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The medium modulates the medusa effect: Perceived mind in analogue and digital images

Salina Edwards [a,b,*], Rob Jenkins [c], Oliver Jacobs [a], Alan Kingstone [a]

[a] Department of Psychology, University of British Columbia
[b] Department of Psychiatry & Behavioural Neurosciences, McMaster University
[c] Department of Psychology, University of York

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ABSTRACT

We effortlessly attribute mental states to other people. We also attribute minds to people depicted in pictures, albeit at a reduced strength. Intriguingly, this reduction in intensity continues for images of people *within* a photograph itself—a phenomenon known as the Medusa effect. The present study replicates the Medusa effect for images shown digitally and on paper. Crucially, we demonstrate that we can reduce the magnitude of the Medusa effect by depicting people digitally within a computer screen (e.g., as if one were interacting with a person on a Zoom call). As well as modulating the *quantity* of the Medusa effect, changes in pictorial medium can affect the *quality* of the perceived mind. Specifically, the dimension of *Experience*—what a depicted person can feel—reflected participants' observations that they could interact with an onscreen person embedded in a digital image. This combination of a robust Medusa effect and the ability to control it both quantitatively and qualitatively opens many avenues for its future application, such as manipulating and measuring mind in immersive media.

1.1. Introduction

Would you treat a person's picture the same way you would treat the living person? As Magritte's famous painting 'Ceci n'est pas une pipe' ('This is not a pipe') suggests, pictures retain the power to affect people in myriad ways, even though they do not capture all aspects of reality. This principle of depiction extends to animate objects. For example, although pictures are not perceived as equivalent in value to living beings, we are often reluctant to damage or discard images of our loved ones (Mitchell, 1996).

Recent research in pictorial representation of people has shown that pictures of people are perceived as having less mind—specifically, less *agency* and *experience* (Gray et al., 2007)—than their real selves (Will et al., 2021). What is more surprising is the element of recursion: viewers attribute even less mind to a picture of a person within a picture (as when a photograph includes a television with actors on screen). Will et al. (2021) referred to this phenomenon as the Medusa effect, alluding to the mythical Gorgon's loss of power when viewed as an abstraction of herself, such as indirectly in a polished shield. By distinguishing layers of representation, the Medusa effect reveals hidden structure within the realm of pictures—structure that has moral ramifications. To label different levels of representational abstraction, the authors adopted the following convention: The real world is Level 0 (L0), a picture is Level 1 (L1), and a picture of a picture is Level 2 (L2; see Fig. 1). As pictorial abstraction increases (from L1 to L2) the perceived mind recedes. Crucially, as mind perception underpins moral judgement (Gray, Young, & Waytz, 2012) these findings suggest that depicted persons will receive greater or lesser ethical consideration, depending on the level of abstraction.

In the original studies, stimuli were presented to participants either on a computer (digital medium) or printed on paper (analogue medium) in separate experiments, without consideration that the medium itself might also affect the perceived mind. There are some grounds for postulating that mode of presentation plays a role. Previous research has compared cognition for real, tangible objects and their pictorial representations (see Gibson, 1954; DeLoache et al., 1998, Flavell et al., 1990; Squires et al., 2016, Dosso & Kingstone, 2018; Marchak et al., 2020; Snow & Culham, 2021). For example, Snow and Culham (2021) showed that real objects are attributed greater value than pictorial representations of the same object. More importantly for the current study, such distinctions can apply even among different pictorial representations. For example, printed photos are attributed greater value (Atasoy &

* Corresponding author at: 1280 Main St. West - PC 303 Hamilton, ON Canada L8S 4K1).
E-mail address: edwars32@mcmaster.ca (S. Edwards).

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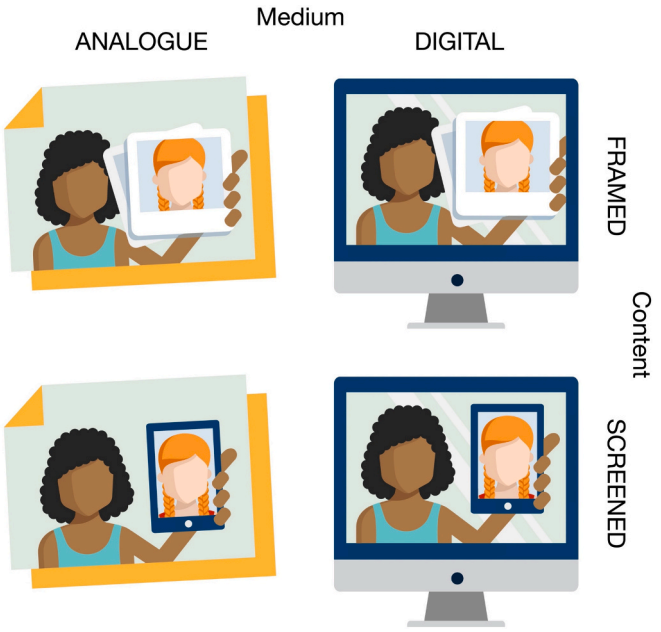

Fig. 1. Schematic summary of experimental conditions. Columns illustrate the two Medium conditions (Analogue and Digital), and rows illustrate the two Content conditions (Framed and Screened), resulting in four quadrants. Each quadrant depicts a Level 1 (L1) person (shown holding a picture) and a Level 2 (L2) person (shown in the held picture). The experimental stimuli (photographs) could not be reproduced for copyright reasons.

Morewedge, 2017) and more aesthetic appeal (Agou, 2020) than digital photos. However, the domain of applicability for medium preference is far from clear. For example, a recent meta-analysis by Furenes et al. (2021) reported an advantage of digital text over printed text for enhancing an individual's vocabulary, yet the opposite for narrative comprehension.

The theoretical import of this issue should not be underestimated. The Medusa effect intersects with at least three areas in cognition: face perception, mind perception, and pictorial representation. It is well established that different depictions of the same face (e.g., smiling or not) give rise to different attributions (e.g., trustworthy or untrustworthy; Oosterhof & Todorov, 2009). The Medusa effect shows that attributions to the very same depiction of a particular face can be manipulated via pictorial abstraction. Separate face recognition studies have shown that mode of presentation can affect identification judgments. For example, embedding a face photograph in an identification document (such as a passport) promotes "same person" judgments ('document bias'; Feng & Burton, 2021). However, unlike the Medusa effect, such tasks do not connect directly to moral agency and moral subjecthood.

Pioneering work on mind perception has focused on properties of the moral subject as inferred from observable cues, such as sex and age (Gray et al., 2007). The Medusa effect draws attention to interactions between the nature of the moral subject and the mode of presentation. Mode of presentation has been raised before in the context of moral cognition. For example, the Identifiable Victim Effect shows that adding more individuals to a picture of one individual can reduce helping behaviour (Lee & Feeley, 2016). However, numerosity could not account for the effects of representational medium or representational level in the Medusa effect.

Finally, the sheer prevalence of pictures of people—from neolithic cave paintings to photo-sharing apps—raises fundamental questions about human thought. What psychological work are pictures doing and what are their limitations? We are all familiar with the idea that manipulating images can manipulate viewers, as when a photograph is doctored or selectively cropped. The Medusa effect suggests an independent route to manipulation: even when the image itself is held constant, the mode of presentation can sway moral evaluations.

Discrepancies between analogue and digital media (e.g. Atasoy & Morewedge, 2017; Agou, 2020) demonstrate a role for picture *medium* in modulating perception, independent of picture *content*. In this exploratory study, we test whether changes in picture medium can modulate the Medusa effect. To this end, we compared Medusa stimuli presented on paper ('Analogue' medium) and on a computer ('Digital' medium). Given that L2 abstractions can take many forms, we also manipulated this nested level. Specifically, the L2 person could be presented as a framed photograph ('Framed' pictorial content) or on a digital screen ('Screened' pictorial content). Combining two types of *Mediums* (*Analogue*, *Digital*) with two types of *Content* (*Framed*, *Screened*) resulted in four experimental conditions in total. Our main interest was whether the Medusa effect would emerge in all these conditions, and whether presentation factors would modulate the effect.

1.1.1. Methods

1.1.1.1. Participants

A power analysis conducted using WebPower (Zhang et al., 2018) suggests a desired sample size of 67.3 for a regression model with 2 predictors achieving 80% power with a medium effect size ($f^2 = 0.15$). In total, 68 undergraduate students from [ANONYMOUS] participated in the study and were remunerated 1/2-course credit for up to 30 min of their time. Four participants were excluded for failing to follow study procedures. The final analysis included data from 64 participants (9 males and 55 females) ranging in age from 18 to 27 (M = 20.1 years; SD = 2.1).

1.1.1.2. Stimuli and design

The stimuli, drawn from Will et al. (2021), comprised 28 images depicting people at both Level 1 (L1) and Level 2 (L2) abstractions. All images were replicated in two mediums: *Analogue* (printed) and *Digital* (shown on a computer screen). In Will et al. (2021), L2 was depicted either as a person in a framed photograph (e.g., a photo of a person hanging on a wall) or as a person on a computer screen (e.g., a person on a computer screen in a video call), with no attempt to balance these content subtypes. However, because there is a natural congruency between our intended manipulation of *Digital* and *Analogue* media and whether L2 is presented as a person in a framed photo or on a computer screen, we ensured that *Framed* and *Screened* subtypes occurred equally often (i.e., 14 *Framed* L2 and 14 *Screened* L2). *Analogue* versions of the 28 images were presented in 8 × 11 in. with landscape orientation. The 28 *Digital* equivalents measured 8.33 × 5.56 in. with a 72-pixel resolution.

Sixty-four participants were randomly selected to receive 14 *Analogue* images (either L2-*Framed* or L2-*Screened*) and 14 *Digital* images (either L2-*Framed* or L2-*Screened*) in random order. This resulted in 32 participants receiving 14 *Digital* (*Framed* or *Screened*) followed by 14 *Analogue* (*Framed* or *Screened*) images, while 32 participants received 14 *Analogue* (*Framed* or *Screened*) followed by 14 *Digital* (*Framed* or *Screened*) images. The order of the images for the factors of Medium (*Digital* vs. *Analogue*) and Content (*Framed* vs. *Screened*) was counterbalanced across participants. The Medusa effect is defined as the preference for L1 over L2 in this task (percentage of L1 responses).

1.1.1.3. Procedure

After indicating consent, participants were led individually into a testing room where demographic information was collected. Overhead lighting conditions were kept constant during each session to ensure a consistent presentation of the analogue photos, and to minimize potential glare or shadow. Similarly, computer screen brightness for the digital presentation of the photos was kept consistent across each individual study.

During a single test session, the study was split into two parts. In the first part, participants were presented with 14 images containing an L1

person and an L2 person, and were asked to indicate which person appeared higher on *Agency* (ability to do), *Experience* (ability to feel), and *Realness* (belonging to the natural world). For each attribution, the participant selected either the person on the left or on the right side of the picture (spatial location was counterbalanced with respect to level of representation). For *Analogue* images, participants entered their selections of *Agency*, *Experience*, and *Realness* for each image by placing a checkmark on a printed table using a pen before physically turning the page to display the next image. For *Digital* images, participants used a computer mouse to select the applicable person (separately for *Agency*, *Experience*, and *Realness*).

Participants then proceeded to the second part of the study. In the second part, participants were given a set of 14 images in the opposite medium and content and asked to attribute *Agency*, *Experience*, and *Realness* to L1 and L2 individuals using the procedures described above. For example, if a participant was randomly selected to receive 14 *Analogue–Framed* images in the first part of the study, the participant would then receive 14 *Digital–Screened* images in the second part of the study. Importantly, participants never viewed the same image twice. After completing the second part of the study, participants were debriefed and remunerated. The experiment took approximately 30 min to complete.

1.1.2. Results

We used R Version 2023.03.0 + 386 (R Core Team, 2022) and the R-packages tidyr Version 1.3.0 (Wickham et al., 2023) and lme4 Version 1.1–31 (Bates et al., 2015). Logistic regression (Wright, 1995) was employed as the method of analysis for this study due to the binary response of the conditional dependent variable, given that dimensions of mind perception were assigned to either "L1" or "L2." To ensure that all variables were tested individually, multiple logistic regressions were run to ascertain the relationship between the two predictor variables of image medium (*Analogue* and *Digital*) and L2 content (*Framed* or *Screened*), separately for each outcome variable (*Agency*, *Experience*, and *Realness*). Results for all three analyses confirmed a statistically significant relationship between predictor variables and outcome variables. Fig. 2 summarizes these results. Data collected from this study are open source and available online at https://osf.io/5gyqj/.

1.1.2.1. Agency

Logistic regression analysis of the *Agency* data found that the *Medium* factor (*Analogue* or *Digital*) was a significant predictor of the outcome variable (L1 vs L2 selection), with a stronger Medusa effect for *Analogue* presentations than for *Digital* presentations overall [$\beta = -0.584$, SE = 0.149, $z = -3.927$, $p < 0.001$]. The *Content* factor (*Framed* or *Screened*) was also a significant predictor, with a stronger Medusa effect for *Framed* presentations than for *Screened* presentations overall [$\beta = -0.835$, SE = 0.155, $z = -5.393$, $p < 0.001$]. The interaction between *Medium* and *Content* was also statistically significant [$\beta = 0.848$, SE = 0.221, $z = 3.843$, $p < 0.001$], reflecting a weaker Medusa effect when *Screened* content was presented in the *Digital* medium (lower right quadrant of Fig. 2).

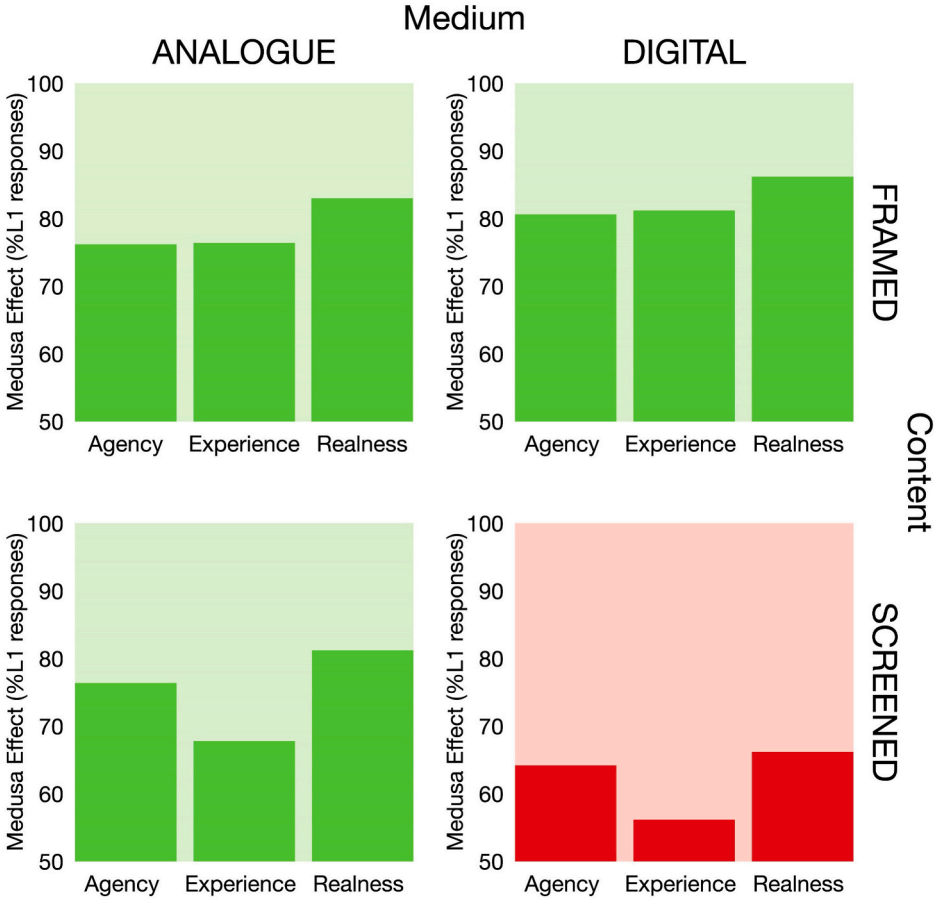

Fig. 2. Magnitude of the Medusa effect as a function of experimental condition. Columns illustrate the two Medium conditions (Analogue and Digital), and rows illustrate the two Content conditions (Framed and Screened), resulting in four quadrants. Each quadrant shows the Medusa effect separately for three dimensions of mind perception (Agency, Experience, and Realness). The magnitude of the effect is the percentage of trials in which participants attributed more mind to L1 than to L2. Scores exceeding 50% illustrate the Medusa effect, which was evident in all conditions. The effect was strong in the Analogue—Framed, Digital—Framed, and Analogue—Screened conditions (shown in green), but was relatively weak in the Digital–Screened condition (shown in red), indicating an interaction between Medium and Content in this study. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

1.1.2.2. Experience

A similar pattern was obtained for the *Experience* dimension. Again, the *Medium* factor (*Analogue* or *Digital*) was a significant predictor of L1 vs L2 choice [$\beta = -0.496$, SE = 0.139, z = −3.569, $p < 0.001$], reflecting a stronger Medusa effect for *Analogue* over *Digital* medium. Likewise, the *Content* factor (*Framed* or *Screened*) was a highly significant predictor [$\beta = -1.215$, SE = 0.154, z = −7.889, $p < 0.001$], owing to a stronger Medusa effect for *Framed* over *Screened* content. The interaction between these factors was again significant [$\beta = 0.791$, SE = 0.215, z = 3.675, $p < 0.001$].

1.1.2.3. Realness

The results for *Realness* echoed those for *Agency* and *Experience*. Image *Medium* was a significant predictor of stimulus choice [$\beta = -0.790$, SE = 0.157, z = −5.032, $p < 0.001$], with *Analogue* exceeding *Digital*. Image *Content* was a significant predictor [$\beta = -1.152$, SE = 0.170, z = −6.800, $p < 0.001$], with *Framed* exceeding *Screened*. The interaction between these factors was again significant [$\beta = 1.030$, SE = 0.243, z = 4.235, $p < 0.001$], with the smallest Medusa effect in the *Digital–Screened* condition.

For all three dimensions (*Agency*, *Experience*, *Realness*), the Medusa effect was smallest in the *Digital–Screened* condition. Indeed, for the *Experience* dimension, the effect was virtually eliminated. To investigate this observation, we ran a series of one-sample *t*-tests to compare the percentage of L1 responses in each condition against chance (50%). We subsequently calculated the corresponding effect sizes using Cohen's *h* to compare the distance between proportions. L1 responses were significantly above chance in all conditions and for all response dimensions (all *p*s < 0.05), except for *Experience* in the *Digital–Screened* condition [$t(31) = 1.8$, $p = 0.08$, $h = 0.12$]. Both *Agency* [$t(31) = 4.7$, $p < 0.001$, $h = 0.29$] and *Realness* [$t(31) = 4.4$, $p < 0.001$, $h = 0.33$] in this condition indicate a small-to-medium sized Medusa effect. Results were similar or larger for all three dimensions in the remaining conditions: *Digital—Framed* (*Agency* [$t(31) = 9.6$, $p < 0.001$, $h = 0.66$], *Experience* [$t(31) = 9.6$, $p < 0.001$, $h = 0.67$], *Realness* [$t(31) = 11.5$, $p < 0.001$, $h = 0.81$]), *Analogue—Screened* (*Agency* [$t(31) = 8.2$, $p < 0.001$, $h = 0.55$], *Experience* [$t(31) = 3.8$, $p < 0.001$, $h = 0.37$], *Realness* [$t(31) = 9.7$, $p < 0.001$, $h = 0.67$]) and *Analogue—Framed* (*Agency* [$t(31) = 7.8$, $p < 0.001$, $h = 0.55$], *Experience* [$t(31) = 10$, $p < 0.001$, $h = 0.55$], *Realness* [$t(31) = 12.1$, $p < 0.001$, $h = 0.72$]). Finally, we note that these findings generalise across images. When the Medusa effect was present, it was generally consistent across all images and all dimensions of mind, with only one or two exceptions. When the Medusa effect was weak or absent (i.e., the *Digital-Screened* condition) this too was consistent across the majority of images.

1.1.3. Discussion

Our findings indicate that L1 abstractions across both pictorial mediums (*Digital* and *Analogue*) were perceived as having higher levels of mind than L2 abstractions. These findings are consistent with the original Medusa effect (Will et al., 2021) and confirm its generality beyond a single medium. More importantly for the current study, the interaction between *Medium* and *Content* reveals a sophistication to mind perception in pictures that was not previously recognized. We consider the quantitative and qualitative aspects of our findings separately.

For *Analogue* presentations, our content manipulation had no discernable impact on the magnitude of the Medusa effect, which was strong for *Framed* abstractions and *Screened* abstractions alike. However, for *Digital* presentations, content had a substantial impact. While the effect was again strong for *Framed* abstractions, it was weak for *Screened* presentations. The interaction of medium and content is key here: The Medusa effect can be strong for *Screened* abstractions (as when the medium is *Analogue*). It can also be strong in the *Digital* medium (as when the content is *Framed*). It is the conjunction of these factors specifically (*Digital–Screened*) that depletes the effect. In that situation, the distinction between L1 and L2 was reduced. See Fig. 3 for a representation.

Why is the abstraction cost reduced when the presentation format is digital and the L2 person is shown on a screen? Our informal debriefing of participants suggests one intriguing possibility. Several participants reported that when seeing a *Screened* person within a *Digital* image, that person retains the potential for interaction (e.g. in the context of a video call). Importantly, the potential for interaction is unique to the *Digital–Screened* condition, as either an *Analogue* medium or *Framed* content would rule it out. Eye tracking has previously been used to demonstrate rapid parsing of L1 and L2 image elements (Will et al., 2021). We suggest that a similar approach could be used to systematically investigate the parsing of *Screened* versus *Framed* L2 representations.

We now turn to qualitative observations, specifically the profile of the Medusa effect across the rated dimensions (*Agency*, *Experience*, and *Realness*). For ratings of *Experience*, the distinction between L1 and L2 was less pronounced for *Screened* content than it was for *Framed* content. This observation applies to both *Analogue* and *Digital* presentations, though especially so for digital images. Apparently, *Experience* survives the journey to screen especially well. Although we did not anticipate this qualitative shift, it does resonate with participants' observations that *Screened* people retain the potential for social interaction. Our choice of stimuli (frontal views of full faces) perhaps encouraged this interpretation by priming social interaction and the interlocutor's 'ability to feel.' In future experiments, it would be interesting to compare images that emphasise 'ability to do' instead. For now, selective conservation of perceived *Experience* underscores the dimensional nature of mind perception and the separability of *Agency* and *Experience* that is central to Gray et al.' (2007) analysis.

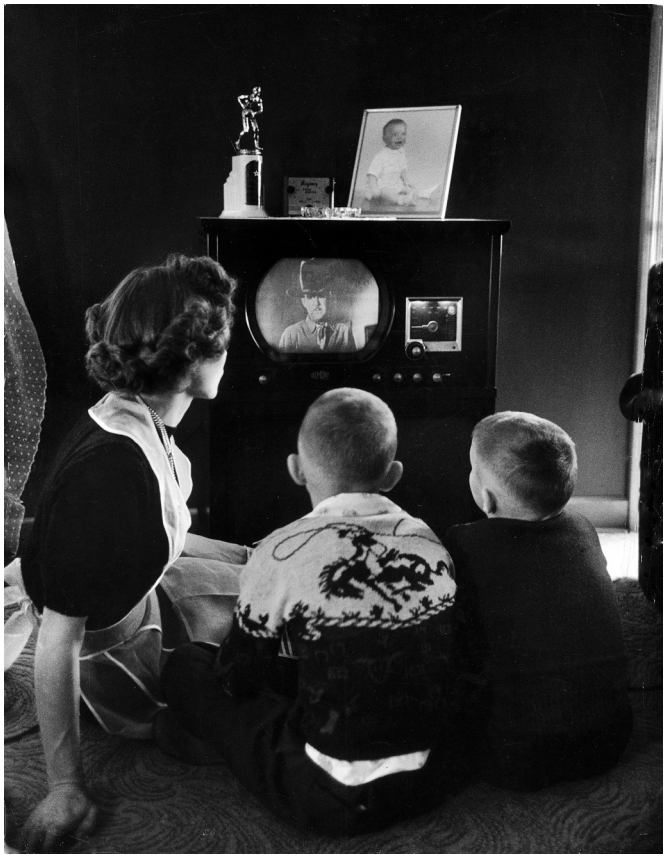

Fig. 3. Representation of L1 with Screened- and Framed-L2. N.B.: Your perception of L2 may differ depending on whether you are reading this article online (i.e., in the Digital medium) or in print (i.e., in the Analogue medium). See main text for details.

Our findings have several theoretical implications. The document effect in face recognition shows that embedding an image in the visual context of an ID-document can affect identification judgments (Feng & Burton, 2021). Our current findings show that embedding a face image in a particular mode of presentation can affect attributions of mind. Although these observations concern different face tasks, both indicate a role for presentation context (as distinct from social context) in person perception. Linking such findings also highlights connections between face perception and mind perception. For example, in the current study, mode of presentation impacted mind perception even when the originating stimulus (facial appearance) was held constant. More generally, we expect the interplay between physical appearance and moral consideration to become an increasingly important topic. As pictorial media continue to proliferate, new ways to spin the ethical heft of images open new possibilities for communication, good and ill. All of these implications are subject to our sample demographics which are female biased. Future research might consider exploring the influence of gender on the Medusa effect.

It was already established that the Medusa effect is reliable (Will et al., 2021; Han et al., 2024). Here, we show that it is also responsive to changes in presentation type. These properties suggest a specific application for the Medusa effect in testing immersive media. At the time of writing, Augmented Reality (AR) devices promise to blur the distinction between L0 (reality) and L1 (representation). For the device wearer, real-world bystanders (L0) become L1 people in a *Digital* medium; and critically, avatars in software windows become L2 people in a *Digital–Screened* setting. This is precisely the situation in which the Medusa effect should be weak. However, if the wearer becomes engrossed in the device output, bystanders in the *Digital* medium may be accepted as L0 ('real') people, such that avatars take the role of L1. In that situation, the Medusa effect should be strong (Will et al., 2021). The implication is that the Medusa effect offers an indirect measure of immersion, with a strong Medusa effect signaling greater immersion and a weak Medusa effect signaling lesser immersion.

The ability to control and apply the Medusa effect demonstrates that the interface between mind perception and pictorial representation is richer and more nuanced than previous studies have recognized. Despite the physical flatness of pictures, levels of representational abstraction imbue them with psychological depth. The Medusa effect provides an experimental tool for traversing these levels. As our current findings show, this effect is sensitive to changes in medium at multiple levels of abstraction.

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CRediT authorship contribution statement

Salina Edwards: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **Rob Jenkins:** Writing – review & editing, Visualization. **Oliver Jacobs:** Formal analysis, Data curation. **Alan Kingstone:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization.

Data availability

Data for this study is made available in the manuscript and can be found via OSF: https://osf.io/5gyqj/

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