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Commentary

When in infancy does the “fear bias” develop?

Tobias Grossmann[a,*], Sarah Jessen[b]

[a] Department of Psychology, University of Virginia, Charlottesville, VA 22903, USA
[b] Department of Neurology, University of Lübeck, 23538 Lübeck, Germany

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ABSTRACT

Much research has focused on how infants respond to emotional facial expressions. One of the key findings in this area of research is that by 7 months of age, but not younger, infants show a bias in processing fearful faces even when compared with other negative and novel facial expressions. A recent study by Heck and colleagues (*Journal of Experimental Child Psychology*, 2016, Vol. 147, pp. 100–110) challenges this idea by showing that 5-month-olds looked longer at fearful faces than at happy and at neutral faces when dynamic displays (videos) are used. Given that previous work failed to find enhanced attention to fearful faces in 5-month-olds using static displays (photographs), this was taken as evidence that biased attention to fear can be observed earlier when dynamic information is presented. However, we computed an analysis indicating that the overall amount of motion displayed in the videos in Heck and colleagues’ study is confounded with emotion such that the greatest amount of motion is evident in the fearful face videos and may have driven infants’ looking patterns. We discuss these findings and their limitations in the context of other research using dynamic emotion stimuli. Although these findings do not rule out the possibility that 5-month-olds are sensitive to fear, we stress the need to control for physical differences such as motion before any conclusions regarding the emergence of the fear bias during infancy can be drawn and in order to improve research practice in the field.

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[*] Corresponding author.

E-mail address: grossmann@virginia.edu (T. Grossmann).

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Emotional facial expressions play an important role for human social interactions. How the sensitivity to process facial emotion develops during infancy has been studied intensively. One of the key findings in this area of research is that by around 7 months of age, but not younger, infants show a bias in processing fearful faces (see Leppänen & Nelson, 2012, for a review). Indeed, there is converging evidence using various methods, including looking time, event-related brain potentials (ERPs), and heart rate, to support the notion that 7-month-old infants show an attentional bias to fearful faces (e.g., Leppänen & Nelson, 2009; Peltola, Hietanen, Forssman, & Leppänen, 2013). This enhanced attention to fear seen in infants does not simply reflect a heightened sensitivity to any negative or novel facial expression given that it is not seen in response to angry faces (Krol, Monakhov, Lai, Ebstein, & Grossmann, 2015) or unfamiliar facial expressions (Peltola, Leppänen, Palokangas, & Hietanen, 2008). Critically, with respect to its developmental emergence, there are studies that compare 7-month-old infants with infants at younger ages (5 months) and find that it is not until 7 months that infants show increased attention to fearful faces (Jessen & Grossmann, 2016; Peltola, Leppänen, Mäki, & Hietanen, 2009).

A recent study by Heck, Hock, White, Jubran, and Bhatt (2016) challenges the idea that the fear bias develops only during the second half of the first year. In this study, the authors used videos of emotional displays (fearful, happy, and neutral) from a previously published stimulus set validated with adults (van der Schalk, Hawk, Fischer, & Doosje, 2011). Specifically, Heck and colleagues (2016) show that when using dynamic facial expressions, 5-month-old infants looked longer at fearful faces than at happy or neutral faces. Given that previous work failed to find enhanced attention to fearful faces in 5-month-olds using static displays (photographs) (e.g., Peltola et al., 2009), this was taken as evidence that biased attention to fear emerges earlier than previously thought but is only elicited when dynamic information is presented.

We agree with Heck and colleagues (2016) that the use of dynamic stimulus material is an important step in increasing the ecological validity of emotional stimuli. Dynamic information has been shown to impact emotion processing not only in adults (e.g., Carretié et al., 2009; Kilts, Egan, Gideon, Ely, & Hoffman, 2003) but also in the perception of emotional body information in infants (Missana, Atkinson, & Grossmann, 2015; Missana, Rajhans, Atkinson, & Grossmann, 2014). Extending existing work by investigating emotion perception from dynamic faces during infancy is, thus, an important endeavor.

However, although using videos may represent a more ecologically valid method to examine infants' sensitivity to emotions, it also introduces methodological difficulties in controlling for dynamic stimulus properties. In particular, the overall amount of motion may confound differences between emotional expressions. In the study by Heck and colleagues (2016) emotional videos showed a face moving from a neutral expression to either a happy or fearful expression, whereas in the neutral videos the facial expression remained the same throughout the videos. Thus, it is possible that the dynamic facial expression videos presented in this study vary systematically with respect to their overall amount of motion. Although systematic differences in motion content do not rule out the possibility that 5-month-olds are sensitive to fear, they do present a major confound that needs to be considered.

To investigate this possibility, we obtained the stimulus material used by Heck and colleagues (2016) from the Amsterdam Dynamic Facial Expression Set (ADFES; van der Schalk et al., 2011). We carried out an analysis of the amount of motion contained in the videos used by Heck and colleagues (2016) based on an established algorithm (e.g., Jessen & Kotz, 2011; Pichon, de Gelder, & Grèzes, 2008; Pichon, de Gelder, & Grèzes, 2009). This algorithm takes individual frames of the video and converts them to grayscale images in order to calculate mean change in luminance per pixel from one frame to the next. To account for random noise, only pixels exceeding a difference in luminance of 10 (on a scale from 0 to 255) are included in the analysis and averaged. This estimation is run for all consecutive pairs of frames over the entire duration of the video, and the overall average per video is computed from these values. The results of this analysis are shown in Figs. 1 and 2. As shown in Fig. 1, the amount of motion systematically varied between the three emotion conditions used in the study. Specifically, the greatest amount of motion is seen in the fearful faces, followed by the happy faces.

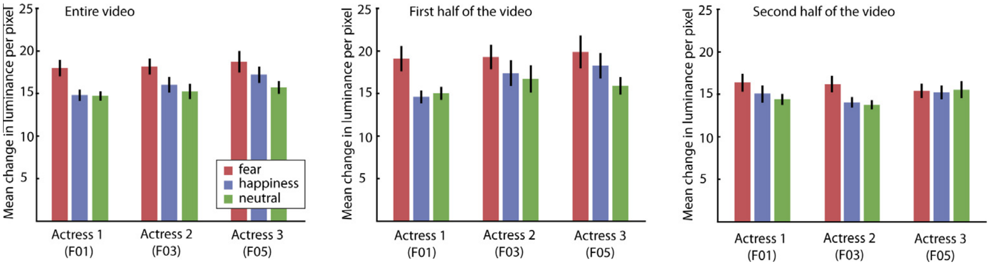

Fig. 1. Mean motion content during video. Shown is the mean motion content (±standard error) during each video used in Heck and colleagues' (2016) study, which includes videos from three actresses displaying fearfulness, happiness, and a neutral expression. Because Heck and colleagues investigated looking time only during the second half of the video, amount of motion is shown separately for the entire duration of the video (left panel), the first half of the video (middle), and the second half of the video (right panel). As can be seen, the motion content is highest for fearful expressions, smaller for happy expressions, and the smallest for neutral expressions during the entire video as well as during the first and second halves of the video.

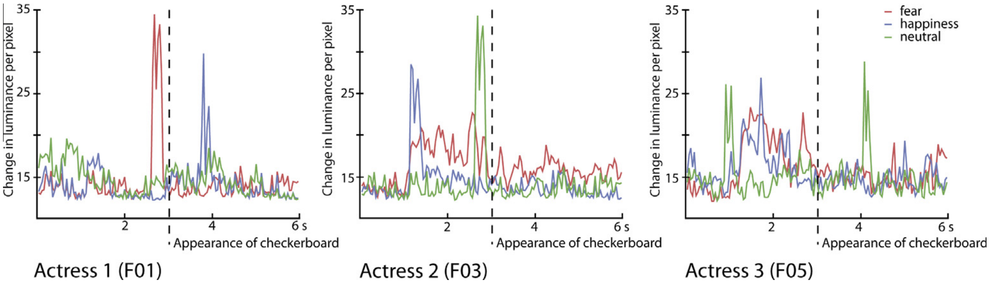

Fig. 2. Motion plotted across time over the entire video. Shown is the motion content (quantified as change in luminance per pixel) over the entire video separately for each actress and video (emotion). The appearance of the checkerboard (dashed line) marks the onset of the second half of the video, which was the main focus of analysis by Heck and colleagues (2016). The spikes correspond to very localized events in the video such as mouth opening (F01, fearful face, ~2.5 s) and eye blinks (F03, neutral face, ~2.5 s).

Neutral faces contain the least amount of motion. With the exception of one actress, this was also the case when only the second half of the videos was considered, which reflects the time window used by Heck and colleagues (2016) for their analysis (see Fig. 1). Given that 5-month-old infants looked longest at fearful face videos, and these are the face videos that also contain the most amount of motion, this appears to be a major confound. Therefore, we caution against the conclusions drawn by Heck and colleagues regarding the emergence of biased attention to fear.

More specifically, it is known that infants show a preference (increased attention) for moving stimuli over static stimuli (Volkmann & Dobson, 1976) as well as for biological motion over non-biological motion (Fox & McDaniel, 1982; Simion, Regolin, & Bulf, 2008). Therefore, it is plausible that infants show greater attention to a facial stimulus containing a greater amount of motion compared with one containing less motion irrespective of the emotional expression displayed by the face.

Here it is important to mention that Heck and colleagues (2016) also tested 3.5-month-old infants and did not find any evidence that infants at this younger age distinguished between the dynamic facial expressions. The finding that 3.5-month-olds did not show the same effect as 5-month-olds could be used to argue that the motion confound, which we identified above, is unlikely to account for the effect of the dynamic fearful faces because then it should also be seen in the 3.5-month-olds. However, based on the means reported in this study, the 3.5-month-olds appear to generally look less at the facial expressions than the 5-month-olds (marginally significant) and, thus, may fail to show any statistically significant differences between conditions (looking to fearful faces is nominally higher also in the 3.5-month-olds; see Fig. 2 of Heck et al., 2016). Furthermore, although already young infants show a high sensitivity in processing local visual motion, the processing of global visual information develops only later in infancy (Hou, Gilmore, Pettet, & Norcia, 2009). For instance, it is not until 5 months of age (Booth, Bertenthal, & Pinto, 2002) that infants reliably show sensitivity to global motion during visual processing, which might be needed to detect motion differences in the dynamic face displays. In addition, 5-month-olds, but not 3-month-olds, show sensitivity to the movement of inner facial features (Johnson, Dziurawiec, Bartrip, & Morton, 1992). Thus, there might be reasons why 3.5-month-olds failed to show sensitivity to the amount of motion of the inner facial features displayed in the dynamic facial expressions.

Another important point to consider is infants' looking behavior during the first half of the video, which was not the main focus of the analysis by Heck and colleagues (2016). Although Heck and colleagues did not find any differences in looking time, the videos clearly differed in motion content (see Fig. 1). Crucially, during this time period, the face video was presented in isolation (i.e., without the checkerboard as a competing stimulus), but no differences between emotions were obtained. This is in contrast to previous studies with older infants, which report differences in looking time to different emotions when the faces were presented without a distractor (Hunnius, de Wit, Vrins, & von Hofsten, 2011; Jessen, Altvater-Mackensen, & Grossmann, 2016). This discrepancy with prior work (i.e., the absence of any emotion effect in Heck et al.'s (2016) study for the looking time measurement when the face was presented in isolation) further challenges Heck and colleagues' conclusion that 5-month-old infants are able to discriminate between facial emotions.

Another line of research to consider is work on the early development of emotion perception using emotional body expressions (Missana et al., 2015; Missana & Grossmann, 2015). Whereas previous studies on face processing typically used static displays, studies investigating emotional body expressions often use video material. Recent studies on emotional body perception during infancy may provide important clues about the potential impact of using dynamic emotional stimuli. For example, Missana and colleagues (2015) presented 4- and 8-month-old infants with dynamic point-light displays of happy and fearful body expressions and measured ERPs. This study shows that 8-month-olds, but not 4-month-olds, distinguished between happy and fearful body expressions. Therefore, in contrast to the current findings by Heck and colleagues (2016), Missana and colleagues (2015) did not find an earlier onset of emotion discrimination when dynamic information was used. Instead, the findings from using dynamic emotional body expressions are in line with previous work using static fearful and happy facial expressions (Peltola et al., 2009, 2013), suggesting that infants' ability to discriminate these emotions from facial and body cues undergoes similar development between the first and second halves of the first year of life. Critically, Missana and colleagues (2015) obtained these findings when controlling for overall amount of motion contained in the dynamic emotion displays used. In addition, this study revealed differences between processing fear and happiness only when point-light displays were presented in an upright orientation but not when presented upside-down. This provides further evidence that motion cannot account for the differences seen at 8 months of age because the same motion content was present in the inverted stimuli.

Further evidence for the similarity in processing emotions from faces and bodies comes from another recent ERP study in which Missana and colleagues (2014) used static fearful and happy body expressions and found that 8-month-old infants discriminate between happy and fearful bodies, showing similar neural signatures as in previous ERP work using happy and fearful facial expressions. Indeed, most recently, Rajhans, Jessen, Missana, and Grossmann (2016) showed that 8-month-olds match body and face when processing fear and happiness. Therefore, the existing evidence from multiple studies, including dynamic stimuli, stands in contrast to Heck and colleagues' (2016) evidence and suggests that detecting fear from body and facial expressions undergoes development later than argued by Heck and colleagues.

Another important line of research with respect to the use of dynamic stimulus material comes from the investigation of multisensory emotion processing during infancy (e.g., Flom & Bahrick, 2007; Vaillant-Molina, Bahrick, & Flom, 2013; see Walker-Andrews, 1997, for a review). In this area of research, videos are commonly paired with auditory information, and several studies show that, using multisensory stimuli, sensitivity to differing emotional expressions can already be observed at 5 months of age. For example, Vaillant-Molina and colleagues (2013) used videos of positive and negative facial expressions along with positive and negative vocal utterances, and provided evidence that at 5 months of age, but not younger (3.5 months), infants are able to match happiness/joy compared with anger/frustration. Although these findings suggest sensitivity to emotional content at 5 months of age, this early onset can probably be attributed to the multimodality rather than the dynamics of the stimulus material. In fact, when comparable stimuli are used in isolation (i.e., only visual or auditory information is provided), sensitivity to emotional content was observed only at 6 months for auditory information and at 7 months for visual information (Flom & Bahrick, 2007). Crucially, Flom and Bahrick (2007) used videos in their study and observed sensitivity to emotions only at 7 months of age, but not younger, providing further support for the notion that dynamic content alone might not be sufficient to enable emotion discrimination at 5 months of age.

In summary, although we agree that it is important to extend existing work by relying more on ecologically valid emotional stimuli, including videos, in developmental research with infants, we also emphasize the importance of controlling for potential differences in physical stimulus properties. Controlling for the overall amount of motion contained in experimental video stimuli appears to be one vital measure that can be taken to improve existing methods. Moreover, it is essential to stress that this issue not only is relevant for the work discussed here but also, more generally, applies to research that relies on methods that are susceptible to motion characteristics such as looking time and ERPs.

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