**Emotion Detection and Estimation (EDE) Paradigm Description**

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**Background.** The EDE paradigm is a computer-based task to investigate the impacts of top-down attention on emotion-related perceptual decision-making and estimation. Perceptual decision-making research on the interactive/integrative effects between emotion and attention has been largely studied from a bottom-up perspective, examining how emotionally charged stimuli capture attention either as a distractor or a primer (e.g., in the dot-probe task). However, in reality, emotionally charged stimuli often occur in familiar contexts, with the contextual information providing cues directing the agent to anticipate emotionally charged stimuli (e.g., anticipating potential threats when walking in the darkness). Importantly, the conceptualization of clinical levels of anxiety is often related to these anticipation-related responses to emotionally charged stimuli (e.g., hypervigilance). Furthermore, anxiety is often related to an overestimation of threats. However, it remains unclear whether this estimation can be impacted by top-down attention such that the same distribution of safe vs. threatening stimuli is perceived differently when the agent is looking for threats vs. safety. This paradigm is designed to address the need to shift from bottom-up to top-down perspectives in investigating the psychological (and neural) mechanisms of emotion-related perceptual decision-making and probability estimation.

**Design.**

*Overall description.* In the EDE paradigm, participants are presented with either a fearful face (FF) image or a neutral face (NF) image in each trial. Their task is to choose between two alternative responses regarding the emotion of the face image. The top-down attention is manipulated as directing the participant to make either a fear-related (i.e., is the following stimulus “Fearful” or “Not Fearful”) or a neutral-related (i.e., is the following stimulus “Neutral” or “Not Neutral”) decision. Critically, such an “A vs. ~A” design engages a different mechanism than an “A vs. B” design in that “A vs. ~A” encourages the participants to utilize a fixed mental template against which to examine whether the sensory data matches the template. The “A vs. B” design does not encourage the participants to form a particular template, leaving the decision-making mechanism relatively vague. In the current context, the participant is encouraged to use a fearful template in the F blocks and a neutral template in the N blocks. To maximize the potential top-down effects, the face images were presented in a low contrast manner.

In addition to the trial-level decision-making responses, the EDE paradigm also included a probability estimation (the second E of the EDE) question. This allows researchers to test whether the F vs. N top-down attention manipulation also has an impact on the perception of the frequency of fearful vs. neutral stimuli. Again, participants are asked to estimate the probability of “fearful face” in the F blocks and the probability of “neutral face” in the N blocks.

*Task details*. The EDE paradigm adopted a nested design, consisting of 6 blocks of 50 trials each and takes about 20 minutes to complete:

* Experiment-level:
  + The experiment begins with the overall instruction (see ‘EDE\_v1\_running\_instruction.docx’). Participants are instructed that they will make quick decisions regarding the emotions of a face image. To provide the context of the probability estimation question, they are told that the computer randomly selects 30 faces from a large face image dataset that contains only fearful and neutral faces, and that they will only see 10 of these faces. Their task is to quickly decide what kind of face it is, and then after all 10 faces are presented, estimate what the probability of the fearful or neutral faces in the underlying face dataset is. They are also informed that the underlying dataset may change after each round.
  + After the cover story, two rounds of practice trials (one from F block and one from N block) are performed.
  + The actual experiment consists of 6 blocks alternating between Fearful-related decision blocks (F blocks) and Neutral-related decision blocks (N blocks). The sequence is counterbalanced between subjects such that even number subjects will experience FNFNFN blocks and odd number subjects will experience NFNFNF blocks.
* Block-level: Within each block, the 50 trials are grouped into 5 rounds, with each round consisting of 10 pseudo-randomized event trials (i.e., FF or NF stimuli trials) followed by the probability estimation question. Specifically, after seeing 10 faces and making 10 decisions, the participant is asked to estimate what is the probability of “Fearful” faces (or “Neutral” faces) in the face image set. For every block, 25 trials are FF and 25 trials are NF.
* Round-level: Each of the 10 trials includes either an FF or an NF. No more than 3 consecutive trials are with the same face emotions (i.e., ≤ 3 consecutive trials can be of the same emotion type). Importantly, every round will contain either 5 FF and 5 NF, or 4 FF and 6 NF, or 6 FF and 4 NF. The exact sequence of these faces is generated for three blocks and replicated for three blocks. In other words, each F block has an identical copy of a N block in terms of trial sequence. Therefore, any difference between the F and N blocks cannot be attributed to the trial sequence.
* Trial-level: Each trial starts with a purple colored fixation cross for 0.5 seconds, which is followed by a mask for 0.3 seconds. The face image stimulus is then shown for 0.1 seconds followed by another mask for 0.3 seconds. The participant can respond anytime between the onset of the face image to 2.8 seconds following the *offset* of the mask image, making it a 3.2 seconds response window in total. If the participant responded within the window, the next trial will begin immediately following the response, otherwise, the next trial starts automatically after time out. In total, each trial would take 4 seconds maximum.

*Stimuli*. 6 number of female fearful, 6 number of female neutral, 9 number of male fearful, and 9 number of male neutral face images are selected from the HKU Face Database. These images are cropped and converted into grey-scale images using PhotoShop, then they are processed through the SHINE toolbox as described in ‘EDE\_ShirleyLI\_VisualStim\_Process.docx’. The SHINE toolbox uses lumMatch, histMatch and sfMatch algorithms (in this order) to equalize low-level physical properties (luminance, histogram, and spatial frequency in sequence). These face image stimuli are presented at 0.1 to 0.2 range of contrast levels. To create each of the 4 mask images, 4 images of 1 female fearful, 1 female neutral, 1 male fearful, and 1 male neutral, are randomly selected. These 4 images are averaged, sliced into 100 blocks and reshuffled, forming a final mask image. This process is repeated 4 times to create 4 mask images. These 4 mask images are processed through the SHINE toolbox as described in ‘EDE\_ShirleyLI\_VisualStim\_Process.docx’, equalizing low-level physical properties. The mask images are presented at the same contrast level as the face image stimulus of each trial.