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One Object With Two Identities: The Rapid Detection of Face Pareidolia in Face and Food Detection Tasks

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Humans are so sensitive to faces and face-like patterns in the environment that sometimes we mistakenly see a face where none exists—a common illusion called "face pareidolia." Examples of face pareidolia, "illusory faces," occur in everyday objects such as trees and food and contain two identities: an illusory face and an object. In this study, we studied illusory faces in a rapid serial visual presentation paradigm over three experiments to explore the detectability of illusory faces under various task conditions and presentation speeds. The first experiment revealed the rapid and reliable detection of illusory faces even with only a glimpse, suggesting that face pareidolia arises from an error in rapidly detecting faces. Experiment 2 demonstrated that illusory facial structures within food items did not interfere with the recognition of the object's veridical identity, affirming that examples of face pareidolia maintain their objecthood. Experiment 3 directly compared behavioral responses to illusory faces under different task conditions. The data indicate that, with extended viewing time, the object identity dominates perception. From a behavioral perspective, the findings revealed that illusory faces have two distinct identities as both faces and objects that may be processed in parallel. Future research could explore the neural representation of these unique stimuli under varying circumstances and attentional demands, providing deeper insights into the encoding of visual stimuli for detection and recognition.

Public Significance Statement

In this article, we find behavioral evidence that rules out the claim that we see illusory faces in examples of face pareidolia because the available object information is weak or unrecognizable. Ambient examples of face pareidolia contain visual cues that are consistent with an object identity and a face identity, even when the attentional load is increased. This highlights the examples of face pareidolia as a unique category of visual stimuli that can be employed to help us understand how the brain builds representations of faces and objects for the purposes of supporting behavior.

Keywords: illusory faces, rapid serial visual presentation, face detection

Face detection mechanisms are thought to emerge very early in human development (Goren et al., 1975; Tsao & Livingstone, 2008) and are shared with other primates (Taubert et al., 2017). We are so sensitive to faces and face-like patterns in the environment that sometimes we mistakenly see a face where none exists—a common illusion called "face pareidolia." Examples of face pareidolia, herein referred to as "illusory faces," frequently occur in ordinary, inanimate objects such as tree trunks, cars, and food items such as sliced capsicums and cups of coffee (see Figure 1A). Studies measuring time-resolved neural signals have suggested that illusory faces are initially processed in similar ways to human faces, engaging face detection mechanisms in the human and macaque brain (Decramer et al., 2021; Rekow et al., 2022; Taubert et al., 2022; Wardle et al., 2020). This error of face detection is then quickly corrected by the brain, and illusory faces are eventually encoded as objects (Decramer et al., 2021; Taubert et al., 2020; Wardle et al., 2020). In this study, we investigated whether these two apparently distinct stages of neural processing are reflected in human behavior.

From a behavioral perspective, it remains unclear whether our perception of illusory faces arises from our capacity to rapidly detect

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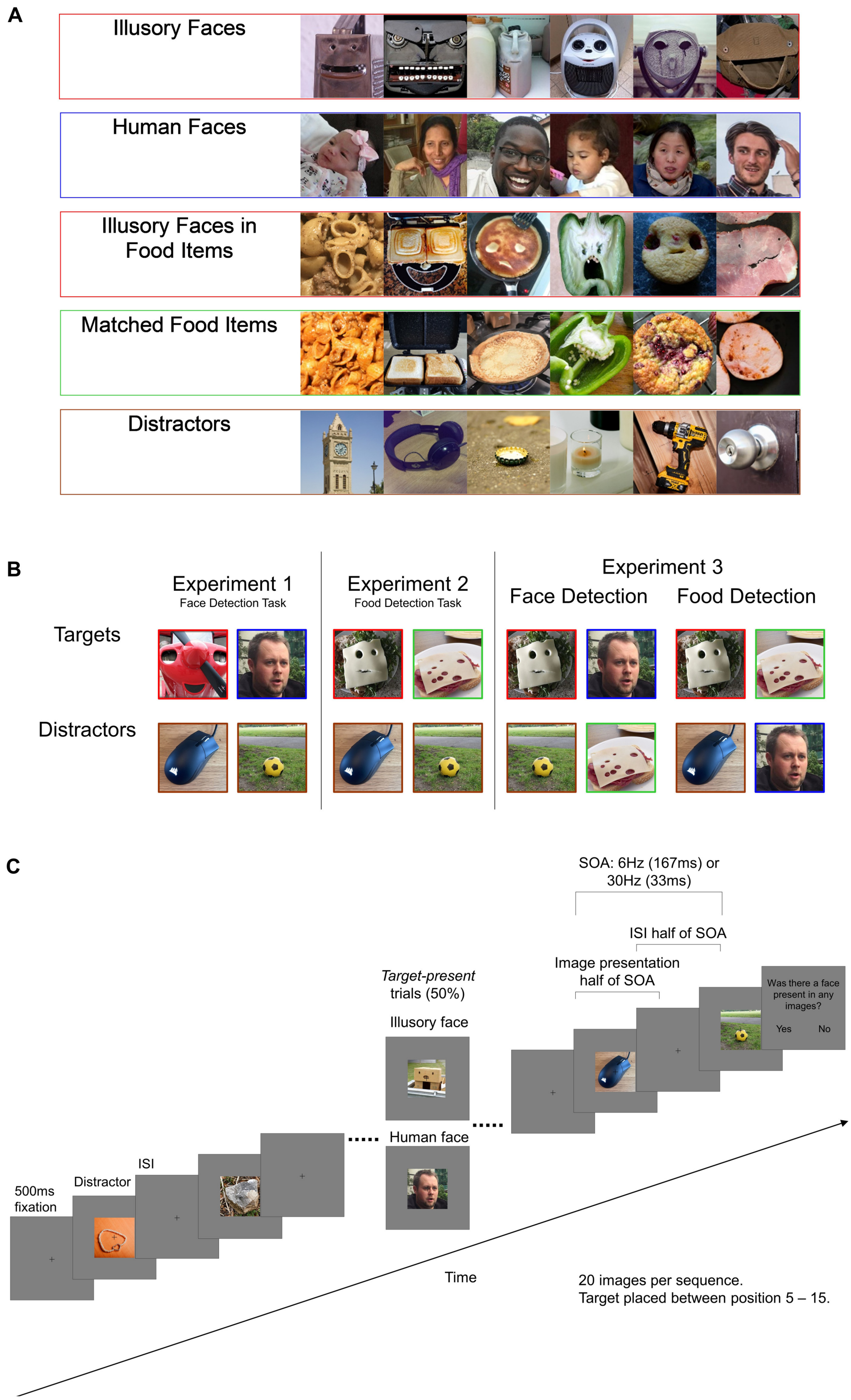
Figure 1
Experimental Design



Note. (A) Example stimuli for each condition across Experiments 1–3. (B) Specific examples of targets and distractors for each experiment. Colors correspond to categories in (A). (C) Example trial timeline for Experiment 1. Images were presented in succession with a blank gap between each image. The presentation rate was 6 or 30 Hz. A face (Experiments 1 and 3) or food target (Experiments 2 and 3) was present in 50% of trials, displayed between distractor images. SOA = stimulus onset asynchrony; ISI = interstimulus interval. See the online article for the color version of this figure.

faces and face-like patterns (Keys et al., 2021) or our capacity to reinterpret visual ambiguity as being "face like" (Liu et al., 2014). In previous tasks designed to measure how similar illusory faces are to human faces, researchers have often instructed the participants to explicitly look for facial structure (Epihova et al., 2022; Omer et al., 2019; Taubert et al., 2023; Uchiyama et al., 2012; Wardle et al., 2022). In other behavioral experiments, the participants have been tasked with judging facial attributes such as expressions, gaze direction, or age (Alais et al., 2021; Palmer & Clifford, 2020; Wardle et al., 2022). These approaches might have inadvertently drawn attention toward any face-like cues available within the larger image—which typically include their natural backgrounds—that could be interpreted as face like and therefore encouraged a particular response profile. Importantly, the perception of the illusory face as an object has never been probed. Therefore, our aim was to measure the detectability of illusory faces under different task conditions and attentional demands. To this end, we used a rapid serial visual presentation (RSVP) paradigm to determine whether illusory faces could be accurately detected in a speeded detection task based on either their face (Experiments 1 and 3) or object (Experiments 2 and 3) identity.

In this study, we addressed three specific questions: First, can illusory faces be detected in a RSVP face detection task (Experiment 1)? Secondly, can illusory faces found in food items be detected in a RSVP food detection task (Experiment 2)? And finally, are illusory faces easier to detect as faces or food, and how does this vary with presentation time (Experiment 3)? We compare behavioral performance in face and food detection tasks because both food items and faces form separate classes of visual stimuli that are biologically relevant to humans. In other words, being able to recognize the things we can eat and the people we can talk to could be considered central to our survival (Jain et al., 2023; Khosla et al., 2022). Further, images of food, like images of faces, form a class of visual stimuli that are known to drive activity in multiple brain areas (Avery et al., 2021; van der Laan et al., 2011), including stimulus-selective visual areas in the fusiform gyrus (Jain et al., 2023; Kanwisher et al., 1997). Given the parallels between food and faces, and the observation that illusory faces frequently occur in food items (Wardle et al., 2022), we chose food as an appropriate target category for Experiments 2 and 3.

For both the face- and food detection tasks (Experiments 1–3), we used an RSVP paradigm where, on every trial, we presented a sequence of 20 naturalistic images in quick succession. In Experiment 1, participants completed a face detection task; the participants were instructed to press a button if they detected a face, which was present in 50% of trials. In this experiment, half of the face targets were human faces and the other half were illusory faces. We included two presentation speeds in the experimental design, 6 and 30 Hz, designed to bias processing to later and earlier stages of processing, respectively (Collins et al., 2018; McKeeff et al., 2007). Previous research has already shown that participants are aware of illusory faces and recognize them as faces at higher frequencies (i.e., 60 Hz; Rekow et al., 2022), but this performance was not benchmarked against human faces. It follows that, in Experiment 1, we expected to partially replicate the results of Rekow et al. (2022) by finding that participants would be able to detect illusory faces as faces even at fast presentation speeds (30 Hz). However, we also expected that the participants would show higher detection sensitivity to human faces than illusory faces (Keys et al., 2021; Saurels et al., 2024).

In Experiment 2, participants completed a food detection task; the participants were instructed to press a button if they saw a food item. In this experiment, targets were either illusory faces in food items or matched food items. Thus, we were able to test whether the object identity of illusory faces was spared at fast presentation speeds when visual processing was limited. Further, if face pareidolia arises from an error of rapid face detection, then the expectation was that illusory faces would be detected more easily than food items without illusory faces because, even when task irrelevant, their face identity would summon attentional resources (Jakobsen et al., 2023; Saurels et al., 2024).

In Experiment 3, we combined the face and food detection tasks in a blocked, repeated measures experiment to distill any task-based differences in the detection of illusory faces. We ensured that the only difference between the two task blocks was the instructions given to the participants about what constituted a target. The same illusory faces were, thus, targets in both tasks, allowing us to directly compare behavior toward these images under different task conditions. Assuming that the perception of face pareidolia is the consequence of erroneous face detection that occurs before the brain encodes the object identity (Wardle et al., 2020), we expected that images containing illusory faces would be more easily detected in the face detection task than the food detection task, when presentation time was limited (30 Hz). Whereas, in the corresponding 6 Hz condition, we expected that the exact same illusory face stimuli would be easier to detect when participants were looking for food than when they were looking for faces because the low-level visual cues in illusory faces are more consistent with the object identity than the face identity (Keys et al., 2021).

Transparency and Openness

Data were analyzed using MATLAB (MathWorks Version R2021_b) and SPSS software (IBM Version 27). All data, analysis code, and research materials are available from the Open Science Framework as the additional online materials (https://osf.io/hvuwd). For each experiment, we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. This study's design and its analysis were not preregistered.

Experiment 1: The Rapid Detection of Illusory Faces in a Face Detection Task

Method

Experiment 1 was designed to probe face detection performance for human and illusory faces during rapid image presentation. Images were shown at two different presentation rates to assess how presentation time influenced face detection for human and illusory faces.

Participants

A power analysis was run on pilot data to determine the sample size. Data from the first participant were analyzed in a one-way repeated measures analysis of variance (ANOVA) of "unique condition" using the trial as the unit of analysis and a proxy for the participant. For this analysis, "unique condition" had four levels (6 Hz human face, 6 Hz illusory face, 30 Hz human face, and 30 Hz illusory face). The observed effect size for the overall F value ($\eta_p^2 = .32$) was used to determine the sample required to find differences across the unique conditions was 20 (using GPower software; Faul et al., 2007). Although we were targeting 20 participants, 27 participants ($M_{age} = 23.6$ years; 13 male and 14 female) volunteered and were tested. This sample size is similar to the previous work of Keys et al. (2021; $n = 18$) and Rekow et al. (2022; Experiment 2, $n = 22$) who also investigated the detection of illusory faces in a laboratory setting. Indeed, Rekow et al. (2022) used a very similar RSVP paradigm and reported the detection of face-like objects at 30 Hz, but they did not compute detection sensitivity as d' making it difficult to determine the expected effect size. In sum, a sample size of 27 was considered appropriate.

For every participant, we investigated whether detection sensitivity was 3 *SD*s away from the group mean, in any condition, but this was not the case. Thus, there were no outliers, and data from all participants were analyzed. All participants gave consent to participate and reported normal or corrected-to-normal vision, and all participants were psychology undergraduate students recruited from a paid participant pool (the School of Psychology Research Participation Scheme). Participants received a \$20 voucher for their time and were debriefed at the conclusion of the experiment.

Stimuli

The stimulus set included 300 distractor images (ordinary objects with no faces such as buildings, tools, and vehicles as well as food images were included as distractors here), 100 illusory faces, and 100 human faces. All stimuli were obtained from Google Images or Pinterest and were uploaded to the Open Science Framework as the additional online materials (https://osf.io/hvuwd/). For the distractor images, the focal objects were in naturalistic settings with complex backgrounds to match the conditions the illusory faces were found in. All 500 images in the stimulus set were cropped to be 400×400 pixels in size and were displayed on a grey background at a size of 4.9×4.9 degrees of visual angle.

Design

The experimental protocol included 400 target-present trials and 400 target-absent trials (800 trials in total). The experimental manipulations included both target type (human face and illusory face) and presentation frequency (6 and 30 Hz).

Procedure

Before beginning the experiment, participants were shown examples of a human face, an illusory face, and a distractor object. The examples shown were not part of the experimental stimulus set. Participants were instructed to detect images of face within a sequence of distractor object images. Participants were told both human faces and illusory faces counted as "faces" in the experiment.

During the experiment, participants were required to focus on the centered fixation cross at the beginning and for the duration of each trial. After an initial fixation period (500 ms), a sequence of 20 images was rapidly presented in the center of the screen, behind the fixation cross. The images were presented at one of the two frequencies: 6 Hz (166.67 ms stimulus onset asynchrony [SOA]) or 30 Hz (33.33 ms SOA). Stimuli were presented with a 50% on–off duty cycle: 83.33 ms stimulus duration and 83.33 ms blank interstimulus interval (ISI; 6 Hz) or 16.67 ms duration and 16.67 ms ISI (30 Hz). Images in fast sequences are subject to forward masking from the previous image and backward masking from the next image in the sequence. A blank ISI was introduced to reduce forward masking (Bachmann & Allik, 1976) and allow strong initial responses to each stimulus (Robinson et al., 2019). It should be noted that the blank ISI following an image allows the image to continue being processed; each image is not masked until the next image appears. Thus, in this design, we consider the unrestricted processing time to be equal to the SOA: 166.67 ms for the 6 Hz sequences and 33.33 ms for the 30 Hz sequences.

A target—an illusory face or a human face—was presented in 50% of trials (target present vs. target absent). Targets could appear between the fifth and 15th distractor images. This constraint was to reduce the effects of primacy and recency on performance. At the conclusion of each trial, participants were asked (with text on the screen): "Was there a face present in any images?" with answer options: "yes" or "no." If participants answered "yes," a secondary question appeared asking, "What type of face did you see?" either an "illusory face" or "human face." Participants responded using a handheld 5-button response box (RESPONSEPixx with custom white buttons; https://vpixx.com/products/handheld/) using the left and right buttons to indicate "yes" or "no." After a response was registered, the next trial would begin. We note that no feedback regarding performance was given. Target-absent trials were identical to target-present trials except no face stimulus was presented.

There were 800 trials in total, and targets were present in 50% of trials. In general, the experiment took participants 40–50 min to complete, with no formal breaks provided, but trials were self-paced. Targets were presented twice each, once in a 6 Hz trial and once in a 30 Hz trial. The order of images in each trial was randomized, and the order of trials was randomized for each participant (see Figure 1C for trial structure).

Apparatus

The experiment was run using MATLAB R2021b (https://www.mathworks.com) and the psychtoolbox (https://psychtoolbox.org/). The stimuli were presented on a cathode ray tube replacement monitor purchased from Vpixx Technologies (https://vpixx.com/products/viewpixx-eeg/; Model: VPX-VPX-2006B). The resolution of the monitor was set to $1{,}920 \times 1{,}080$ pixels, and its refresh rate was 60 Hz. Participants viewed the trials 720 mm away from the monitor with their heads placed on a chin rest.

Analysis

For every condition per participant, we computed a sensitivity index (d') for each of the four unique experimental conditions because a valid measure of "detection performance" needs to take into account both hit rate and false alarm rate. Hit rate was calculated as the percent of correctly detected targets in each condition (6 Hz human face, 6 Hz illusory face, 30 Hz human face, and 30 Hz illusory face). False alarm rate was calculated using the percent of non-target trials per frequency (6 and 30 Hz) for which participants reported a target was present. Notably, the same false alarm rate was used for the human and illusory faces per frequency condition. The d' value is undefined when a false alarm or hit rate is equal to 0% or 100%. Therefore, for participants with zero false alarms, the false alarm rate was set to 0.5%, and for participants with 100% accuracy in target-present trials, the hit rate was set to 99.5%.

To assess how detection performance varied over task condition, we performed a 2×2 repeated measures ANOVA with factors of presentation frequency (6 and 30 Hz) and target type (human face and illusory face). Additionally, we assessed if the detection performance was above chance using one-sample t tests for each of the four conditions compared to zero, Bonferroni corrected for the two tests per frequency.

Results

The analysis of the target detection sensitivity showed performance varied across target type and presentation frequency (Figure 2A). A 2 (frequency: 6 and 30 Hz) × 2 (target type: human face and illusory face) repeated measures ANOVA revealed a main effect of frequency, $F(1, 26) = 138.40$, $p < .001$, indicating that the participants were better at detecting target faces in the 6 Hz condition ($M = 2.61$, $SE = 0.16$) compared to the 30 Hz condition ($M = 1.36$, $SE = 0.11$). There was a significant main effect of the target type, indicating that the participants were better at detecting human faces ($M = 2.65$, $SE = 0.14$) than illusory faces ($M = 1.32$, $SE = 0.12$). There was a significant interaction between frequency and target type, $F(1, 26) = 8.71$, $p = .007$. Paired sample t tests were conducted to compare detection sensitivity for human and illusory faces at each presentation frequency (adjusted for multiple comparisons using the Bonferroni rule). In 6 Hz trials, participants were significantly better at detecting human faces ($M = 3.35$, $SE = 0.17$) compared to illusory faces ($M = 1.87$, $SE = 0.16$), $t(26) = 15.74$, $p_{\text{Bonferroni}} < .001$. Similarly, in 30 Hz trials, human faces ($M = 1.96$, $SE = 0.13$) were significantly more detectable than illusory faces ($M = 0.76$, $SE = 0.10$), $t(26) = 16.31$, $p_{\text{Bonferroni}} < .001$.

One-sample t tests were also conducted to determine if detection sensitivity was above chance in each condition (i.e., $d' >$ zero). In 6 Hz trials, the detection was significantly above chance performance for human faces, $t(26) = 19.24$, $p_{\text{Bonferroni}} < .001$, and illusory faces, $t(26) = 11.50$, $p_{\text{Bonferroni}} < .001$. In 30 Hz trials, detection was significantly above chance performance for human faces, $t(26) = 15.08$, $p_{\text{Bonferroni}} < .001$, and illusory faces, $t(26) = 7.77$, $p_{\text{Bonferroni}} < .001$.

Experiment 2: The Rapid Detection of Illusory Faces in a Food Detection Task

In Experiment 1, we uncovered evidence that the illusory faces in examples of face pareidolia can be reliably detected as faces, even at fast presentation speeds (30 Hz). This finding is consistent with the neural correlates described by Wardle et al. (2020; see also Mei et al., 2022). However, the examples of face pareidolia have two identities: an illusory face and an object. Is the perception of the object identity subject to the same temporal processing limitations as the face identity?

In Experiment 2, we examined rapid detection of food items using the same task described in Experiment 1. There were two target conditions in Experiment 2; illusory faces in food items and matched, nonface, food items (see Figure 1A). The distractors were limited to manmade inanimate objects such as tools, sporting equipment, and vehicles as well as buildings (see Figure 1B). On one hand, if, at fast presentation speeds (30 Hz), illusory faces are perceived as faces but not objects, detection sensitivity would be lower in the illusory face condition than in the food item condition. On the other hand, if illusory faces are perceived as both faces and objects, then there should be no effect of target type, even in the 30 Hz condition.

Method

Participants

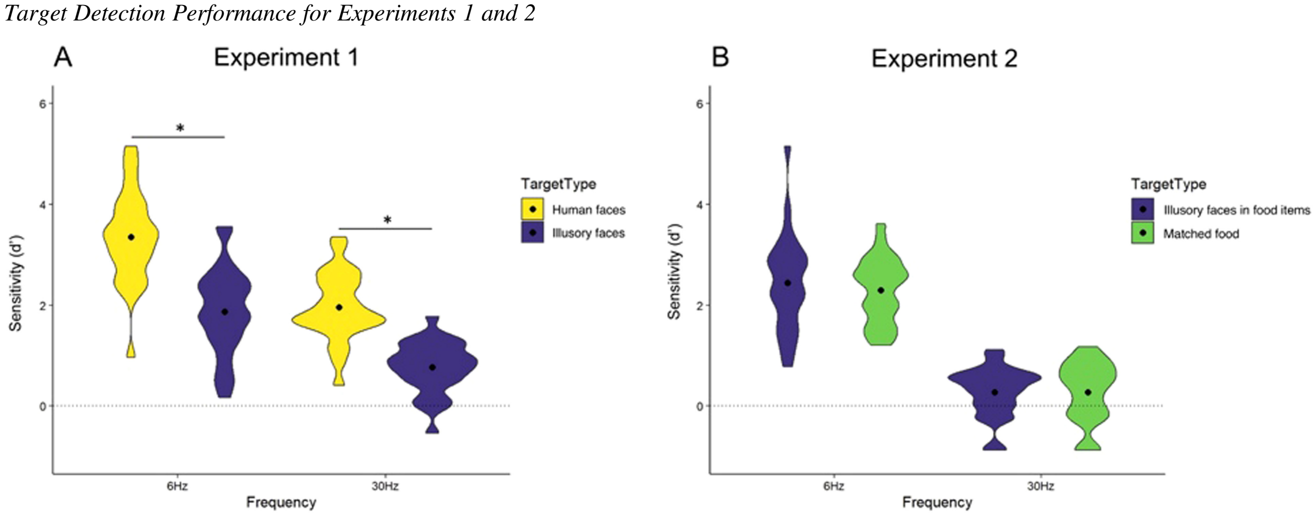
Given the similarity between Experiments 1 and 2 in terms of experimental design and analysis, minimally, we required a sample size of 20. Ultimately, 25 participants ($M_{\text{age}} = 22.8$; 19 female and six male) were recruited by the University of Queensland School of Psychology First Year Research Participation Scheme. Participants either received course credit or a $20 voucher as compensation. All participants gave consent to participate and reported having normal or corrected-to-normal vision. As in Experiment 1, we determined that there were no outliers; however, we note that two participants had previously completed Experiment 1.

Stimuli

The stimulus set in Experiment 2 included 234 distractors (inedible objects; e.g., cars and pens), 50 illusory faces found in food items (referred to as illusory faces), and 50 matched food items

Figure 2

Target Detection Performance for Experiments 1 and 2



Note. Violin plots showing detection sensitivity for (A) Experiment 1: Face detection task ($n = 27$) and (B) Experiment 2: Food detection task ($n = 25$). See the online article for the color version of this figure.
* $p < .05$.

with no facial structure present (referred to as matched food; see Figure 1A).

Design

The experimental protocol included 200 target-present trials and 200 target-absent trials (400 trials in total). The experimental manipulations included both target type (illusory face and matched food) and presentation frequency (6 and 30 Hz).

Procedure

The task was to detect food items among a sequence of distractor objects. Before beginning the experiment, participants were shown illustrative examples of what matched food targets and distractor images would look like. It was explained that "food" counted as all consumables, which included drinks and ingredients involved in cooking. Participants were told to ask for clarification from the experimenter if they were unsure about whether an image counted as "food." The examples of illusory face images were not presented as illustrative examples because the presence of illusory faces was not discussed until the conclusion of the experiment. This was to discourage participants from expecting and looking for both food items and illusory faces.

The trial structure of Experiment 2 was replicated from Experiment 1. Targets were shown twice in the experiment, once in a 6 Hz trial and once in a 30 Hz trial. At the conclusion of each trial, participants were asked on the screen "Was there food present in any images?" with answer options "yes" or "no." If participants answered "yes," a secondary question appeared asking, "Did you like the type of food you saw?" with answer options "yes" or "no." This secondary question was designed to keep the trial structure of Experiment 2 comparable to that of Experiment 1, but the results of this question were not analyzed. Again, no feedback regarding performance was given. It took participants approximately 35 min to complete Experiment 2. The order of images in each trial was randomized, and the order of trials was randomized for each participant.

Apparatus and Analysis

We used the same instruments and analysis pipeline for Experiment 2 as were described for Experiment 1.

Results

A 2 (frequency: 6 and 30 Hz) × 2 (target type: illusory face and matched food) repeated measures ANOVA was performed (see Figure 2B). The main effect of frequency was significant, $F(1, 24) = 185.09$, $p < .001$, such that participants were better at detecting targets in the 6 Hz frequency ($M = 2.37$, $SE = 0.16$) compared to the 30 Hz frequency ($M = 0.28$, $SE = 0.10$). However, we found no evidence of a main effect of target type, $F(1, 24) = 0.829$, $p = .372$. The interaction between frequency and target type was also not significant, $F(1, 24) = 0.983$, $p = .331$.

One-sample *t* tests were also conducted to determine if detection sensitivity was above chance performance in each condition (adjusted for multiple comparisons using the Bonferroni rule). In 6 Hz trials, detection sensitivity was significantly above chance performance for matched food items ($M = 2.44$, $SE = 0.19$), $t(24) = 12.70$, $p_{\text{Bonferroni}} < .001$, and food items with illusory faces ($M = 2.30$, $SE = 0.13$), $t(24) = 17.78$, $p_{\text{Bonferroni}} < .001$. However, in 30 Hz trials, detection sensitivity was only above chance for matched food items ($M = 0.28$, $SE = 0.10$), $t(24) = 2.81$, $p_{\text{Bonferroni}} = .02$, not for food items with illusory faces ($M = 0.28$, $SE = 0.12$), $t(24) = 2.30$, $p_{\text{Bonferroni}} = .06$.

Experiment 3: Repeated Measures Experimental Design

Collectively, the results of Experiments 1 and 2 demonstrate that examples of face pareidolia have two distinct identities that can be recognized even at fast presentation speeds. More specifically, when the pareidolia illusion occurs by happenstance in food items, the object can be recognized either as a face or as a food item. This suggests that examples of face pareidolia have two recognizable identities that co-occur even when seen very briefly (Mei et al., 2022). However, it remains unclear whether the examples of face pareidolia seen in Experiments 1 and 2 were more easily recognized in the face- or food detection task because different samples were collected, and different stimuli were employed. Therefore, to address this question, we combined both tasks into a repeated measures design. Further, we used the exact same stimuli in both tasks. In other words, we employed illusory faces in food items as targets in both the face detection task and food detection task (see Figure 1A). We used the same distractors as in Experiment 2, except we removed and replaced a small number of kitchen tools because they were "food related." In accordance with how illusory faces are represented in the brain during the first 200 ms (Wardle et al., 2020), we predicted that detection sensitivity for illusory faces would be higher in the face detection task than in the food detection task when presentation time was limited in the 30 Hz condition. In contrast, detection sensitivity for illusory faces would be equivalent across tasks when participants have more time to view the stimuli (i.e., in the 6 Hz condition).

Method

Participants

As this study combines Experiments 1 and 2, we took the original target sample size ($n = 20$) and doubled it because (a) we needed to counterbalance task order and (b) if task order was a significant factor, we would need to perform the full analysis, separately, on the two groups. Although 42 participants (29 female and 13 male) volunteered to participate, two had been excluded from the analysis because of scores in one condition falling more than 3 *SD*s below the group mean. After these participants were replaced, the final analysis included 40 participants (27 female, 13 male; $M_{\text{age}} = 22.8$ years); 20 completed the face detection task first. Participants reported normal or corrected-to-normal vision and gave informed consent to participate. Participants were compensated with a $20 voucher or course credit.

Stimuli

The stimuli for Experiment 3 were 50 human faces, 50 food items with illusory faces (illusory faces), 50 matched food items without illusory faces (hereafter referred to as food items), and 229 distractor objects. Twelve of the illusory faces from Experiment 2 were replaced with different stimuli in Experiment 3. This was to improve the detectability of the food identity as some of the original stimuli were thought to be too ambiguous (e.g., stimuli depicting raw chicken, dipping oil, or empty drinking glasses). The 50 human faces were randomly selected from the set that had been employed in Experiment 1. We note that the same 50 faces were used to test every participant.

Design

The experiment included 400 target-present trials and 400 target-absent trials (800 trials in total). The experimental design included three factors in a repeated measures design: (a) task type (face and food), (b) presentation frequency (6 and 30 Hz), and (c) target type (illusory face target and real target).

The face- and food detection tasks were organized as blocks, and these two blocks of trials were counterbalanced across participants such that half of the participants completed the face detection task first, whereas the others completed the food detection task first. In the face detection task, the targets were faces (human faces or illusory faces). In the food detection task, the targets were food items (food items with or without illusory faces). Consequently, the exact same illusory face stimuli served as targets in both tasks, while the human faces and matched nonface food items functioned as targets in their respective task blocks, but as distractors in the opposing task block (Figure 1B). Trials were either 6 or 30 Hz, and every target was presented once in each frequency condition in each task block. A summary of all the stimuli deployed in Experiment 3 is available in Table 1.

On an individual participant basis, every target image was placed among distractor images to form the trial sequences for Block 1. Then, in Block 2, the trial sequences were kept intact, althrough the image order was reshuffled. Therefore, the exact same trial sequences were presented in in Block 1 and Block 2 with the only difference being the instructions to participants. This was to ensure that targets placed among weaker or stronger distractors in Block 2 could not explain performance. In the face detection task, after viewing a trial sequence, participants were asked whether a face was present among the images. Conversely, in the food detection task after viewing a trial sequence, participants were asked whether a food item was present among the images. There were no secondary questions in this experiment to ensure the only difference between the task-type blocks was the task instructions.

Among the target-present trials, we included trials where both a human face and a food item were present. Depending on the task type block, one would be a target and the other a distractor. This is because participants may have learnt that the presence of one target type could indicate the absence of the other target type. For example, participants who had completed the face detection block and were onto the food detection block may have learnt that when a human face was present in a trial, a food item would not be. They may then see a human face in a trial and disengage from the trial, knowing a food item target would not appear. To prevent this from happening, when a nonillusory face target (i.e. human face or ordinary food item) was present, 25% of the time, it was paired with an opposing target. Therefore, participants would not form a belief that only one type of target would ever appear in a sequence. In each 20-item sequence, a target could appear between the fifth and 15th items. In sequences where both food and faces appeared, they were at least three positions apart.

Procedure

The tasks used were identical to those described in Experiments 1 and 2. The only difference in procedure was the blocked task structure and the instructions to participants. At first, participants were shown examples of the targets and distractors that would be used in their first task. The second task was not mentioned until the participant had reached the end of the first block and was preparing to begin the second block of trials. Participants were not given verbal instructions about how to respond to images containing illusory faces but were shown illusory faces as examples of targets for both tasks. The entire experiment took participants approximately 40–50 min to complete.

Apparatus and Analysis

The same apparatus and calculations of detection performance were used for Experiment 3 as were described for Experiments 1 and 2. To assess how detection performance varied over task condition, we performed a 2 × 2 × 2 repeated measures ANOVA with factors of task type (face detection, food detection), presentation frequency (6 and 30 Hz) and target type (nonillusory face, illusory face).

Results

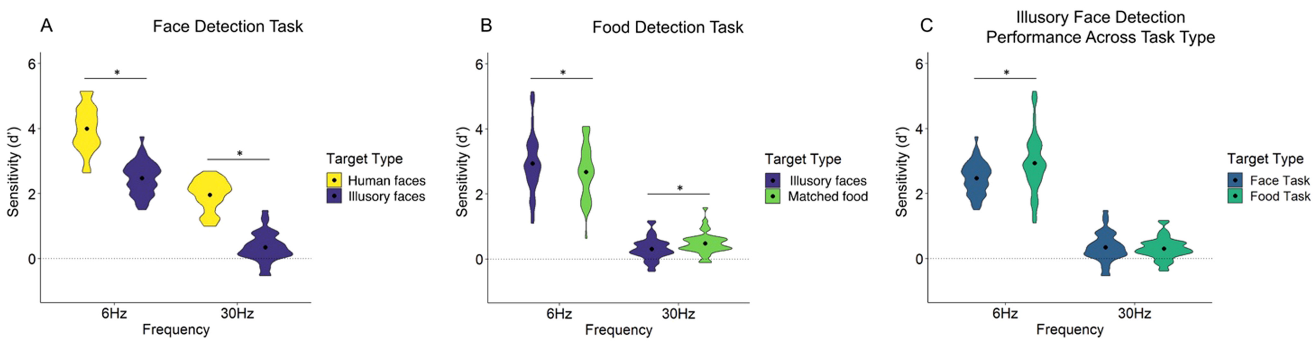
The results of Experiment 3 revealed a distinction in detection performance across the food and face tasks (Figure 3). A three-way ANOVA among task type, target type, and frequency was conducted. A main effect of task type was revealed, $F(1, 39) = 85.34$, $p < .001$, with participants better at detecting targets in the face

Table 1
Summary of the Trial Structure Used in Experiment 3

Stimuli per sequence			Number of Sequences per Frequency × Task	Target present or absent	
Human face	Illusory face	Matched food		Face detection task	Food detection task
1	0	0	25	Target present	Target absent
1	0	1	25	Target present	Target present
0	1	0	50	Target present	Target present
0	0	1	25	Target absent	Target present
0	0	0	75	Target absent	Target absent

Note. This table provides an overview of the number of human faces, illusory faces, and matched food stimuli per sequence in Experiment 3. We note that the exact same sequences were used in both tasks (i.e., face- and food detection).

Figure 3
Target Detection Performance for Experiment 3



Note. Violin plots showing target detection performance for each condition in Experiment 3 ($n = 40$). (A) Performance in the face detection task. (B) Performance in the food detection task. (C) Comparisons between illusory face detection performance across task types. See the online article for the color version of this figure.
* $p < .05$.

detection task ($M = 2.20$, $SE = 0.06$) compared to the food detection task ($M = 1.60$, $SE = 0.08$). As expected, we also found a main effect of frequency, $F(1, 39) = 776.88$, $p < .001$, such that detection sensitivity was higher in 6 Hz trials ($M = 3.03$, $SE = 0.10$) compared to 30 Hz trials ($M = 0.78$, $SE = 0.05$). A main effect of target type was revealed, $F(1, 39) = 270.64$, $p < .001$, such that participants were better at detecting nonillusory stimuli (human faces and food items; $M = 2.28$, $SE = 0.07$) compared to food items with illusory faces ($M = 1.52$, $SE = 0.06$).

The three-way interaction among frequency, task type, and target type was significant, $F(1, 39) = 8.68$, $p = .005$. To follow-up the significant three-way interaction, six Bonferroni-corrected pairwise comparisons between discrete conditions were conducted. When participants were detecting faces and the presentation speed was slow (6 Hz; Figure 3A, left), detection sensitivity was significantly higher for human face targets ($M = 4.0$, $SE = 0.11$) compared to illusory face targets ($M = 2.48$, $SE = 0.08$), $t(39) = 15.22$, $p_{\text{Bonferroni}} < .001$. Similarly, when the presentation speed was fast (30 Hz; Figure 3A, right), detection sensitivity was still significantly higher for human faces ($M = 1.97$, $SE = 0.07$) compared to illusory faces ($M = 0.35$, $SE = 0.07$), $t(39) = 21.77$, $p_{\text{Bonferroni}} < .001$. This is consistent with results in Experiment 1; when looking for faces, human faces were more easily detected than illusory faces at both slow and fast presentation speeds.

However, we found a different pattern of results when participants were looking for food items. When the presentation speed was slow (6 Hz), sensitivity was significantly higher for food items with illusory faces ($M = 2.94$, $SE = 0.15$) compared to matched food items without illusory faces ($M = 2.68$, $SE = 0.13$), $t(39) = -4.28$, $p_{\text{Bonferroni}} < .001$ (see Figure 3B, left). However, at the faster presentation speed (30 Hz), this behavior pattern reversed. Participants were less sensitive to food items with illusory faces ($M = 0.31$, $SE = 0.05$) than matched food items ($M = 0.48$, $SE = 0.05$), $t(39) = 3.07$, $p_{\text{Bonferroni}} = .02$ (see Figure 3B, right). Therefore, sensitivity to the food targets with and without illusory faces depended on the presentation speed.

Next, we compared sensitivity to illusory face stimuli across the face- and food detection tasks (Figure 3C). On one hand, in the 6 Hz frequency condition, participants were more sensitive to illusory faces when looking for food than when looking for faces, $t(39) = -3.61$, $p_{\text{Bonferroni}} = .005$ (see Figure 3C). On the other hand, in the 30 Hz condition, participants were equally sensitive to illusory faces, regardless of the task at hand, $t(39) = -0.58$, $p_{\text{Bonferroni}} = 1$ (see Figure 3C).

Discussion

This study investigated the rapid detection of illusory faces across different task conditions. Consistent with the findings of Rekow et al. (2022), Experiment 1 revealed evidence that participants are sensitive to illusory faces in a face detection task, even when presentation time was extremely limited. This capacity to reliably detect illusory faces with only a glimpse supports the claim that the experience of face pareidolia is the consequence of an error in the processes responsible for rapidly detecting human faces (Jakobsen et al., 2023; Keys et al., 2021; Omer et al., 2019; Saurels et al., 2024; Taubert et al., 2018, 2020, 2022; Wardle, et al.,. 2020). However, detection sensitivity was higher for human faces than illusory faces, an observation which is consistent with a number of previous behavioral findings (Alais et al., 2021; Jakobsen et al., 2023; Keys et al., 2021; Saurels et al., 2024). This is consistent with the claim that illusory faces are more heterogeneous than human faces in terms of their low-level visual properties (Caruana & Seymour, 2022; Epihova et al., 2022).

In Experiment 2, we measured behavioral responses to illusory faces in a task focused on object attributes rather than face attributes. To this end, we designed a food detection task and collected examples of food items, such as a sliced capsicum, with and without illusory faces. The results revealed that food items could be accurately detected in both the 6 and 30 Hz conditions. This is consistent with the idea that food items, like faces, form a class of biologically relevant and visually salient stimuli that can be detected, even under extreme processing limitations. Although we found no evidence that frequency interacted with target type, when we tested whether sensitivity across the four unique conditions was above chance, we found that food detection in the 30 Hz condition was only spared for matched food items. This result suggests that, when faces are irrelevant to the task at hand, the presence of an illusory face might interfere with the categorization of an object's veridical identity, but only at fast presentation speeds.

The specific motivation for Experiment 3 was to directly compare behavioral responses to a set of illusory faces under different task conditions. Thus, we combined the face detection task with the food detection task in a repeated measures design. The results demonstrate that when images of food that also contain illusory faces were presented at 6 Hz, people were more sensitive to their food identity than their face identity. However, this advantage for illusory faces in the food task was not observed when the presentation time was reduced; when images containing illusory faces were presented at the faster rate of 30 Hz, there was no evidence of a difference for illusory faces across the two tasks. Interestingly, when asked to detect food, participants in Experiment 3 showed higher sensitivity to food items with illusory faces than matched food items in the 6 Hz condition, a similar trend to Experiment 2 (see Figure 2B). Yet, when the presentation speed was increased to 30 Hz, the participants in both Experiments 2 and 3 showed lower sensitivity to the illusory faces. Collectively, these findings suggest that when the presentation time is longer, allowing for more processing, the presence of an illusory face might, under some experimental circumstances, bolster performance in a food detection task. However, when presentation time is decreased, the presence of an illusory face reliably and negatively impacts food detection; in Experiment 2, illusory faces eliminated detection sensitivity and, in Experiment 3, although sensitivity remained above chance, it was lower in the illusory face condition than in the matched food item condition. Overall, these findings are consistent with recent neurophysiological and neuroimaging data showing that the neural representation of illusory faces changes over time with examples of face pareidolia being initially represented as more similar to faces and then, later, being represented as more similar to objects (Wardle et al., 2020).

The tasks employed in Experiments 1–3 involved the detection of stimuli from broad categories (faces and food) among a set of highly variable distractor stimuli. We show that participants could detect targets in both tasks, even at the fastest presentation rate, indicating that illusory faces have two robust, yet concurrent identities perhaps being processed in parallel. Lower sensitivity at the faster 30 Hz presentation speed supports previous findings that faster RSVP streams lead to lower fidelity image representations because of image masking (Maguire & Howe, 2016; Potter et al., 2014; Robinson et al., 2019). Thus, one intriguing finding is the heightened sensitivity to illusory faces relative to matched food items at 6 Hz but not 30 Hz (Figure 3B). The same pattern of results was evident in Experiment 2, though was not significant (Figure 2B) possibly because we used a number of ambiguous stimuli as food targets in Experiment 2, such as oil and raw chicken. Nonetheless, the observation that illusory faces were easier to detect than matched food items in Experiment 3, when participants were directed to look for food items, indicates that illusory faces spontaneously boosted food detection. This is consistent with the idea that illusory facial features are often incorporated into architecture, art, and commercial products because they automatically summon attention (Delbaere et al., 2011; Di Salvo & Gemperle, 2003; Martinez-Conde et al., 2015; C. Wang et al., 2022; Wodehouse et al., 2018). Further, previous work has shown that attentional enhancement occurs 150 ms after image presentation (Moerel et al., 2022). Thus, the benefit of having a superfluous illusory face should be pronounced when an image can be continually processed for longer than 150 ms, as was the case in Experiment 3. In sum, by measuring behavior toward illusory faces in a food detection task, we found that illusory facial features confer attentional benefits for object targets that are independent of task.

Our findings highlight a number of gaps in our understanding of illusory face perception. From the findings, we conclude that the object identity of illusory faces dominates perception at slow, but not fast, presentation speeds. One alternative explanation is that we were unable to detect differences at the fast presentation speed owing to poor performance. However, target detection performance was still above chance at this speed, and the results do fit with previous work on the face identity of illusory faces. Indeed, in the food detection task of Experiment 3, the detection of matched food items was higher than that of illusory faces at 30 Hz (i.e., the reverse trend to 6 Hz), which fits with the claim that illusory faces might be initially detected as faces and that this mistake might interfere with food detection. Yet, at longer presentation times, this interference is reduced perhaps because the erroneous face identity is suppressed. Nevertheless, these results indicate that illusory face stimuli can be detected as either faces or food items, even at very short durations. One unknown is whether different features in the images are prioritized according to the task at hand, although we think this unlikely because of the high featural variation in the illusory face images.

General Discussion

At present, representations of visual stimuli in the primate brain are thought to be organized according to whether the stimulus is an animate object, like a face, or an inanimate object, like a food item (Downing et al., 2006; Kiani et al., 2007; Kriegeskorte et al., 2008; Long et al., 2018). However, the factors that give rise to this apparent organization are unknown (Op de Beeck et al., 2019; Taubert et al., 2022). Understanding how the brain processes objects with two identities, one animate and one inanimate, as is the case with examples of face pareidolia, will be important for obtaining a complete understanding of how the brain encodes visual stimuli for visual recognition in the real world. But, first, we need to understand how the perception of face pareidolia changes across time and circumstance. In this study, we took steps toward understanding how illusory faces are perceived across different time limitations and task conditions. Our data reveal that examples of face pareidolia have two overlapping identities that are recognizable at two time points. This distinguishes ambient examples of face pareidolia, as a class of visual stimuli separate from faces in noise (Liu et al., 2014; Summerfield et al., 2006; Zimmermann et al., 2019) or difficult to see Mooney faces (Palmer et al., 2022; Taubert & Parr, 2011) because those stimuli are only perceived as faces once structure is detected, before that they are merely noise. Similarly, these results suggest that the perception of an illusory face in an example of face pareidolia differs from the perception of a bistable face stimulus, which is thought to oscillate between a face and a nonface identity over time (Tong et al., 1998; M. Wang et al., 2013). Future research can now focus on characterizing the neural representation of these unique stimuli under different circumstances by manipulating task.

References

Alais, D., Xu, Y., Wardle, S. G., & Taubert, J. (2021). A shared mechanism for facial expression in human faces and face pareidolia. *Proceedings of the Royal Society B: Biological Sciences*, *288*(1954), Article 20210966. https://doi.org/10.1098/rspb.2021.0966

Avery, J. A., Liu, A. G., Ingeholm, J. E., Gotts, S. J., & Martin, A. (2021). Viewing images of foods evokes taste quality-specific activity in gustatory insular cortex. *Proceedings of the National Academy of Sciences*, *118*(2), Article e2010932118. https://doi.org/10.1073/pnas.2010932118

Bachmann, T., & Allik, J. (1976). Integration and interruption in the masking of form by form. *Perception*, *5*(1), 79–97. https://doi.org/10.1068/p050079

Caruana, N., & Seymour, K. (2022). Objects that induce face pareidolia are prioritized by the visual system. *British Journal of Psychology*, *113*(2), 496–507. https://doi.org/10.1111/bjop.12546

Collins, E., Robinson, A. K., & Behrmann, M. (2018). Distinct neural processes for the perception of familiar versus unfamiliar faces along the visual hierarchy revealed by EEG. *NeuroImage*, *181*, 120–131. https://doi.org/10.1016/j.neuroimage.2018.06.080

Decramer, T., Premereur, E., Zhu, Q., Van Paesschen, W., van Loon, J., Vanduffel, W., Taubert, J., Janssen, P., & Theys, T. (2021). Single-unit recordings reveal the selectivity of a human face area. *The Journal of Neuroscience*, *41*(45), 9340–9349. https://doi.org/10.1523/JNEUROSCI.0349-21.2021

Delbaere, M., McQuarrie, E. F., & Phillips, B. J. (2011). Personification in advertising. *Journal of Advertising*, *40*(1), 121–130. https://doi.org/10.2753/JOA0091-3367400108

Di Salvo, C., & Gemperle, F. (2003). *From seduction to fulfillment: The use of anthropomorphic form indesign*. Proceedings of the conference on Designing Pleasurable Products and Interfaces. https://doi.org/10.1145/782896.782913

Downing, P. E., Chan, A. Y., Peelen, M. V., Dodds, C. M., & Kanwisher, N. (2006). Domain specificity in visual cortex. *Cerebral Cortex*, *16*(10), 1453–1461. https://doi.org/10.1093/cercor/bhj086

Epihova, G., Cook, R., & Andrews, T. J. (2022). Recognition of pareidolic objects in developmental prosopagnosic and neurotypical individuals. *Cortex*, *153*, 21–31. https://doi.org/10.1016/j.cortex.2022.04.011

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Goren, C. C., Sarty, M., & Wu, P. Y. (1975). Visual following and pattern discrimination of face-like stimuli by newborn infants. *Pediatrics*, *56*(4), 544–549. https://doi.org/10.1542/peds.56.4.544

Jain, N., Wang, A., Henderson, M. M., Lin, R., Prince, J. S., Tarr, M. J., & Wehbe, L. (2023). Selectivity for food in human ventral visual cortex. *Communications Biology*, *6*(1), Article 145. https://doi.org/10.1038/s42003-023-04546-2

Jakobsen, K. V., Hunter, B. K., & Simpson, E. A. (2023). Pareidolic faces receive prioritized attention in the dot-probe task. *Attention, Perception, & Psychophysics*, *85*(4), 1106–1126. https://doi.org/10.3758/s13414-023-02685-6

Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: A module in human extrastriate cortex specialized for face perception. *The Journal of Neuroscience*, *17*(11), 4302–4311. https://doi.org/10.1523/JNEUROSCI.17-11-04302.1997

Keys, R. T., Taubert, J., & Wardle, S. G. (2021). A visual search advantage for illusory faces in objects. *Attention, Perception, & Psychophysics*, *83*(5), 1942–1953. https://doi.org/10.3758/s13414-021-02267-4

Khosla, M., Ratan Murty, N. A., & Kanwisher, N. (2022). A highly selective response to food in human visual cortex revealed by hypothesis-free voxel decomposition. *Current Biology*, *32*(19), 4159–4171.e9. https://doi.org/10.1016/j.cub.2022.08.009

Kiani, R., Esteky, H., Mirpour, K., & Tanaka, K. (2007). Object category structure in response patterns of neuronal population in monkey inferior temporal cortex. *Journal of Neurophysiology*, *97*(6), 4296–4309. https://doi.org/10.1152/jn.00024.2007

Kriegeskorte, N., Mur, M., Ruff, D. A., Kiani, R., Bodurka, J., Esteky, H., Tanaka, K., & Bandettini, P. A. (2008). Matching categorical object representations in inferior temporal cortex of man and monkey. *Neuron*, *60*(6), 1126–1141. https://doi.org/10.1016/j.neuron.2008.10.043

Liu, J., Li, J., Feng, L., Li, L., Tian, J., & Lee, K. (2014). Seeing Jesus in toast: Neural and behavioral correlates of face pareidolia. *Cortex*, *53*, 60–77. https://doi.org/10.1016/j.cortex.2014.01.013

Long, B., Yu, C. P., & Konkle, T. (2018). Mid-level visual features underlie the high-level categorical organization of the ventral stream. *Proceedings of the National Academy of Sciences*, *115*(38), E9015–E9024. https://doi.org/10.1073/pnas.1719616115

Maguire, J. F., & Howe, P. D. L. (2016). Failure to detect meaning in RSVP at 27 ms per picture. *Attention, Perception, & Psychophysics*, *78*(5), 1405–1413. https://doi.org/10.3758/s13414-016-1096-5

Martinez-Conde, S., Conley, D., Hine, H., Kropf, J., Tush, P., Ayala, A., & Macknik, S. L. (2015). Marvels of illusion: Illusion and perception in the art of Salvador Dali. *Frontiers in Human Neuroscience*, *9*, Article 496. https://doi.org/10.3389/fnhum.2015.00496

McKeeff, T. J., Remus, D. A., & Tong, F. (2007). Temporal limitations in object processing across the human ventral visual pathway. *Journal of Neurophysiology*, *98*(1), 382–393. https://doi.org/10.1152/jn.00568.2006

Mei, N., Santana, R., & Soto, D. (2022). Informative neural representations of unseen contents during higher-order processing in human brains and deep artificial networks. *Nature Human Behaviour*, *6*(5), 720–731. https://doi.org/10.1038/s41562-021-01274-7

Moerel, D., Grootswagers, T., Robinson, A. K., Shatek, S. M., Woolgar, A., Carlson, T. A., & Rich, A. N. (2022). The time-course of feature-based attention effects dissociated from temporal expectation and target-related processes. *Scientific Reports*, *12*(1), Article 6968. https://doi.org/10.1038/s41598-022-10687-x

Omer, Y., Sapir, R., Hatuka, Y., & Yovel, G. (2019). What is a face? Critical features for face detection. *Perception*, *48*(5), 437–446. https://doi.org/10.1177/0301006619838734

Op de Beeck, H. P., Pillet, I., & Ritchie, J. B. (2019). Factors determining where category-selective areas emerge in visual cortex. *Trends in Cognitive Sciences*, *23*(9), 784–797. https://doi.org/10.1016/j.tics.2019.06.006

Palmer, C. J., & Clifford, C. W. G. (2020). Face pareidolia recruits mechanisms for detecting human social attention. *Psychological Science*, *31*(8), 1001–1012. https://doi.org/10.1177/0956797620924814

Palmer, C. J., Goddard, E., & Clifford, C. W. (2022). Face detection from patterns of shading and shadows: The role of overhead illumination in generating the familiar appearance of the human face. *Cognition*, *225*, Article 105172. https://doi.org/10.1016/j.cognition.2022.105172

Potter, M. C., Wyble, B., Hagmann, C. E., & McCourt, E. S. (2014). Detecting meaning in RSVP at 13 ms per picture. *Attention, Perception, & Psychophysics*, *76*(2), 270–279. https://doi.org/10.3758/s13414-013-0605-z

Rekow, D., Baudouin, J.-Y., Brochard, R., Rossion, B., & Leleu, A. (2022). Rapid neural categorization of facelike objects predicts the perceptual awareness of a face (face pareidolia). *Cognition*, *222*, Article 105016. https://doi.org/10.1016/j.cognition.2022.105016

Robinson, A. K., Grootswagers, T., & Carlson, T. A. (2019). The influence of image masking on object representations during rapid serial visual presentation. *NeuroImage*, *197*, 224–231. https://doi.org/10.1016/j.neuroimage.2019.04.050

Saurels, B. W., Peluso, N., & Taubert, J. (2024). A behavioral advantage for the face pareidolia illusion in peripheral vision. *Scientific Reports*, *14*(1), Article 10040. https://doi.org/10.1038/s41598-024-60892-z

Summerfield, C., Egner, T., Mangels, J., & Hirsch, J. (2006). Mistaking a house for a face: Neural correlates of misperception in healthy humans. *Cerebral Cortex*, *16*(4), 500–508. https://doi.org/10.1093/cercor/bhi129

Taubert, J., & Parr, L. A. (2011). Geometric distortions affect face recognition in chimpanzees (*Pan troglodytes*) and monkeys (*Macaca mulatta*). *Animal Cognition*, *14*(1), 35–43. https://doi.org/10.1007/s10071-010-0341-x

Taubert, J., Ritchie, J. B., Ungerleider, L. G., & Baker, C. I. (2022). One object, two networks? Assessing the relationship between the face and body-selective regions in the primate visual system. *Brain Structure and Function*, *227*(4), 1423–1438. https://doi.org/10.1007/s00429-021-02420-7

Taubert, J., Wally, S., & Dixson, B. J. (2023). Preliminary evidence of an increased susceptibility to face pareidolia in postpartum women. *Biology Letters*, *19*(9), Article 20230126. https://doi.org/10.1098/rsbl.2023.0126

Taubert, J., Wardle, S., Flessert, M., Basile, B., Koele, E., James, C., Murray, E., & Ungerleider, L. (2018). Amygdala damage eliminates monkeys' viewing preference for real and illusory faces. *Journal of Vision*, *18*(10), Article 1232. https://doi.org/10.1167/18.10.1232

Taubert, J., Wardle, S. G., Flessert, M., Leopold, D. A., & Ungerleider, L. G. (2017). Face pareidolia in the rhesus monkey. *Current Biology*, *27*(16), 2505–2509.e2. https://doi.org/10.1016/j.cub.2017.06.075

Taubert, J., Wardle, S. G., Tardiff, C. T., Koele, E. A., Kumar, S., Messinger, A., & Ungerleider, L. G. (2022). The cortical and subcortical correlates of face pareidolia in the macaque brain. *Social Cognitive and Affective Neuroscience*, *17*(11), 965–976. https://doi.org/10.1093/scan/nsac031

Taubert, J., Wardle, S. G., & Ungerleider, L. G. (2020). What does a "face cell" want?'. *Progress in Neurobiology*, *195*, Article 101880. https://doi.org/10.1016/j.pneurobio.2020.101880

Tong, F., Nakayama, K., Vaughan, J. T., & Kanwisher, N. (1998). Binocular rivalry and visual awareness in human extrastriate cortex. *Neuron*, *21*(4), 753–759. https://doi.org/10.1016/S0896-6273(00)80592-9

Tsao, D. Y., & Livingstone, M. S. (2008). Mechanisms of face perception. *Annual Review of Neuroscience*, *31*(1), 411–437. https://doi.org/10.1146/annurev.neuro.30.051606.094238

Uchiyama, M., Nishio, Y., Yokoi, K., Hirayama, K., Imamura, T., Shimomura, T., & Mori, E. (2012). Pareidolias: Complex visual illusions in dementia with Lewy bodies. *Brain*, *135*(8), 2458–2469. https://doi.org/10.1093/brain/aws126

van der Laan, L. N., de Ridder, D. T. D., Viergever, M. A., & Smeets, P. A. M. (2011). The first taste is always with the eyes: A meta-analysis on the neural correlates of processing visual food cues. *NeuroImage*, *55*(1), 296–303. https://doi.org/10.1016/j.neuroimage.2010.11.055

Wang, C., Yu, L., Mo, Y., Wood, L. C., & Goon, C. (2022). Pareidolia in a built environment as a complex phenomenological ambiguous stimuli. *International Journal of Environmental Research and Public Health*, *19*(9), Article 5163. https://doi.org/10.3390/ijerph19095163

Wang, M., Arteaga, D., & He, B. J. (2013). Brain mechanisms for simple perception and bistable perception. *Proceedings of the National Academy of Sciences*, *110*(35), E3350–E3359. https://doi.org/10.1073/pnas.1221945110

Wardle, S. G., Paranjape, S., Taubert, J., & Baker, C. I. (2022). Illusory faces are more likely to be perceived as male than female. *Proceedings of the National Academy of Sciences*, *119*(5), Article e2117413119. https://doi.org/10.1073/pnas.2117413119

Wardle, S. G., Taubert, J., Teichmann, L., & Baker, C. I. (2020). Rapid and dynamic processing of face pareidolia in the human brain. *Nature Communications*, *11*(1), Article 4518. https://doi.org/10.1038/s41467-020-18325-8

Wodehouse, A., Brisco, R., Broussard, E., & Duffy, A. (2018). Pareidolia: Characterising facial anthropomorphism and its implications for product design. *Journal of Design Research*, *16*(2), 83–98. https://doi.org/10.1504/JDR.2018.092792

Zimmermann, K. M., Stratil, A. S., Thome, I., Sommer, J., & Jansen, A. (2019). Illusory face detection in pure noise images: The role of interindividual variability in fMRI activation patterns. *PLoS ONE*, *14*(1), Article e0209310. https://doi.org/10.1371/journal.pone.0209310

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