month-old infants. Parents reported their infant's productive vocabulary, and infants participated in an entirely non-linguistic emotion categorization task via an eye tracker. Results revealed that overall infant vocabulary did not significantly predict nonverbal emotion categorization when accounting for infant age, gender and general object perception ability. However, a gender difference was observed: Girls' vocabulary scores related to nonverbal emotion categorization when controlling for age and general categorization ability, but not boys' vocabulary scores. Further, boys showed a stronger preference for the novel emotion category vs. girls. These data suggest that pathways of processing emotional information (e.g., using language vs visual information) may differ for girls and boys in late infancy.

In Study 2, I examined what natural emotion conversation occurs between mothers and their young children in order to better understand how young children learn to talk about and understand emotions. This study examined nearly 2,000 transcripts from 181 children ranging from 15- to 47-months of age from the Child Language Data Exchange System (CHILDES) database. Results provided key descriptive, developmental, and predictive information regarding child emotion language production, including the finding that child emotion word production was predicted by mothers' emotion word production but not by child or mother general language complexity. The frequencies of specific emotion words were also presented, as were

developmental trends in early emotion language production and input. These results help to improve our understanding of children's daily emotion language environments.

Study 3 sought to identify whether emotion words *causally* influence children's learning about new emotions, as words do for learning about other categories. Across two experiments, 72 3-year-old children took part in a pre-test post-test design, assessing whether they associated particular stereotypical facial expressions with complex emotional scenarios (annoyed, disgusted, nervous). Between pre-test and post-test, children saw one face paired with the appropriate story while they heard the emotion labeled explicitly or heard irrelevant information (Experiment 1) or heard a vague emotion label versus irrelevant information (Experiment 2). Results revealed that children improved in their understanding of the emotions more in the explicit label versus irrelevant condition, but the vague emotion labels did not provide an advantage over irrelevant information. Ultimately, these results suggest that explicit emotion labels may be particularly helpful for young children learning about new, complex emotions.

Taken together, the results of these three studies suggest an important role of language in the early development of emotion understanding. This is particularly notable considering the diverse array of methodologies included in the present studies. Although the strength of the findings varied across the three studies, evidence was found supporting a relation between language and emotion understanding across an eye tracking emotion categorization task, transcript analysis, and a live-action assessment of emotion category learning. This is important as it suggests the robustness of this effect and the broad significance of the role of language on emotion understanding development. This is also important because the development of emotion understanding is often measured in a variety of ways. Within the infant emotional development literature, researchers investigate what infants understand and perceive in emotional expressions

using discrimination, event-related potential (ERP), categorization, intermodal matching, and social referencing tasks (Ruba & Repacholi, 2019). Among slightly older age groups, researchers have used looking-time, ERP, behavioral-response, and verbal-response tasks to assess how children reason about emotions (Ruba & Pollak, 2020). Thus, there are many different ways that emotion understanding can be measured at various developmental stages, each taking into account different developmental processes, including motor skills, perceptual skills, attention, and memory (Ruba & Pollak, 2020). Therefore, the present results indicating a key relation between language and emotion understanding across a variety of methodologies indicates an important step toward understanding how important the influence of language may be. It will be important for future research to continue investigating this relation using a wide range of tasks to more comprehensively understand the influence of language across multiple methodologies, developmental processes and skills, and ages.

Another important factor to consider when interpreting the results of these three studies is the role of age. Participants in the present studies were children ranging from 15- to 47-months of age, with Study 1 focused on the youngest ages (15- to 18-months), Study 2 focusing on the full age range, and Study 3 focusing on the oldest ages (36- to 47-months). In terms of supporting the hypothesis that language influences children's developing emotion understanding, Study 1 offered the weakest evidence, with a relation between the two variables found only for girls, but not boys. Study 2 found a relation between emotion language production and age, with children and mothers both including a greater proportion of emotion words in speech as children got older. Finally, Study 3 found strong evidence that the use of explicit emotion words helped 3-year-old children to learn about complex emotions. In conjunction, these results suggest that language may play some role in the development of emotion understanding beginning in infancy,

but that the role of language may increase as children get older. Across the first few years, children's language abilities increase dramatically (Frank, Braginsky, Yurovsky, & Marchman, 2017), and children's understanding of emotion continues to increase across this age range, with children younger than 3 generally having trouble interpreting more complex aspects of emotional scenarios (Ensor, Spencer, & Hughes, 2011). Thus, it is possible that language has the strongest influence on developing emotion understanding when children already have an existing foundation of knowledge in these two areas. Future research may wish to directly examine whether the relation between vocabulary and emotion understanding changes as children get older using the same emotion understanding task across a wide developmental age range.

A further important consideration is the role of emotion language specifically versus general language abilities in the development of emotion understanding. Study 1 examined overall vocabulary in late infancy and found that this related to infant emotion categorization, but only for girls. Thus, this presents some evidence that general vocabulary may be important for developing emotion understanding. However, Study 2 found that when examining naturalistic transcript data, only mothers' emotion language (and *not* mothers' general language complexity or child language complexity), related to children's propensity to talk about emotions. Thus, these results suggest that hearing emotion words, not just generally complex language, may be more important for children to learn and talk about emotions. Finally, Study 3 found that only the use of explicit emotion words, but not vague emotion words or irrelevant information, helped young children to learn about new emotions. This provides strong evidence that *emotion words* specifically may be the most important for children's developing understanding of emotions, with general vocabulary perhaps playing a smaller or more supplementary role. However, it is important to note that this is in contrast to previous research among 6- to 25-year-olds, which has

found that only general verbal knowledge and *not* emotion vocabulary nor fluid reasoning skill mediated the relation between age and a more mature conceptualization of emotions (Nook, Sasse, Lambert, McLaughlin, & Somerville, 2017). It is possible that this apparent contrast may be driven by a need for children to first develop a foundation of emotion knowledge, including relevant emotion vocabulary terms, at a young age. Once emotion vocabulary has aided children in building this foundation, they may then be able to use more general vocabulary terms to help them learn about various new aspects of emotions that they encounter. In this way, emotion vocabulary may be particularly important among young age groups, with general vocabulary supplementing children's learning about emotions across development. This hypothesis remains to be tested in future research. Longitudinal research following the same children across early development and assessing their general vocabulary, emotion vocabulary, and emotion understanding at various time points may prove particularly helpful for further elucidating the role of emotion language versus general language in this development.

The results of these studies are highly beneficial to the field because they inform existing theories of emotional development. Across three studies using a diverse array of methodologies and age ranges, we found support for the idea that linguistic experiences are important for emotional development, as posited by the Theory of Constructed Emotion (Barrett, 2017). These findings are in contrast to Basic Emotions Theory, which suggests that language should not be fundamental to emotion understanding development (Ekman, 1992). Although the strength of the findings vary by study and suggest that language may be more predictive of emotion understanding under certain circumstances (e.g., Stronger evidence found for the importance of language in Study 3 than in Study 1), the studies converge on the conclusion that language matters for early emotion understanding development. Ultimately, these results are informative

for furthering our knowledge of emotion understanding development, and may be beneficial for moving the field forward toward better identifying early mechanisms behind this development.

These findings also hold implications for policy and interventions. These findings may be beneficial for creating effective early emotion understanding interventions for children who struggle to interpret emotional information at a young age. Previous studies have shown that increasing the active use of emotional terms in preschool classrooms results in increases in emotion understanding for 3- to 5-year-old children (Grazzani & Ornaghi, 2011; Grazzani, Ornaghi, Agliati, & Brazzelli, 2016). Additionally, a recent meta-analysis has shown that emotion understanding interventions in childhood appear effective and promising (Sprung, Münch, Harris, Ebesutani, & Hofmann, 2015). However, these interventions vary dramatically in their specific approach to improving early childhood emotion understanding, including perspectives that target parental emotion regulation (Hajal & Paley, 2020) and motivational states and behaviors (Hajal, Teti, Cole, & Ram, 2019). The results of the present studies suggest that emotion understanding interventions which incorporate more emotion language may be particularly beneficial, aligning with prior studies examining parent and child conversations about past emotional events (Fivush & Kuebli, 2018). Indeed, the results of Study 2 suggest that increasing emotion language among primary caregivers, specifically, may be an important area of focus. Additionally, these results suggest that such interventions among children under the age of 4 may be warranted, as language appears to already play a role in emotion understanding development among this young age group. Altogether, these results may aid in identifying how to best help children who are lagging behind their peers in emotion understanding at young ages.

Conclusion

In summary, the three studies included in this dissertation explored the relation between emotion understanding and language during the first four years after birth. These results provide valuable insight into language as a potential mechanism behind the development of emotion understanding, and thereby present additional support for the Theory of Constructed Emotion (Barrett, 2017) reflecting how this crucial early social skill develops. Ultimately, these results are highly informative for our growing understanding of emotional development, and may lead to interventions for early emotion understanding during a crucial early developmental window.

Appendix A: List of Target Emotion Words (Study 2)

Affectionate
Afraid
Agony
Alarmed
Angry
Annoyed
Anxious
Apologetic
Appalled
Ashamed
Astonished
Astounded
Baffled
Betrayed
Bored
Bothered
Broken
Brokenhearted
Calm
Carefree
Cheated
Cheered
Cheerful
Cold
Compassionate
Concerned
Confident
Confused
Content
Crabby
Cranky
Crushed
Defeated
Defensive
Delighted
Depressed
Desire
Despair
Desperate
Disappointed
Disbelief
Discontented

Discouraged
Disgust
Disheartened
Dismayed
Dispirited
Displeased
Distress
Disturbed
Dread
Eager
Ecstatic
Embarrassed
Enjoyment
Enraged
Enthusiastic
Excited
Fear
Fed up
Fired up
Frightened
Frustrated
Furious
Glad
Gloomy
Glum
Grateful
Grief
Grouchy
Grumpy
Guilty
Happy
Hate
Heartache
Heartbroken
Heated
Helpless
Homesick
Hopeful
Hopeless
Horrified
Humiliated
Humored
Impatient

Infuriated
Insulted
Irritated
Jealous
Jolly
Joy
Jubilant
Lonely
Longing
Love
Lovesick
Mad
Merry
Miserable
Moody
Nervous
Numb
Offended
Outraged
Overjoyed
Overwhelmed
Panic
Pity
Playful
Pleased
Proud
Puzzled
Regret
Relief
Sad
Sassy
Scared
Sensitive
Shocked
Shy
Sickened
Sneaky
Spiteful
Sulky
Surprised
Tearful
Tender
Tense

Terrified
Terror
Thankful
Threatened
Thrilled
Timid
Uneasy
Unhappy
Upset
Weary
Weepy
Worried
Worthless

Appendix B: Vignettes (Study 3)

Annoyed

1. Chelsea was watching a movie. Her little sister started talking. Chelsea asked her sister to stop, but she kept talking. Chelsea couldn't hear the movie over her sister. She didn't like it.
2. Mary was playing at the playground. She was playing tag with her friends. Her shoe was a little too big. It kept falling off. She had to keep putting it back on again. It made her slow down when she wanted to run fast.
3. Olivia was playing with her toys. A fly started buzzing around her. Olivia didn't like the fly. She tried to shoo it away, but it kept buzzing near her and wouldn't stop.
4. Violet was in bed. She was trying to go to sleep. Outside, a dog was barking. Violet wanted the dog to stop barking so she could go to sleep, but the dog kept barking.
5. Zoey was playing in the house. Her baby brother started to cry. Zoey did not like the sound. She tried to cover her ears, but she could still hear her brother crying.
6. Emma was reading a book. One of the pages was falling out. She wanted the page in the book, so she put it back, but the page fell out again and again.
7. Ava was eating lunch with her brother. She told him to be careful with his milk glass, but he didn't listen even though she warned him many times. Then, he spilled his milk all over her shirt. She wished he had listened to her.
8. Sophia was playing outside with her friends. It was cold outside, but every time she ran her coat unzipped. She kept zipping it back up, but it would always unzip again.

Disgusted

1. Ally found an apple. It looked yummy, so she took a big bite. Then, she saw that there was a worm in the apple. She spit it out as fast as she could and threw the apple far away. She did not want it.
2. Brittany went to the store with her mom. Outside, they walked past a big garbage can. The garbage was very stinky. Brittany did not like it.
3. Isabelle wanted some milk. She poured some milk into a glass. When she looked in the glass, there were big, yucky chunks in it. She dumped the milk in the sink.
4. Charlotte was eating some candy outside. She dropped the candy on the ground. She picked it up and took a bite, but there was dirt all over the candy. She didn't want to eat it more candy.
5. Tammy has a baby sister. Her mom changed her baby sister's diaper. Tammy walked past and smelled her sister's stinky diaper. She wanted to leave the room.
6. Mia wanted a snack. She got some bread from the kitchen. She took a bite, then noticed some green fuzzy spots on the bread. She spit the bread out and did not eat any more.
7. Evelyn was in the car with her mom and brother. Her brother didn't feel very good, so he threw up. The whole car smelled bad, and Evelyn wanted to go outside.
8. Victoria was at her friend's birthday party. There was a swimming pool there. Victoria was about to jump in, when she noticed lots of green slime on top of the water. She didn't want to swim anymore.

Nervous

1. Lucy is going to a new school. She doesn't know anyone there. She is not sure if it will be good or bad.
2. Violet is at the swimming pool. She is going to start swimming lessons. She doesn't know if she will like it.
3. Zoey is playing soccer. She is on a new soccer team. She is worried that she won't be very good at it.
4. Brittany made a new friend. She is going over to her house tomorrow. She doesn't know if her new friend will like to play Legos like she does.
5. Ally was playing at home. She accidentally broke her mom's favorite cup. She is going to tell her mom about it, but she doesn't know what her mom will say.
6. Gabriella is going camping with her family. She will be sleeping in a tent outside. She has never done this before, and isn't sure if it will be fun or not.
7. Maddy was painting a picture in the living room. She accidentally spilled the paint and made a big mess on her mom's carpet. She tries to cover it with a rug, but thinks her mom will still find it.
8. Naomi was watching a movie with her friends. Her favorite character was in trouble, and she didn't know what was going to happen.

References

Atzil, S., Gao, W., Fradkin, I., & Barrett, L. F. (2018). Growing a social brain. *Nature Human Behaviour, 2,* 624-636. doi:10.1038/s41562-018-0384-6

Balaban, M. T., & Waxman, S. R. (1997). Do words facilitate object categorization in 9-month-old infants? *Journal of Experimental Child Psychology, 64,* 3-26. doi:10.1006/jecp.1996.2332

Baron-Cohen, S., Golan, O., Wheelwright, S., Granader, Y., & Hill, J. (2010). Emotion word comprehension from 4 to 16 years old: A developmental survey. *Frontiers in Evolutionary Neuroscience, 2,* 109. doi:10.3389/fnevo.2010.00109

Barrett, L. F. (2017). *How Emotions Are Made: The Secret Life of the Brain.* New York, NY: Houghton-Mifflin-Harcourt.

Barrett, L. F., Adolphs, R., Marsella, S., Martinez, A. M., & Pollak, S. D. (2019). Emotional expressions reconsidered: Challenges to inferring emotion from human facial movements. *Psychological Science in the Public Interest, 20*, 1-68. doi:10.1177/1529100619832930

Bergelson, E., & Swingley, D. (2012). At 6-9 months, human infants know the meanings of many common nouns. *Proceedings of the National Academy of Sciences of the USA, 109,* 3253-3258. doi:10.1073/pnas.11113380109

Bornstein, M. H., & Arterberry, M. E. (2003). Recognition, discrimination and categorization of smiling by 5-month-old infants. *Developmental Science, 6,* 585-599. doi:10.1111/1467-7687.00314

Bornstein, M. H., & Haynes, O. M. (1998). Vocabulary competence in early childhood: Measurement, latent construct, and predictive validity. *Child Development, 69,* 654-671.

doi:10.1111/j.1467-8624.1998.tb06235.x

Bretherton, I., Fritz, J., Zahn-Waxler, C., & Ridgeway, D. (1986). Learning to talk about emotions: A functionalist perspective. *Child Development, 57,* 529-548. doi:10.1111/j.1467-8624.1986.tb00225.x

Brown, J. R., & Dunn, J. (1996). Continuities in emotion understanding from three to six years. *Child Development, 67,* 789-802. doi:10.1111/j.1467-8624.1996.tb01764.x

Brown, R. (1958). *Words and things: An introduction to language.* Glencoe, IL: Free Press

Caron, R. F., Caron, A. J., & Myers, R. S. (1982). Abstraction of invariant face expressions in infancy. *Child Development, 53,* 1008-1015. doi:10.2307/1129141

Cassidy, J., Parke, R. D., Butkovsky, L., & Braungart, J. M. (1992). Family-peer connections: The roles of emotional expressiveness within the family and children's understanding of emotions. *Child Development, 63,* 603-618. doi:10.1111/j.1467-8624.1992.tb01649.x

Cook, E. T., Greenberg, M. T., & Kusche, C. A. (1994). The relations between emotional understanding, intellectual functioning and disruptive behavior problems in elementary school aged children. *Journal of Abnormal Child Psychology, 22,* 205-219. doi:10.1007/BF02167900

Crivello, C., & Poulin-Dubois, D. (2019). Infants' ability to detect emotional incongruency: Deep or shallow? *Infancy, 24,* 480-500. doi:10.1111/infa.12277

Cutting, A. L., & Dunn, J. (1999). Theory of mind, emotion understanding, language, and family background: Individual differences and interrelations. *Child Development, 70,* 853-865. doi:10.1111/1467-8624.00061

Denham, S. A. (1986). Social cognition, prosocial behavior, and emotion in preschoolers: Contextual validation. *Child Development, 57,* 194-201. doi:10.1111/j.1467-

8624.1986.tb00020.x

Denham, S. A., Bassett, H., Brown, C., Way, E., & Steed, J. (2015). "I know how you feel": Preschoolers' emotion knowledge contributes to early school success. *Journal of Early Childhood Research, 13,* 252-262. doi:10.1177/1476718X13497354

Denham, S. A., Bassett, H. H., Way, E., Mincic, M., Zinsser, K., & Graling, K. (2012). Preschoolers' emotion knowledge: Self-regulatory foundations, and predictions of early school success. *Cognition and Emotion, 26,* 667-679. doi:10.1080/02699931.2011.602049

Denham, S. A., Bassett, H. H., & Wyatt, T. (2010). Gender differences in the socialization of preschoolers' emotional competence. In R. A. Kennedy & S. A. Denham (Eds.),*The Role of Parent and Child Gender in the Socialization of Emotional Competence* (pp. 29-49). San Francisco: Jossey-Bass.

Denham, S. A., Blair, K., DeMulder, E., Levitas, J., Sawyer, K., Auerbach-Major, S., & Queenan, P. (2003). Preschool emotional competence: Pathway to social competence? *Child Development, 74,* 238-256. doi:10.1111/1467-8624.00533

Denham, S. A., Zoller, D., & Couchoud, E. A. (1994). Socialization of preschoolers' emotion understanding. *Developmental Psychology, 30,* 928–936. doi:10.1037//0012-1649.30.6.928

Dunn, J., Brown, J., & Beardsall, L. (1991). Family talk about feeling states and children's later understanding of others' emotions. *Developmental Psychology, 27,* 448-455. doi:10.1037/0012-1649.27.3.448

Dunn, J., Brown, J. R., & Maguire, M. (1995). The development of children's moral sensibility: Individual differences and emotion understanding. *Developmental Psychology, 31,* 649-

659. doi:10.1037/0012-1649.31.4.649

Dunn, J., Brown, J. R., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young children's understanding of other people's feelings and beliefs: Individual differences and their antecedents. *Child Development, 62,* 1352-1366. doi:10.1111/j.1467-8624.1991.tb01610.x

Eggum, N. D., Eisenberg, N., Kao, K., Spinrad, T. L., Bolnick, R., Hofer, C., Kupfer, A. S., & Fabricius, W. V. (2011). Emotion understanding, theory of mind, and prosocial orientation: Relations over time in early childhood. *The Journal of Positive Psychology, 6,* 4-16. doi:10.1080/17439760.2010.536776

Eisenberg, N., Sadovsky, A., & Spinrad, T. L. (2005). Associations of emotion-related regulation with language skills, emotion knowledge, and academic outcomes. *New Directions for Child and Adolescent Development, 109,* 109-118. doi:10.1002/cd.143

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6,* 169-200. doi:10.1080/02699939208411068

Ekman, P. (1999). Basic Emotions. In T. Dalgleish & M. Power (Eds.) *Handbook of Cognition and Emotion* (pp. 45-60). Sussex, U.K.: John Wiley & Sons, Ltd.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion Review, 3,* 364-370. doi:10.1177/1754073911410740

Endendijk, J. J., Groeneveld, M. G., Bakermans-Kranenburg, M. J., & Mesman, J. (2016). Gender-differentiated parenting revisited: Meta-analysis reveals very few differences in parental control of boys and girls. *PLoS One, 11,* e0159193. doi:10.1371/journal.pone.0159193

Ensor, R., Spencer, D., & Hughes, C. (2011). 'You feel sad?' Emotion understanding mediates

effects of verbal ability and mother-child mutuality on prosocial behaviors: Findings from 2 to 4 years. *Social Development, 20,* 93-110. doi:10.1111/j.1467-9507.2009.00572.x

Fabes, R. A., Eisenberg, N., Hanish, L. D., & Spinrad, T. L. (2001). Preschoolers' spontaneous emotion vocabulary: Relations to likability. *Early Education and Development, 12,* 11–27. doi:10.1207/s15566935eed1201_2

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59,* 1-173. doi:10.1111/j.1540-5834.1994.tb00173.x

Fenson, L., Marchman, V. A., Thal, D. J., Dale, P. S., Reznick, J. S., & Bates, E. (2007). *MacArthur-Bates Communicative Development Inventories: User's guide and technical manual* (2nd ed.). Baltimore, MD: Brookes.

Ferguson, B., & Waxman, S. R. (2016). Linking language and categorization in infancy. *Journal of Child Language, 44,* 527-552. doi:10.1017/S0305000916000568

Fivush, R., & Kuebli, J. (1997). *Making everyday events emotional: The construal of emotion in parent-child conversations about the past.* In N. L. Stein, P. A. Ornstein, B. Tversky, & C. A. Brainerd (Eds.), Memory for everyday and emotional events (pp. 239-266). Hillsdale, NJ: Erlbaum.

Frank, M. C., Braginsky, M., Yurovsky, D., & Marchman, V. A. (2017). Wordbank: An open repository for developmental vocabulary data. *Journal of Child Language, 44,* 677-694. doi:10.1017/S0305000916000209

Fulkerson, A. L., & Waxman, S. R. (2007). Words (but not tones) facilitate object categorization: Evidence from 6- and 12-month-olds. *Cognition, 105,* 218-228.

doi:10.1016/j.cognition.2006.09.005

Gendron, M., Lindquist, K. A., Barsalou, L., & Barrett, L. F. (2012). Emotion words shape emotion percepts. *Emotion, 12,* 314-325. doi:10.1037/a0026007

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014). Perceptions of emotion from facial expressions are not culturally universal: Evidence from a remote culture. *Emotion, 14,* 251-262. doi: 10.1037/a0036052

Grazzani, I., & Ornaghi, V. (2011). Emotional state talk and emotion understanding: A training study with preschool children. *Journal of Child Language, 38,* 1124-1139. doi:10.1017/S0305000910000772

Grazzani, I., Ornaghi, V., Agliati, A., & Brazzelli, E. (2016). How to foster toddlers' mental-state talk, emotion understanding, and prosocial behavior: A conversation-based intervention at nursery school. *Infancy, 21,* 199–227. doi:10.1111/infa.12107

Hajal, N. J., & Paley, B. (2020). Parental emotion and emotion regulation: A critical target of study for research and intervention to promote child emotion socialization. *Developmental Psychology, 56,* 403-417. doi:10.1037/dev0000864

Hajal, N. J., Teti, D. M., Cole, P. M., & Ram, N. (2019). Maternal emotion, motivation, and regulation during real-world parenting challenges. *Journal of Family Psychology, 33,* 109-120. doi:10.1037/fam0000475

Hepach, R., & Westermann, G. (2013). Infants' sensitivity to the congruence of others' emotions and actions. *Journal of Experimental Child Psychology, 115,* 16-29. doi:10.1016/j.jecp.2012.12.013

Hesse, P., & Cicchetti, D. (1982). Perspectives on an integrative theory of emotional development. In D. Cicchetti & P. Hesse (Eds.), *Emotional Development* (pp. 33-48). San

Francisco: Jossey-Bass.

Hoemann, K., Gendron, M., & Barrett, L. F. (2017). Mixed emotions in the predictive brain. *Current Opinions in Behavioral Sciences, 15*, 51-57. doi:10.1016/j.cobeha.2017.05.013

Hoemann, K., Xu, F., & Barrett, L. F. (2019). Emotion words, emotion concepts, and emotional development in children: A constructionist hypothesis. *Developmental Psychology, 55,* 1830-1849. doi:10.1037/dev0000686

Hoff, E. (2013). *Language Development.* Belmont, CA: Wadsworth/Thomson Learning.

Hunter, M. A., & Ames, E. W. (1988). A multifactor model of infant preferences for novel and familiar stimuli. In L. P. Lipsitt (Ed.), *Advances in child development and behavior* (pp. 69–95). New York: Academic.

Hurley, K. B., & Oakes, L. M. (2015). Experience and distribution of attention: Pet exposure and infants' scanning of animal images. *Journal of Cognition and Development, 16,* 11-30. doi:10.1080/15248372.2013.833922

Huttenlocher, J. (1998). Language input and language growth. *Preventive Medicine, 27,* 195-199. doi:10.1006/pmed.1998.0301

Izard, C. E., Fine, S., Schultz, D., Mostow, A. J., Ackerman, B., & Youngstrom, E. (2001). Emotion knowledge as a predictor of social behavior and academic competence in children at risk. *Psychological Science, 12,* 18-23. doi:10.1111/1467-9280.00304

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental perspective. *Developmental Psychology, 25,* 343-354. doi:10.1037/0012-1649.25.3.343

Kowalski, K., & Zimiles, H. (2006). The relation between children's conceptual functioning with color and color term acquisition. *Journal of Experimental Child Psychology, 94,* 301-321. doi:10.1016/j.jecp.2005.12.001

Kuebli, J., Butler, S., & Fivush, R. (1995). Mother-child talk about past emotions: Relations of maternal language and child gender over time. *Cognition and Emotion, 9,* 265-283. doi:10.1080/02699939508409011

LaBabera, J. D., Izard, C. E., Vietze, P., & Parisi, S. A. (1976). Four- and six-month-old infants' visual responses to joy, anger, and neutral expressions. *Child Development, 47,* 533-538. doi:10.2307/1128816

Lane, J. D., Wellman, H. M., Olson, S. L., LaBounty, J., & Kerr, D. C. R. (2010). Theory of mind and emotion understanding predict moral development in early childhood. *British Journal of Developmental Psychology, 28,* 871-889. doi:10.1348/026151009X483056

LaTourrette, A., & Waxman, S. (2019). A little labeling goes a long way: Semi-supervised learning in infancy. *Developmental Science, 22*. doi:10.1111/desc.12736

Lindquist, K. A., & Gendron, M. (2013). What's in a word? Language constructs emotion perception. *Emotion Review, 5,* 66-71. doi:10.1177/1754073912451351

Lindquist, K. A., Gendron, M., Barrett, L. F., & Dickerson, B. C. (2014). Emotion perception, but not affect perception, is impaired with semantic memory loss. *Emotion, 14,* 375-387. doi:10.1037/a0035293

Lindquist, K. A., MacCormack, J. K., & Shablack, H. (2015). The role of language in emotion: Predictions from psychological constructionism. *Frontiers in Psychology, 6,* Article 444. doi:10.3389/fpsyg.2015.0044

Loewenstein, J., & Gentner, J. (2005). Relational language and the development of relational mapping. *Cognitive Psychology, 50,* 315-353. doi:10.1016/j.cogpsych.2004.09.004

MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk. Third Edition.* Mahwah, NJ: Lawrence Erlbaum Associates.

Nook, E. C., Lindquist, K. A., & Zaki, J. (2015). A new look at emotion perception: Concepts speed and shape facial emotion recognition. *Emotion, 15,* 569-578. doi:10.1037/a0039166

Nook, E. C., Sasse, S. F., Lambert, H. K., McLaughlin, K. A., & Somerville, L. H. (2017). Increasing verbal knowledge mediates development of multidimensional emotion representations. *Nature Human Behaviour, 1,* 881-889. doi:10.1038/s41562-017-0238-7

Ogren, M., & Johnson, S. P. (2020). Intermodal emotion matching at 15 months, but not 9 or 21 months, predicts early childhood emotion understanding: A longitudinal investigation. *Cognition and Emotion,* 1-14. doi:10.1080/02699931.2020.1743236

Ogren, M., & Johnson, S. P. (submitted). Nonverbal emotion perception and vocabulary in late infancy.

Ogren, M., & Sandhofer, C. M. (submitted$_a$). Emotion words in early childhood: A language transcript analysis.

Ogren, M., & Sandhofer, C. M. (submitted$_b$). Emotion words link faces to complex emotional scenarios in early childhood.

Olson, D. R., Astington, J. W., & Harris, P. L. (1988). Introduction. In J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (pp. 1-8). Cambridge, England. Cambridge University Press.

Ontai, L. L., & Thompson, R. A. (2002). Patterns of attachment and maternal discourse effects on children's emotion understanding from 3 to 5 years of age. *Social Development, 11,* 433-450. doi:10.1111/1467-9507.00209

Palama, A., Malsert, J., & Gentaz, E. (2018). Are 6-month-old human infants able to transfer emotional information (happy or angry) from voices to faces? An eye-tracking study.

PLOS One, 13(4), e0194579. doi:10.1371/journal.pone.0194579

Perszyk, D. R., & Waxman, S. R. (2018). Linking language and cognition in infancy. *Annual Review of Psychology, 69,* 231-250. doi:10.1146/annurev-psych-122216-011701

Pons, F., & Harris, P. L. (2005). Longitudinal change and longitudinal stability of individual differences in children's emotion understanding. *Cognition and Emotion, 19,* 1158-1174. doi:10.1080/02699930500282108

Pons, F., & Harris, P. L. (2019). Children's understanding of emotions or Pascal's "Error": Review and prospects. In LoBue, V., Perez-Edgar, K., & Buss, K. A. (Eds.), *Handbook of emotional development* (pp. 431-450). New York, NY, US: Springer Nature.

Pons, F., Lawson, J., Harris, P. L., & De Rosnay, M. (2003). Individual differences in children's emotion understanding: Effects of age and language. *Scandinavian Journal of Psychology, 44,* 347-353. doi:10.1111/1467-9450.00354

Quinn, P. C., Yahr, J., Kuhn, A., Slater, A. M., & Pascalis, O. (2002). Representation of the gender of human faces by infants: A preference for female. *Perception, 31,* 1109-1121. doi:10.1068/p3331

Rakison, D. H., & Oakes, L. M. (Eds.). (2003). *Early category and concept development: Making sense of the blooming buzzing confusion.* New York: Oxford University Press.

Reschke, P. J., Walle, E. A., & Dukes, D. (2017). Interpersonal development in infancy: The interconnectedness of emotion understanding and social cognition. *Child Development Perspectives, 11,* 178-183. doi:10.1111/cdep.12230

Richmond, L. L., & Zacks, J. M. (2017). Constructing experience: Event models from perception to action. *Trends in Cognitive Sciences, 21,* 962-980. doi:10.1016/j.tics.2017.08.005

Ridgeway, D., Waters, E., & Kuczaj, S. A. (1985). Acquisition of emotion-descriptive language:

Receptive and productive vocabulary norms for ages 18 months to 6 years. *Developmental Psychology, 21,* 901-908. doi:10.1037/0012-1649.21.5.901

Rieffe, C., & Wiefferink, C. H. (2017). Happy faces, sad faces: Emotion understanding in toddlers and preschoolers with language impairments. *Research in Developmental Disabilities, 62,* 40-49. doi:10.1016/j.ridd.2016.12.018

Ruba, A. L., Johnson, K., Harris, L., & Wilbourn, M. (2017). Developmental changes in infants' categorization of anger and disgust facial expressions. *Developmental Psychology, 53,* 1826-1832. doi:10.1037/dev0000381

Ruba, A. L., & Pollak, S. D. (2020). The development of emotion reasoning in infancy and early childhood. *Annual Review of Developmental Psychology, 2,* 503-531. doi:10.1146/annurev-devpsych-060320-102556

Ruba, A. L., & Repacholi, B. M. (2019). Do preverbal infants understand discrete facial expressions of emotion? *Emotion Review,* 1-16. doi:10.1177/1754073919871098

Russell, J. A., & Widen, S. C. (2002). A label superiority effect in children's categorization of facial expressions. *Social Development, 11,* 30-52. doi:10.1111/1467-9507.00185

Sanchez, A., Meylan, S., Braginsky, M., MacDonald, K. E., Yurovsky, D., & Frank, M. C. (2018). Childes-db: A flexible and reproducible interface to the Child Language Data Exchange System. Retrieved from psyarxiv.com/93mwx

Sandhofer, C., & Smith, L. B. (1999). Learning color words involves learning multiple mappings. *Developmental Psychology,* 35, 668-679. doi:10.1037/0012-1649.35.3.668

Schwartz, G. M., Izard, C. E., & Ansul, S. E. (1985). The 5-month-old's ability to discriminate facial expressions of emotion. *Infant Behavior and Development, 8*, 65-77. doi:10.1016/S0163-6383(85)80017-5

Shablack, H., & Lindquist, K. A. (2019). The role of language in emotional development. In V. LoBue, K. Perez-Edgar, & K. Buss (Eds.), *Handbook of Emotional Development*. New York, NY: Springer.

Skerry, A., & Spelke, E. (2014). Preverbal infants identify emotional reactions that are incongruent with goal outcomes. *Cognition, 130,* 204-216. doi:10.1016/j.cognition.2013.11.002

Smith, L. B., Jayaraman, S., Clerkin, E., & Yu, C. (2018). The developing infant creates a curriculum for statistical learning. *Trends in Cognitive Sciences, 4,* 325-336. doi:10.1016/j.tics.2018.02.004

Sprung, M., Münch, H., Harris, P., Ebesutani, C., & Hofmann, S. (2015). Children's emotion understanding: A meta-analysis of training studies. *Developmental Review, 37,* 41-65. doi:10.1016/j.dr.2015.05.001

Steele, H., Steele, M., Croft, C., & Fonagy, P. (1999). Infant-mother attachment at one year predicts children's understanding of mixed emotions at six years. *Social Development, 8,* 161-178. doi:10.1111/1467-9507.00089

Vaillant-Molina, M., Bahrick, L., & Flom, R. (2013). Young infants match facial and vocal emotional expressions of other infants. *Infancy, 18,* E97-E111. doi:10.1111/infa.12017

van Dijk, M., van Geert, P., Korecky-Kröll, K., Maillochon, I., Laaha, S., Dressler, W. U., & Bassano, D. (2013). Dynamic adaptation in child-adult language interaction. *Language Learning, 63,* 243-270. doi:10.1111/lang.12002

Vesker, M., Bahn, D., Kauschke, C., Tschense, M., Dege, F., & Schwarzer, G. (2018). Auditory emotion word primes influence emotional face categorization in children and adults, but not vice versa. *Frontiers in Psychology, 9,* 618. doi:10.3389/fpsyg.2018.00618

Voltmer, K., & Von Salisch, M. (2017). Three meta-analyses of children's emotion knowledge and their school success. *Learning and Individual Differences, 59,* 107-118. doi:10.1016/j.lindif.2017.08.006

Walker, A. S. (1982). Intermodal perception of expressive behaviors by human infants. *Journal of Experimental Child Psychology, 33,* 514-535. doi:10.1016/0022-0965(82)90063-7

Walker-Andrews, A. S. (1986). Intermodal perception of expressive behaviors: Relation of eye and voice? *Developmental Psychology, 22,* 373-377. doi:10.1037/0012-1649.22.3.373

Walle, E. A., & Campos, J. J. (2012). Interpersonal responding to discrete emotions: A functionalist approach to the development of affect specificity. *Emotion Review, 4,* 413-422. doi:10.1177/1754073912445812

Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology, 29,* 257-302. doi:10.1006/cogp.1995.1016

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion: Evidence from natural language. *Cognition and Emotion, 9,* 117-149. doi:10.1080/02699939508409005

Widen, S. C., & Russell, J. A. (2008). Children acquire emotion categories gradually. *Cognitive Development, 23,* 291-312. doi:10.1016/j.cogdev.2008.01.002