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DOI:
10.53841/bpscog.2023.1.8.47

Document Version
Peer reviewed version

Citation for published version (Harvard):
Keating, C & Cook, J 2023, 'ExpressionMap: a novel method for indexing features of visual emotion representations', *Cognitive Psychology Bulletin*, no. 8, pp. 47-50. https://doi.org/10.53841/bpscog.2023.1.8.47

ExpressionMap: A novel method for indexing features of visual emotion representations

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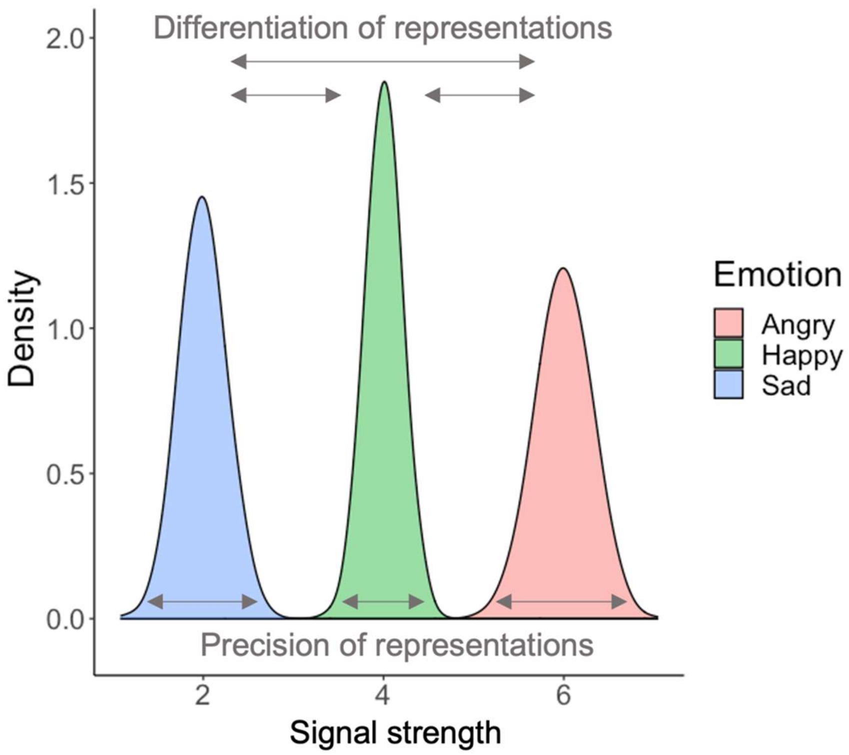
Keywords: Emotion Representations, Facial Expressions

The study of visual representations of emotion - the way facial expressions look in the "mind's eye" – is a burgeoning field (e.g., Jack, Garrod, Yu, Caldara & Schyns, 2012; Jack, Garrod & Schyns, 2014; Jack, Sun, Delis, Garrod & Schyns, 2016; Chen, Garrod, Ince, Schyns & Jack, 2021). This is unsurprising since studying visual emotion representations uniquely allows us to identify the precise contribution of different types of face information (e.g., face movements, morphology, complexion, etc.) to the judgements we make about others (e.g., "they look happy", "they look trustworthy"; Jack & Schyns, 2017). Studying visual representations of emotion, however, is methodologically challenging. Existing studies often adopt psychophysical approaches (e.g., reverse correlation) to index emotion representations, and compare them across emotions (e.g., Jack, Garrod & Schyns, 2014; Chen et al., 2018), cultures (e.g., Jack, Caldara & Schyns, 2012; Jack, Sun, Delis, Garrod & Schyns, 2016), and participant groups (e.g., Pichon et al., 2020). One significant advantage of these psychophysical approaches is that they permit construction of *comprehensive* visual representations of facial expressions, which can vary across numerous dimensions (e.g., acceleration, peak amplitude, onset latency, offset latency, etc.). As such, researchers can quantify many aspects of participant's imagined emotional expressions. However, these methods typically require thousands of trials and take several hours or more to complete.

Mitigating this limitation, Carlisi and colleagues (2021) employ a genetic algorithm framework to index visual emotion representations. In their task, on each trial participants are shown 10 computer-generated faces and are required to select three expressions that most closely represent the target emotion. Across trials, the genetic algorithm combines features from the chosen expressions (with noise added, or "random mutations") until the "gene pool" (of facial expressions) converges or evolves toward the participant's ideal visual emotion representation (Carlisi et al., 2021). Since this approach requires considerably fewer trials it presents exciting opportunities for quantifying expression representations in contexts where long-duration experiments are infeasible. At present, however, this approach has only been applied to static representations (i.e., snapshots of emotional facial expressions at peak). Further work is required to capture dynamic features - such as the kinematics and temporal unfolding - that are known to be important emotion cues (e.g., Sowden et al., 2021; Jack et al., 2014).

The aforementioned tasks are useful when one wants to capture what individuals see in their mind's eye when they imagine static or dynamic emotional facial expressions. However, these paradigms typically overlook accompanying features of these representations, for example the precision (i.e., how clear the representation is) or differentiation of visual emotion representations (i.e., how well differentiated the visual emotion representations are for distinct emotions; see Figure 1). Nevertheless, indexing the precision and differentiation of emotion representations should be a priority since these features a) may also vary across emotions, cultures, and participant groups (just like the appearance of these representations), and b) determine how well individuals can recognize their own and others' emotions (see Keating & Cook, pre-print). For example, people from East Asian cultures (relative to those from Western cultures) have less differentiated (i.e., more overlapping) visual representations of fear and disgust (Jack et al., 2012), potentially leading to difficulties recognizing these expressions (Jack et al., 2009).

Figure 1: A diagram illustrating what we mean by the precision and differentiation of visual emotion representations.

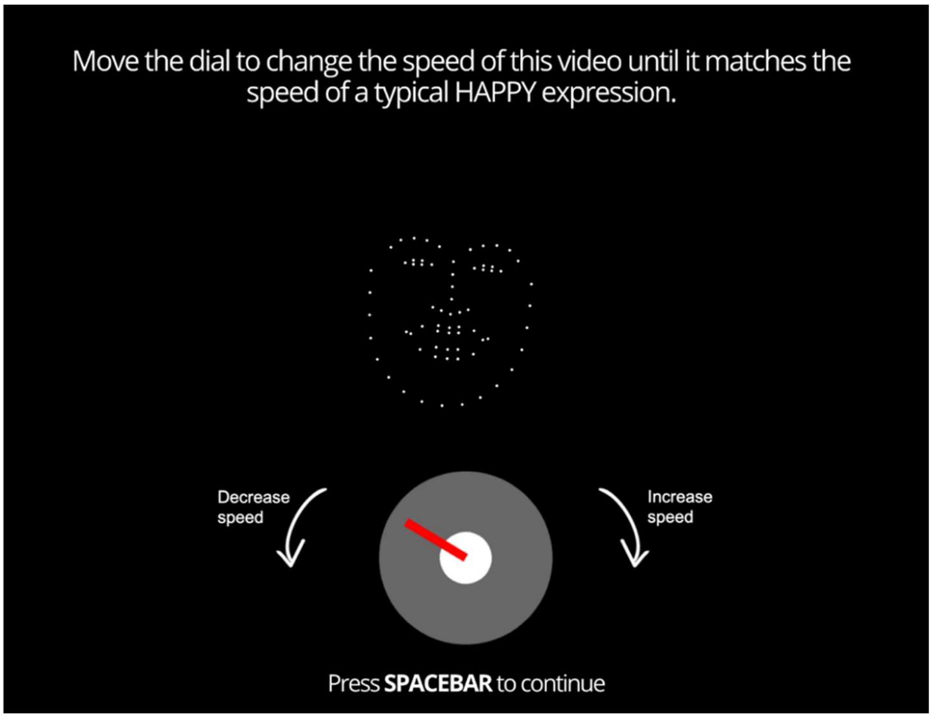


Introducing ExpressionMap: A novel tool for indexing the precision and differentiation of visual emotion representations

The ExpressionMap paradigm (see Keating & Cook, pre-print) is a novel tool for indexing the precision and differentiation of visual emotion representations. In this task (which employs the method of adjustment design), on each trial participants are asked to move a dial to change the speed of a moving facial expression until it matches the speed they would typically associate with an angry, happy, or sad expression (and thus they are matching to their visual emotion representation; see Figure 2). Point light displays of facial expressions (PLFs) are used to encourage participants to focus on dynamic cues. This task follows the logic that, relative to participants with precise visual representations, those with less precise representations would attribute more variable speeds to the expressions (see Keating & Cook, 2022). For instance, someone with a precise representation of happiness would be consistent in their attributions (e.g., by attributing 1.20 pixels/frame, 1.21 pixels/frame, and 1.19

pixels/frame to the happy expression). In contrast, someone with a less precise representation would be more variable (e.g., by attributing 2.50 pixels/frame, 0.60 pixels/frame, and 5.80 pixels/frame). In addition, an individual that has highly overlapping representations of the speed of anger, happiness and sadness would attribute more similar speeds to these expressions than those with more distinct imagined representations of these expressions.

Figure 2: The screen shown to participants on each trial. Participants can move the dial clockwise to increase the speed of the animation or anticlockwise to decrease the speed of the animation.



To our knowledge, "ExpressionMap" is the first task specifically designed to index the precision and differentiation of visual emotion representations - abilities now known to be important for reading other's emotions (see Keating & Cook, pre-print). This paradigm has great utility: ExpressionMap features intricately designed attention checks, can be completed online and, by employing method of adjustment, only takes 20-30 minutes to complete. As mentioned previously, it is worth noting that this task may serve a different function to that of traditional methods. Whilst traditional methods aim to build up comprehensive representations of emotional facial expressions, ExpressionMap seeks to assess accompanying features of those representations (e.g., speed of expressions, precision of visual representations differentiation of visual representations).

Next steps

At present the ExpressionMap paradigm focuses specifically on the speed of facial expressions. Whilst this was an active design choice, motivated by previous literature illustrating a causal role for speed cues in emotion recognition (Sowden et al., 2021; and other *a priori* hypotheses not discussed here; Keating, Fraser, Sowden & Cook, 2022; Keating, Sowden & Cook, 2022), in future work we will further develop the ExpressionMap paradigm to encompass other spatiotemporally varying emotion cues (e.g., degree of spatial exaggeration, movement onset/offset, texture and colour).

Acknowledgements
We thank the British Psychological Society Cognitive Section for awarding us the grant. The funds were used to offset the costs of online testing (e.g., recruiting participants via Prolific).

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