

Age Differences in Rapid Attention to Emotional Stimuli Are Driven More by Valence Than by Discrete Emotions

Participant-visible method context. Results, discussion, captions, and the target figure are excluded.

Participants One hundred twenty younger adults and 120 older adults completed the study ($N = 240$). Data from 31 participants were removed from the final sample data set: five participants (aged 34–47 years) for being aged far outside the target age ranges for younger adults (18–30 years) and older adults (over 60 years), 1 two for failing to complete the first day of the experiment (one younger adult, one older adult), 11 for failing to complete the second day of the experiment (six younger adults, five older adults), and an additional 13 participants for poor performance (eight younger adults, five older adults; see the Data Screening section). The final sample comprised 209 participants (101 younger adults, 108 older adults). The mean age of younger adults was 25.2 years ($SD = 3.0$ years, range: 19–30 years); 49 younger adults identified as female, 48 as male, two as nonbinary, one as agender, and one as gender-fluid. The mean age of older adults was 66.6 years ($SD = 5.2$ years; range: 58–80 years); 66 older adults identified as female and 42 as male. Younger adults described their highest level of education as a high school degree or equivalent ($n = 35$), some undergraduate work ($n = 15$), an associate's degree ($n = 7$), an undergraduate degree (e.g., bachelor's; $n = 36$), a graduate degree (e.g., JD, master's, or PhD; $n = 6$), or a vocational degree ($n = 2$). Older adults described their highest level of education as a high school degree or equivalent ($n = 20$), some undergraduate work ($n = 10$), an associate's degree ($n = 15$), an undergraduate degree (e.g., bachelor's; $n = 32$), a graduate degree (e.g., JD, master's, or PhD; $n = 27$), or a vocational degree ($n = 4$). One younger adult and 57 older adults self-reported being retired. We aimed to recruit at least 100 participants in each group, to achieve a sample size capable of observing small-to-medium effects in our main comparisons of interest. The final sample of 209 participants was powered to observe a repeated measures withinbetween analysis of variance (ANOVA) interaction with effect sizes of $f = .12$ and Pearson correlations with effect sizes of $p = .19$, with $\alpha = .05$ and power ($1 - \beta$) = 0.80 (calculated with G*Power; Faul et al., 2007).

We used the CloudResearch recruitment platform to target participants within specified age ranges, and the study advertisement clearly outlined these age requirements. Nevertheless, some participants were aged outside of these ranges. We decided to retain data from participants whose ages were within 5 years of the target ranges but excluded data from participants whose ages exceeded that extended range.

FOX, MATHER, AND KENNEDY

Participants were recruited from Australia and the United States via CloudResearch (Litman et al., 2017). Participants were eligible for the study if they were aged within the required age ranges (18–30 years or 60 years or older), had normal or corrected-to-normal vision, had the necessary technology (a computer with internet connection), were not taking β -blocker medication, and could complete both Day 1 and Day 2 of the study. Participants who completed Day 1 received \$5 USD. Those who completed all 200 trials on Day 1 were invited to participate in Day 2 via an email sent 12–24 hr later. Participants who completed Day 2 completed it on average 28.2 hr later ($SD = 11.43$, range: 14.6–94.3 hr) and received an additional \$7 USD for their participation. Each session took approximately 30 min to complete. Data were collected between June and July 2023. Ethics was approved by the University of Western Australia Human Research Ethics Committee (2023/ET000257; “Discrete Emotions in Attention”).

Materials Participants completed the experiment on their own computer via the internet. The experiment was programmed using custom scripts in Inquisit (Inquisit 6, 2021) and Qualtrics software.

Stimuli Stimuli were colored 320×240 -pixel images presented against a white background. Images were used as either distractor, target, or filler images in the emotion-induced blindness task. Distractor images depicted fear, disgust, excitement, contentment, or neutral content. Two hundred distractor images (40 images per distractor type) were selected from the International Affective Pictures System (IAPS; Lang et al., 2008), Nencki Affective Picture System (NAPS; Marchewka et al., 2014), and Disgust-Related-Images (DIRTI; Haberkamp et al., 2017). Distractor images were chosen based on the databases' normative ratings of valence and arousal, as well as previous research ratings of discrete emotion categories (Haberkamp et al., 2017; Mikels et al., 2005; Riegel et al., 2016) and also from some unpublished ratings from a clinical trial (Nashiro et al., 2024). Haberkamp et al. (2017) provided a database consisting primarily of disgust-eliciting images, and ratings from this database were used to

choose disgust images rated high in disgust and low in fear. Mikels et al. (2005) and Riegel et al. (2016) had participants rate images from the IAPS and NAPS databases respectively across discrete categories and additionally assigned discrete emotion category labels for each image, and Nashiro et al. (2024) similarly had participants categorize IAPS, NAPS, and DIRT1 images with discrete emotion category labels. We chose images for our four emotion categories based on category assignments from these previous studies to ensure that they were previously confirmed as depicting the targeted emotion over other emotions. The only exception was in the excitement image set; there were few images that were labeled as uniquely depicting excitement over all other emotions, so we also included images that were categorized as both excitement and awe. When there were insufficient images from previous research for a discrete emotion category, images depicting similar content were supplemented with images from the Open Affective Standardized Image Set (Kurdi et al., 2017) based on the judgment and agreement of authors BLK and CF.

From the sets of discrete emotion images, we further eliminated images that were inappropriate for the emotion-induced blindness design. These were images that depicted scenes without clear people, animals, or prominent objects visible, which would make them difficult to serve as distractors among other landscape images in the task trials. Finally, we used ratings of arousal and valence to best match between the final sets of images and also establish a set of “neutral” category images. Neutral images were chosen to resemble images used in previous emotion-induced blindness experiments clearly depicting people, animals, or prominent objects and were rated as low in arousal and neither negatively nor positively valenced. All of the databases that we used to collect images (i.e., IAPS, NAPS, DIRT1, and Open Affective Standardized Image Set) provided normative ratings of valence and arousal on scales from 1 (negative valence; low arousal) to 9 (positive valence; high arousal). A list of the specific images used in the experiment is provided on the Open Science Framework at <https://osf.io/j2cpd> (Fox et al., 2025), and descriptive statistics, including average valence and arousal ratings for each image category, are provided in the Supplemental Material. In our final set of distractor images, there was no significant difference between fear and disgust images in valence, $t(78) = 0.97$, $p = .335$, $d = 0.22$, or arousal, $t(78) = 0.69$, $p = .495$, $d = 0.15$, ratings. By their nature, excitement images are more arousing than contentment images, so unlike the negative emotion categories, we chose not to match them on valence or arousal ratings. This allowed us to prioritize images that best represented the discrete categories as well as specifically disconnect the positive categories by high arousal and high valence ratings. Excitement images were higher in arousal, $t(78) = 4.63$, $p < .001$, $d = 1.03$, and less positive, $t(78) = 5.06$, $p < .001$, $d = 1.12$, than contentment images. Both contentment and excitement image sets were rated as more positively valenced than disgust and fear image sets ($t \geq 12.80$, $p \leq .001$). Excitement images were significantly more arousing than fear and disgust images ($t \geq 2.15$, $p \leq .035$), while contentment images were less arousing than fear images, $t(78) = 2.62$, $p = .011$, $d = 0.59$, but not less arousing than disgust images, $t(78) = 1.88$, $p = .064$, $d = 0.42$. Compared to neutral, fear and disgust images were significantly more negative in valence ($t \geq 9.70$, $p \leq .001$), whereas excitement and contentment images were significantly more positive ($t \geq 5.96$, $p \leq .001$). Fear, disgust, excitement, and contentment images were all significantly higher in arousal than neutral images ($t \geq 3.15$, $p \leq .002$). Similar image themes were evident within the final discrete emotion subsets of distractor images. Fear images included scenes of threatening animals, weapons, or violent acts. Disgust images included scenes of medical injuries, vomit, or rotting food. Excitement images included images of people playing extreme sports, such as motocross or skiing. Contentment images included images such as smiling babies or kittens. Neutral images included people with neutral facial expressions or engaging in passive activities, such as supermarket shopping. Target images depicted landscape or architectural scenes, but did not include people or animals, and were rotated 90° to the left or 90° to the right. These comprised 52 images rotated 90° to the left and 90° to the right (104 images total). An additional 204 filler images depicted landscape or architectural scenes and did not include people or animals but were not rotated. Target and filler images were the same as those used in previous emotion-induced blindness research (Kennedy et al., 2020; Kennedy & Most, 2015; Most et al., 2005). All image types were divided into two sets (Set A and Set B). Each set had 100 distractor type images (20 images per distractor

DISCRETE EMOTIONS IN THE POSITIVITY EFFECT

type); both sets were balanced for content, valence, and arousal of each distractor type, so there was no significant difference between Set A and Set B image sets on these measures. Similarly, target and filler images were split across the two sets and had similar images on both. Each set included 26 of the 52 target images and 102 of the 204 filler images, so that no target or filler images appeared on both days. The sets were counterbalanced so that approximately half of participants viewed Set A on Day 1 ($n = 107$) and the other participants viewed Set B on Day 1 ($n = 102$).

Participants were notified when they had completed a block of trials and pressed Enter (or equivalent) on their computer keyboard when ready to commence the next block. Before the task, participants completed six practice trials. The initial three practice trials presented images at 200 ms per image, and the final three practice trials presented images at the experiment speed of 100 ms per image. All practice trials had a filler image instead of a distractor image, such that no emotional images were shown during practice.

Emotion-Induced Blindness Task

Questionnaires

Each experimental session consisted of 200 trials divided into four blocks (50 trials per block; 400 trials across both days). Each trial contained 15 images: one target (rotated) image, one distractor (emotional) image, and 13 filler (unrotated) images. Images were presented in a rapid serial visual presentation and were shown one at a time in the center of the screen for 100 ms before being rapidly replaced by the following image (see Figure 1). The target image always appeared sometime after the distractor image. In half of the trials, the target appeared as the second image after the distractor image (Lag 2) or as the fourth image after the distractor image (Lag 4). Previous research indicates that effects of distractor images are particularly strong at early lags, such as Lag 2, and weaken with later lags, such as Lag 4 (e.g., Kennedy & Most, 2015; Most et al., 2005). Distractor images and lags were quasirandomized from trial to trial to reduce participant anticipation of a particular emotional distractor appearing. At the beginning of each trial, participants viewed a fixation cross for 500 ms before the rapid stream of images. After all 15 images for the trial were presented, there was a screen with text ("rotated left [F] or right [J]?") prompting the participant's response. There was no time limit for responding. Once participants entered their response, the program provided feedback ("correct!" or "incorrect."). The subsequent trial began 500 ms after participants submitted their response.

Participants completed a demographic questionnaire, which included questions regarding the participants' age, gender, education, profession, retirement status, and whether their vision was normal or corrected-to-normal. We also administered five additional questionnaires: The Depression Anxiety and Stress Scales–21 (Lovibond & Lovibond, 1995), a subset of the World Health Organization Quality of Life Scale–Brief Version (World Health Organization, 2004); the Disgust Propensity and Sensitivity Scale–Revised (Fergus & Valentiner, 2009); the Positive and Negative Affect Schedule (Watson et al., 1988); and the Cognitive Emotional Regulation Questionnaire (Garnefski et al., 2001). These questionnaires were included for secondary exploratory analyses outside of the main scope of the experiment, but we report these analyses in the Supplemental Material for interested readers.

Figure 1 Schematic of a Partial Trial in the Emotion-Induced Blindness Task

Note. Participants searched for a single target image rotated to the left or to the right. A distractor that depicted either fear, disgust, excitement, contentment, or emotionally neutral scenes appeared either two or four items before the target in each trial. The images depicted here serve as examples of the types of images that appeared in the experiment but were not part of the stimulus set. Images are used with permission. See the online article for the color version of this figure.

Procedure Participants registered for the study online through CloudResearch. On Day 1 of the study, participants clicked a link redirecting them to Qualtrics, where they were presented with information about the study and shown examples of emotional images to ensure they were comfortable with the experiment. Participants read the consent form and after providing consent completed demographic questionnaires, the Depression Anxiety and Stress Scales–21, and Positive and Negative Affect Schedule. Participants were automatically redirected to the emotion-induced blindness task. After the emotion-induced blindness task, participants were thanked and given information about how to complete Day 2: that it would take approximately 30 min to complete, that they would be sent an invitation for Day 2 within 12–24 hr, and that they should complete Day 2 within 48 hr of receiving the invitation. Participants were also given information about psychological support if needed, contact information if they had questions, and received compensation for completing Day 1. After 12–24 hr, participants received an email invitation for Day 2 to complete the emotion-induced blindness task within 48 hr of receiving the invitation. This period was chosen to allow enough time between sessions and reduce participant attrition. Participants clicked the link provided, where they were welcomed back to the experiment and automatically redirected to the emotion-induced blindness task. The main experiment ran the same way as Day 1. After completing the task, participants were redirected to complete the World Health Organization Quality of Life Scale–Brief Version, Disgust

Propensity and Sensitivity Scale–Revised, and Cognitive Emotional Regulation Questionnaire. At the end of the experiment, participants were thanked, debriefed about the study's aims, and received compensation for Day 2. It took approximately 1 hr total to complete the task across both days.

FOX, MATHER, AND KENNEDY

Transparency and Openness We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. The experimental materials, including custom code, anonymized data, and summarized results, are available on the Open Science Framework and can be accessed at <https://osf.io/j2cpd/> (Fox et al., 2025). Data were analyzed using R (Version 4.3.1; psych package) and SPSS (Version 29). Figures were made with ggplot2 and tables were formatted using gt in R. The experiment was not preregistered.