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Do Dynamic Facial Expressions Convey Emotions to Children Better than Do Static Ones?

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Abstract

Past research has found that children recognize emotions from facial expressions poorly and improve only gradually with agebut the stimuli in such studies have been static faces. Because dynamic faces include more information, it may well be that children more readily recognize emotions from dynamic facial expressions. The current study of children (N=64, 5-10 years) who freely labeled the emotion conveyed by static and dynamic facial expressions found no advantage of dynamic over static expressions; in fact, reliable differences favored static expressions. An alternative explanation of gradual improvement with age is that children's emotional categories change over development from a small number of broad emotion categories to a larger number of narrower ones–a pattern found here with both static and dynamic expressions.

Keywords: Facial expressions, emotion, static, dynamic, labeling

In daily experience, a child seeks to understand what others are thinking and feeling by, among other things, watching their facial expressions. These facial expressions are, of

course, *dynamic*. Yet most studies on children's understanding of facial expressions have been done with static photographs. One surprising result of this research with static faces is that children appear less able to recognize basic emotions from faces than expected and improve only gradually with age (Widen, 2013). The current study asked if this result is an artifact of the use of static photographs and whether showing children dynamic versions of facial expressions would reveal greater ability to recognize emotions than has been apparent so far.

Research with adults points to an advantage (Atkinson, Dittrich, Gemmell, & Young, 2004) of dynamic over static expressions(see Krumhuber, Kappas, & Manstead, 2013, for a review). Dynamic ones are more ecologically valid, perhaps even more so when the expresser is more emotional(Atkinson et al., 2004). Areas of the brain associated with social and emotion processing (superior temporal sulci and amygdalae) were activatedwhen shown dynamic facial expressions but not static expressions (Kessler et al., 2011; Kilts, Egan, Gideon, Ely, & Hoffman, 2003). Adult studies with intense prototypical facial expressions have found mixed results: Some find no significant difference between dynamic and static facial expressions (Bould, Morris, & Wink, 2008; Dubé, 1997; Wehrle, Kaiser, Schmidt, & Scherer, 2000) and others find an advantage for some static expressions (Kamachi et al., 2001). But because adults are close to ceiling with both modes of presentation, other methods are needed (e.g., van der Schalk, Hawk, Fischer, &Doosje, 2011; Wehrle et al., 2000). Studies in which adults are shown subtle expressions have found an advantagefor dynamic over static expressions (Ambadar, Schooler, & Cohn, 2005; Wehrle, Kaiser, Schmidt, & Scherer, 2000).

The dynamic advantage has also been proposed for children. Various researchers have suggested thatchildren should be more likely to label emotions from dynamic thanstatic facial expressions "correctly" because they are more similar to what children see in their daily experience(Caron, Caron, & Myers, 1985; Eibl-Eibesfeldt, 1970; Flavell, 1985; Fogel, 1983; Vieillard & Guidetti, 2009). For example, VieillardandGuidettiargued that "it may be that findings based on static emotional material underestimate children's emotional perceptual skills"(p. 80). There is some support for this view: Infants look longer at dynamic than static faces (Wilcox & Clayton, 1968). When children (6-8 years) grouped dynamic facial expressions (happy, pleasant, anger, irritation, neutral), their groups were systematic and adult-like (Vieillard & Guidetti, 2009).

Surprisingly, there are only four developmental studies that directly compared static with dynamic expressions(Nelson, Hudspeth, & Russell, 2013, Study 1 and 2; Nelson & Russell, 2011b, Study 1 and 2), and all were based on a single actor. These studies produced mixed results. Each study asked children to freely label intense expressions; some expressions were static and some were dynamic. Of the four studies, none found an overall dynamic advantage, but one found a significantoverall static advantage and a significant advantage for static over dynamic anger expressions (Nelson & Russell, 2011b). These studies represent an important first step in testing the dynamic advantage assumption. But having all the results based on a single actor is problematic, in that it might be specific to the one actor. This actor's expressions may have been clearer or more intense than other people's expressions. Indeed, her static expressions were

significantly more likely to be labeled "correctly" than Ekman and Friesen's (1976) gold standard Pictures of Facial Affect (Nelson & Russell, 2011b). In addition, labeling the same actor for both static and dynamic expressions may have impacted children's labeling, perhaps making them more likely to provide the same label for both modes– supported by the three studies that found no significant difference between static and dynamic expressions (Nelson, Hudspeth, & Russell, 2013, Study 1 and 2; Nelson & Russell, 2011b, Study 2).

Children's poor recognition of emotion from facial expressions and gradual improvement with age led to an alternate hypothesis of the development of children's understanding of emotion. Analysis of all of children's responses, both "correct" and "incorrect," showed that children's emotion categories develop from a small number of broad categories to a larger number of narrower, more specific categories (Massarani, Gosselin, Montembeault, Gagnon, & Suurland, 2011; Widen & Russell, 2003, 2008a, 2010a, 2010b). According to this differentiation account, children's initial emotion categories are very broad–feels good, feels bad--typically labeled by English-speaking children as *happy* and *sad* (or, alternatively, *angry*). Children then gradually differentiate these categories into narrower, more specific, adult-like ones. Thus, the youngest children label facial expressions using only *happy* and *sad* (or *angry*), older children add *angry* (or *sad*), then *scared* and *surprised*, and *disgusted*. Children who use only *happy* and *sad* use them for all the facial expressions, thus assimilating fear, anger, and disgust to these two categories. Even children who use six emotion terms initially assimilate social emotions such as pride and embarrassment to a basic-level emotion concept that they already have–

happy and sad, respectively–and later distinguish the social emotion from the earlier-emerging basic-level emotion concept(Nelson & Russell, 2012; Widen & Russell, 2010a).

Tests of this differentiation account were so far based on children's responses to static facial expressions (except Nelson & Russell, 2012, which focused on pride specifically). The same differentiation pattern has also been shown with children's free-labeling responses to stories describing the causes and consequences of emotions (Widen & Russell, 2010a, 2010b). Thus, it is possible that the pattern of differentiation will be different or faster for dynamic facial expressions. Because researchers have rarely studied children's understanding of dynamically presented expressions, there are, to our knowledge, no specific hypotheses on the difference made by static versus dynamic presentations. It is conceivable that the timing of a facial movement is an important cue to emotion (Bould et al., 2008). If so, what appears to be the late development of recognition of a specific emotion could be an artifact of the absence of dynamic cues.

The current study examined two hypotheses: (1) that children better recognize emotions from dynamic expressions than from static ones and (2) that the differentiation pattern observed with static expressions is systematically different with dynamic expressions. Expressions for eight emotions–happiness, sadness, anger, fear, surprise, disgust, embarrassment, and pride–were shown to children from 5 to 10 years of age, a period during which both gradual improvement in recognition and differentiation has been observed (Massarani et al., 2011; Widen & Russell, 2010a). Thefacial expressions were

from a standardized set in which models posed dynamic expressions: the Amsterdam Dynamic Facial Expression Set (ADFES; van der Schalk et al.2011). The expressions were posed in accordance with the Facial Action Coding System specifications (Ekman & Friesen, 1978). From this set, we selected two models, one male and one female. From their videos, static photographs were extracted from each expression at its apex, thus replicating the stimuli common in prior research. Children were randomly assigned to seeeither the dynamic expressions of the male model and the static expressions of the female (Condition 1) or the dynamic expressions of the female model and the static expressions of the male (Condition 2). Within each condition, order of mode (dynamic versus static expressions) was counterbalanced. The child was asked to freely label the emotion expressed in each of 16 trials.

METHOD

Participants

Participants were 128 children recruited from a science museum in Boston. All children were proficient in English. The sample was divided into two age groups of 64 children each (32 girls): 5-7-year-olds (5;0 to 7;11, M_{age} = 74 months, *SD* = 10.5) and 8-10-year-olds (8;0 to 10;11, M_{age} = 72.5 months, *SD* = 11.2). The sample was representative of the ethnic composition of the area: 61.7% were Caucasian, 3.1% Asian, 2.3% Hispanic, 5.5% of mixed ethnicity, and 4.8% other (the remainder did not report ethnicity).

Dynamic And Staticfacial Expressions

Two sets of video-recorded facial expressions for eight emotions (happiness, sadness, anger, fear, surprise, disgust, pride and embarrassment; each approximately 6 seconds long) were used, one posed by an adult male (#M02), one by an adult female (#F01); both Caucasian and in their 20s(van der Schalk et al., 2011).The facial expressions in this set were posed to match the prototypical expressions for happiness, sadness, anger, fear, surprise, disgust (Ekman & Friesen, 1978), pride (Tracy & Robins, 2004), and embarrassment (Keltner, 1995)–see http://psyres.uva.nl/research/content/programme-group-social-psychology/adfes-stimulus-set/stimulus-set-contents/stimulus-set-contents.html for a full description of the facial expressions in this set. The static photographs were extracted from the peak moment of the videos. In each video, the poser begins with a neutral expression, followed by the onset of the expression, and displays a full emotional expression for 5 seconds. Adult's selection of the predicted label for each video clip was: happiness (95%), surprise (93%), anger (92%), disgust (90%), sadness (90%), fear (87%), embarrassment (76%), and pride (74%; van der Schalk et al., 2011).

Procedure

Each child participated in the two parts of the study. First, the experimenter initiated a brief conversation with the child in which each target emotion label was mentioned twice (e.g., "Sad is a feeling. Do you ever feel sad?"). This conversation was intended to prime the child's emotion concepts and to make the emotion labels they already knew more accessible.

Second, each child was randomly assigned to one of two conditions. In Condition 1, the child saw the male poser in the dynamic videos and the female poser in the static photographs. In Condition 2, the child saw the female poser in the dynamic videos and the male poser in the static photographs. For each stimulus, the child was asked, "How did she (he) feel?" For a dynamic stimulus, the child could ask to see it again, and the experimenter offered to show it again if the child hesitated when responding to the question. The static facial expression remained on display until the child labeled it.[1] If the child provided several emotion words or a story, the child was asked for the single best emotion word. Within each condition, half of the children saw dynamic videos first; the other half saw the static ones first. For the eight stimuli within each mode, the emotions were presented in one of four orders, two random and two the reverse of those. The study lasted about 10 minutes.

Scoring

The scoring key for the freely produced labels had been developedearlier based on the ratings of two judges blind to the source of the labels(Widen & Russell, 2003, 2010a). Two raters placed each label into one of 9 categories (happiness, sadness, anger, fear, surprise, disgust, embarrassment, pride, embarrassment) or indicated it fit in none of these. In the original study for which this key was created, the first two raters agreed on the category for 84% of responses. Disagreements as to emotion category were resolved by a third rater. In the current study, collectively, the 128 children had 2048 opportunities to label a facial expression. These 2048 opportunities yielded 47 different types of responses. The labels that occurred in this study and that were scored as correct

were: for happiness, *happy* (372)*, excited* (3)*, glad* (5)*, good* (1),*great* (2); for sadness*, sad* (287)*, depressed (1), disappointed* (7)*, upset* (5); for anger, *angry* (135)*, annoyed* (1)*, cross* (2)*, frustrated* (7)*, jealous* (3)*, mad* (193); for fear, *scared* (159)*, freaked out* (1)*, frightened* (6)*, nervous* (6), *worried* (1); for surprise, *surprised* (302)*, shocked* (16); for disgust, *disgusted* (162)*, grossed out* (9)*, icky* (1), *nasty* (4), *yucky* (4); for pride, *proud* (121); for embarrassment, *embarrassed* (131)*, shy* (5). Responses could vary from what was just listed in syntax or by being embedded in a phrase (e.g., *very scared*). These were all the labels children used in the current study that came close to specifying one of the target emotions. The dependent variable was whether or not children used the "correct" label for each expression, scored 1 or 0, respectively.

RESULTS AND DISCUSSION

Emotion Recognition Fromdynamic Vs. Static Expressions

Dynamic facial expressions did *not* provide an advantage over static expressions. The difference between dynamic and static was tiny: 69% of children used the expected label for the dynamic faces; 70% did so for the static faces. In a mixed-design ANOVA (α= .05), age (2 levels: 5-7, 8-10 years) and sex (2 levels) were between-subjects factors; mode-of-presentation (2 levels: dynamic, static) and emotion (8 levels: happiness, sadness, anger, fear, surprise, disgust, embarrassment, pride) were within-subject factors.[2, 3]The main effect for mode was not significant, $F(1, 124) = .65$, $p = .42$.

The main effect for emotion was significant, $F(7, 868) = 58.16$, $p < .001$, partial $\eta_p^2 = .32$: The rank order is shown in Figure 1: Happiness was "correctly"labeled on most trials,

followed by, surprise, anger, sadness, disgust, fear, and pride;embarrassmentwas least often "correctly" labeled. As illustrated by Figure 1, the Mode x Emotion interaction was also significant, $F(7, 868) = 2.09$, $p = .04$, partial $\eta_p^2 = .02$,however, HSD comparisons found no significant differences between modes . For no emotion was there a significant advantage of dynamic face over the static one; the difference between modes for sadness was not significant. Dynamic and static were similar across the range of emotions and below ceiling level (except for happiness and perhaps surprise) which speaks against a ceiling effect interpretation of the results.

Finally, the main effect for age was significant, $F(1, 124) = 42.36$, $p < .001$, partial $\eta_p^2 = .25$: 8-10-year-olds used the "correct" labels (77%) significantly more than did the 5-7-year-olds (62%). The Age x Emotion interaction was also significant, $F(7, 868)=6.22$, $p<.001$, partial $\eta_p^2 = .05$: 8-10-year-olds were significantly more ($p < .05$) likely than 5-7-year-olds to use the "correct" label for surprise (98%, 87%, respectively), disgust (76%, 50%), fear (63%, 50%), pride (64%, 28%), and embarrassment (54%, 22%). There was no significant difference between groups for happiness (99%, 99%), sadness (80%, 76%), or anger (82%, 84%). The Age x Mode interaction was not significant ($p = 1.00$).

Differentiation Of Emotion Categories

Children's Concepts For Emotion Showed The Same Pattern Of Differentiation With Dynamic And Static Expressions. For This Analysis, Age Group Was Redefined As Six 12-Month Groups: 5;0-5;11 (N=29), 6;0-6;11 (N=18), 7;0-7;11 (N=17), 8;0-8;11 (N=23), 9;0-9;11 (N=16), And 10;0-10;11 (N=25). Figure 2 Shows The Modal Response To

Each Facial Expression For Each Age Group. (For Ties In Modal Responses For The Same Stimulus, A Generous Decision Rule Was Used Such That The "Correct" Label Was Counted As The Mode.)

The number of different modal labels increased with age. Five-year-olds used five emotion labels modally for the eight facial expressions; 6-year-olds, six labels; 7-year-olds, seven labels; and 8- and 9-year-olds used all eight target labels. Five-year-olds used *scared* modally only for fear faces and *surprised* modally only for surprise faces. They used each of the other labels more broadly: *Angry* was used modally for both anger and disgust faces; *happy* for happiness and pride faces; and *sad* for sadness and embarrassment faces.

Differentiation of these broader categories occurred at different ages. Six-year-olds used *angry* modally only for anger and used *disgusted* modally for disgust. Seven-year-olds used *happy* for only happiness and *proud* for pride. Eight-year-olds used *sad*only for sadness and *embarrassed* for embarrassment. There were no reversals in the differentiation pattern: once children started to differentiate two emotions, all older children also differentiated those two emotions.

The same pattern was observed for both dynamic and static faces with one exception. Differentiation of *sad* and *embarrassed* occurred earlier for static than dynamic faces. When labeling static faces, 7-year-olds used *sad* for sad faces and *embarrassed* for

embarrassment. When labeling dynamic faces, 7-year-olds used *sad* for both sad and embarrassment, but 8-year-olds differentiated the two.

CONCLUSION

Contrary to many researchers' expectations, dynamic facial expressions communicated emotion to children no better than did static expressions. Consistent with a handful of other recent studies (Nelson et al., 2013; Nelson & Russell, 2011a, 2011b), the present study found no overall advantage for dynamic over static facial expressions. Indeed, the two specific reliable differences found here favored static over dynamic: Children were more likely to label the static than dynamic sad expression as *sad*. Differentiation of *sad* and *embarrassed*also occurred earlier for static than dynamic expressions.

The lack of a dynamic advantage for children is counter-intuitive. On one hand, infants attend to dynamically moving faces over static ones (Wilcox & Clayton, 1968). Children have more experience with dynamic than static facial expressions. The motion of a dynamic expression increases adults' sensitivity to changes in the expression compared to viewing a static image or a series of static images for subtle facial expressions (Ambadar et al., 2005). On the other hand, for children2years of age and older, static expressions convey emotion as well as do dynamic ones (current study; Nelson et al., 2013; Nelson & Russell, 2011a, 2011b). Perhaps the advantage of a static image of an intense prototypical facial expression comes from the opportunity to focus on just that peak moment of expression. Neither the current study nor prior studies used response time or eye tracking. It is possible that children look longer at astatic expression before

attributing an emotion to it. Studies that use these additional methods might help identify why children (and adults) are more likely to "correctly" label emotion from a static than dynamic expression.

A fascinating contrast is emerging in the literature: Intense prototypical static expressions of negative emotions are equal to or even slightly better than dynamic ones in conveying emotions to children and adults(current study; Kamachi et al., 2001; Nelson et al., 2013; Nelson & Russell, 2011b). Subtle dynamic expressions are better than static ones in conveying emotions to adults(Ambadar et al., 2005; Wehrle et al., 2000; see Krumhuber et al., 2013, for a review). Thus, one question is if this dynamic advantage for subtle facial expressions also occurs for children and at what age it emerges.

Prior research demonstrated surprisingly poor recognition of emotion and gradual improvement in children's recognition of static facial expressions (Widen, 2013). The current study found the same pattern with static expressions and extended that finding to dynamic expressions. This pattern has now been found for three types of emotion stimuli–static and dynamic facial expressions and stories describing the causes and consequences of emotions–making it unlikely that the general pattern is an artifact of the particular type of stimuli with which children are presented. Of course, lack of a significant difference must be interpreted with caution, but we are now convinced that prior findings with static facial expression replicated well with dynamic expressions. In the present study, the comparison between modes was within-subjects, and so any alternative explanation stemming from group differences can be ruled out.

Ours was a single study, and so the hypothesis about the advantages of a dynamic mode needs to be examined in other contexts and with other measures. For example, we used free labeling as our measure of recognition, and other measures of recognition will have to be examined. Free labeling has been criticized on the grounds that it taps children's (limited)productive vocabulary, rather than their emotion knowledge. However, considerableevidence now shows that the poor performance in labeling emotions from facial expressions is not a vocabulary problem (Widen, 2013; Widen & Russell, 2003, 2008b). Moreover, no nonverbal measure of recognition has emerged that demonstrates the specific emotion a child attributes to the face (for a discussion, Widen & Russell, 2008b, 2013).

The present study also replicated the finding that the child's small number of broad categories isgradually replaced by a larger number of narrower categories. Importantly, this pattern replicated with both static and dynamic facial expressions. The two findings of the present study thus complement one another in indicating that, contrary to a plausible worry about prior research, the use of static photographs of facial expressions is not the explanation for children's poor performance in emotion recognition tasks. Rather, the more likely explanation of this "poor performance" is the gradual change in the number and breadth of children's emotional categories.

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Footnotes

[1]Based on our own viewing of the videos and watching children respond to the videos in a pilot study, we were convinced that the dynamic expressions gave children ample time to view the expression at its apex. For both the dynamic and static expressions, children typically responded quickly.

[2] Although unconventional, analysis of variance can be used on binary data when the number of degrees of freedom of the error term is above 40 (Brechet, Baldy, & Picard, 2009; Greer & Dunlap, 1997; Lunney, 1970). This condition was satisfied here.

[3]In a preliminary analysis, effect of condition (dynamic male/static female vs. dynamic female/static male) was tested. The significant Condition x Mode x Emotion interaction indicated that the difference reflected a poser difference rather than a condition

difference:Children were less likely to “correctly” label the male than the female for the dynamic sad face and static sad, angry, and pride faces. Children were more likely to “correctly” label the male than the female only for the dynamic pride face.

Figure 1. Percent of children who labeled each dynamic and static facial expression "correctly."

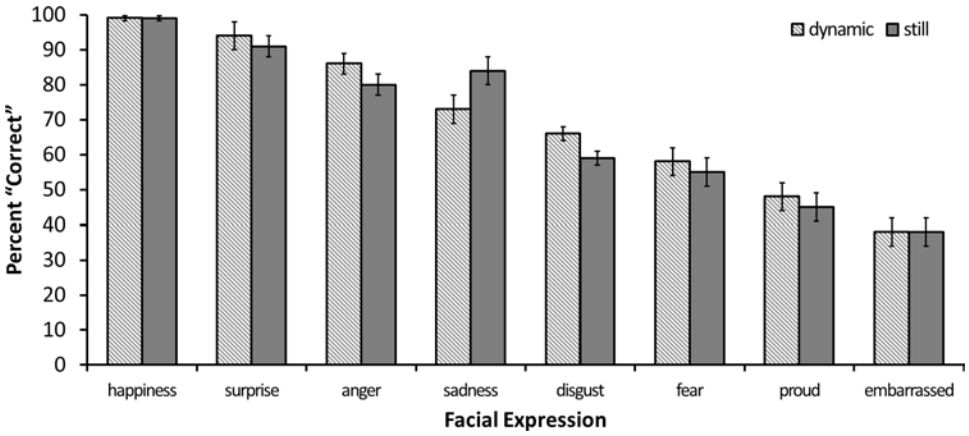

Figure 2. The modal label that was used for each facial expressions by each age group.