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Disambiguating auditory information causes priming, but not aftereffects, in the perception of ambiguous faces

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In five experiments, we used a visual aftereffects paradigm to probe whether emotion- and gender-relevant information presented in the auditory domain would affect the formation of visual aftereffects or would instead create a priming effect. In experiment 1, participants fixated on surprise facial expressions while listening to a story that described the surprise as either happy or sad, and then were asked to classify the expression of a briefly presented neutral face. Subsequently, the identity of the model (experiment 2) and the timing of the auditory presentation (experiment 3) were manipulated. In experiment 4, this approach was extended to judgments of gender. Experiment 5 serves as a control experiment in which the story, but no visual stimuli, was presented during the adaptation phase. In each case results revealed evidence of priming, but no evidence that information in the auditory domain affected the formation of aftereffects.

1. Introduction

The central aim of this set of experiments was to test for top-down cross-modal effects of auditory information, during the perception of faces that are ambiguous with respect to emotion valence or gender. Faces are special visual objects (Farah, Wilson, Maxwell Drain, & Tanaka, 1995; Yin, 1969; Young, McWeeny, Hay, & Ellis, 1986), perceived using dedicated perceptual processes (Kanwisher & Yovel, 2006). It is reasonable to expect top-down influence on face perception: top-down information could help to disambiguate facial signals in some contexts. For example, if a person's facial expression is ambiguous, their tone of voice could provide additional emotional information that would influence visual processing, allowing the system to disambiguate the facial expression. If a person's gender is ambiguous, voice information could disambiguate the visual signal. This study tested whether top-down perceptual effects of disambiguating auditory information are consistent with visual aftereffects, or with priming effects.

1.1. Aftereffects

Visual aftereffects occur when prolonged exposure to a visual stimulus affects the perception of a subsequently viewed stimulus. After fixating on a visual stimulus, the perception of subsequent stimuli is more psychologically distinct from the fixated stimulus than it otherwise would have been. For example, following prolonged exposure to a happy facial expression, a subsequently viewed neutral expression might be judged to be sad. This phenomenon has been documented in several domains, including color (see Smithson & Zaidi, 2004, for review), haptic space (Gibson & Backlund, 1963), tilt (Gibson, 1937), and auditory motion (Shu, Swindale, & Cynader, 1993). Such adaptation can be used to reveal psychological relationships: color aftereffects provide evidence for opponent coding of color and adapting to an emotion expression leads to the perception of a neutral stimulus as the opposite emotion (e.g. Rutherford, Chattha, & Krysko, 2008). Face aftereffects occur with respect to a variety of facial information, including gender (Davidenko, Winawer, & Witthoft, 2006; Jaquet & Rhodes, 2008) attractiveness (Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003) emotion (Cheal & Rutherford, 2013; Rutherford, Troubridge, & Walsh, 2012; Rutherford et al., 2008) and age (Little, DeBruine, Jones, & Waitt, 2008) was well as the distortions of identity information (Webster & MacLin, 1999).

1.2. Evidence of top-down processing in face perception

The aftereffects phenomenon can be exploited to probe top-down effects of face processing. For example, in an investigation of gender aftereffects, Davidenko, Winawer, and Witthoft (2006) found evidence of aftereffects when participants were adapted to black and white silhouettes of faces in profile, but viewed gray-scale photos of full faces at

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test, and when participants adapted to right-facing silhouettes but viewed left-facing (or vice versa) silhouettes at test (Davidenko et al., 2006). Since the adapting image and the test image cast different retinal images, this study provides convincing evidence that aftereffects rely on higher-level processing.

Fox and Barton report a study in which they varied the adapting stimuli and tested for facial expression aftereffects. If the model depicted in the adapting image was different from the model depicted in the test image, the aftereffect was weaker than if the model was the same. The authors saw this as evidence that there was a neural representation of the emotion that was independent from the representation of the individual. However, there was no face aftereffect if the adapting stimulus was an auditory or verbal representation of the target emotion, leading the authors to conclude that the identity independent representation of emotion was still visual (Fox & Barton, 2007).

In addition, there is evidence of differences in the latency of N170 response to the presentation of a happy face versus a sad face, even when the difference is an illusory difference, created by an aftereffect. In this case, the N170 response differed between a perceived happy versus perceived sad face, even though the participant was viewing a neutral face in each case (Cheal, Heisz, Walsh, Shedden, & Rutherford, 2014). If perception of the neutral face was based only on physical features of the stimulus, there would have been no difference in N170 response time following a happy, sad, or neutral face. Face identity aftereffects have been observed following adaptation to faces, names, voices and to identity-specific semantic information (Hills, Elward, & Lewis, 2010). Moreover, aftereffects emerged even when participants just imagined the adapting face (Ryu, Borrmann, & Chaudhuri, 2008).

1.3. Ambiguity in face perception

A surprise expression may be ambiguous with respect to valence, and information presented in the auditory domain may influence the perception of a surprise face. One study found evidence of categorical perception in a surprise-fear continua only in cases when the valence of the surprise was disambiguated with the audio presentation of a story of either a good or a bad surprise (Cheal & Rutherford, 2013). Etcoff and McGee, who originally reported evidence of categorical perception in emotional expressions did not find categorical perception in continua that included surprised faces (Etcoff & Magee, 1992). Similarly, previous research documenting the opponent relationship of positive and negative emotions found no unique "opposite" of surprise (Rutherford et al., 2008). Gender can also be ambiguous in face perception. Although gender perception is usually fast, between 145 and 185 ms from stimulus onset (Mouchetant-Rostaing, Giard, Bentin, Aguera, & Pernier, 2000), some faces are not categorized as quickly or with certainty.

1.4. Current research

The current experiments presented observers with faces that were ambiguous with respect to emotional valence (Experiments 1, 2, and 3) or gender (Experiment 4), and tested whether information presented in the auditory domain that disambiguated the face information would influence the subsequent perception of another ambiguous face image in a way that was more consistent with the aftereffect phenomenon or with priming.

2. Experiment 1: Can auditory information affect the perceived valence of a surprise expression aftereffect?

While fixating on a positive expression leads to the perception of a neutral image as negative and vice versa, surprised expressions are ambiguous with respect to valence, and do not yield aftereffects of a reliable valance (Rutherford et al., 2008). Experiment 1 was designed to test whether disambiguating the valence of a surprise, by providing context through the auditory modality, would affect face perception. Participants were adapted to a surprise facial expression while listening to a story that disambiguated the valence of the surprise, then labeled a neutral probe expression in a 6-alternative forced-choice task.

2.1. Method

2.1.1. Participants

Participants were 28 undergraduate students (5 males) who received partial course credit for participation. They ranged from 17 to 21 years of age ($M = 17.9$, $SD = 1.47$) and were recruited through first year psychology courses. All students had normal or corrected-to-normal vision. This work was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Informed consent was obtained, and research was approved by the McMaster Research Ethics Board.

2.1.2. Materials

Face images were selected from the Pictures of Facial Affect (POFA) set (Ekman & Friesen, 1976). There was a total of 14 neutral and surprised face models (8 female) used in the experimental trials: 2 angry, 2 happy, 1 disgust, and 1 fearful images, modeled by a subset of the same models. All face images were presented in grey-scale (1614 × 1394 pixels). Stimulus presentation and data collection was controlled by E-prime (version 1.1).

2.1.3. Procedure

Participants were seated in a well-lit room and positioned in a chinrest at a viewing distance of 66.04 cm from a 17″ CRT monitor. They wore noise-cancelling Sennheiser HD 429 headphones over both ears and were instructed to request adjustment in volume if necessary.

In 3 practice trials participants saw an image of a model portraying an emotion expression (happy, disgust, or angry) for 5 s. They then completed a 6-alternative-forced-choice (AFC) emotional labelling task, choosing among angry, unhappy, disgust, fear, happy or surprised, via keypress. Participants had to complete the practice trial with 100% accuracy in order to proceed with the experiment. They were given a second opportunity to reach criterion if necessary.

On each of the 14 experimental trials, an image of a surprised face was presented on screen for 45 s while the participant heard a Happy or Sad story via headphones. Stories ranged in duration from 11 s to 26 s. On half of the trials, the story described a Happy surprise, and on half of the trials, a Sad surprise. An example of each can be found in Appendix A. These stories have been used successfully in previous experiments (Cheal & Rutherford, 2013). The surprised face (the adapting image) was then replaced by a probe image of the same model showing a neutral expression. Then the probe image was presented for 1 s. Participants completed the 6-AFC task by choosing a label to describe the probe face.

In 4 diversion trials the probe face showed an emotional expression (fear, happiness, disgust, and anger). The purpose of the diversion trials was to prevent participants from concluding that the second of every pair of images was a neutral expression. An inclusion criterion was getting at least three of four diversion trials correct. Following the presentation of the probe face, participants completed the same 6-AFC task, choosing a label to describe the probe face.

The 14 experimental trials and 4 diversion trials were presented in random order. Participants were not time-restricted during the 6-AFC task. The experimental session lasted approximately 30 min.

2.2. Results

The negative category comprised four emotional responses: anger, disgust, fear, and unhappy, while happy was the positive response. Surprise responses were excluded from analyses. A paired t test using participants' proportion of positive responses revealed that story type