Adults tailor their emotional expressions to infants through "emotionese"

Yang Wu (yangm.wu@utoronto.ca)[1], **Isobel M. Taylor (isobel.taylor@stanford.edu)**[2],
Hanqi Chen (hanqi.chen@mail.utoronto.ca)[1], **& Michael C. Frank (mcfrank@stanford.edu)**[2]
[1]Department of Psychology, University of Toronto Scarborough, Scarborough, ON M1C 1A4 Canada
[2]Department of Psychology, Stanford University, Stanford, CA 94305 USA

Abstract

In many cultures, adults use simple, slow, and dynamic speech when talking to infants ("parentese," or infant-directed speech) and make expansive, repetitive movements when demonstrating object properties to infants ("motionese," or infant-directed actions). These modifications enhance infants' attention to and learning about language and goal-directed actions. Adults' interactions with infants are also full of emotions—do adults also modify their emotional expressions when interacting with infants? Here we showed parents of infants (aged 7 to 14 months; $N = 25$) emotion-evoking pictures including colorful bubbles, adorable stuffed animals, yummy snacks, broken toys, dangerous fire, and rotten fruits. We asked parents to describe their feelings about these pictures either to their infant or to an adult partner (i.e., an experimenter). While the parents' use of emotion words did not differ between conditions, their emotional expressions did: Their infant-directed emotional expressions were more positive when they discussed positive pictures and more negative when they discussed negative pictures compared to their adult-directed emotional expressions. These findings suggest that besides "parentese" and "motionese," there is also a unique form of emotional communication in parent-child interaction—"emotionese."

Keywords: infant-directed speech; motionese; infant-directed emotional expressions; parent-infant interaction

Introduction

Adults display a wide range of emotions when interacting with young children. They smile, laugh, frown, and act surprised and delighted. These emotional expressions provide a powerful source of information for young children's learning (see Wu, Schulz, Frank, & Gweon, 2021 for review). Even infants can use observed emotional expressions to make rich inferences about the physical world and direct their active exploration (e.g., Sorce, Emde, Campos, & Klinnert, 1985; Walle, Reschke, Camras, & Campos, 2017; Wu, Muentener, & Schulz, 2017). Children are also increasingly able to use emotional expressions to reason about the social world, such as when inferring others' goals, beliefs, and desires (e.g., Lagattuta, Wellman, & Flavell, 1997; Repacholi & Gopnik, 1997; Wu & Schulz, 2018, 2020). These findings suggest remarkable abilities to learn from emotional expressions at a young age. Yet, the developmental origin of these abilities in early childhood remains unknown.

In this study, we explore how caregivers facilitate infants' acquisition of emotion knowledge. In particular, we are interested in whether adults exaggerate, or even feign, emotional expressions in front of infants in ways that aid infants' learning about (and from) those emotional expressions.

Adults from many cultures modify their behaviors when interacting with infants. The most well-documented phenomenon is infant-directed speech (or "parentese"), a special register of speech used when addressing infants. Such speech is characterized by a variety of intonational and prosodic characteristics, including heightened pitch, broader pitch range, lengthened vowels, longer pauses, shorter utterances, and exaggerated intonation contours (e.g., Fernald et al., 1989; Papoušek, Papoušek, & Symmes, 1991; Albin & Echols, 1996; Ratner, 1986; Stern, Spieker, & MacKain, 1982, see Golinkoff, Can, Soderstrom, & Hirsh-Pasek, 2015 for review). These features have the effect of holding infants' attention (ManyBabies Consortium, 2020), highlighting boundaries between word units (Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989; Golinkoff & Alioto, 1995), and facilitating language acquisition (see Spinelli, Fasolo, & Mesman, 2017 for review). Such infant-directed speech is used by not only mothers but also most adults (and even older children) in many cultures (Barton & Tomasello, 1994; Fernald et al., 1989; Kitamura, Thanavishuth, Burnham, & Luksaneeyanawin, 2001; Papoušek et al., 1991).

Adults also modify their actions when interacting with infants, a phenomenon known as "motionese" (Brand, Baldwin, & Ashburn, 2002). When demonstrating object functions to infants, adults exaggerate relevant features of actions, showing greater repetitiveness and reduced complexity (Brand et al., 2002; Brand, Shallcross, Sabatos, & Massie, 2007). Such modifications enhance infants' attention (Brand & Shallcross, 2008) and their imitation of those actions (Koterba & Iverson, 2009).

Do adults also modify their emotional expressions when interacting with infants? Initial evidence suggests that they do, and most of the evidence comes from research on parentese and motionese (Benders, 2013; Brand et al., 2002; Chong, Werker, Russell, & Carroll, 2003; Trainor, Austin, & Desjardins, 2000; Singh, Morgan, & Best, 2002; Stern, 1974). For instance, caregivers tend to express more emotions, particularly positive ones, in infant-directed speech than adult-directed speech (Benders, 2013; Trainor et al., 2000; Singh et al., 2002). They also tend to be more enthusiastic when engaging in infant-directed actions than adult-directed actions (Brand et al., 2002).

However, despite the prevalence of emotional signals in children's early interactions, past work has only investigated a fraction of these emotional signals. Most studies have con-

In M. Goldwater, F. K. Anggoro, B. K. Hayes, & D. C. Ong (Eds.), *Proceedings of the 45th Annual Conference of the Cognitive Science Society.*

sidered emotion to be part of, or even epiphenomenal to, infant-directed speech (see Saint-Georges et al., 2013 for review). Thus, they only looked at the emotion content in speech, leaving other forms of emotional expressions, such as facial expressions, under-explored. Further, the range of emotion-eliciting contexts used in prior work has been limited. Most studies used non-emotional or positive contexts such as play (e.g., Fernald et al., 1989; Papoušek et al., 1991; Albin & Echols, 1996; Ratner, 1986; Stern et al., 1982; Benders, 2013; Brand et al., 2002). As a result, even for the limited studies that have recognized the importance of emotions, there has been an emphasis on positive affect (Benders, 2013; Singh et al., 2002; Brand et al., 2002). However, real-life situations can elicit a variety of emotions. For instance, a stove fire may elicit fear, a broken object may elicit sadness, and spoiled food may elicit disgust. It remains unclear how adults express this wide range of emotions in front of infants, and how these emotional expressions differ from those directed to adults.

The expression of emotion is a significant area of research in affect science. An early and influential theory suggests that humans possess innate abilities to express a set of basic emotions, including happiness, sadness, anger, fear, disgust, and surprise (e.g., Darwin, 1965; Ekman & Friesen, 1971; Izard, 2009). However, empirical research has produced mixed findings. While individuals across cultures may exhibit emotions similarly to some degree, emotional expressions also depend largely on contexts, making the relationship between emotional expressions and emotional states elusive (see Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019 for review). The functions of emotional expressions have also been widely debated. While some theories propose that emotional expressions have evolutionary roots and help us survive (e.g., the widened eyes of fear increase perception; e.g., Darwin, 1965; Ekman & Friesen, 1971; Izard, 1994), others suggest that emotional expressions primarily serve social purposes, providing a means of communicating information to others (e.g., Kraut & Johnston, 1979; Janney & Arndt, 1992; Shariff & Tracy, 2011). Importantly however, the majority of this literature has focused on how people express emotion in intra-personal contexts, or in front of other adults. Limited research has explored how adults express emotions in front of infants and the potential functions of these emotional expressions.

To address gaps in prior work, the current study asked parents to describe their feelings about a range of emotion-evoking pictures to either their infant or an adult partner for comparison. In contrast to previous studies on infant-directed speech that have focused on vocal expressions of emotion (e.g., Benders, 2013; Trainor et al., 2000; Singh et al., 2002), our study explores the expression of emotion through facial expressions. Also unlike studies that have focused on positive affect (e.g., Benders, 2013; Singh et al., 2002; Brand et al., 2002), we included a wide range of emotion-eliciting contexts, including both positive (i.e., colorful bubbles, adorable stuffed animals, and yummy snacks) and negative ones (i.e., broken toys, dangerous electrical fire, and rotten fruits; see Figure 1). The study also bridges the gap between research in developmental psychology and affective science. Rather than studying adults' emotional expressions in intra-personal or adult-directed contexts (see Barrett et al., 2019 for review), the current study focused on how adults express emotions in front of infants. This provides us with a more comprehensive view of how people express emotions, as well as shedding light on how infants may acquire emotion knowledge from adults' emotional expressions.

We hypothesized that besides modifying infant-directed speech ("parentese") and actions ("motionese"), adults would also modify their infant-directed emotional expressions ("emotionese"). While these emotional expressions are an integral part of a broader spectrum of infant-directed inputs like "parentese" and "motionese," they may play a unique role in facilitating infants' learning about emotions and emotional expressions. As an initial step to testing this theoretical perspective, the current study examined how adults modify their emotional expressions directed to infants. Suggested by studies on infant-directed speech (Singh et al., 2002; Benders, 2013) and actions (Brand et al., 2002), one possibility is that adults might express more positive emotion to infants than to adults regardless of the emotional content of the pictures they were referring to. However, an alternative possibility we favor is that adults modify their emotional expressions based on the emotional content of the pictures. Compared to adult-directed emotional expressions, infant-directed emotional expressions may be more positive when referring to positive pictures and more negative when referring to negative pictures. These modifications may play a crucial role in supporting infants' acquisition of emotion knowledge.

Method

Participants

We recruited 25 parents whose infants were 7- to 14- months ($M = 11.1$ months). This broad infant age range includes ages at which parentese and motionese are typically found (e.g., Fernald et al., 1989; Brand et al., 2002). All participants lived in the United States and were recruited via online recruitment methods such as Facebook advertisements and the lab participant database. All respondents identified as female and took part in our study virtually via a Zoom video call. Five additional participants were tested but excluded due to: poor network connection ($n = 1$), interference from infants' siblings ($n = 2$), unable to see the parent's facial expression ($n = 1$), and infant interrupting the experiment multiple times ($n = 1$). As part of our standard recruitment procedure, we only collected information about the race/ethnicity of infants. Parents reported their infants' race/ethnicity as White ($n = 12$), Asian ($n = 4$), Caucasian-Asian ($n = 3$), Hispanic ($n = 1$), Caucasian-Hispanic ($n = 1$), Caucasian-Pacific Islander ($n = 1$), Caucasian-other ($n = 1$), Hispanic-African ($n = 1$), and other ($n = 1$).

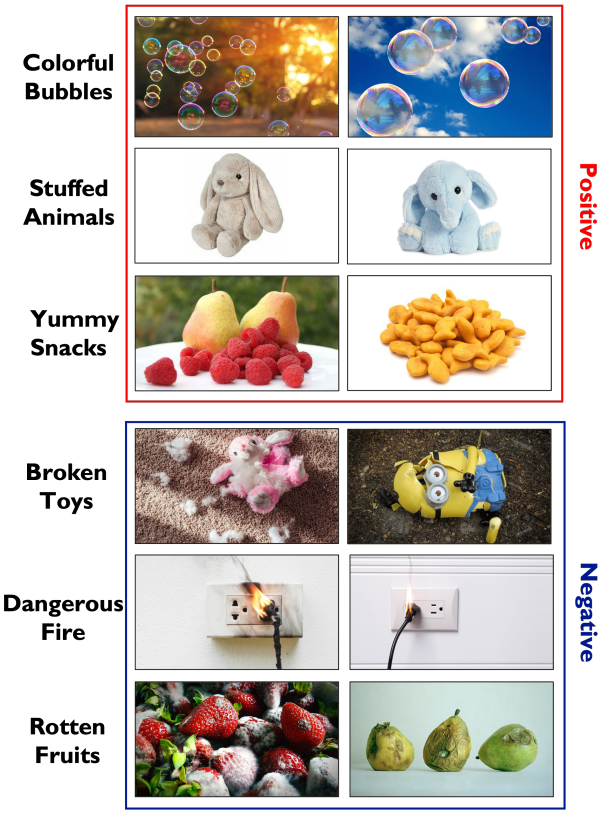

Figure 1: Emotion-evoking stimuli

Materials and Design

Six categories of pictures were used (see Figure 1). Three of them were positively valenced: colorful bubbles, adorable stuffed animals, and yummy snacks. The other three were negatively valenced: broken toys, dangerous electrical fire, and rotten fruits. There were two pictures in each category.[1]

Participants described six pictures (one from each category) to their infants and the other six (the other picture in each category) to an adult experimenter. We counterbalanced the order of condition (infant-directed vs. adult directed), the selection of pictures, and the order of picture categories across participants.

Procedure

Participants were tested and recorded virtually in a Zoom video call. They were first asked to give verbal consent at the beginning of the call. Then the experimenter went through an extensive set-up procedure with the participant to ensure consistency across participants (e.g., Zoom was in full screen mode, experimenter's video was in the same place, participants could not see their own videos; see Chuey et al., 2021).

After setting up the devices, participants received two practice trials. They saw a boy making a funny face in one trial and a sleeping cat in the other. Participants were asked to describe their feelings about each picture either to their infants or to the experimenter, depending on which test condition (infant-directed vs. adult-directed) would come first next. If a participant only described the content of a picture rather than how they felt about it, the experimenter reminded them to focus on their feelings and asked them to re-do the trial. Participants were instructed to say "next" when they completed discussing a picture and the experimenter would then show the next picture.

Following the practice trials, participants received two blocks of test trials. One block consisted of 6 infant-directed trials and the other consisted of 6 adult-directed trials (order of blocks counterbalanced). In the infant-directed trials, participants were asked to share their feelings about each picture with their infants, during which the experimenter covered her video so that she would not be distracting to participants. The experimenter stayed on the call, and showed participants a new picture whenever they said "next." In the adult-directed trials, the experimenter uncovered her video and maintained a mildly-positive emotional expression. Participants were asked to share their feelings about each picture with the experimenter. The experimenter showed participants a new picture whenever they said "next."

Coding

Two coders blind to the hypothesis of the study and the emotion condition were trained to code participants' emotional expressions offline from videos using a video annotation tool, *Datavyu* (Datavyu Team, 2014). To eliminate the influence of speech (e.g., "I'm worried that..."), all video clips were muted during coding. All videos were also edited to remove the presentation of the emotion-evoking pictures to ensure that the coders were blind to the emotion condition. As it is challenging to code discrete emotions (e.g., fear, disgust) expressed during a conversation, the coders coded the valence of participants' emotional expressions.

The two coders rated the valence of a participant's emotional expression while the participant discussed the picture in each trial on a scale from -5 (very negative) to 5 (very positive). As part of the coding training, a set of video examples with pre-determined ratings were given to coders to calibrate the scale and to ensure consistency between coders. If a parent displayed both positive and negative emotions in a trial, coders were instructed to give an average rating based on the frequency and length of those expressions. We used the average ratings across the two coders as our primary dependent variable; the average-score intra-class correlation coefficient (ICC) was 0.819.

We also coded emotion words in participants' speech. One coder first manually transcribed participants' speech during the experiment. Then, all emotion words in the transcript were identified using a text processing tool, *Linguistic Inquiry and Word Count* (*LIWC*; Boyd, Ashokkumar, Seraj, & Pennebaker, 2022). The tool has been widely used to identify emotion words (e.g., Donnellan & Warren, 2022; Luo, Yang,

[1]Study materials, data, and code can be accessed at https://osf.io/697jp/?view_only=32996a386503432a9e68dd07fc34a3a2

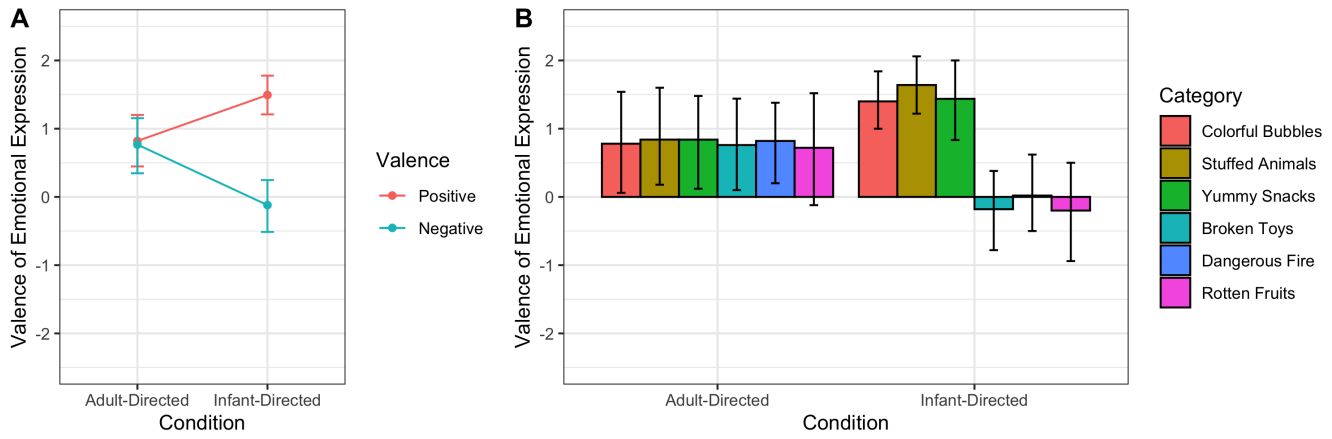

Figure 2: (A) Valence of participants' emotional expression split by Valence of Picture (Positive vs. Negative) and Condition (Adult-Directed vs. Infant-Directed). (B) Valence of participants' emotional expression split by Category of Picture and Condition.

Teo, et al., 2022; McDonnell, Owen, Bantum, et al., 2020; Vine, Boyd, & Pennebaker, 2020). We relied on LIWC to find emotion words except that we manually excluded "yum" and "yummy" from the output, both because their antonyms "yuck" and "yucky" were not considered emotion words by LIWC and because all these words focus more on the features of food than people's emotional responses to those features (e.g., disgust).

Results

To answer our main question of interest, we analyzed valence ratings of participants' emotional expressions. We fit a linear mixed-effects model (using the *nlme* package in *R*; Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2021) in which Condition (adult-directed vs. infant-directed) and Valence of the pictures (positive vs. negative) were fixed effects. We also included a maximal random effect structure such that random intercepts and random slopes of Condition and Valence were all fit by subject.[2] There was a significant interaction between Condition and Valence ($\beta = 1.56$, $t(271) = 3.57$, $p < .001$; see Figure 2A).

We next ran follow-up analyses on simple effects of Condition and Valence. In the adult-directed condition, participants maintained a mildly positive emotional expression regardless of which picture they were talking about ($\beta = .053$, $t(124) = .15$, $p = .885$). By contrast, in the infant-directed condition, participants' emotional expressions differed depending on the valence of the pictures ($\beta = 1.61$, $t(123) = 5.00$, $p < .001$). They were more positive for positive pictures ($\beta = .67$, $t(123) = 1.91$, $p = .058$) and more negative for negative pictures ($\beta = -.89$, $t(124) = -2.50$, $p = .014$), compared to their adult-directed emotional expressions (see Figure 2A). We also explored differences among the three emotion categories in each valence domain, and found no significant differences in either the three positive emotion categories (infant-directed: all $ps > .355$; adult-directed: all $ps > .856$) or the three negative emotion categories (infant-directed: all $ps > .518$; adult-directed: all $ps > .818$; see Figure 2B). These results support the hypothesis that adults' emotional expressions are more extreme in both directions in the infant-directed condition than the adult-directed condition.

As a secondary analysis, we analyzed participants' use of emotion words between conditions. There was no significant difference in the total number of emotion words used between the infant-directed condition ($M = 10.13$) and the adult-directed condition ($M = 9.33$; $t(23) = .72$, $p = .478$). There was also no significant difference in the number of unique emotion words used between conditions (infant-directed: $M = 6.29$, adult-directed: $M = 6.92$; $t(23) = .70$, $p = .491$).

Collectively, we found that while participants' use of emotion words did not appear to differ significantly between conditions, their emotional expressions did: in contrast to adult-directed emotional expressions, infant-directed emotional expressions were more positive in positive conditions and more negative in negative conditions.

Discussion

Do adults modify their emotional expressions when interacting with infants? In this study, we asked parents to share their feelings about a wide range of emotion-evoking pictures either with their infant or with an adult experimenter. While participants' use of emotion words were similar between conditions, they relied more on nonverbal emotional expressions when communicating with infants than with adults. Compared to their adult-directed emotional expressions, their infant-directed emotional expressions were more positive when they discussed positive pictures and more neg-

[2]Model: lme(Rating ~ Condition * Valence, random = ~ Condition * Valence | Subject, method = "REML")

ative when they discussed negative pictures. These results are consistent with the possibility that adults exaggerate their emotional expressions (relative to the adult-directed baseline) in ways that facilitate infants' learning about those emotional expressions and the contexts that these expressions refer to. These findings provide initial evidence that beyond infant-directed speech ("parenthese") and actions ("motionese"), there is also a special form of emotional communication in parent-infant interaction—"emotionese."

One interesting finding of our study is that in the adult-directed condition, participants exhibited a mildly positive emotional expression throughout regardless of the emotional content of the pictures; they relied on emotion words instead to convey their feelings. This finding aligns with a large body of work showing that adults' emotional expressions often do not match their emotional states (e.g., Mehu, Grammer, & Dunbar, 2007; Fernandez-Dols, Sanchez, Carrera, & Ruiz-Belda, 1997; Matsumoto & Kupperbusch, 2001), leading to the conclusion that emotional expressions are not informative (see Barrett et al., 2019 for review). Such conclusion has posed a puzzle to the field: why, on one hand, do people have strong intuitions about what happy, sad, scared, and angry expressions are like, but on the other hand, research has difficulty finding evidence that people express emotions in ways that are consistent with such lay understanding (Barrett, 2006)? Our study provides a potential answer to this puzzle. It is possible that people acquire their lay knowledge of emotions and emotional expressions in their childhood from their parents, who exhibit more extreme (and perhaps more prototypical, though we did not measure this in our study) emotional expressions. However, as they grow older, they learn to regulate their emotions, comply with social display rules, and rely on alternative means (e.g., emotion words) to express their feelings.

Another noteworthy finding of our study is that when discussing negative pictures, although participants' infant-directed emotional expressions were more negative than adult-directed expressions, these expressions were not intense; instead, they were rated as neutral overall (see Figure 2, negative pictures in the infant-directed condition). There are several factors to consider when we interpret this result. First, as we coded participants' emotional expressions in a global, intuitive fashion (i.e., each coder only gave a single valence score per trial), these neutral ratings may reflect mostly neutral expressions throughout the trial, or a mix of positive and negative expressions. Our current coding scheme cannot differentiate between the two possibilities. Second, even if participants displayed neutral expressions, they may have still been communicating *negative* feelings to infants. This is because people share the social norm that the baseline emotional expression in social contexts should be mildly positive, and neutral expressions are considered to be negative (Chiarella & Poulin-Dubois, 2015), especially in parent-infant interactions (Adamson & Frick, 2003). Thus, participants may have still been signalling negative feelings to infants (and infants perceived them so) through neutral expressions. Last, it is also possible that participants were intentionally trying to balance the informativeness of their emotional expressions and the emotional impact of those expressions on infants. That is, while they had the intention to communicate their negative feelings, they also did not want to upset their babies; neutral expressions, or mixed positive and negative expressions, struck a balance between the two goals.

We have two follow-up steps. As mentioned above, our current coding scheme is relatively coarse. Our future work will do a more fine-grained coding, including coding participants' emotional expressions frame by frame, categorizing emotional expressions beyond valence, and coding both facial and vocal emotional expressions. Additionally, the conversational partner in the adult-directed condition was a stranger to participants (i.e., an experimenter), while the one in the infant-directed condition was a close family member (i.e., participants' babies). It is possible that the difference between conditions was driven by differences in closeness with the conversational partner, rather than whether the conversational partner was an adult or infant. Our follow-up work will ask participants to talk to a close adult partner (e.g., their spouse) in the adult-directed condition to replicate our findings.

Our study suggests broader directions for future research. First, all participants in our study were from a western culture. Shaped by culture-specific norms and values however, how people express emotions varies across cultures (Tsai, 2007; Matsumoto, Yoo, & Fontaine, 2008). Do these cultural differences extend to parent-infant interactions? While it is possible that they do, it is also possible that the ways in which adults display emotions in front of infants are relatively universal. This is conceivable to the degree that humans have the intent to communicate with and teach prelinguistic infants. Indeed, research has found that "parentese" exists in a wide range of cultures (Fernald et al., 1989; Kitamura et al., 2001; Papoušek et al., 1991; see Soderstrom, 2007 for review). Whether this is the same for "emotionese" requires further research. Second, to better understand the scope and robustness of the phenomenon, it is important to examine the generalizability of our findings beyond parents (e.g., among adults without children and older siblings of infants) as well as beyond the current set of picture stimuli used (e.g., real objects, completely novel stimuli). Third, future work should directly test the outcomes of infant-directed emotional expressions. Given that infant-directed speech supports language acquisition (Spinelli et al., 2017) and infant-directed actions facilitate action learning (Koterba & Iverson, 2009), infant-directed emotional expressions may play a critical role in scaffolding the acquisition of emotion knowledge.

To conclude, the current results encourage us to broaden our perspectives on the potential richness and benefits of parent-infant interactions. They suggest that beyond infant-directed speech and actions, infant-directed emotional expressions may be another type of input that is curated by help-

ful, knowledgeable adults. These emotional expressions may well accelerate infants' emotion knowledge acquisition, acting as a powerful catalyst for development. These findings connect research in developmental, cognitive, and affective sciences, moving us towards a better understanding of the unique features of parent-child interactions.

References

Adamson, L. B., & Frick, J. E. (2003). The still face: A history of a shared experimental paradigm. *Infancy*, *4*(4), 451–473.

Albin, D. D., & Echols, C. H. (1996). Stressed and word-final syllables in infant-directed speech. *Infant Behavior and Development*, *19*(4), 401–418.

Barrett, L. F. (2006). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review*, *10*(1), 20–46.

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), 1–68.

Barton, M. E., & Tomasello, M. (1994). The rest of the family: The role of fathers and siblings in early language development. In C. Gallaway & B. J. Richards (Eds.), *Input and interaction in language acquisition* (pp. 109–134). Cambridge University Press.

Benders, T. (2013). Mommy is only happy! dutch mothers' realisation of speech sounds in infant-directed speech expresses emotion, not didactic intent. *Infant Behavior and Development*, *36*(4), 847–862.

Boyd, R. L., Ashokkumar, A., Seraj, S., & Pennebaker, J. W. (2022). *The development and psychometric properties of liwc-22*. Austin, TX: University of Texas at Austin.

Brand, R. J., Baldwin, D. A., & Ashburn, L. A. (2002). Evidence for 'motionese': modifications in mothers' infant-directed action. *Developmental Science*, *5*(1), 72–83.

Brand, R. J., & Shallcross, W. L. (2008). Infants prefer motionese to adult-directed action. *Developmental Science*, *11*(6), 853–861.

Brand, R. J., Shallcross, W. L., Sabatos, M. G., & Massie, K. P. (2007). Fine-grained analysis of motionese: Eye gaze, object exchanges, and action units in infant-versus adult-directed action. *Infancy*, *11*(2), 203–214.

Chiarella, S. S., & Poulin-Dubois, D. (2015). "aren't you supposed to be sad?" infants do not treat a stoic person as an unreliable emoter. *Infant Behavior and Development*, *38*, 57–66.

Chong, S., Werker, J. F., Russell, J. A., & Carroll, J. M. (2003). Three facial expressions mothers direct to their infants. *Infant and Child Development: An International Journal of Research and Practice*, *12*(3), 211–232.

Chuey, A., Asaba, M., Bridgers, S., Carrillo, B., Dietz, G., Garcia, T., ... others (2021). Moderated online data-collection for developmental research: Methods and replications. *Frontiers in Psychology*, *12*, 734398.

Darwin, C. (1965). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press. (Original work published in 1872).

Datavyu Team. (2014). *Datavyu: A video coding tool*. Databrary Project, New York University. http://datavyu.org.

Donnellan, W. J., & Warren, J. G. (2022). Emotional word use in informal carers of people living with dementia: Linguistic analysis of online discussion forums. *Journal of Medical Internet Research: Aging*, *5*(2), e32603.

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17*(2), 124–129.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language*, *16*(3), 477–501.

Fernandez-Dols, J.-M., Sanchez, F., Carrera, P., & Ruiz-Belda, M.-A. (1997). Are spontaneous expressions and emotions linked? an experimental test of coherence. *Journal of Nonverbal Behavior*, *21*, 163–177.

Golinkoff, R. M., & Alioto, A. (1995). Infant-directed speech facilitates lexical learning in adults hearing chinese: Implications for language acquisition. *Journal of Child Language*, *22*(3), 703–726.

Golinkoff, R. M., Can, D. D., Soderstrom, M., & Hirsh-Pasek, K. (2015). (baby) talk to me: the social context of infant-directed speech and its effects on early language acquisition. *Current Directions in Psychological Science*, *24*(5), 339–344.

Izard, C. E. (1994). Innate and universal facial expressions: evidence from developmental and cross-cultural research. *Psychological Bulletin*, *115*(2), 288–299.

Izard, C. E. (2009). Emotion theory and research: Highlights, unanswered questions, and emerging issues. *Annual Review of Psychology*, *60*, 1–25.

Janney, R. W., & Arndt, H. (1992). Intracultural tact versus intercultural tact. In J. W. Richard, I. Sachiko, & E. Konrad (Eds.), *Politeness in language: Studies in its history, theory and practice* (pp. 21–41). Mouton de Gruyter Berlin.

Kitamura, C., Thanavishuth, C., Burnham, D., & Luksaneeyanawin, S. (2001). Universality and specificity in infant-directed speech: Pitch modifications as a function of infant age and sex in a tonal and non-tonal language. *Infant Behavior and Development*, *24*(4), 372–392.

Koterba, E. A., & Iverson, J. M. (2009). Investigating motionese: The effect of infant-directed action on infants' attention and object exploration. *Infant Behavior and Development*, *32*(4), 437–444.

Kraut, R. E., & Johnston, R. E. (1979). Social and emotional messages of smiling: an ethological approach. *Journal of Personality and Social Psychology*, *37*(9), 1539.

Lagattuta, K. H., Wellman, H. M., & Flavell, J. H. (1997). Preschoolers' understanding of the link between thinking and feeling: Cognitive cuing and emotional change. *Child Development*, 1081–1104.

Luo, K., Yang, Y., Teo, H. H., et al. (2022). The asymmetric influence of emotion in the sharing of covid-19 science on social media: Observational study. *Journal of Medical Internet Research: Infodemiology*, *2*(2), e37331.

ManyBabies Consortium. (2020). Quantifying sources of variability in infancy research using the infant-directed-speech preference. *Advances in Methods and Practices in Psychological Science*, *3*(1), 24–52.

Matsumoto, D., & Kupperbusch, C. (2001). Idiocentric and allocentric differences in emotional expression, experience, and the coherence between expression and experience. *Asian Journal of Social Psychology*, *4*(2), 113–131.

Matsumoto, D., Yoo, S. H., & Fontaine, J. (2008). Mapping expressive differences around the world: The relationship between emotional display rules and individualism versus collectivism. *Journal of Cross-Cultural Psychology*, *39*(1), 55–74.

McDonnell, M., Owen, J. E., Bantum, E. O., et al. (2020). Identification of emotional expression with cancer survivors: validation of linguistic inquiry and word count. *Journal of Medical Internet Research: Formative Research*, *4*(10), e18246.

Mehu, M., Grammer, K., & Dunbar, R. I. (2007). Smiles when sharing. *Evolution and Human behavior*, *28*(6), 415–422.

Nelson, D. G. K., Hirsh-Pasek, K., Jusczyk, P. W., & Cassidy, K. W. (1989). How the prosodic cues in motherese might assist language learning. *Journal of Child Language*, *16*(1), 55–68.

Papoušek, M., Papoušek, H., & Symmes, D. (1991). The meanings of melodies in motherese in tone and stress languages. *Infant Behavior and Development*, *14*(4), 415–440.

Pinheiro, J., Bates, D., DebRoy, S., Sarkar, D., & R Core Team. (2021). nlme: Linear and nonlinear mixed effects models [Computer software manual]. Retrieved from `https://CRAN.R-project.org/package=nlme` (R package version 3.1-152)

Ratner, N. B. (1986). Durational cues which mark clause boundaries in mother–child speech. *Journal of Phonetics*, *14*(2), 303–309.

Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: evidence from 14-and 18-month-olds. *Developmental Psychology*, *33*(1), 12–21.

Saint-Georges, C., Chetouani, M., Cassel, R., Apicella, F., Mahdhaoui, A., Muratori, F., ... Cohen, D. (2013). Motherese in interaction: at the cross-road of emotion and cognition?(a systematic review). *PloS One*, *8*(10), e78103.

Shariff, A. F., & Tracy, J. L. (2011). What are emotion expressions for? *Current Directions in Psychological Science*, *20*(6), 395–399.

Singh, L., Morgan, J. L., & Best, C. T. (2002). Infants' listening preferences: Baby talk or happy talk? *Infancy*, *3*(3), 365–394.

Soderstrom, M. (2007). Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants. *Developmental Review*, *27*(4), 501–532.

Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: its effect on the visual cliff behavior of 1-year-olds. *Developmental Psychology*, *21*(1), 195–200.

Spinelli, M., Fasolo, M., & Mesman, J. (2017). Does prosody make the difference? a meta-analysis on relations between prosodic aspects of infant-directed speech and infant outcomes. *Developmental Review*, *44*, 1–18.

Stern, D. N. (1974). Mother and infant at play: The dyadic interaction involving facial, vocal, and gaze behaviors. In M. Lewis & L. A. Rosenblum (Eds.), *The effect of the infant on its caregiver.* Wiley-Interscience.

Stern, D. N., Spieker, S., & MacKain, K. (1982). Intonation contours as signals in maternal speech to prelinguistic infants. *Developmental Psychology*, *18*(5), 727–735.

Trainor, L. J., Austin, C. M., & Desjardins, R. N. (2000). Is infant-directed speech prosody a result of the vocal expression of emotion? *Psychological Science*, *11*(3), 188–195.

Tsai, J. L. (2007). Ideal affect: Cultural causes and behavioral consequences. *Perspectives on Psychological Science*, *2*(3), 242–259.

Vine, V., Boyd, R. L., & Pennebaker, J. W. (2020). Natural emotion vocabularies as windows on distress and well-being. *Nature Communications*, *11*(1), 1–9.

Walle, E. A., Reschke, P. J., Camras, L. A., & Campos, J. J. (2017). Infant differential behavioral responding to discrete emotions. *Emotion*, *17*(7), 1078–1091.

Wu, Y., Muentener, P., & Schulz, L. E. (2017). One-to four-year-olds connect diverse positive emotional vocalizations to their probable causes. *Proceedings of the National Academy of Sciences*, *114*(45), 11896–11901.

Wu, Y., & Schulz, L. E. (2018). Inferring beliefs and desires from emotional reactions to anticipated and observed events. *Child Development*, *89*(2), 649–662.

Wu, Y., & Schulz, L. E. (2020). Understanding social display rules: Using one person's emotional expressions to infer the desires of another. *Child Development*, *91*(5), 1786–1799.

Wu, Y., Schulz, L. E., Frank, M. C., & Gweon, H. (2021). Emotion as information in early social learning. *Current Directions in Psychological Science*, *30*(6), 468–475.