Clarifying the Conceptualization, Dimensionality, and Structure of Emotion: Response to Barrett and Colleagues

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Abstract

We present a mathematically based framework distinguishing the dimensionality, structure, and conceptualization of emotion-related responses. Our recent findings indicate that reported emotional experience is highdimensional, involves gradients between categories traditionally thought of as discrete (e.g., 'fear', 'disgust'), and cannot be reduced to widely used domain-general scales (valence, arousal, etc.). In light of our conceptual framework and findings, we address potential methodological and conceptual confusions in Barrett and colleagues' commentary on our work.

Our study recently published in *Proceedings of the National Academy of Sciences* [1] and commented on by Barrett and colleagues [2] in *Trends in Cognitive Sciences* applies a mathematically based framework to the study of reported emotional experience. Barrett and colleagues' commentary frames our work as the 'latest installment' in a longstanding debate between discrete/categorical and dimensional/constructionist theories of emotion. Are emotions discrete categories, or are they constructed from continuously varying, domain-general dimensions? From our perspective, this framing of our paper conflates several questions about emotion and may leave readers with a mistaken impression of our findings. We believe our findings are better situated within a new framework that distinguishes among the dimensionality, structure, and conceptualization of emotion-related responses.

The dimensionality of emotion concerns the number of distinct varieties of emotion needed to characterize variation in emotion-related responses. How many kinds of emotion are there? The structure of emotion concerns the distribution of emotional states along these dimensions. Are anger and disgust, or love and desire, distinct clusters of states or states bridged by continuous gradients? The conceptualization of emotion concerns the nature of the concepts that characterize emotion-related responses. Are emotion categories fundamental, or can emotion-related responses be described in non-emotion-specific terms, such as degrees of 'valence' and 'arousal'? Figure 1A represents this framework as it applies to reported emotional experience.

Based on this conceptual approach, in our study we use large-scale statistical inference to investigate the dimensionality, structure, and conceptualization of emotional responses to 2185 videos. Dimensionality is determined by finding the number of dimensions, or linearly

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separable patterns of emotion judgments, needed to explain the emotions people reliably report in response to the same videos. We find that this requires at least 27 dimensions: emotional experience is much richer in variety than typically assumed (most current taxonomies detail 10–15 distinct states). Structure is addressed by measuring how states are distributed along these dimensions. We uncover continuous gradients between categories traditionally thought of as discrete. Finally, conceptualization is addressed by modeling whether domain-general concepts drawn from theories of emotional appraisal/construction (valence, arousal, dominance, etc.) explain reported emotion categories. We find that these domain-general concepts are unable to fully explain reported emotional experience (Figure 1B). Emotion categories (e.g., 'awe') seem to be fundamental to conceptualizing reported emotional experience and are not reducible to a small set of domain-general concepts. These methods and findings inform the taxonomy of emotional experience and can readily be applied to other modalities of emotion-related response.

Beyond their framing of our study, Barrett and colleagues' commentary misinterprets the nature of our methods. With reference to our method for determining the dimensionality of reported emotional experience, they assert that canonical correlation analysis (CCA) is a 'confirmatory data-analytic approach'. This assertion is critical in light of concerns that investigators' preconceptions define the taxonomies of emotion they eventually discover [7]. Barrett and colleagues effectively raise questions about whether our preconceptions influenced the dimensionality we found. In point of fact, CCA is unsupervised/discovery-based, and not confirmatory [8–11]. It inductively estimated the number of dimensions required to explain similarities in participants' reported emotional experiences.

As an alternative to CCA, Barrett and colleagues recommend determining how many dimensions involve more than one feature (eigenvalue > 1), a conventional factor-analytic approach. In our study, we explain why we move beyond conventional factor analysis, which disregards the reliability of reports of individual items and thus cannot identify whether an individual category, like awe, is reported differently than every other category. CCA reveals this is true for many categories by incorporating the reliability of reports of individual categories in addition to correlations between categories.

Regarding Barrett and colleagues' characterization of our findings regarding the conceptualization and structure of emotion, we offer two more minor, but important, clarifications. Barrett and colleagues state that 'The similarity and differences among categories [could] be described by their proximity along affective scales such as valence, arousal, effort, and so on.' There is no doubt that emotion categories can be compared in terms of features such as valence and arousal. However, what our findings critically show is that the placement of videos along scales of valence, arousal, etc. is insufficient to explain the reported categories of emotional experience they reliably elicit. Thus, widely used affective scales do not capture the similarities and differences among categories of emotion.

Barrett and colleagues also state that emotional experiences were 'structured as 27 emotion clusters (i.e., categories)'. It is a position of discrete emotion theories that emotion categories correspond to clusters. What we find is that categories describe 27+ linearly separable dimensions of reported emotional experience. With respect to the structure of
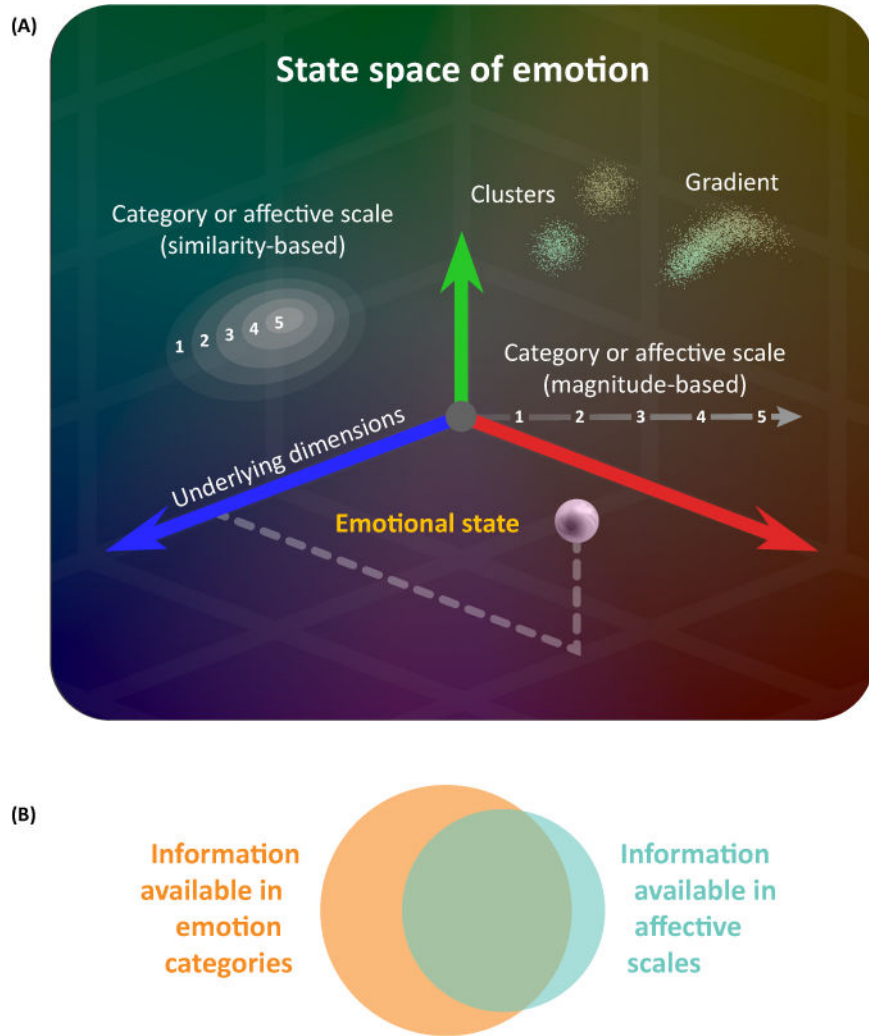
emotion, we find that reported emotional experience is 'neither simply clustered nor uniform'.

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Figure 1.

(A) A state space of emotion underlying reported emotional experience. The number of dimensions (colored vectors) determines the dimensionality [3], or variety, of emotion. The distribution of emotional states within clusters (discrete families of states) or gradients bridging broadly different states [4] determines the structure of emotion [3]. How categories and affective scales describe the space, and whether each are separately sufficient to infer the emotional state, determines the conceptualization [5] of emotion. Numbers represent a report of the magnitude of a given feature (1–5 Likert) or quantity of individuals reporting it ($n = 5$), which can be used similarly to infer position in the state space [6]. (B) Degree to which the explainable variance in category judgments was captured by affective scale judgments, and vice versa. Reported experiences of 34 emotion categories (e.g., amusement, awe) largely captured the information available in 14 commonly-measured affective scales (e.g., valence, arousal, safety) but to a large extent could not be explained by the affective scales.