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Categorical Perception of Facial Affect: An Illusion

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ABSTRACT

Facial affect is central to many VMC & affective computing applications, which often compress motion or frame-rate to reduce video bandwidth. Our studies show that claims that "categorical perception" effects protect facial affect from temporal degradation are illusory. Preserving motion is essential, even at the cost of image compression.

Keywords

Facial affect**,** facial expressions, video compression, VMC

INTRODUCTION

The effectiveness of facial expressions in communicating emotion (or "affect") makes it a topic of great import to video-mediated communication (VMC) and affective computing [3]. As online bandwidth increases, VMC becomes increasingly commonplace. Affective computing AI models are beginning to recognize facial expressions in video, with many potential applications (e.g., unobtrusive product testing, stress & lie detection, affective avatars). Possibilities seem limitless, but current applications still suffer from bandwidth constraints or prohibitive compute times. The usual compensatory strategy is to lower temporal resolution (compressing or reducing frame-rate), often with severe losses in visual dynamics [1].

Recent psychological studies claim that facial affect shows "categorical perception", an illusion which could make it especially robust under temporal degradation. [4]. AI modeling has already begun [2]. Categorical perception refers to an illusory tendency towards phenomenal assimilation (enhanced similarity) of items within a perceptual category, and contrast (enhanced distinction) between categories. Such effects have been useful in other domains, most notably speech recognition [1]. Facial expressions develop over time yet change abruptly. The net effect of categorical perception would be to blur the distinction between images of an emotion during its trajectory, but also to sharpen the detection of a new emotion. Thus, an emotion should be perceived fairly consistently across its trajectory, while changes in emotion should be quickly detected, even under compression or low frame-rate conditions.

Categorical perception is assessed through identification and discriminability tasks. Prototypical exemplars from two distinct categories are morphed to create an interpolated continuum of equal physical intervals. Categorical perception predicts that identification should be at asymptote for category prototypes at the continuum endpoints, with a sharp boundary region of abrupt change in the middle values. Discrimination between equally-spaced stimuli should peak at the category boundary. Previous studies of categorical perception of facial affect suffer from significant methodological flaws, including limited image quality or quantity, and unsystematic experimentation. The standard ("ABX") discriminability task imposes an unnecessary memory load. And "forced-choice" response formats are standard for both tasks. Forced-choice methods may bias results, making what is perceived continuously appear categorical. We addressed this issue and its import for affective applications in a recent paper [3].

In this study, we systematically investigate categorical perception of facial affect using improved methods and materials from our previous work [1,3]. Extremely high quality images and morphs were used. For identification, an alternative to the forced-choice format permitted multiple and open-ended responses. A direct comparison with naturalistic transitions was added, to compare identification of morphed transitions with that of actual movement. For discriminability, a simultaneous same/different task was used to avoid memory load and forced-choice response bias. To the extent that the results appear categorical, facial affect perception may be expected to be robust under temporal (& perhaps other) degradations.

EXPERIMENT

Method

Participants

60 local university students participated, 40 in the identification, and 20 in the discriminability, tasks.

Materials

Forty-nine full-color, full-resolution 8" digital video clips were made of 2 actors transitioning between all pairs of 7 emotional expressions (anger, disgust, fear, happiness, sadness, surprise, neutral). *Naturalistic transition* images comprised 9 frames taken at 1-sec intervals. *Morphed transition* images included the first & last frames plus 7 equally-spaced morphs (Gryphon Morph) between them.

Procedure

Identification Task

Participants viewed images from either morphed or naturalistic transitions from 1 actor (counterbalanced) on a 20" video monitor and made a "multiple-choice" [3] response on a PowerMac. The response screen showed an alphabetized list of the 7 emotional expressions plus "other:" with a 7-pt intensity rating scale. 10 practice & 216 test trials were done in random order in < 1 hour.

Discriminability Task

Participants viewed pairs of images from morphed angry, fearful, happy and sad transition continua for 1 actor. Image pairs were either of the same frame or 1 step apart (e.g., frames 0 & 2, 1 & 3); each was shown 5 times. The response task was to type in whether each pair showed the same ("S") or different ("D") images. Ten practice & 1080 self-paced test trials were done randomly, in < 1.5 hours.

Results and Discussion

Analyses are in progress, but initial results argue strongly against categorical perception. Figure 1 shows overall proportion of morphed transitions assessed as *continuous* (v *categorical*) in the identification data. Multiple responses per frame were counted for each transition.

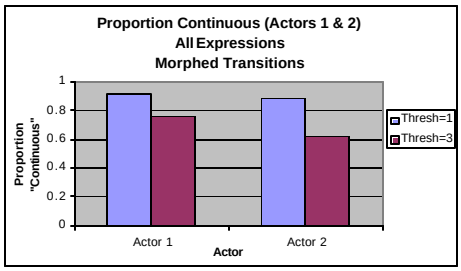

Figure 1. Proportion of transitions assessed as showing *continuous* perception in the identification task.

Lenient (1+ frame with multiple responses) and strict (3+ frames) thresholds were used to assess continuousness. Most transitions were continuous even under the strict criterion. Individual transitions showed little evidence of sharp boundaries after asymptotic categorization. Initial findings for naturalistic images show the same pattern.

For the discriminability task, Figure 3 shows overall proportion of correct discrimination across transitions. Categorical perception requires a sharp peak in discriminability at the category boundary; the data does not support this. Reaction-time results are similar.

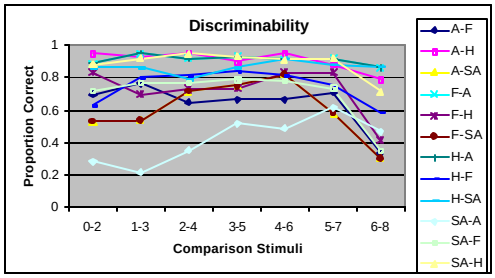

Figure 2. Proportion correct responses for 2-step pairs in the discriminability task.

The studies described here are part of a large research effort on facial affect perception and its applications. The present results converge well with our previous work establishing new methods and baselines for affect recognition [1] and exploring the role of motion cues in disambiguating degraded images [3]. Further research will systematically compare natural and compressed motion. Designers of VMC and affective computing applications must make tradeoffs to deal with limited bandwidth or large compute times. Decisions to compress video or reduce frame-rate directly affect visual dynamics and require caution. Our previous work demonstrated that facial affect is perceived well in highly degraded images if motion cues are preserved, suggesting that compressing images (spatial & color resolution) rather than motion cues (temporal resolution) [3] be considered. The hope that categorical perception would provide special protection for facial affect perception against temporal degradations is apparently itself an illusion.

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