

Pareidolic faces receive prioritized attention in the dot-probe task

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Abstract

Face pareidolia occurs when random or ambiguous inanimate objects are perceived as faces. While real faces automatically receive prioritized attention compared to non-face objects, it is unclear whether pareidolic faces similarly receive special attention. We hypothesized that, given the evolutionary importance of broadly detecting animacy, pareidolic faces may have enough faceness to activate a broad face template, triggering prioritized attention. To test this hypothesis, and to explore where along the faceness continuum pareidolic faces fall, we conducted a series of dot-probe experiments in which we paired pareidolic faces with other images directly competing for attention: objects, animal faces, and human faces. We found that pareidolic faces elicited more prioritized attention than objects, a process that was disrupted by inversion, suggesting this prioritized attention was unlikely to be driven by low-level features. However, unexpectedly, pareidolic faces received more privileged attention compared to animal faces and showed similar prioritized attention to human faces. This attentional efficiency may be due to pareidolic faces being perceived as not only face-like, but also as human-like, and having larger facial features—eyes and mouths—compared to real faces. Together, our findings suggest that pareidolic faces appear automatically attentionally privileged, similar to human faces. Our findings are consistent with the proposal of a highly sensitive broad face detection system that is activated by pareidolic faces, triggering false alarms (i.e., illusory faces), which, evolutionarily, are less detrimental relative to missing potentially relevant signals (e.g., conspecific or heterospecific threats). In sum, pareidolic faces appear “special” in attracting attention.

Key terms: visual attention, attention capture, attention prioritization, privileged attention, faces, face-like, face detection, dot-probe, face template, own-species bias, pareidolia

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Pareidolic faces receive prioritized attention in the dot-probe task

Face pareidolia occurs when one perceives illusory faces in the configuration of random or ambiguous everyday objects (e.g., wall outlet) or a collection of objects (e.g., table setting). Pareidolic faces, as shown in Figure 1, are perceived to have facial features that are associated with faceness: eyes and mouths (Omer et al., 2019), similar to human eyes and mouths (e.g., Itier et al., 2011), as well as left-right symmetry and top-bottom asymmetry (Turati, 2004). Even though pareidolic faces provide no useful social information, they may be interpreted as having social qualities (Palmer & Clifford, 2020). For example, people follow the eye gaze direction of pareidolic faces (Takahashi & Watanabe, 2013) and perceive emotions in pareidolic faces (Alais et al., 2021; Wardle et al., 2022).



Figure 1. Example stimuli.

One interpretation of these illusory social processing biases is that humans may have a general face template—including specific features, such as the eyes and mouth—that guide visual attention (Itier et al., 2011; Omer et al., 2019; Shibata et al., 2002). This hypothesis would explain why the brain appears to be attuned to stimuli that activate the percept of a face (Meng et al., 2012). Indeed, faces are reported to capture attention automatically, even when task-irrelevant (Cerf et al., 2008; Langton et al., 2008; Simpson et al., 2014b), and hold attention for longer durations of time compared to non-face stimuli (Bindemann et al., 2005; Farroni et al., 2005). Pareidolic faces likewise appear to elicit superior attention capture relative to non-face objects (Guido et al., 2019).

A broadly tuned face template that privileges sensitivity over selectivity (Omer et al., 2019; Taubert et al., 2017; Tsao & Livingstone, 2008) may explain why pareidolic faces are misperceived as real faces (Wardle et al., 2020). Pareidolic faces may activate this general face template, resulting in spontaneous “false alarm” errors perceiving illusory faces (Zhou & Meng, 2021) which are theorized to be adaptive, given that such false positives have less detrimental consequences to fitness relative to false negatives (i.e., missing signals) of evolutionary relevance (Alais et al., 2021). That is, it is more important to over-identify rather than miss signals with important consequences, including those that may indicate potential threats or affiliative opportunities (e.g., mates) relevant to survival or reproduction. Consistent with this hypothesis, humans’ attentional biases (e.g., detection, attention capture, attention holding) to faces include not only human faces but also animal faces (Jakobsen et al.,

2021) and images that appear face-like (Caruana & Seymour, 2022; Guido et al., 2019; Rekow et al., 2022; although see Ariga & Arihara, 2017).

Faces and inanimate objects may vary in their degree of faceness. Although faces in general activate attentional biases (e.g., rapid, automatic attention capture), human faces appear to elicit privileged attentional biases to an even greater degree compared to animal faces (Crouzet et al., 2010; Hunter & Markant, 2021; Jakobsen et al., 2021; Sigala et al., 2011; Simpson et al., 2014a). Further, animal faces that are more similar to human faces (e.g., primates) receive greater attentional biases compared to more distantly related species (e.g., non-primate mammals; Simpson et al., 2014b), suggesting that, even among biological faces, there may be differences in where they fall on humans' prototypical faceness continuum. For example, faces that are more like a prototypical face template may be detected more effectively than those that are less prototypical, and therefore, may be prioritized in their processing (Caruana & Seymour, 2022). Additionally, both human and animal faces are processed qualitatively differently from objects (Rousselet et al., 2004), suggesting non-face objects may not activate the face template, falling low in the faceness continuum, and thereby, not activating prioritized attentional processing.

However, when it comes to early attentional biases, it is unclear the degree to which pareidolic faces are treated more like real faces or non-face objects. Such a study is important for determining whether and where pareidolic faces fit within humans' faceness continuum in terms of their ability to automatically capture attention. The study of pareidolic faces, therefore, can provide unique insights into the mechanisms that underlie face processing (Zhou & Meng, 2021).

One paradigm that can assess the degree of covert attention to competing images is the dot-probe paradigm (MacLeod et al., 1986). In this paradigm, participants fixate on a central location and are shown pairs of images for 100 or 1000 ms in the periphery, after which they indicate the location of a target probe in one of the two locations (Figure 2) as quickly and accurately as they can. Participants' reaction times (RTs) to respond to the target probe indicate the spatial location of participants' covert attention (Posner & Peterson, 1990). Faster RTs to the target probe suggest the participants were already attending to the target location, whereas slower RTs suggest the participants needed additional time to shift their focus to detect the target (e.g., Bindemann et al., 2007; Jakobsen et al., 2021). Furthermore, the two cue display durations allow for distinctions between rapid, automatic processing of stimuli (100 ms) and processing that occurs following sufficient time to gather some initial information about stimuli (1000 ms). Typically, RTs for shorter cue display durations result in slower RTs compared to longer cue display durations because participants must respond while they are still processing the information about the cue, whereas in the longer cue display duration, they have had sufficient time to process the cue at least superficially and can therefore more quickly respond to the target probe when it appears (Bannerman et al., 2009; Hunt et al. 2007).

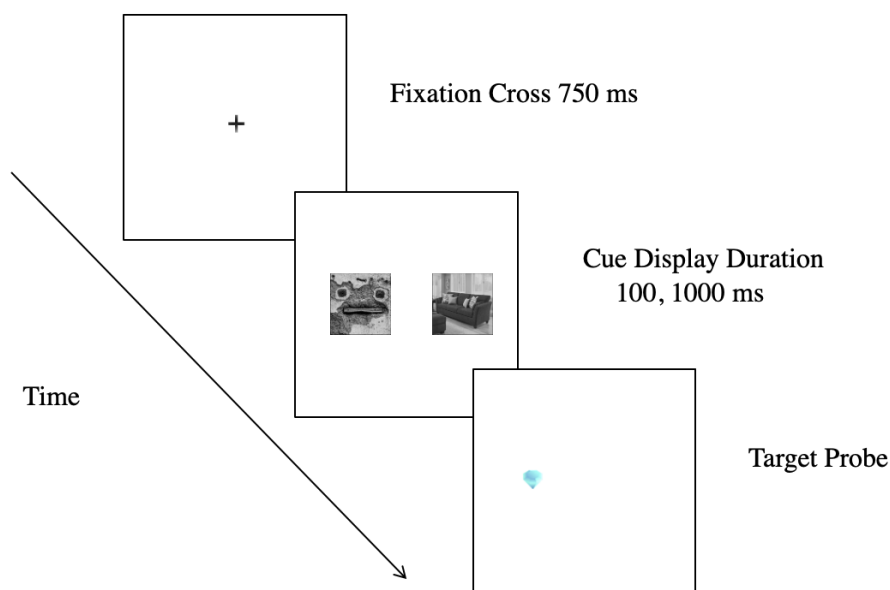


Figure 2. Dot-probe paradigm.

In dot-probe paradigms, participants respond more quickly to target probes located on the side of human faces compared to those on the side of objects (Bindemann et al., 2007; Jakobsen et al., 2021; Ro et al., 2001), consistent with numerous studies using various behavioral paradigms—such as visual search, gap-overlap, go/no-go categorization, saccadic choice, and continuous flash suppression—that report general attentional biases to faces compared to non-social objects (e.g., Cerf et al., 2008; Crouzet et al., 2010; Bindemann et al., 2007; Jakobsen et al., 2021; Simpson et al., 2014a). However, it is unclear whether, in the context of a dot-probe task, pareidolic faces automatically capture attention like real faces, compared to non-face objects.

Faces and face-like stimuli are attentionally prioritized to different degrees. That is, not all faces are processed in the same way. For example, studies using various paradigms including visual search (Hershler & Hochstein, 2005; Keys et al., 2021; Simpson et al., 2014a; Simpson et al., 2019), continuous flash suppression (Caruana & Seymour, 2022; Stein et al., 2011), saccadic choice task (Crouzet et al., 2010), and the rapid serial visual presentation-paradigm (Ariga & Arihara, 2017), as well as imaging studies (Decramer et al., 2021; Taubert et al., 2020; Wardle et al., 2020), consistently suggest that human faces are prioritized over other types of faces (e.g., animal faces and pareidolic faces; Akdeniz, 2020; Caharal et al., 2013; Churches et al., 2009; Hadjikhani et al., 2008; Keys et al., 2021; Simpson et al., 2020; Zhou et al., 2021). These types of paradigms typically compare responses to stimuli that are presented independently of each other (i.e., one at a time, presenting either face type but not both together) and compare processing speed or detection across trial types. In contrast, an advantage of the dot-probe paradigm is that it allows for stimuli to be presented in direct competition with each other—and only each other—and therefore, helps tease apart which stimulus may be attentionally prioritized. Another advantage of the dot-probe paradigm is that the pairs of images are task-irrelevant (i.e.,

unrelated to the location of the subsequent target probe); therefore, any differential responding indicates differences in how the images automatically bias attention.

The dot-probe paradigm can, therefore, assess participants' degree of covert attention to two competing images. Given that pareidolic faces have yet to be put in direct competition with human faces and animal faces to see if they differ in the extent to which they automatically capture covert attention, it is unclear whether one type of face would be prioritized over the other. In the "real world," we are confronted with more than one visual image at a time, and our attentional systems must prioritize what we attend to. This direct comparison is, therefore, key because it provides information about whether these stimuli are attentionally treated as having similar levels of faceness.

In the current study, participants completed dot-probe tasks in which they viewed pareidolic faces paired with objects (Experiment 1), inverted pareidolic faces paired with inverted objects (Experiment 2), pareidolic faces paired with animal faces (Experiment 3), and pareidolic faces paired with human faces (Experiment 4). We hypothesized that pareidolic faces would elicit more prioritized attention than objects but would do so to a lesser extent than human faces, falling in the middle-range near animal faces. Finally, we evaluated whether participants' subjective perceptions of face stimuli and the objective structural features of face stimuli influenced attention (Experiment 5). We hypothesized that faces perceived to be more face-like and human-like, and that have prominent inner features (e.g., large eyes) will be attentionally privileged, compared to faces lower in these qualities, consistent with the proposal that humans have a broad and highly sensitive face-detection system.

Experiment 1: Pareidolic faces vs Objects

Pareidolic faces have attentional processing advantages compared to non-face objects. For example, electrophysiological studies suggest that pareidolic face recognition occurs earlier (faster) than the processing of non-face objects (e.g., Hadjikhani et al., 2008). Consistent with this finding, in a breaking continuous flash suppression paradigm, in which different images were presented to each eye and participants had to indicate the location of a previously masked target, participants were faster to indicate the location of a target when it was a pareidolic face than when it was a non-face object, suggesting that pareidolic faces enter visual awareness more quickly than non-face objects (Caruana & Seymour, 2022). Similarly, in a visual search task in which participants were asked to search for specific target images (i.e., presented prior to each trial) of pareidolic faces and non-face objects hidden among matched object distractors (e.g., a purse with a pareidolic face among purses without faces; a purse without a face among purses without faces), participants detected the pareidolic faces more quickly than the non-face object targets, again suggesting a visual attention advantage for pareidolic faces (Keys et al., 2021).

However, this apparent pareidolic face detection advantage may not persist when pareidolic faces are task-irrelevant (Ariga & Arihara, 2017), unlike human and animal faces that continue to show attentional advantages even when task-irrelevant (e.g., Ariga & Arihara, 2017; Langton et al., 2008; Sato & Kawahara, 2015; Simpson et al., 2014a). For example, in a rapid serial visual presentation paradigm, task-irrelevant pareidolic faces did not automatically capture attention when presented as distractors periodically in a sequence of multiple distractors (Ariga & Arihara, 2017). Together, these findings suggest that when pareidolic faces are task-relevant (i.e., something for which a person is searching, as when someone points out, "hey look at the face in that cloud!"), they may be detected more readily. In

contrast, when pareidolic faces are simply encountered in our everyday lives (i.e., are not actively being searched for), they may not automatically capture attention as real faces do. However, it remains untested whether pareidolic faces may be attentionally privileged relative to non-face objects when task-irrelevant and in direct competition with objects, a scenario most reflective of how they would be encountered in the “real world.”

Experiment 1, therefore, aimed to establish whether the faceness of pareidolic faces elicits an automatic privileged attentional bias for task-irrelevant pareidolic faces when presented in direct competition with objects. We predicted that participants would have faster RTs for target probes presented on the same side as the pareidolic faces compared to when presented on the same side of the objects, consistent with the proposal of an automatic and covert attentional bias to face-like images.

Method

Participants. A power analysis conducted in G*Power (Faul et al., 2007) indicated that, for a repeated measures analysis of variance (ANOVA), given $\alpha = .05$ and a power of 0.95, detecting a medium effect ($f = 0.25$) would require at least 36 participants. We, therefore, recruited 45 undergraduate students ($N_{Women} = 36$, $N_{Men} = 9$), who participated for course credit at a large southeastern U.S. university. The average age was 19.04 years old ($SD = 1.22$). Among the participants, 34 identified as White, four identified as Black/African American, one identified as Asian, and six identified as multi-racial/ethnic (one identified as White and Armenian, two identified as White and Asian, one identified as White and Black/African American, one identified as White and Hispanic/Latino, and one identified as White and Pacific Islander). Participants reported normal or corrected-to-normal vision. Participants in Experiment 1 did not participate in any of the other dot-probe experiments (Experiments 2-4).

Materials. Stimuli included 18 photographs of everyday objects and 18 photographs of pareidolic faces (see examples in the third and fourth rows of Figure 1). Images were collected from online image search engines (e.g., Google). Pareidolic faces were objects (e.g., cars, buildings, handbags; 300×300 pixels) that had inner elements in the locations of facial features, including two eyes above a mouth, and were independently rated by a separate group of participants ($N = 25$) as being face-like, having forward-facing eye gaze, and displaying a neutral expression (Supplementary Materials, pp. S1-S2, Figures S1-S3). All stimuli were presented in grayscale. We used the SHINE Toolbox (Willenbockel et al., 2010) to match images on their luminance.

Images were shown two at a time. Pareidolic faces and objects were semi-randomly paired; although not all possible pair combinations were presented, no two image pairs appeared more than once. The location (left or right side) of the pareidolic faces and objects was counterbalanced across trials and the pairs of stimuli appeared in a semi-randomized order.

The study was administered remotely, so participants needed a laptop or desktop computer with a reliable internet connection and webcam. The task was created using PsychoPy3 (Peirce et al., 2019) and data were collected on Pavlovio.org. PsychoPy is reported to have a mean precision RT of 1.36 – 4.84 ms and is thus considered a reliable method for collecting online responses (Bridges et al., 2020). Participants were monitored during the session on Zoom software (<https://zoom.us>) to ensure they were on-task.

Procedure. All procedures (Experiments 1-5) were approved by [institution blinded for review]’s Institutional Review Board. Participants joined a Zoom session with an experimenter. Following

completion of the consent form, the researcher shared a link with the participant, which began the presentation of the task in a full-screen browser window. Participants did not see the researcher during the task. Participants were asked to keep their eyes in the center of the screen throughout the test session; the experimenter watched the participant throughout the task to ensure they were on-task (i.e., keeping their eyes at the center of the screen).

A flashing central fixation cross (black cross on a white screen) appeared at the beginning of each trial for 750 ms. Next, a cue display (a pair of images: one pareidolic face and one object) appeared for 100 ms or 1,000 ms, with half of the trials at each cue duration. Upon the end of the cue display, a target probe (i.e., blue gemstone) appeared immediately in the center of one of the cue locations (equally likely to occur either on the left or the right). Participants were instructed to indicate the location of the target probe by pressing the corresponding key on a keyboard (left arrow key if it appeared on the left, right arrow key if it appeared on the right) as quickly and accurately as they could. The target remained on the screen until the participant's key press response or until 2500 milliseconds elapsed. Following the participant's response, the next trial began immediately (starting again with the presentation of the fixation cross for 750 ms).

Participants completed 18 practice trials, which included pairs of non-face objects. They received feedback about whether they correctly pressed keys in the location of the target probe. Next, participants completed six blocks of 48 trials with opportunities to take breaks between blocks. Following the dot-probe task, participants rated the 36 images on how face-like they were (see Experiment 5 for details). In total, the experiment lasted approximately 30 minutes.

Data analysis. RTs were computed based on the side on which the target probe appeared (RTs for pareidolic faces were those trials in which the target probes appeared in the same locations as the pareidolic faces; RTs for objects were those trials in which the target probes appeared in the same locations as the objects). We collapsed RT data across the cue locations (left, right) and target probe locations (left, right). Trials were excluded if participants did not correctly indicate the location of the target probe (1% of trials), if participants' RTs were less than 200 ms (indicating anticipatory responses; 0.002% of trials), and trials in which participants' average RTs for that condition were greater than 2.5 standard deviations (*SD*) greater than the mean for that condition, trimmed within subjects (indicating being off-task; Salemnik et al., 2007; 3% of trials). These RTs were analyzed with a 2 (Cue type: pareidolic face, object) $\times$ 2 (Cue display time: 100 ms, 1000 ms) repeated measures ANOVA. We also analyzed accuracy with a 2 (Cue type: pareidolic face, object) $\times$ 2 (Cue display time: 100 ms, 1000 ms) repeated measures ANOVA (see Supplemental Materials for results, p. S3).

Results and Discussion

There was a main effect of Cue type, $F(1, 44) = 4.92$, $p = .032$, $\eta_p^2 = .10$ (Figure 3), with faster responses to target probes on the side of pareidolic faces ($M = 416$ ms, $SD = 37$) than those on the side of objects ($M = 418$ ms, $SD = 40$). There was also a main effect of Cue display time, $F(1, 44) = 25.12$, $p < .001$, $\eta_p^2 = .36$, with faster responses to target probes in the 1000 ms cue display time ($M = 409$ ms, $SD = 41$) than the 100 ms cue display time ($M = 425$ ms, $SD = 40$). We detected no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.74$, $p = .395$.

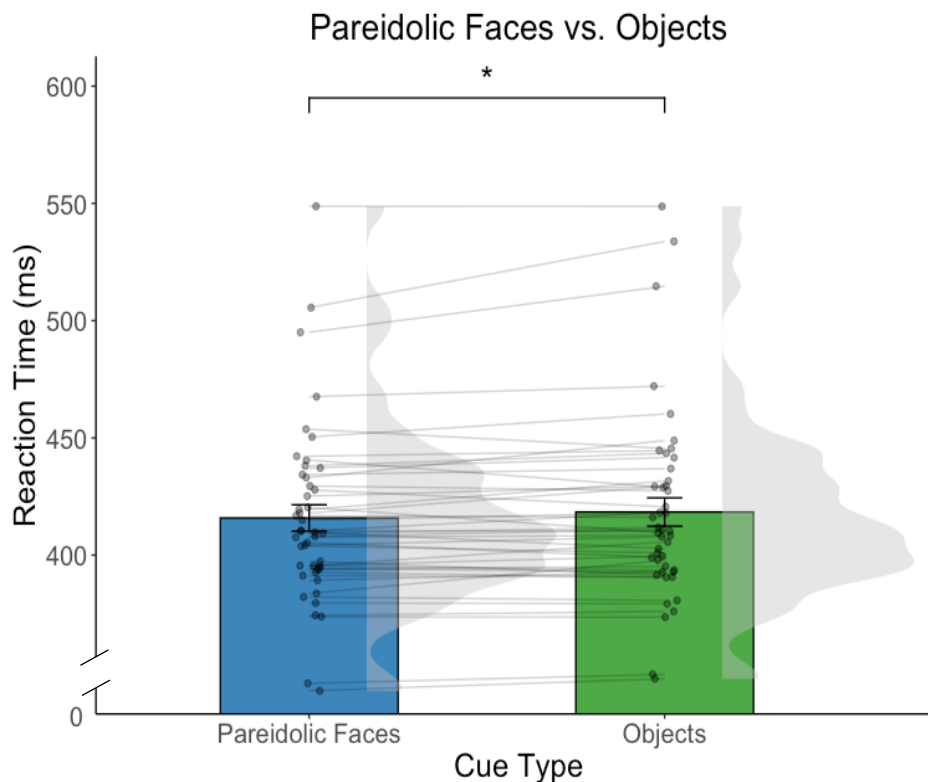


Figure 3. Reaction times (in milliseconds) to identify the location of the target were faster when the preceding cue was on the side of the pareidolic face (left) compared to the side of the non-face object (right). Gray dots connected with lines reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean. $*p = .032$. For a graph detailing Cue Type and Cue Duration, see Supplemental Materials, p. S5, Figure S4.

Participants responded more quickly to target probes following the 1000 ms cue display duration than the 100 ms cue display duration, consistent with previous dot-probe studies (Cooper & Langton, 2006; Petrova et al., 2013; Stevens et al., 2011; Weierich et al., 2008), suggesting that, with sufficient time to process stimuli (i.e., 1000 ms), participants more quickly responded to the target probe location than with short cue display durations (i.e., 100 ms), in which the target probe appeared while they were still processing the cue (Bannerman et al., 2009). This pattern is particularly interesting because when animal faces are paired with objects in a dot-probe study (Jakobsen et al., 2021), participants needed 1000 ms to demonstrate a RT advantage for animal faces. That is, 100 ms was insufficient time to show an animal face advantage over objects. However, here we found that, when pareidolic faces were paired with objects, participants demonstrated a RT advantage for pareidolic faces even with 100 ms. This finding may suggest that the processing for pareidolic faces may be more rapid than the processing for animal faces, at least in this type of paradigm.

Participants' attentional bias for pareidolic faces over objects suggests that they processed the pareidolic images as face-like. This finding—that there are pareidolic face biases in a dot-probe paradigm—is in line with previous findings using other tasks that also report other types of attentional biases for pareidolic faces over objects, such as faster processing speeds and target detection (Caruana

& Seymour, 2022; Hadjikhani et al., 2008). Our findings also extend those from prior dot-probe studies which reported an attentional bias for human faces over objects (Bindemann et al., 2007; Jakobsen et al., 2021), suggesting the dot-probe paradigm may also be sensitive in detecting attentional differences driven by objects varying in their faceness. Our results provide additional support for our hypothesis that pareidolic faces fall on a faceness dimension, appearing more face-like than non-face objects.

However, an alternative interpretation is that a difference in faceness may not be driving this apparent attention capture advantage, but rather, it may be driven by some lower-level superficial feature(s) of the images that unintentionally varied between the pareidolic and non-pareidolic objects (e.g., texture, contrast, shape, complexity). We tested this possibility in Experiment 2 by inverting (i.e., presenting upside-down) pareidolic faces and objects. We hypothesized that, if the higher-level perception is driving the attentional efficiency to pareidolic faces compared to objects, then inversion would disrupt some processing of the first-order relations (i.e., reduced faceness), leading to disruptions in attentional biases to pareidolic faces similar to those reported for pareidolic faces in other tasks (e.g., recognition; Pavlova et al., 2020), and similar to the inversion disruptions to attention that occur for human faces in dot-probe tasks (e.g., Wirth & Wentura, 2020).

Experiment 2: Inverted Pareidolic faces vs Inverted Objects

Inversion is proposed to disrupt some of the perception of the first-order configuration (e.g., two eyes above the nose and mouth) of faces, which tends to be associated with poorer detection, identification, and discrimination of inverted human faces compared to upright faces (Valentine, 1988; Yin, 1969) more so than inversion effects for non-face objects (Albonico et al., 2018; Langton et al., 2008; Yin, 1969). Additionally, the presence of upright, but not inverted, human faces is reported to increase the time it takes participants to find a non-face target in a visual search task (Langton et al., 2008), consistent with the proposal that upright, but not inverted, faces automatically capture, and thereby, distract attention. Yet, it remains unclear the extent to which these inversion effects extend also to pareidolic faces in the dot-probe paradigm.

Here we tested whether our interpretation in Experiment 1—that the apparent attention bias that we found for pareidolic faces compared to non-face objects—was due to differences in their faceness, including their first-order configuration (i.e., eyes above the mouth), rather than being driven by one or more lower-level stimulus features (e.g., edge density, local contrast) that may have unintentionally varied between the pareidolic and non-pareidolic objects. To test this possibility in Experiment 2, we sought to determine whether inverting (i.e., presenting upside-down) pareidolic faces would disrupt their processing. This comparison of inverted images is important because it enables us to rule out potential low-level features—such as stimulus saliency driven by texture, contrast, shape, or complexity—that may underly what appears to be a higher-level effect driven by the differential meaning (e.g., faceness) of the stimuli (Kelley et al., 2003; Naber & Nakayama, 2013). Therefore, if the pareidolic face advantage is no longer evident (or is lessened) when inverted pareidolic faces are paired with inverted objects, then this is consistent with a higher-level interpretation of the effect (i.e., the first-order configuration of the facial elements—eyes above the mouth—was critical for the privileged attention) we observed in Experiment 1, rather than being due to low-level features.

To test this hypothesis, in Experiment 2 we examined the extent to which the attentional bias for pareidolic faces relative to objects is disrupted by inversion. If pareidolic faces are processed similarly

to human faces, as suggested by previous literature, then the inversion of pareidolic faces should disrupt their processing, slowing reaction times, as it does for human faces relative to objects. That is, the attentional bias for pareidolic images relative to objects that we found in Experiment 1 (i.e., main effect of cue type) should no longer be present, or should be reduced, when images are inverted. In contrast, if the Experiment 1 effect was driven by one or more low-level features, we predicted the pareidolia face bias would be unaffected by inversion (i.e., we would still observe faster reaction times to the inverted pareidolic faces compared to the inverted objects).

Method

Participants. A new sample of 45 undergraduate students ($N_{Women} = 32$, $N_{Men} = 13$) participated for course credit at a large southeastern U.S. university. The average age was 19.09 years old ($SD = 1.08$); 37 participants identified as White, two participants identified as Black, two participants identified as Asian, one participant identified as Asian and Hispanic/Latino, one participant identified as Black/African American and Middle Eastern/Northern African, one participant identified as White and Hispanic/Latino, and one participant identified as Hispanic/Latino. Participants reported normal or corrected-to-normal vision.

Materials. Stimuli included the same images as in Experiment 1, but the photos were inverted 180°. All stimuli were presented in grayscale. We obtained ratings from a separate set of adults confirming that the inverted pareidolic faces were perceived less face-like compared to the upright pareidolic faces, similar to the inversion effect for human faces (see Supplementary Materials, p. S9, Figure S8).

Procedure. The procedure for Experiment 2 was the same as that in Experiment 1 except the cues were inverted pareidolic faces and inverted non-face objects.

Data analysis. We analyzed the data in Experiment 2 in the same way as in Experiment 1. We removed trials with incorrect responses (1.4% of trials), responses that were too fast (< 200 ms; 0.006% of responses), and responses that were too slow ($> 2.5 SD$ above the mean; 3.5% of trials). We conducted a 2 (Cue display time: 100 ms, 1000 ms) $\times$ 2 (Cue type: inverted pareidolic face, inverted object) repeated measures ANOVA on participants' RTs. See Supplemental Materials (p. S3) for accuracy results.

Results and Discussion

We detected no main effect of Cue type, $F(1, 44) = 1.42$, $p = .239$ (Figure 4), with participants showing equally fast RTs to inverted pareidolic faces ($M = 422$ ms, $SD = 47$) and inverted objects ($M = 424$ ms, $SD = 47$). There was a main effect of Cue display time, $F(1, 44) = 31.89$, $p < .001$, $\eta_p^2 = .42$, with participants responding faster to target probes in the 1000 ms cue display time ($M = 414$ ms, $SD = 44$) than the 100 ms cue display time ($M = 432$ ms, $SD = 52$). We detected no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.40$, $p = .532$.

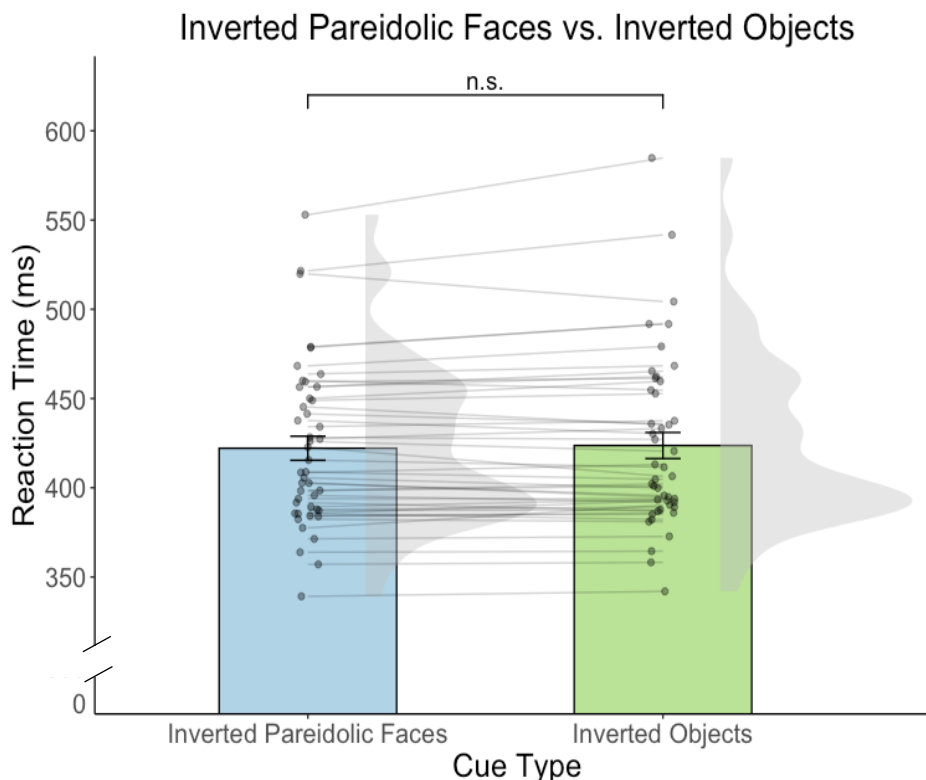


Figure 4. Reaction times (in milliseconds) were equally fast to identify the location of the target when the preceding cue was on the side of the inverted pareidolic face (left) compared to the side of the inverted non-face object (right). Gray dots connected with lines reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean, n.s. = not statistically significant, $p = .239$. For a graph detailing Cue Type and Cue Duration, see Supplemental Materials, p. S6, Figure S5.

Participants in Experiment 2 did not show an attentional bias for inverted pareidolic faces over inverted non-face objects, consistent with reports of human face inversion effects in the dot-probe task (Wirth & Wentura, 2020). These results suggest that, if an image portrays some degree of faceness, its ability to capture attention may be disrupted when inverted. This finding is consistent with previous reports of accuracy and RT costs for task-relevant inverted, relative to upright, pareidolic faces. For example, when participants indicated whether they saw a face or not in individually presented images of inverted and upright pareidolic faces, they were less accurate and took longer to identify a face in inverted—compared to upright—pareidolic images (Pavlova et al., 2020). Participants also took longer to detect inverted—compared to upright—pareidolic faces in a breaking continuous flash suppression task (Caruana & Seymour, 2022). Our findings suggest face inversion effects may also occur when pareidolic faces are task-irrelevant, underscoring their potential influence on more automatic attention capture.

Additionally, the results of Experiment 2 suggest that the attentional bias for pareidolic faces that we found in Experiment 1 was unlikely to be due to low-level features of our pareidolic and object images. Rather, because inversion disrupted the processing of pareidolic faces, it is more likely that the

faceness of the images, possibly including the first-order configuration of the critical facial features—eyes above the mouth—is, at least in part, responsible for the privileged attention capture we observed in Experiment 1. Together, these findings suggest that the perception of pareidolic faces, compared to objects, may be closer to a prototypical face. Further, these findings are consistent with reports that pareidolic faces elicit face-like neural response patterns (Decramer et al., 2021; Taubert et al., 2020; Wardle et al., 2020) suggesting that pareidolic faces may fall on the faceness continuum, potentially in between real faces and non-face objects.

However, it is still unclear where, more specifically, pareidolic faces fall in terms of faceness. Are they attentionally privileged to the same extent as real, biological faces? We began to explore this issue in Experiment 3, in which we paired pareidolic faces with animal faces in a dot-probe paradigm, to experimentally test whether pareidolic faces differ in the extent to which they are attentionally prioritized compared to animal faces when task-irrelevant and in direct competition with one another.

Experiment 3: Pareidolic faces vs. Animal faces

Humans quickly detect animals in their environments (Crouzet et al., 2012; Guyonneau et al., 2006; Kirchner & Thorpe, 2006; Thorpe et al., 2001), particularly when their faces are visible (Drewes et al., 2011). For example, animal faces are attentionally prioritized over objects in a dot-probe task, at least in the 1000 ms condition, suggesting participants needed sufficient time to process the stimuli (Jakobsen et al., 2021). Unlike animal faces, in Experiment 1, we found that pareidolic faces received an attentional bias over objects in both the 100 and 1000 ms conditions, suggesting that pareidolic faces may receive attentional priority over animal faces. That is, our findings hint at an intriguing question: do pareidolic faces have some attentional advantages over animal faces?

To answer this question, In Experiment 3, we directly compared pareidolic faces and animal faces when in competition with one another. We explored where animal and pareidolia faces fit on the faceness continuum relative to one another, when in direct competition with each other. While pareidolic faces may be prioritized compared to animal faces, as we previously hypothesized (given our Experiment 1 findings), another possibility is that attention to faces is prioritized according to biological importance. Compared to pareidolic faces, animal faces are more biologically meaningful, as humans have interacted with animals for various purposes throughout our evolutionary history, including as resources (e.g., food, clothing), domesticated companions, and predators (Staňková et al., 2021). Further, the false detections of illusory faces (e.g., pareidolic faces) may come at a cost by distracting individuals from ongoing task demands, including detecting real faces. Therefore, an attentional bias specifically tuned to real faces may have evolved to prioritize faces of highest biological importance (Brosch et al., 2007). In this case, we would expect faster RTs for target probes on the side of the real (animal) faces compared to target probes on the side of pareidolic faces.

Method

Participants. A new sample of 45 undergraduate students ($N_{Women} = 36$, $N_{Men} = 9$) participated for course credit at a large southeastern U.S. university. The average age was 19.4 years old ($SD = 2.11$); 37 participants identified as White, two participants identified as Asian, one participant identified as an Alaskan Native/American Indian and Black/African American, one participant identified as Black/African American and White, one participant identified as Middle Eastern/North African, one participant

identified as White and Asian, one participant identified as White and Black/African American, and one participant preferred not to answer. Participants reported normal or corrected-to-normal vision.

Materials. The pareidolic images were the same as those used in Experiment 1. We used a variety of non-threatening mammal and marsupial animal faces (e.g., cow, kangaroo, gorilla; 18 photos) obtained from online searches (e.g., Google) that a separate group of participants ($N = 25$) rated as having forward-facing eye gaze and a neutral expression (see Supplementary Materials, pp. 1-2, Figures S1 and S2). All stimuli were presented in grayscale (see examples in the second row of Figure 1).

Procedure. The procedure for Experiment 4 was the same as that in Experiment 1 except the cues were pareidolic faces and animal faces.

Data analysis. We analyzed the data in Experiment 4 in the same way as in Experiments 1, 2, and 3. We removed trials with incorrect responses (1.4% of trials), responses that were too fast (<200 ms; 0.006% of trials), and responses that were too slow (>2.5 SD above the mean; 2.9% of trials). We analyzed participants' RTs with a 2 (Cue type: pareidolic face, animal face) $\times$ 2 (Cue display time: 100 ms, 1000 ms) repeated measures ANOVA. See Supplemental Materials (p. S3) for accuracy results.

Results and Discussion

There was a main effect of Cue type, $F(1, 44) = 15.74$, $p < .001$, $\eta_p^2 = .26$ (Figure 5), with faster responses to target probes on the side of pareidolic faces ($M = 422$ ms, $SD = 34$) than those on the side of animal faces ($M = 425$ ms, $SD = 34$). There was also a main effect of Cue display time, $F(1, 44) = 14.69$, $p < .001$, $\eta_p^2 = .25$, with faster responses to target probes in the 1000 ms cue display time ($M = 418$ ms, $SD = 34$) than the 100 ms cue display time ($M = 429$ ms, $SD = 36$). We did not detect a Cue type $\times$ Cue display time interaction, $F(1, 44) = 2.18$, $p = .147$.

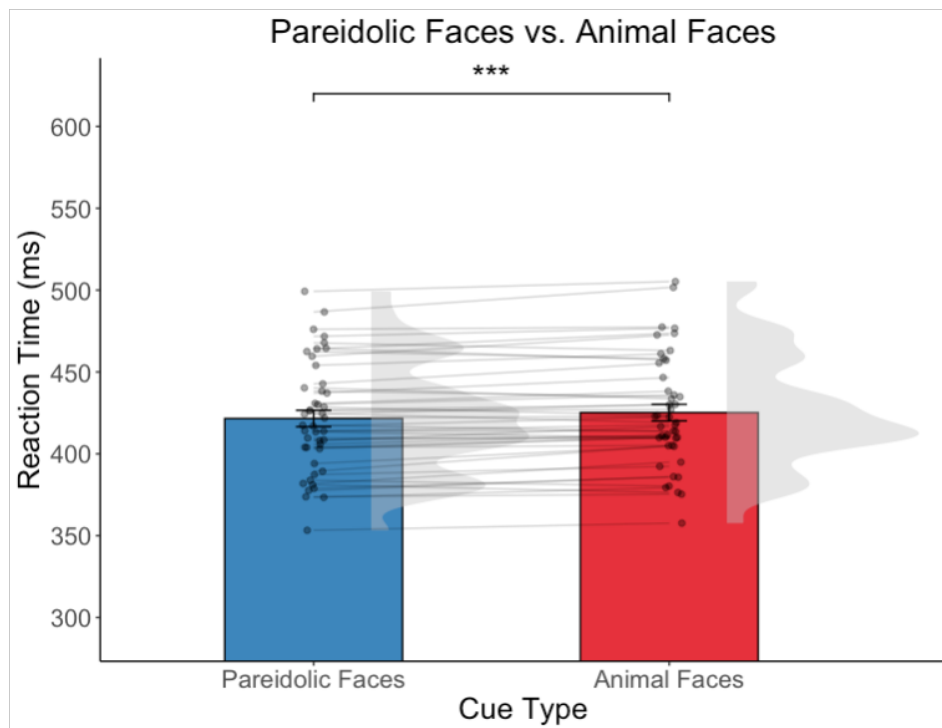


Figure 5. Reaction times (in milliseconds) to identify the location of the target were faster when the preceding cue was on the side of the pareidolic face (left) compared to the side of the animal face (right). Gray dots connected with lines reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean. *** $p < .001$. For a graph detailing Cue Type and Cue Duration, see Supplemental Materials, p. S7, Figure S6.

Participants responded faster to target probes in the location of pareidolic faces than animal faces. Although animals have biological relevance, they may not have been attentionally prioritized in this context compared to pareidolic faces because they were non-threatening species (e.g., koalas) with neutral expressions. While evolution may have shaped humans to be broadly sensitive to detecting animacy (Calvillo et al., 2016; Öhman, 2007), it may have fine-tuned them to be particularly sensitive to animacy that indicates threats. In line with this interpretation, dangerous animals (e.g., snakes, wild cats) may receive prioritized attention compared to evolutionary neutral animals (Yorzinski et al., 2014), especially when such animals were forward-facing, potentially indicating predator interest, and therefore, elevated risk (Yorzinski et al., 2018). Future studies with more evolutionarily relevant species (e.g., predators) will be necessary to test this hypothesis more fully.

One interpretation of our findings is that pareidolic faces may be perceived as having higher prototypical faceness—that is, they may be perceived as more human-face-like—than animal faces. If this is the case, pareidolic faces may be attentionally prioritized, similar to human faces. Indeed, the attentional advantages we found for pareidolic faces over animal faces are similar to previous reports of human face advantages over animal faces in the dot-probe paradigm (Brosch et al., 2007; Jakobsen et al., 2021). Together, these findings suggest that animal faces, broadly, may not be as salient at capturing attention as human faces (i.e., own-species bias; Scott & Fava, 2013). In fact, not only did we find an attentional advantage for pareidolic faces paired with animal faces at 1000 ms cue display time, but also at 100 ms cue display time, directly paralleling reported human face advantages when paired with animal faces (Jakobsen et al., 2021). However, pareidolic faces and human faces need to be directly compared to test the hypothesis that human and pareidolic face biases parallel one another. Thus, in Experiment 4, we examined whether pareidolic faces capture attention to a similar extent as human faces, or whether human faces have additional attentional advantages.

Experiment 4: Pareidolic faces vs. Human faces

There is at least some empirical support for the proposal that human faces may receive prioritized processing relative to pareidolic faces. For example, although human faces and pareidolic faces both activate the fusiform face area when presented one at a time (e.g., Ariga & Arihara, 2017; Hadjikhani et al., 2009; Liu et al., 2014), human face processing occurs earlier than pareidolic face processing (Akdeniz, 2020; Caharal et al., 2013; Churches et al., 2009; Hadjikhani et al., 2008). Additionally, in a visual search task, human faces are found more quickly than pareidolic faces (Keys et al., 2021). These findings are consistent with our hypothesis that human faces are more face-like than pareidolic faces. Additionally, when pareidolic faces were task-irrelevant (i.e., not the target for which participants were searching), but simply appeared as a distractor in image arrays, they did not disrupt the speed of locating a subsequent target (Ariga & Arihara, 2017) as reported for human and non-

human primate faces (Simpson et al., 2014b), suggesting that pareidolic faces may not automatically capture attention to the same degree as human and animal faces.

Because human faces are socially relevant and are likely the prototypical face template (Campbell et al., 1997; Damon et al., 2017), we hypothesized that human faces would receive an attentional bias compared to pareidolic faces, resulting in faster RTs for target probes on the side of human faces compared to target probes on the side of pareidolic faces. However, based on the results of Experiment 3, pareidolic faces may be more prototypical than animal faces, and therefore, may be more closely aligned with human faces, which may result in pareidolic faces being prioritized similarly to human faces. In this case, RTs to target probes in the locations of pareidolic faces and human faces may not differ from one another.

Method

Participants. A new sample of 45 undergraduate students ($N_{Women} = 37$, $N_{Men} = 8$) participated for course credit at a large southeastern U.S. university. The average age was 18.91 years old ($SD = 1.32$); 32 participants identified as White, one participant identified as Black/African American, five participants identified as Asian, one participant identified as an Alaskan Native/American Indian, Black/African American, and White, one participant identified as an Alaskan Native/American Indian and White, one participant identified as Asian and Black/African American, one participant identified as Asian and Hispanic/Latino, one participant identified as White and Black/African American, and two participants identified as White and Hispanic/Latino. Participants reported normal or corrected-to-normal vision.

Materials. The pareidolic images were the same as those used in Experiment 1. Eighteen human face photos were obtained from online searches (e.g., Google) and, identically to the pareidolic images, were also rated by a separate group of individuals ($N = 25$) as having forward-facing eye gaze and a neutral expression (see Supplementary Materials, pp. 1-2). In addition, we ensured the racial make-up of our human face stimuli reflected the ethnic diversity of our sample. All stimuli were presented in grayscale (see examples in the first row of Figure 1).

Procedure. The procedure for Experiment 3 was the same as that in Experiment 1 except the cues were pareidolic faces and human faces.

Data analysis. We analyzed the data in Experiment 4 in the same way as in Experiments 1-3. We removed trials with incorrect responses (1.5% of trials), responses that were too fast (<200 ms; 0.002% of trials), and responses that were too slow ($>2.5 SD$ above the mean; 2.7% of trials). We conducted a 2 (Cue type: pareidolic face, human face) $\times$ 2 (Cue display time: 100 ms, 1000 ms) repeated measures ANOVA on participants' RTs. See Supplemental Materials (p. S3) for accuracy results.

Results and Discussion

There was no main effect of Cue type, $F(1, 44) = 0.03$, $p = .859$ (Figure 6), with participants responding equally fast to pareidolic faces ($M = 423$ ms, $SD = 34$) and human faces ($M = 423$ ms, $SD = 40$). There was a main effect of Cue display time, $F(1, 44) = 9.77$, $p = .003$, $\eta_p^2 = .18$, with faster responses to target probes in the 1000 ms cue display time ($M = 419$ ms, $SD = 37$) than the 100 ms cue display time ($M = 428$ ms, $SD = 38$). We detected no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.001$, $p = .975$.

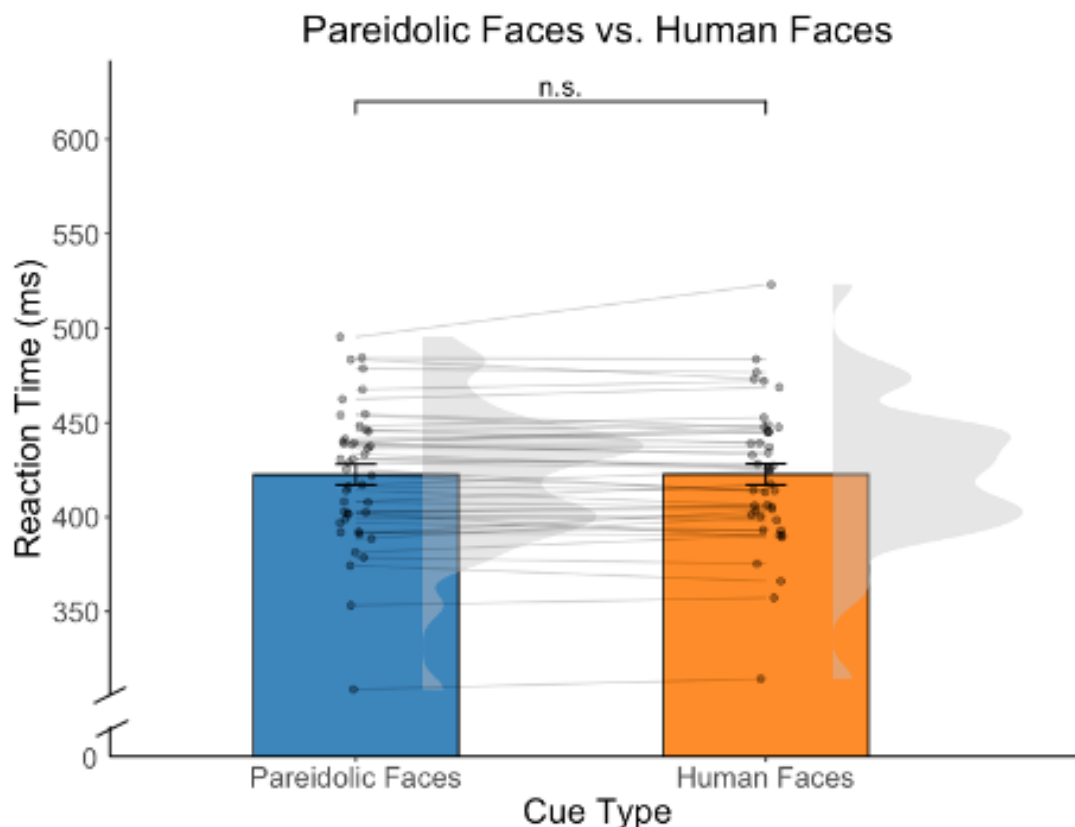


Figure 6. No differences were detected in reaction times (in milliseconds) to identify the location of the target when the preceding cue was on the side of the pareidolic face (left) compared to the side of the human face (right). Gray dots connected with lines reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean, n.s. = not statistically significant, $p = .859$. For a graph detailing Cue Type and Cue Duration, see Supplemental Materials, p. S8, Figure S7.

Participants were equally fast in responding to pareidolic faces and human faces. Remarkably, this occurred even with the 100 ms cue display time. One explanation for our null findings is that, in this type of task, we failed to detect a true difference between human faces and pareidolic faces (i.e., a type II error). That is, perhaps the dot-probe paradigm was insensitive in detecting subtle differences among face types. However, we think this interpretation is unlikely given that prior dot-probe studies have reported RT differences among specific types of faces, including effects of face race (Al-Janabi et al., 2012; Hodsoll et al., 2010; Trawalter et al., 2008) facial expressions (happy face bias: Wirth & Wentura, 2020; angry face bias: Cooper & Langton, 2006), facial attractiveness (Roth et al., 2022), facial neoteny/age (baby-face bias: Brosch et al., 2007; Hodsoll et al., 2010), and eye gaze direction (eye-contact bias: Miyazaki et al., 2012), as well as differences among faces of different species (human face own-species bias: Brosch et al., 2007; Jakobsen et al., 2021). Furthermore, we detected differences in

RTs between pareidolic faces and animal faces in Experiment 3, suggesting our paradigm is unlikely to lack sensitivity. Therefore, it seems reasonable to assume that, if human faces elicited at least a moderate effect of privileged detection relative to pareidolic faces, we would have captured those differences in the current study. So, the evidence here appears to suggest that human faces and pareidolic faces both have privileged automatic attention capture. These findings are consistent with previous reports that human faces and pareidolic faces are processed similarly (Ariga & Arihara, 2017; Hadjhikani et al., 2009; Liu et al., 2014). Together, these findings suggest that at least some features of pareidolic faces may be processed similarly to human faces.

However, an additional or alternative interpretation of our finding is that, even though there appeared to be similarities in attentional efficiency for human faces and pareidolic faces at the behavioral level, there may be differences in the underlying mechanisms driving these effects. While fully exploring this topic is largely beyond the scope of the current paper and will require additional measures (e.g., eye-tracking, physiology), we began to initially explore this possibility in Experiment 5. In Experiment 5, we examined participants' perceptions of the features of human faces, pareidolic faces, and animal faces. We also conducted an image analysis to determine what features, if any, were similar, or dissimilar, across our stimuli.

Experiment 5: Stimulus Perceptions and Image Analysis

Our findings in Experiments 1-4 indicated that pareidolic faces are preferentially attended to when paired with objects and animal faces, but not when paired with human faces. Thus, pareidolic faces seem to fall higher on the continuum of faceness than we hypothesized, above animal faces and potentially even tied with human faces. This positioning above animal faces suggests that pareidolic faces may elicit privileged automatic detection despite not being biologically or socially relevant faces.

We next decided to test a series of hypotheses. We first hypothesized that this apparent attentional advantage for pareidolic faces may be related to the subjective perceptions of these faces (Experiment 5a). For example, participants may have initially perceived pareidolic faces as more face-like compared to animal faces. We then tested the hypothesis that pareidolic faces are viewed as more human-face-like than animals (Experiment 5b). Indeed, previous studies report that social qualities—such as emotion, gender, and eye gaze direction—are attributed to pareidolic faces as they are to human faces (Alais et al., 2021; Palmer & Clifford, 2020; Takahashi & Watanabe, 2013; Wardle et al., 2022). A human-like perception of pareidolic faces may explain the similar RTs to human and pareidolic faces observed in Experiment 4.

Finally, we tested the hypothesis that there may be structural properties of pareidolic faces that underly the attention biases to them relative to real faces, which we observed across Experiments 3-4 (Experiment 5c). For example, human and pareidolic faces may be perceived as more prototypical if the sizing of their inner features were more like each other than when compared to animal faces. If so, this finding would be consistent with participants' particularly sensitive to eye size and spacing (Itier et al., 2011). Furthermore, previous dot-probe studies reported attention biases to baby faces, which have relatively large eyes compared to other face features (i.e., babyface schema; Brosch et al., 2007; Hodsoll et al., 2010). Therefore, one dimension of the pareidolic faces that may have driven their privileged attention capture relative to real faces is their large eyes.

To evaluate how subjective perceptions and objective structural features of faces may have influenced participants' attention, we examined the following factors: (1) perceptions of how face-like (Experiment 5a) and (2) human-like (Experiment 5b) each image was perceived to be, and (3) the objective sizing of the critical features (i.e., eyes and mouth) for pareidolic, human, and animal faces (Experiment 5c). We predicted that pareidolic faces would be perceived as more face-like than objects, more human-face-like than animal faces, and have larger, and therefore, more exaggerated inner facial features compared to human and animal faces.

Experiment 5a: Evaluations of images as "Face-Like"

Method

Participants. The same participants from Experiments 1-4 ($N = 180$) completed the ratings of how face-like they perceived each image to be.

Materials. Photos of the objects, pareidolic faces, animal faces, and human faces from Experiments 1-4 were included, for a total of 72 images (18 per category). Images were sized 300 × 300 pixels.

Procedure. Participants rated each image on a scale from 0 ("Not at all face-like") to 10 ("Very face-like"). These ratings were always completed after the dot-probe task, to ensure that participants were seeing the images for the first time in the context of the dot-probe task. Images were presented in a randomized order.

Data Analysis. We conducted a 4 × 4 mixed design ANOVA with the within subjects factors of Image Type (Pareidolic face, Object, Human face, Animal face) and the between subjects factor of Experimental Condition (Experiment 1: Pareidolic-Object; Experiment 2: Inverted Pareidolic-Inverted Object; Experiment 3: Pareidolic-Human; Experiment 4: Pareidolic-Animal). While we did not expect an effect of which Experimental Condition participants completed, we wanted to check to ensure that the type of dot-probe task completed prior to the rating did not impact subsequent ratings.

Results and Discussion

We detected no main effect of Experimental Condition, $F(3, 176) = 0.65, p = .583$, and no Image Type × Experimental Condition interaction, $F(9, 528) = 0.61, p = .785$, indicating that completing the dot-probe task with a specific set of cue types did not prime participants to perceive the images as more or less face-like compared to other cue type conditions. There was a main effect of Image Type, $F(3, 528) = 1376, p < .001, \eta_p^2 = .89$, in which participants rated human faces as the most face-like ($M = 9.89, SD = 0.73$), followed by animal faces ($M = 7.79, SD = 2.20$), then pareidolic faces ($M = 5.62, SD = 2.07$), and finally objects, which were rated as not face-like at all ($M = 0.46, SD = 0.57$; Figure 7); all conditions were statistically significantly different from each other ($ts > 11.18, ps < .001, ds > 0.83-10.27$). Together, these findings suggest that the pareidolic faces were not rated as more face-like than the human or animal faces, so this cannot account for our results in Experiments 3 or 4.

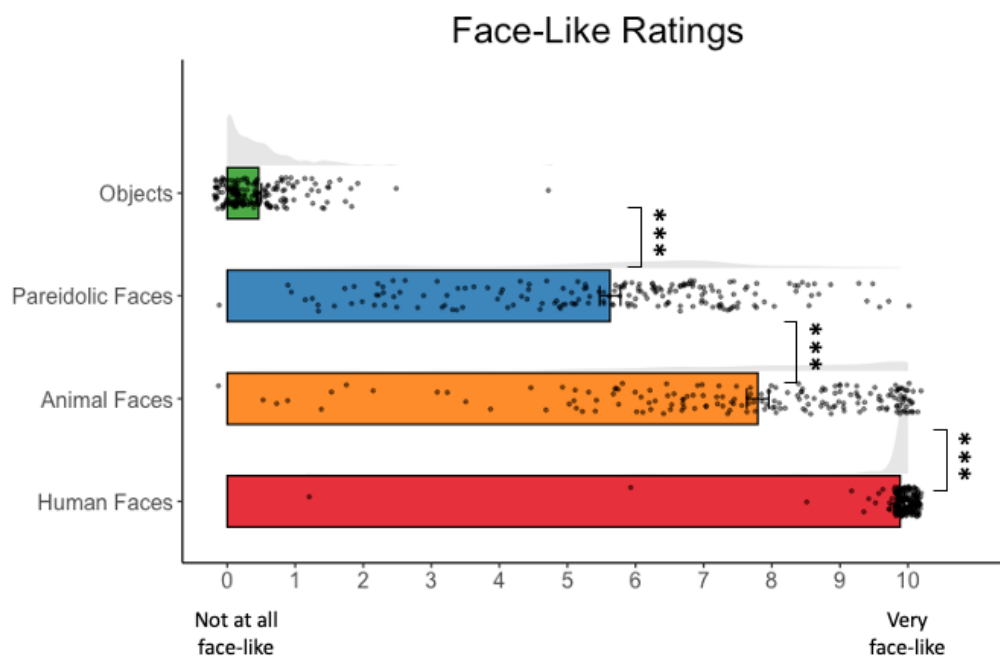


Figure 7. Images ratings of how face-like images were, from not at all (left) to very (right). Human faces (bottom) were rated as the most face-like, followed by animal faces, then pareidolic faces, and objects (top). Dots reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean, *** p s < .001.

In Experiment 5a, as predicted, participants rated human faces as the most face-like, followed by animal faces, and then pareidolic faces. However, this appears in contrast to our previous finding that pareidolic faces received prioritized attention compared to animal faces in Experiment 3. Together, these results suggest that, when participants have sufficient time to evaluate how face-like stimuli are, and the images are task-relevant, they rated animal faces higher in faceness than pareidolic faces, but when the task involved a quick response—in some cases without time to fully process the stimulus—and the images were task-irrelevant, participants responded more quickly to target probes on the side of the pareidolic face compared to target probes on the side of the animal face, suggesting pareidolic faces were attentionally treated as if they were higher in faceness relative to animal faces. These apparently contradictory findings may reflect a difference in slower, more controlled, purposeful cognitive evaluation in the rating task (favoring animal faces) compared to faster, more automatic/implicit initial processing in the dot-probe task (favoring pareidolic faces). In other words, although pareidolic faces were not rated as face-like, they were attentionally treated as a special class of faces.

These findings generally appear consistent with reports that the more face-like an object appears to be, the better the detection of that object (Takahashi & Watanabe, 2015). However, this interpretation still does not explain why pareidolic faces were attentionally prioritized over animal faces. Another possibility is that pareidolic faces are perceived not only as high in their faceness but also as

more “human-like” than animal faces. This possibility seems likely, given previous reports that humans attribute social qualities to pareidolic faces (Alais et al., 2021; Palmer & Clifford, 2020; Takahashi & Watanabe, 2013; Wardle et al., 2022). We, therefore, tested this hypothesis in Experiment 5b.

Experiment 5b: Evaluations of images as “Human-like”

Method

Participants. A separate group of 50 participants ($N_{Women} = 26$, $N_{Men} = 24$) who did not complete any of the dot-probe or rating studies completed a new set of ratings to indicate how human-like vs. animal-like each face image was. The average age was 19.23 years old ($SD = 1.11$); 36 participants identified as White, one participant identified as an Alaskan Native/American Indian, one participant identified as Asian, one participant identified as Black/African American, four participants identified as Hispanic/Latino, one participant identified as an Alaskan Native/American Indian and White, one participant identified as Black/African American, Hispanic/Latino, and White, four participants identified as Asian and White, and one participant identified as Hispanic/Latino and White.

Materials. Photos of pareidolic faces, animal faces, and human faces from Experiments 1-4 were included, for a total of 54 images. Images were sized 300×300 pixels.

Procedure. Participants rated each image on a scale from 1 (“It has an extremely human-like face”) to 10 (“It has an extremely animal-like face”). Images were presented in a randomized order.

Data Analysis. We conducted a one-way repeated measures ANOVA on the ratings exploring the Image Type (Pareidolic Face, Human Face, Animal Face).

Results and Discussion

We detected a main effect of Image Type, $F(2,98) = 853$, $p < .001$, $\eta_p^2 = .95$ (Figure 8). Human faces were rated as more human-like ($M = 1.17$, $SD = 0.04$) than pareidolic faces ($M = 2.23$, $SD = 0.10$), $t(49) = 13.12$, $p < .001$, $d = 1.86$, and animal faces ($M = 8.96$, $SD = 0.22$), $t(49) = 32.49$, $p < .001$, $d = 4.59$. Pareidolic faces were also rated as more human-like than animal faces ($t(49) = 27.52$, $p < .001$, $d = 3.89$). These findings suggest that the pareidolic faces were rated as more human-like than animal faces, which may explain the pareidolic face advantage relative to animal faces that we observed in Experiment 3. However, pareidolic faces were still viewed as less human-like than human faces, which cannot explain why we found similar attention to pareidolic faces and human faces in Experiment 4. Perhaps there is a threshold of human-likeness that, once reached, results in attention prioritization, and pareidolic faces reached that threshold.

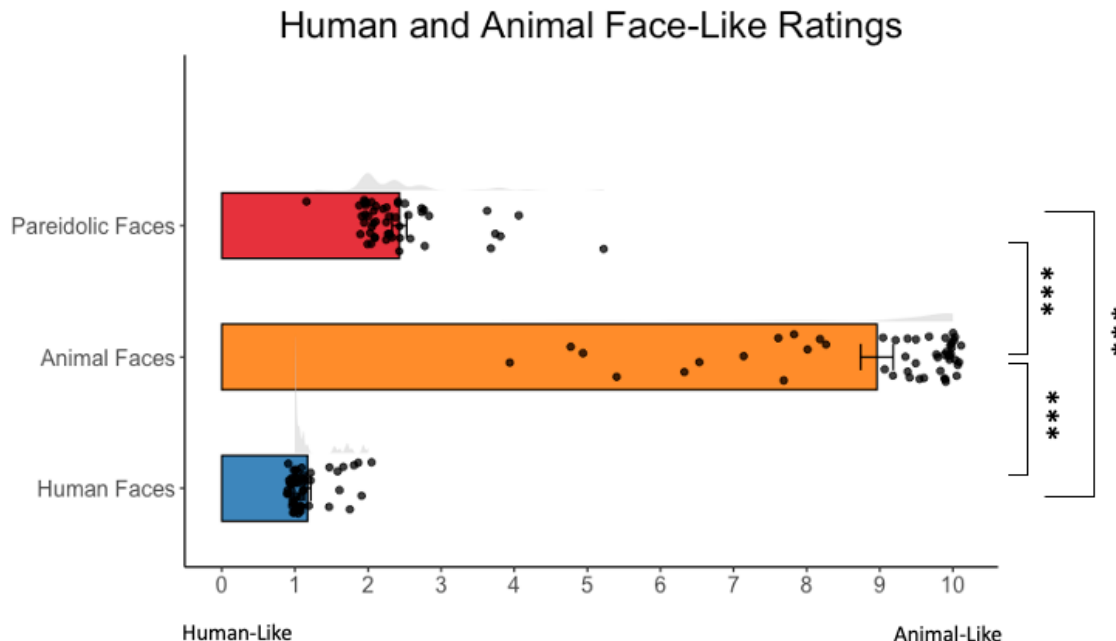


Figure 8. Images ratings from human-like (left) to animal-like (right). Pareidolic faces (top) were rated as more human-like than animal faces (middle), although less so than human faces (bottom). Dots reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean, *** p s < .001.

Our results suggest that pareidolic faces are not only perceived as more face-like than objects (Experiment 5a), but they are also rated as more human-like than animal faces (Experiment 5b). As highly social creatures (Tomasello, 2020), humans have tendencies to anthropomorphize (i.e., cognitive biases to attribute human characteristics to nonhumans; Dacey, 2017). The degree to which anthropomorphic characteristics are applied to objects seems to correspond with their degree of faceness. For example, cars judged to have more human-like features more strongly activate the fusiform face area (Kühn et al., 2014). Similarly, the degree of anthropomorphism perceived in robots is positively linked to feelings of psychological warmth but also elevated dislike (Kim et al., 2019). The elevated dislike may be due to the “uncanny valley” phenomenon, which refers to the experience of eeriness to highly human-like objects (Grebot et al., 2022). Perhaps it is this eeriness that is elevating initial attention capture to pareidolic faces. Future studies could explore viewers’ emotional responses to pareidolic faces relative to human faces as they relate to the degree of human-likeness to test this hypothesis.

Additionally, there may be objective structural features of faces that contribute to attention biases. For example, previous studies report that the eyes and mouth are particularly critical features of faces (Itier et al., 2011; Omer et al., 2019). Larger eyes are proposed to be part of the baby schema (Lorenz, 1943), which can play a role in attentional biases (Brosch et al., 2007), affective biases (Miesler

et al. 2011), perception of animacy (Looser et al., 2010), and positive ratings (e.g., cuteness: Borgi et al., 2014; Little, 2012) for individuals with this feature (e.g., human and animal infants). In fact, even products (e.g., cars) with exaggerated “eyes” (i.e., headlights) are perceived more positively than products without such features (Hellén & Sääksjärvi, 2013). Therefore, in Experiment 5c, we evaluated several aspects of our stimuli to determine whether their inner facial features could help explain our findings.

Experiment 5c: Image Analysis of Eye and Mouth Size

Method

Materials. Photos of pareidolic faces, animal faces, and human faces from Experiments 1-4 were included, for a total of 54 images. Images were sized 300 × 300 pixels.

Procedure. We compared the structural features of human, animal, and pareidolic faces to determine whether our results may be explained by differences in eye and/or mouth sizes across face types. We measured the total area of eyes and mouths (in pixels) using Adobe Photoshop.

Data Analysis. Levene’s tests suggested that there were unequal variances for eye area ($F(2, 51) = 11.38, p < .001$) and mouth area ($F(2, 51) = 39.65, p < .001$); therefore, we conducted two one-way Welch’s ANOVAs exploring the variable of Image Type (Pareidolic Face, Human Face, Animal Face): one on eye area and one on mouth area. Independent samples t tests with equal variances not assumed were conducted following statistically significant main effects.

Results and Discussion

For eye area, we found a main effect of Image Type, $F(2, 30.21) = 4.08, p = .027, \eta_p^2 = .21$ (Figure 9A). Total eye area was larger for pareidolic faces ($M = 3529.33 \text{ pixels}^2, SD = 4879.44$) compared to human faces ($M = 640.89 \text{ pixels}^2, SD = 337.19; t(17.16) = 2.51, p = .023, d = .84$) and animal faces ($M = 499.28 \text{ pixels}^2, SD = 313.49; t(17.14) = 2.63, p = .018, d = .88$). However, total eye area did not differ for human and animal faces ($t(33.82) = 1.31, p = .201$). Thus, eye sizes were largest for pareidolic faces, consistent with our hypothesis that these images may activate the babyface schema.

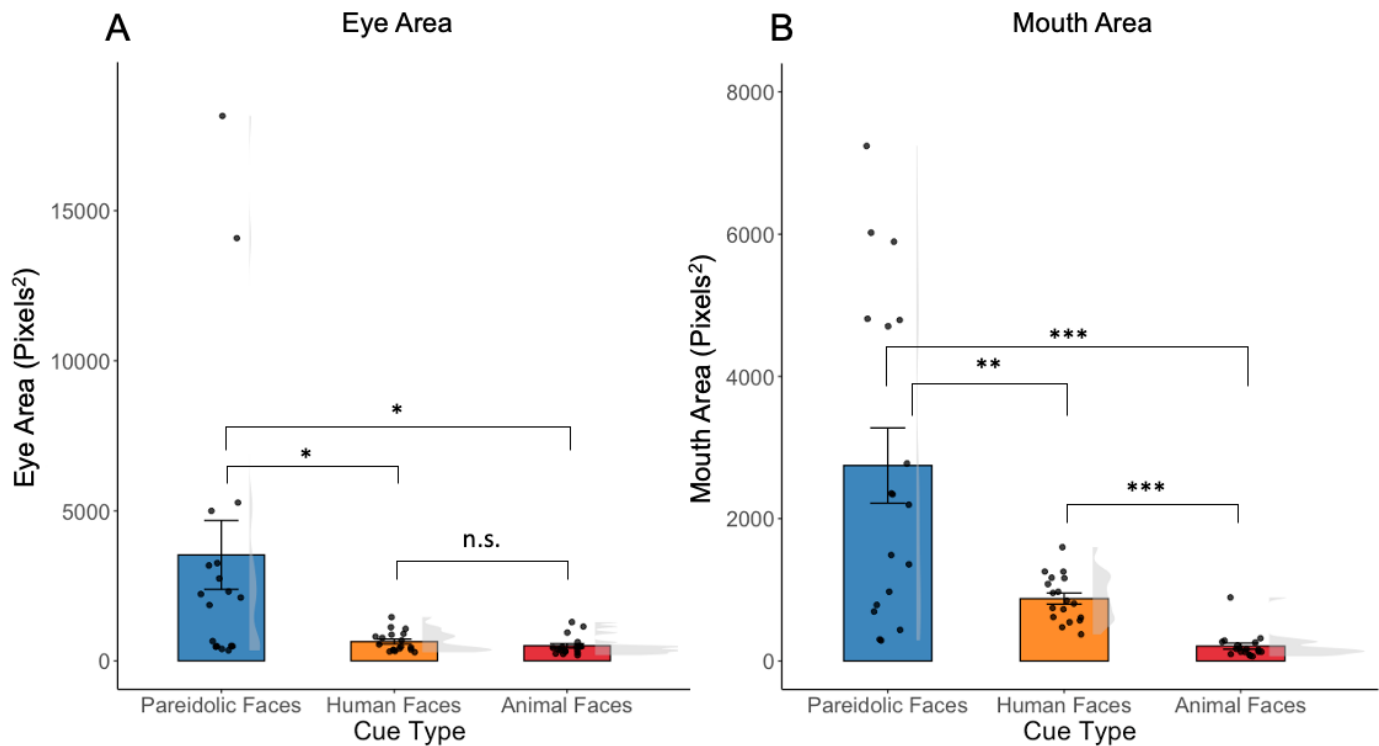


Figure 9. Facial feature size. Pareidolic faces (left) had larger eye areas (A) and mouth areas (B) compared to human (middle) and animal faces (right). Dots reflect individual participants. Frequency distributions are depicted in gray. Bars display means and error bars reflect standard error of the mean, * $ps < .05$; ** $ps < .01$; *** $ps < .001$.

Mouth area also varied by Image Type, $F(2,27.88) = 37.19$, $p < .001$, $\eta_p^2 = .41$ (Figure 9B). Pareidolic faces contained larger mouths ($M = 2747.90$ pixels², $SD = 2246.17$) than human faces ($M = 876.17$ pixels², $SD = 328.98$; $t(17.73) = 3.50$, $p = .003$, $d = 1.17$) and animal faces ($M = 208.67$ pixels², $SD = 186.29$; $t(17.23) = 4.78$, $p < .001$, $d = 1.59$). Mouth area was also larger for human faces compared to animal faces ($t(26.89) = 7.49$, $p < .001$, $d = 2.50$). Therefore, in addition to larger eyes, pareidolic faces also had larger mouths, suggesting that the sizes of these critical inner facial features were exaggerated relative to real faces.

Exaggerated features may have allowed participants to rapidly process pareidolic face images as faces (Brosch et al., 2007; Hodsoll et al., 2010), supporting biased attention to pareidolic faces relative to objects and animal faces (Experiments 1-3) and equally engaging relative to human faces (Experiment 4). This interpretation is consistent with prior studies. Previous work investigating attention to human faces suggested that exaggerated features, such as large eyes of baby faces, may be effective at capturing attention (Brosch et al., 2007; Hodsoll et al., 2010). In adult faces, faces with larger eyes are perceived as more attractive (Baudouin & Tiberghien, 2004) and attractive faces receive prioritized attention (Nakamura & Kawabata, 2014).

Further, given that participants identify emotions in pareidolic faces (Alais et al., 2021; Wardle et al., 2022), larger mouths may indicate the mouths are open which may indicate more intense facial expressions (Ciu et al., 2021) or threat and thereby may enhance detection (Horstmann et al., 2012). Indeed, viewing other humans yawning (with open mouths)—suggesting others around you may be less vigilant—is reported to enhance visual attention for threats (e.g., snake detection; Gallup & Meyers, 2021). However, our findings also appear in contrast to a prior dot-probe study reporting that human faces displaying teeth (angry face), compared to those hiding teeth (closed mouth angry face, and therefore, smaller mouth areas), did not elicit enhanced attention as a function of mouth size (Wirth & Wentura, 2018). It is possible that larger mouths in the context of human faces may be attended to differently compared to when the larger features are in the context of nonhuman faces, i.e., pareidolic faces.

Faces with larger features may be perceived as more distinct and may be better recognized. For example, one study reported people are better at recognizing familiar faces of celebrities in caricature drawings compared to more accurate drawings (Benson et al., 1994; Lee et al., 2000). It is possible that pareidolic faces, with their larger inner facial features, may be perceived as more caricature-like. Larger features may facilitate the activation of a general face template (e.g., Brosch et al., 2007; Hodsoll et al., 2010), facilitating detection. In addition, larger eyes and mouths may also suggest an animate creature that is closer, indicating a looming threat. Approaching threats and those perceived as closer may be detected more readily and attentionally prioritized, compared to those further away, as a defensive adaptation (de Haan et al., 2016; Ellena et al., 2020). Further studies that systematically vary the sizes of faces and the sizes and spacing of their inner features within and across face types (pareidolic, human, and animal) will help to shed light on the contributions of these qualities in prioritizing attention.

General Discussion

The visual system is remarkably good at detecting faces, yet also has a natural inclination to perceive faces from various nonsocial visual patterns. Our results suggest that, when it comes to rapid attention prioritization, pareidolic faces seem to be attentionally privileged relative to animal faces, much like human faces. Pareidolic faces appeared attentionally advantaged compared to objects (Experiment 1), and their attentional processing was disrupted by inversion (Experiment 2), much like faces generally (Wirth & Wentura, 2020). Experiments 1 and 2 support our hypothesis that pareidolic faces are processed like real faces. However, we also discovered that pareidolic faces are not only processed as faces but appear to be a *special* type of face. We found that pareidolic faces received privileged attention compared to animal faces (Experiment 3), similar to human faces, and we failed to detect any human-face-specific attentional advantages for human faces relative to pareidolic faces (Experiment 4). In sum, our dot-probe task results suggest, unexpectedly, that pareidolic faces are processed much like human faces. To explore these attentional effects further, we examined various qualities of the images themselves, which revealed people rated pareidolic faces not only as face-like (Experiment 5a) but specifically as human-like (Experiment 5b). These findings suggest that pareidolic faces may not only share some attentional advantages with human faces but also perceptual similarities. Further, pareidolic faces had larger features—eyes and mouths—compared to human and animal faces (Experiment 5c), which may indicate that the “specialness” of pareidolic faces may, at least in part, come from their large, exaggerated inner facial features.

Faceness is theorized to be one potential dimension that may, in part, underly a face template matching process involved in face detection (Lewis & Edmonds, 2003). These results are the first, to our knowledge, to help determine where on the face continuum pareidolic faces fall. Together, these findings suggest that, when it comes to early attentional processing, pareidolic faces may fall near human faces on a faceness continuum—potentially even being “super-faces”—further from animal faces and furthest from non-face objects.

Pareidolic Faces Are on the Face Continuum

Although participants show preferential processing for human faces compared to animal faces (Brosch et al., 2007; Jakobsen et al., 2021; Scott & Fava, 2013), the results of Experiment 4 did not reveal any attentional bias for human faces over pareidolic faces. Experiments 3 and 4 provide evidence that pareidolic faces may be perceived as more prototypical—in other words, more similar to human faces—than animal faces are. This interpretation is in line with a norm-based coding model in which each face to be encoded is compared to an average face representation (i.e., the norm or mental prototype), and individual faces can be considered in the extent to which they deviate from that norm (Halit et al., 2000; Valentine, 1991).

Our findings of an attentional advantage for human and pareidolic faces, which is shared to a lesser extent with animal faces, are consistent with the animate bias hypothesis. Animacy detection may be supported by different visual cues, depending on the type of animate individual, i.e., across different species (Koldewyn et al., 2014). In this type of task (dot-probe), pareidolic and human faces may appear to be processed similarly initially, both activating a general, broad “human-like” face template during their initial, likely subcortically-driven stages of processing (Caruana & Seymour 2022; Johnson, 2005). However, the specific facial features driving this activation may be distinct across different types of faces. For instance, pareidolic faces, with their larger facial features, may activate a general face template due to the size of the eyes (Omer et al., 2019), whereas human faces may activate other dimensions based on more species-specific features, such as skin color (Bindemann & Burton, 2009; Nestor et al., 2013) or skin texture (Vaitonytė et al., 2021). We speculate that the attentional biases we found may have been the result of multiple dimensions of faces being activated to varying degrees by different types of faces. For example, relative to a prototypical face, faces with features that closely resemble the prototype may be detected more readily than faces that do not resemble the prototype as closely. Under these assumptions, the results of our dot-probe study may suggest that human faces represent the most prototypical face and pareidolic faces are closer to the prototypical face than animal faces.

Limitations and Future Directions

The dot-probe task used in Experiments 1-4 presented participants with two stimuli at a time. This design allowed us to directly compare attention biases to objects, pareidolic faces, animal faces, and human faces. However, these visual stimuli were relatively simplistic in contrast to the complex environments in which faces are often encountered in daily life. It is, therefore, still unclear the extent to which these highly controlled and artificial experimental studies translate into real world behavior. Future investigations may examine attentional biases to pareidolic, animal, and human faces when presented in the context of multiple competing distracting sources of information, such as by using

videos of naturalistic scenes and live interactions. Eye tracking while participants move around a virtual reality environment, for example, could shed light on how attention is prioritized to various types of faces and nonface stimuli and the features that drive these attentional biases in more ecologically valid contexts (e.g., Gregory et al., 2022).

Our study was not designed to address whether the face-like ratings, human-like ratings, or feature sizes impact participants' face detection at the individual stimulus level. Future studies are needed to more systematically study the qualities of face-like images that may be driving the effects we found. For example, manipulating the size of facial features (e.g., eyes and mouth) to be more similar across pareidolic faces, human faces, and animal faces may provide insight into how facial features may play a role in attention capture. Future research may also evaluate whether "real-world" object size (e.g., a larger pareidolic face from a car with face-like headlights and grill versus a smaller pareidolic face from a leaf with face-like pattern) influences a pareidolic object's effectiveness at capturing attention. Additionally, if pareidolic faces are perceived as more novel or unique (e.g., interesting, humorous) compared to human and animal faces, these qualities may drive attentional biases. For example, unattractive faces, which are generally less prototypical, capture attention more quickly than attractive, more prototypical faces, suggesting that participants' perceptions of facial characteristics may impact attentional biases (e.g., Sui & Liu, 2009). Previous research shows that both child and adult participants distinguish individual pareidolic images on various characteristics, including emotional state, age, and gender (Wardle et al., 2022); however, how the perceptions of these qualities impact attentional biases have not yet been studied with pareidolic faces.

Given the evolutionary importance of faces, face detection abilities are widely shared ontogenetically and phylogenetically. Even human fetuses (Reid et al., 2017) and nonhuman animals (e.g., newborn monkeys: Paukner et al., 2013; newly hatched chicks: Rosa-Salva et al., 2010; tortoise hatchlings: Versace et al., 2020) preferentially attend to face-like images (e.g., with spots for eyes, nose, and mouth in the correct first-order configuration) compared to heads with scrambled or inverted inner elements (e.g., mouth above the eyes). While the extent of pareidolic face processing across development and species remains to be fully explored, a few studies suggest children (Guillon et al., 2016; Ryan et al., 2016) and monkeys (Taubert et al., 2017) are susceptible to face pareidolia. Although young infants prefer looking at face-like stimuli, suggesting an early-developing sensitivity to faces in general (Farroni et al., 2005), extensive work demonstrates that attention to faces across development is shaped by experience with specific types of faces (e.g., species, race, gender; see Scherf & Scott, 2012 for review). The few studies to date with developmental populations suggest babies as young as 4 months of age perceive pareidolic objects as faces (e.g., Flessner et al., 2022; Rekow et al., 2021). Future work with developmental populations is needed to identify the extent to which infants' and children's attention is biased towards pareidolic faces relative to other types of faces, and whether these attention biases undergo periods of perceptual attunement specialization, as individuals accumulate experience. Furthermore, it is unclear the extent to which our findings may reflect human universals, as our sample consisted of young adults in the United States. Future work is, therefore, needed to test whether our findings generalize across cultures to other populations.

Conclusions

Together, our findings suggest that pareidolic faces are attentionally privileged among faces, similar to human faces. When in direct competition for attention resources, pareidolic faces appear to fall on the continuum of faceness somewhere near human faces, a bias that enables them to have privileged automatic detection above and beyond objects and animal faces, but "neck and neck" with human faces. Future studies are needed to explore what characteristics underlie pareidolic faces' surprisingly impressive ability to attract attention and to what extent these qualities are distinct or shared with human faces.

The data and materials are available from the corresponding author on reasonable request.

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Supplementary Materials

Stimulus Rating Data

Prior to conducting our dot-probe studies, we wanted to first ensure that our stimuli were perceived in the ways we intended them to be, including emotion and eye gaze direction. The data reported below are for the images used in the current study.

Participants and Method. Separate groups of participants ($N = 25$ for each face type (human, animal, pareidolic); $N = 75$ total) who were undergraduate students at a large southeastern U.S. university, rated the faces on a series of dimensions. All image ratings consisted of participants viewing one image at a time and responding with a mouse click. Images were presented in a randomized order. To prevent habituation and fatigue effects, comparisons were between-subjects. Participants rated each image on emotion (1 = very negative, 4 = neutral, 9 = very positive), and direction of eye gaze (1 = right, 2 = left, 3 = up, 4 = down, 5 = straight ahead, 6 = I can't tell). Pareidolic images were also rated for how face-like they were (0 = not face-like at all, 10 = very face-like). We only had the pareidolic faces rated on how face-like they were (and not the human and animal faces) because the human and animal faces *were* actual faces, whereas the pareidolic images were not. Having the pareidolia faces rated is consistent with other studies (e.g., Takahashi & Watanabe, 2013). In total, the rating task took approximately 5-10 minutes.

Results. The face emotion rating data revealed that participants rated the faces as relatively neutral (Figure S1) and most participants rated the faces as having eyes that looked straight ahead (Figure S2). The average rating for how face-like the pareidolic faces was 6.52 ($SD = 2.02$; Figure S3), indicating that participants viewed the pareidolic faces as at least somewhat face-like.

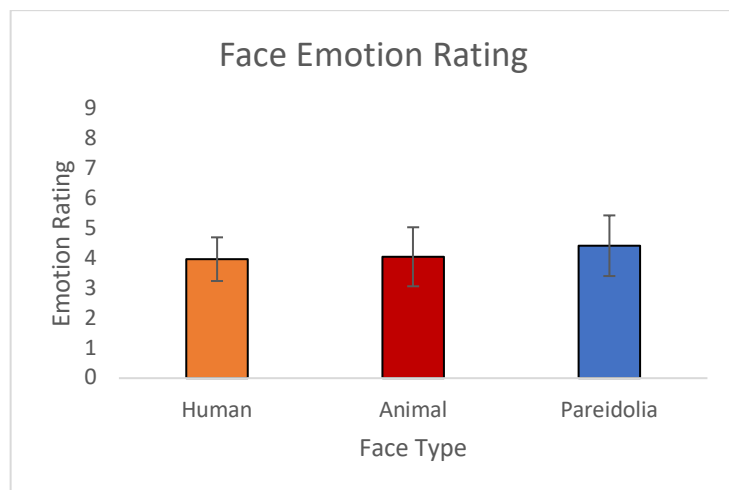


Figure S1. Participants rated the emotions of all the face types as neutral. Bars display means and error bars reflect standard error of the mean.

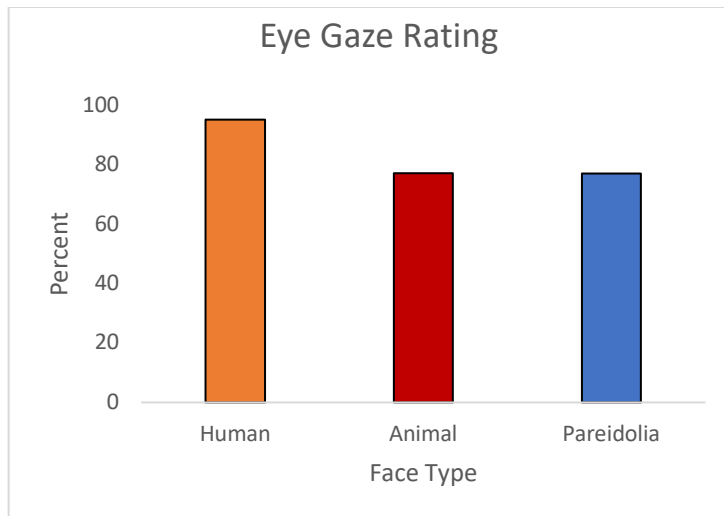


Figure S2. The percentage of participants who rated each face type as having eyes that look straight ahead were high across all face types.

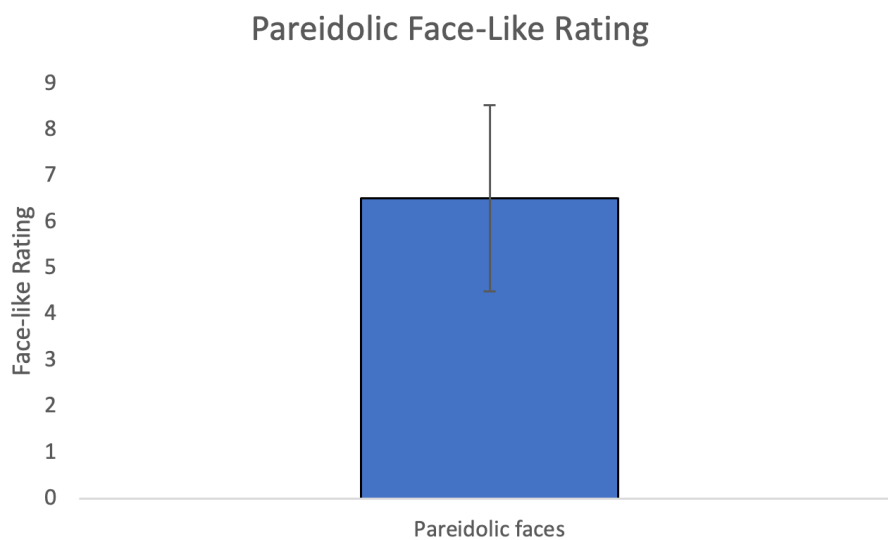


Figure S3. Participants rated the pareidolic faces as face-like, overall. Bar displays the mean and error bars reflect standard error of the mean.

Accuracy Analyses in the Dot Probe Tasks

The accuracy (i.e., proportion of correct trials pressing the key for target probes on the side of pareidolic faces and objects) within each experiment was analyzed with a 2 (Cue type: pareidolic face, object) $\times$ 2 (Cue display time: 100 ms, 1000 ms) repeated measures ANOVA.

Experiment 1: Pareidolic faces vs objects. There was no main effect of Cue type, $F(1, 44) = 2.20$, $p = .145$, no main effect of Cue display time, $F(1, 44) = 0.95$, $p = .335$, and no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.50$, $p = .482$. These results suggest that participants were similarly accurate in their responses when the target probes appeared on side of the pareidolic faces and objects (See Table S1).

Experiment 2: Inverted pareidolic faces and inverted objects. There was no main effect of Cue type, $F(1, 44) = 2.39$, $p = .129$, no main effect of Cue display time, $F(1, 44) = 0.06$, $p = .801$, and no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.24$, $p = .627$. These results suggest that participants were similarly accurate in their responses when the target probes appeared on side of the inverted pareidolic faces and inverted objects (See Table S1).

Experiment 3: Pareidolic faces vs. Animal faces. There was no main effect of Cue type, $F(1, 44) = 0.09$, $p = .769$, no main effect of Cue display time, $F(1, 44) = 1.07$, $p = .307$, and no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.12$, $p = .728$. These results suggest that participants were similarly accurate in their responses when the target probes appeared on side of the inverted pareidolic faces and animal faces (See Table S1).

Experiment 4: Pareidolic faces vs. Human faces. There was no main effect of Cue type, $F(1, 44) = 1.25$, $p = .27$, no main effect of Cue display time, $F(1, 44) = 0.09$, $p = .764$, and no Cue type $\times$ Cue display time interaction, $F(1, 44) = 0.65$, $p = .425$. These results suggest that participants were similarly accurate in their responses when the target probes appeared on side of the inverted pareidolic faces and human faces (Table S1).

Experiment	Cue Type	Cue Duration (ms)	Mean (SD)
Experiment 1	Pareidolic face	100	98.8 (.01)
		1000	98.8 (.01)
	Object	100	99.3 (.01)
		1000	99.0 (.02)
Experiment 2	Inverted pareidolic face	100	98.6 (.02)
		1000	98.7 (.01)
	Inverted object	100	98.5 (.02)
		1000	98.4 (.02)
Experiment 3	Pareidolic face	100	98.5 (.02)
		1000	98.5 (.01)
	Animal face	100	98.5 (.02)
		1000	98.8 (.02)
Experiment 4	Pareidolic face	100	98.6 (.02)
		1000	98.6 (.02)
	Human face	100	98.2 (.02)
		1000	98.5 (.02)

Table S1. Mean accuracy (percent correct response to indicate the location of the target probe) and standard deviation (SD) for each experiment, cue type, and cue duration condition. Consistent with previous studies, participants in our study were highly accurate in their responses to target probes.

Detailed Figures Depicting All Conditions for All Dot-Probe Experiments

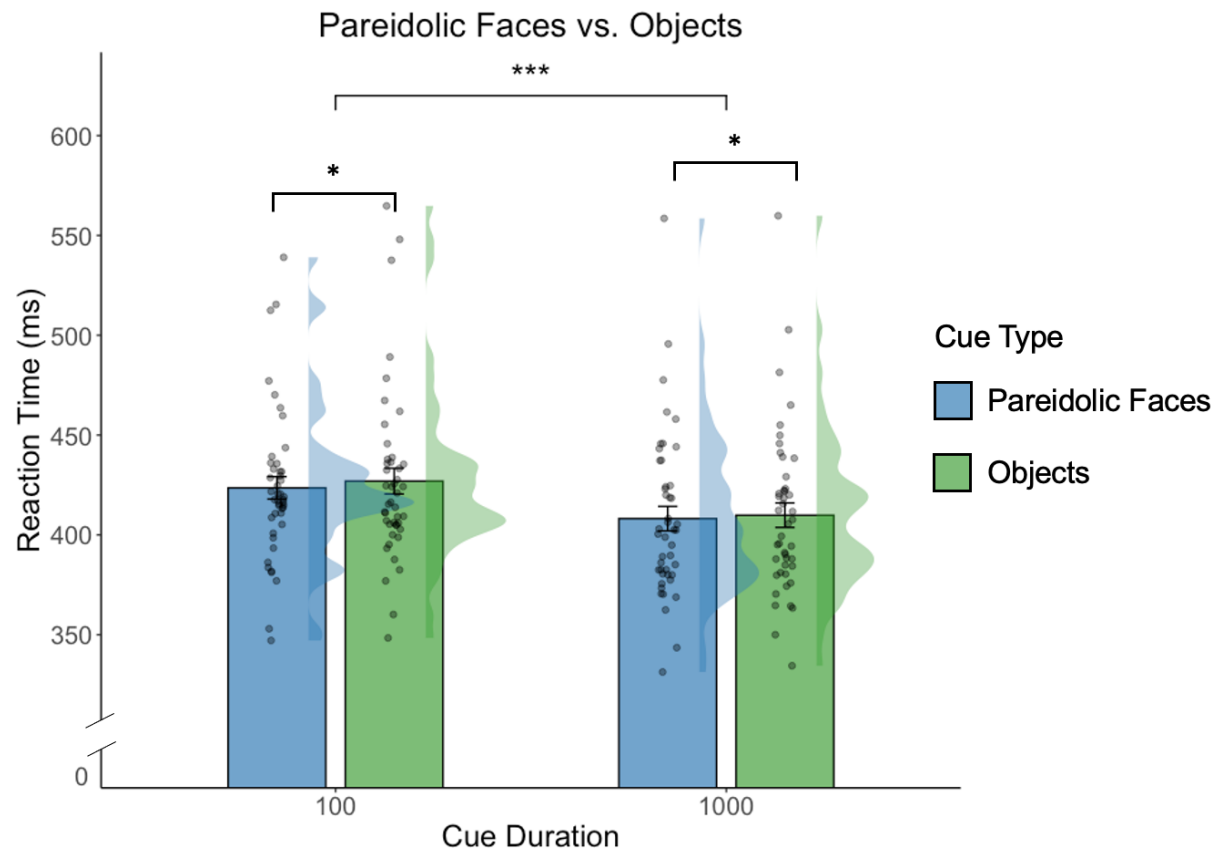


Figure S4. Reaction times in milliseconds (ms) to the cue type and cue duration for pareidolic faces (blue) and objects (green) (Experiment 1). Bars display means and error bars reflect standard error of the mean. Gray dots reflect individual participants. Frequency distributions are depicted to the right of each bar. Responses were faster to 100ms than 1000ms cue durations, *** $p < .001$, and were faster to pareidolic faces than objects, * $p = .032$ (see Figure 3 for main effect of cue type). We detected no interaction effect, $p = .395$.

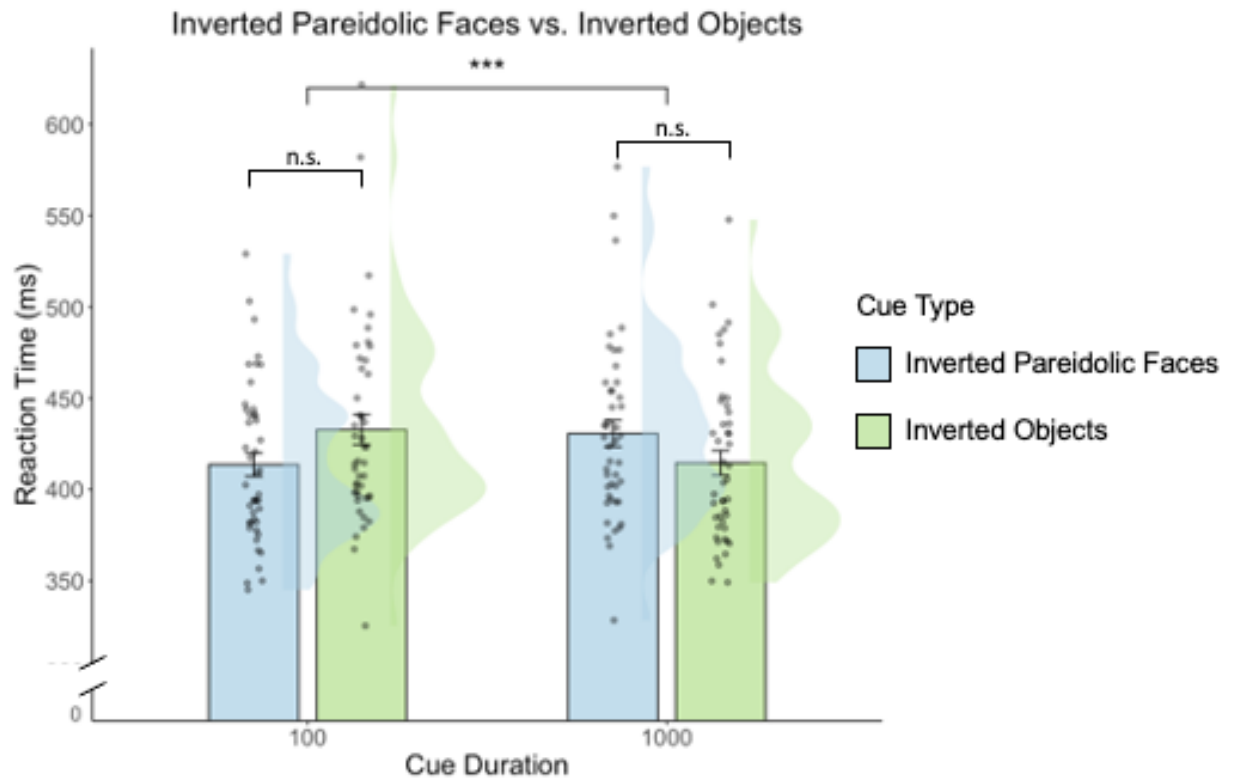


Figure S5. Reaction times in milliseconds (ms) to the cue type and cue duration for inverted pareidolic faces and inverted objects (Experiment 2). Bars display means and error bars reflect standard error of the mean. Gray dots reflect individual participants. Frequency distributions are depicted to the right of each bar. Responses were faster to 100ms than 1000ms cue durations, *** $p < .001$. There were no main nor interaction effects for cue type; n.s. = not statistically significant, $ps > .10$. That is, when they were inverted, participants responded similarly to pareidolic faces and objects (Experiment 2), unlike when they were upright (Experiment 1).

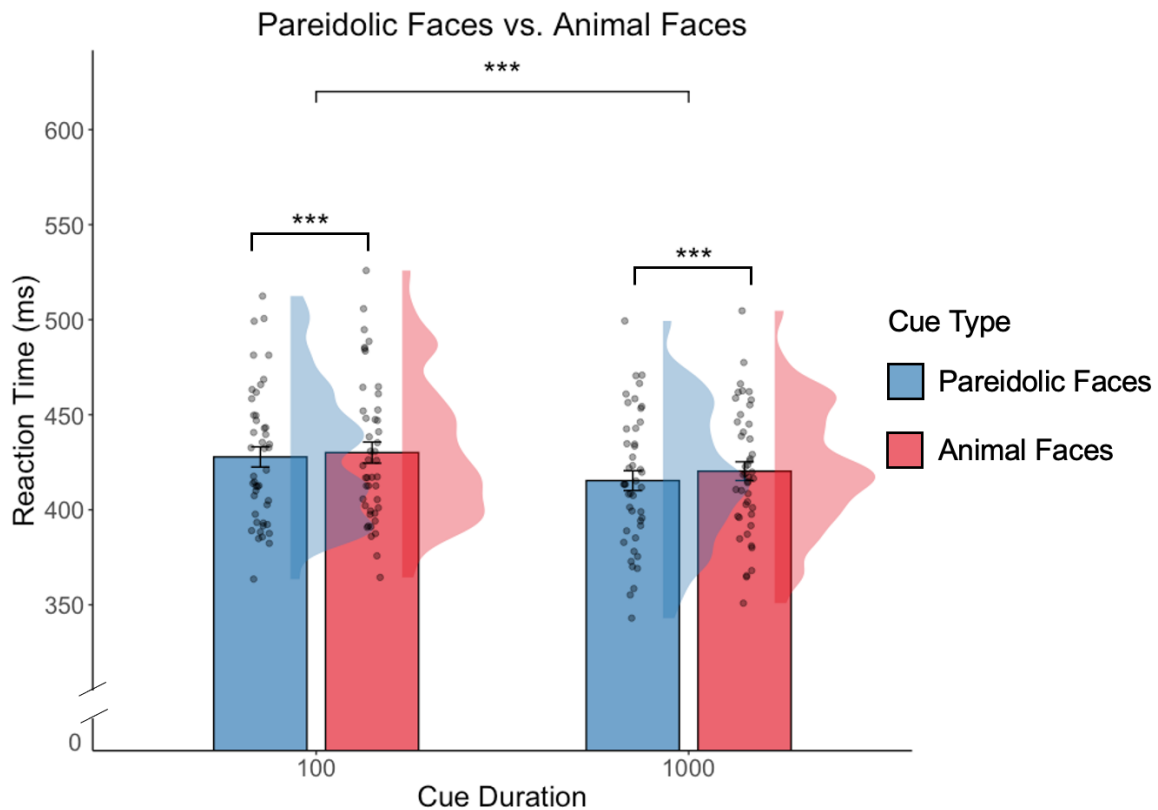


Figure S6. Reaction times in milliseconds (ms) to the cue type and cue duration for pareidolic faces and animal faces (Experiment 3). Bars display means and error bars reflect standard error of the mean. Gray dots reflect individual participants. Frequency distributions are depicted to the right of each bar. Responses were faster to 100ms than 1000ms cue durations, and to the pareidolic faces (blue) than the animal faces (red), $***p < .001$. We detected no interaction effect. Pareidolic faces appeared attentionally prioritized compared to animal faces.

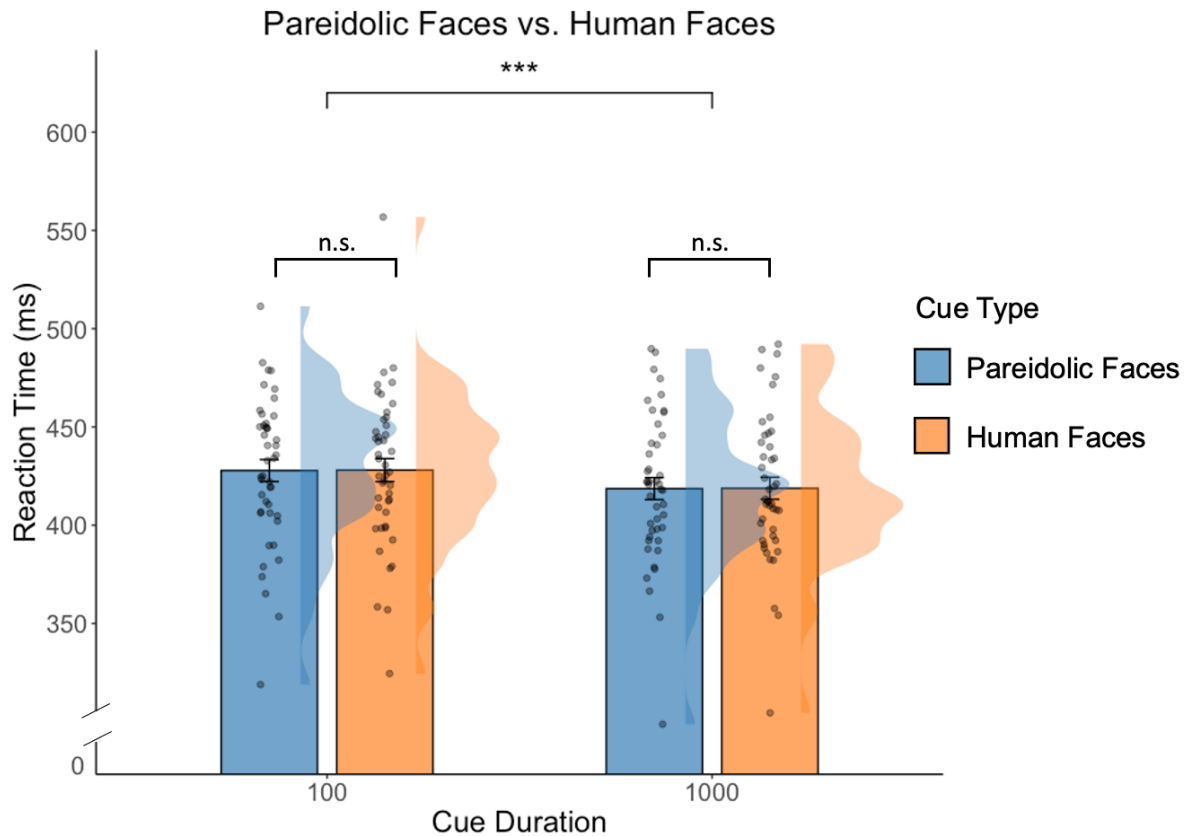


Figure S7. Reaction times in milliseconds (ms) to the cue type and cue duration for pareidolic faces and human faces (Experiment 4). Bars display means and error bars reflect standard error of the mean. Gray dots reflect individual participants. Frequency distributions are depicted to the right of each bar. Responses were faster to 100ms than 1000ms cue durations, *** $p < .001$. Participants were equally fast in responding to pareidolic faces (blue) and human faces (orange); n.s. = not statistically significant, $ps > .10$. We detected no interaction effect. Pareidolic faces appeared as attentionally prioritized as human faces.

Inverted face-likeness of pareidolic and human faces

In Experiment 2, we found inversion of pareidolic images appeared to disrupt their biased attention capture relative to objects. We wanted to explore whether inversion may make pareidolic images no longer appear to be faces, and, if so, whether it does this to a similar extent as with real faces. We, therefore, compared ratings of how face-like pareidolic and human faces were when they were upright and inverted.

Participants and Method. A separate group of participants ($N = 45$) rated the inverted pareidolic and human faces on how face-like they were (0 = not face-like at all, 10 = very face-like), which we compared to the ratings. The participants rating the inverted images were a new sample, different from those who rated the upright faces. To balance the sample sizes in each group, we randomly selected 45 participants' data from Experiment 5a.

Data analysis. We ran a mixed design ANOVA with Cue Type (pareidolic, human) as the within-subjects factor and Orientation (upright, inverted) as the between-subjects measure.

Results. We found a main effect of Cue Type, with participants rating human faces as more face-like than pareidolic faces, $F(1, 88) = 481.86, p < .001, \eta_p^2 = 0.85$. We also found a main effect of Orientation, with participants rating upright faces as more face-like than inverted faces, $F(1, 88) = 8.37, p = .005, \eta_p^2 = 0.09$. We detected no Cue Type $\times$ Orientation interaction, $F(1, 88) = 2.22, p = .14$.

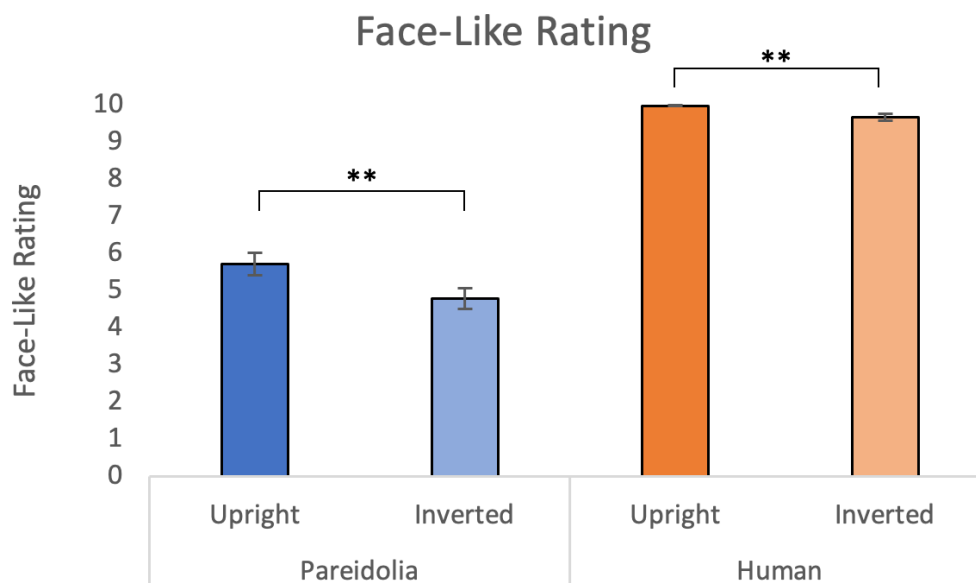


Figure S8. Face-like ratings for upright (darker) and inverted (lighter) pareidolic (blue) and human (orange) faces. Bars display means and error bars represent standard error of the mean. Upright faces were rated as more face-like than inverted faces, $**p = .005$. The lack of an interaction effect, however, suggests that the inversion effect for pareidolic faces is similar to that for human faces.