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Comment: Emotions Are Abstract, Conceptual Categories That Are Learned by a Predicting Brain

Katie Hoemann [iD]

Madeleine Devlin
Department of Psychology, Northeastern University, USA

Lisa Feldman Barrett
Department of Psychology, Northeastern University, USA
Department of Psychiatry, Massachusetts General Hospital, USA
Martinos Center for Biomedical Imaging, USA

Abstract

In their review, Ruba and Repacholi summarize the methods used to assess preverbal infants' understanding of emotions, and analyze the existing evidence in light of classical and constructionist accounts of emotional development. They conclude that aspects of both accounts are plausible and propose a perceptual-to-conceptual shift in infants' emotional development. In this comment, we clarify the nature of emotions as abstract, conceptual categories and suggest that infants may learn them as such from the start by using language to infer functional similarities across highly variable instances. This hypothesis is supported by predictive processing accounts of brain function, which can speak to the context-dependent nature of emotion and may be able to resolve debates in the study of emotion concept development.

Keywords

In their review of early emotion concept development, Ruba and Repacholi (2020) provide a summary of the methods used to assess preverbal infants' understanding of emotions, and the factors that complicate the debate between classical and constructionist accounts. Further, the authors highlight the role language plays in concept development, and how findings from the object categorization literature may be applied to emotion categories. They conclude that aspects of both classical and constructionist accounts of emotional development could be plausible given the available evidence, yet propose questions and hypotheses for future research. In particular, Ruba and Repacholi suggest that infants' emotional abilities can be classified as perceptual versus conceptual (e.g., Eimas, 1994; Quinn & Eimas, 1997). In this comment, we clarify the nature of emotion categories as abstract and conceptual. Rather than understanding the developmental trajectory as a perceptual-to-conceptual shift, however, we sug-

Corresponding author: Katie Hoemann, Department of Psychology, Northeastern University, 360 Huntington Ave, 125 Nightingale Hall, Boston, MA 02115-5005, USA.
Email: khoemann@gmail.com

gest that infants learn emotion categories as abstract (i.e., conceptual) from the start. This reframing brings with it new challenges for the study of emotional development, including the role of language. On this point, we suggest that recent research from neuroscience and related disciplines can be brought to bear in interpreting the infancy literature, formulating biologically plausible hypotheses for emotional development, and integrating affective and developmental science.

By and large, research on emotional development has assumed that emotion categories are either classical (natural kind) categories or prototype categories (for a review, see Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019). According to a classical account (e.g., Ekman, 2017; Izard et al., 1995), instances of the same category share a common set of necessary and sufficient features, whereas instances of different categories have clearly distinguishing features. According to a prototype account (e.g., Cowen & Keltner, 2017; Russell, 1991), instances of the same category share a degree of typicality with a single mental representation, resulting in more within-category variation and between-category similarity than for a classical category. Yet, empirical evidence suggests that instances of emotion categories are more heterogeneous still, describing substantial variation within categories as well as similarity between categories. This variation manifests in studies of peripheral physiology (e.g., Siegel et al., 2018), brain imaging (e.g., Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012), facial muscle movement (e.g., Barrett et al., 2019), emotion functions (e.g., Ceulemans, Kuppens, & Mechelen, 2012), and affective experience (e.g., Wilson-Mendenhall, Barrett, & Barsalou, 2013, 2015).

These findings support the hypothesis that emotion categories are abstract, conceptual categories whose instances are yoked together by their situated, functional similarities, and need not share observable similarities (Barrett, 2017a; Hoemann, Xu, & Barrett, 2019). To put this in terms of the distinction applied by Ruba and Repacholi (2020), instances of the same emotion category may share conceptual but not perceptual features. If this is the case, then right off the bat infants must learn to establish functional similarity based on the context-specific goal met by each emotional instance. Instances involve different bodily sensations, actions, perceptions, and yet may share a similar purpose in a given situation. Existing evidence might seem to support a perceptual-to-conceptual shift because infants' learning task has been misspecified as one of identifying perceptual similarities among instances: studies have been limited in their ability to capture how and when infants learn to transcend perceptual features and infer functional similarities. Until infants are able to do so, they may only experience and perceive affective dimensions such as valence and arousal, rather than specific categories of emotion (e.g., anger, fear, happiness).

This is where language comes in. As reviewed by Ruba and Repacholi (2020) among others (e.g., Gelman & Roberts, 2017; Perszyk & Waxman, 2018), studies on object categorization suggest that words encourage infants to impose similarities on physically different instances (or impose differences on physically similar instances), thereby delineating category boundaries. In this way, words have been shown to be useful for learning concrete categories whose instances may share statistical regularities in their perceptual features. But, we hypothesize, words may be essential for learning abstract, conceptual categories, such as emotions, that do not show such regularities. To date, however, the precise role of words in emotional development has been underspecified. Predictive processing accounts of brain function provide just such a framework for emotion concept development in relation to language (e.g., Hutchinson & Barrett, 2019).

Advances in neuroscience and computational modeling suggest that the brain operates as an internal model of the body in the world, flexibly recombining previous experience to issue predictions about what sensory input is most likely to occur (e.g., Barrett, 2017b; Clark, 2013; Friston, 2010). These predictions prepare the body for action while simultaneously making meaning of the incoming sensory array. As such, predictions can also be understood as ad hoc concepts that attempt to categorize sensory inputs to achieve a situation-specific purpose. As the developing brain accrues experience, it hones the ability to construct predictions efficiently and according to the concepts of its culture. To categorize sensory inputs as instances of emotion, the developing brain must have previous experiences that have been "tagged" as these emotions. We hypothesize that emotion words serve this purpose, guiding infants to find functional similarity between instances, and make emotional meaning of their internal and external context.

As Ruba and Repacholi (2020) note, there are many outstanding questions about emotion concept development, including the exact role words play (for discussion, see Hoemann et al., 2020; Hoemann et al., 2019). We second the authors' insight that, to answer these questions, developmental and affective scientists must work together. We would extend this invitation to linguists, neuroscientists, and more; fully interdisciplinary collaboration is necessary to map the social, physiological, and cognitive mechanisms underlying emotional development. As a foundation for this collaboration, however, there must be a biologically based and computationally tractable framework for generating and testing hypotheses. A predictive processing account of brain function can speak to the highly variable and context-dependent nature of emotion, and may be able to resolve the debate between classical and constructionist approaches to emotion concept development.

ORCID iD

Katie Hoemann https://orcid.org/0000-0002-9938-7676

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Beyond Language in Infant Emotion Concept Development

Ashley L. Ruba [iD]
Department of Psychology, University of Wisconsin – Madison, USA

Betty M. Repacholi
Department of Psychology, University of Washington, USA

Abstract

The process by which emotion concepts are learned is largely unexplored. Hoemann, Devlin, and Barrett (2020) and Shablack, Stein, and Lindquist (2020) argue that emotion concepts are learned through emotion labels (e.g., "happy"), which cohere variable aspects of emotions into abstract, conceptual categories. While such labeling-dependent learning mechanisms (supervised learning) are plausible, we argue that labeling-independent learning mechanisms (unsupervised learning) are also involved. Specifically, we argue that infants are uniquely situated to learn emotion concepts given their exceptional learning abilities. We provide evidence that children learn from complex, irregular input in other domains (e.g., symbolic numbers) without supervised instruction. Thus, while labels undoubtedly influence emotion concept learning, we must also look beyond language to create a comprehensive theory of emotion concept development.

Keywords

emotions, infants, language, supervised learning, unsupervised learning