Philosophy of Perception in the Psychologist's Laboratory

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Abstract

Perception is our primary means of accessing the external world. What is the nature of this core mental process? Although this question is at the center of scientific research on perception, it has also long been explored by philosophers, who ask fundamental questions about our capacity to perceive: Do our different senses represent the world in commensurable ways? How much of our environment can we be aware of at one time? Which aspects of perception are 'objective', and which 'subjective'? What properties count as perceptual in the first place? Although these parallel research programs typically proceed independently in contemporary scholarship, previous eras recognized more active collaboration and interaction across philosophical and scientific approaches to perception. Here, we review an emerging research focus that has begun to reunite these approaches, by putting several longstanding philosophical questions to empirical test. Unlike more general sources of philosophical inspiration, the work described here draws a direct line from a prominent philosophical conjecture or thought experiment about perception to a key test of that question in the laboratory—such that the relevant experimental work would not (and even *could* not) have proceeded as it did without the preceding philosophical discussion. Finally, we explore themes arising from these successful interactions, and point to further philosophical questions that might be amenable to empirical approaches.

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Introduction

In 1688, the Irish polymath William Molyneux wrote to John Locke with a question: If a person born blind had learned to identify spheres and cubes by touch, and then were somehow granted sight, could they identify those same objects by vision alone? This epistolary event gave rise to what is now known as *Molyneux's Question*, a philosophical puzzle about the relation between our senses. Locke and Molyneux, along with other empiricists, answered "no", believing that correspondence between vision and touch was learned from experience. In contrast, Leibniz and other rationalists answered "yes", believing that information from different senses could be related by reason alone. Many scholars have been captured by this puzzle in the centuries since, with opinion divided to the present day.

How might this sort of dispute be adjudicated? Is further reflection our only hope for resolution? Some philosophical conundrums may well be stubborn in this way; but others might be amenable to a different approach: Collecting empirical data that bear on the problem of interest. Indeed, while Molyneux's question began as a thought experiment, it could also become a scientific experiment, if ever the right conditions arose. This problem thus highlights an opportunity (one that goes beyond Molyneux's question itself): Using the methods of modern perceptual psychology to advance questions from the philosophy of perception.

Boundary-blurring work of this sort has existed in the past, embodied by early figures such as James, Calkins, Helmholtz, and Michotte, who blended philosophical and scientific approaches to the study of perception. But disciplinary specialization and methodological divergence have increasingly put these fields out of touch with one another. Intriguingly, several new research programs seem poised to revive this interdisciplinary relationship, as philosophers join perception scientists to answer questions of interest to both.

Here, we review some of the fruits of this new work, by discussing multiple "case studies" drawing a direct line from a prominent philosophical conjecture to an empirical investigation of that question in the laboratory. These include Molyneux's famous question, along with several other problems from decades- or centuries-old philosophical sources—including the perception of causality, the nature of visual perspective, perceptual indeterminacy, and the perception of absence. We also discuss how these empirical projects often feed back into the philosophical discussions that inspired them, creating a virtuous circle that places the two fields in genuine dialogue. Finally, we explore themes arising from these successful interactions, and point to new opportunities and directions.

1. Molyneux's Question

How could Molyneux's unusual scenario be realized under laboratory conditions? Restored vision after a life of blindness might seem fantastical; indeed, the few cases that have been accessible to scientists are quite exceptional (e.g., Gregory and Wallace, 1963). However, today this remarkable state is actually the outcome of a standard medical procedure: lens replacement surgery for congenital cataracts. Cataracts are the leading cause of blindness worldwide, and the recommended treatment for infants born with them is to replace their natural lenses with artificial ones, effectively restoring their vision. However, in regions of the world where this procedure is unavailable, cataract patients often live with little-to-no vision. Recently, a human-

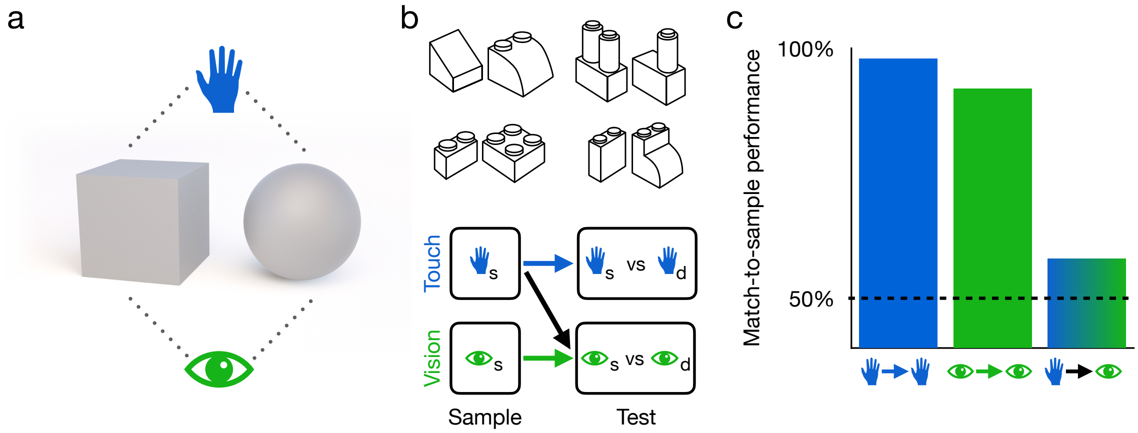

Figure 1: Molyneux's Question. **(a)** Do our different senses represent the world in commensurable ways? Must we learn from experience how to translate between representations in different sensory modalities? Molyneux's Question approaches these issues by way of a thought experiment: If a person born blind had learned to identify and distinguish spheres and cubes by touch, and then their sight were somehow restored, could they then identify those same objects just by looking at them? **(b)** In a modern, scientific test of this centuries-old question, Held et al. (2011) studied children whose sight had been restored after surgery for congenital cataracts. Moments after seeing the world for the very first time, participants were introduced to novel shape stimuli (3D solids from a children's toy set), and had to determine which of two objects ("choice"—sample [s] vs distractor [d]) was identical to a previously presented object ("sample"). Participants either: (1) held the objects without seeing them (Touch-Touch); (2) viewed the objects without touching them (Vision-Vision), or, crucially, (3) held the sample object and saw the test objects (Touch-Vision). **(c)** Performance was near ceiling for the two intramodal tasks (Touch-Touch and Vision-Vision); however, performance was indistinguishable from chance in the cross-modal condition (Touch-Vision), suggesting that correspondence between the senses requires time and experience to develop. Adapted from Held et al. (2011).

itarian and scientific project offered free cataract surgery to needy children in north India, some of whom then participated in studies of restored sight.

These conditions enabled the first modern, rigorous, multi-subject test of Molyneux's Question, with direct inspiration from the philosophical text (Figure 1). Held et al. (2011) tested children aged 8–17 with severe but curable ocular pathologies. After surgery, participants wore eyepatches during a two-day recovery period, until removing them to complete three match-to-sample tasks. Subjects were presented with a sample object, followed by two test objects: the original sample, and a foil; the task was simply to decide which test object was the original sample. What varied was presentation: (1) "Touch-Touch": feeling the sample object, then feeling the test objects (under a table), (2) "Vision-Vision": seeing the sample object, then seeing the test objects (on top of the table), and crucially (3) "Touch-Vision": feeling the sample object under the table, then viewing the test objects on top of the table. This final condition requires matching seen with felt, despite never having done so before.

Participants performed near ceiling at Touch-Touch and Vision-Vision, suggesting proper functioning of each sensory modality (including their recently restored sight). Remarkably, however, performance fell to chance in the Touch-Vision condition. In other words, participants who could easily tell that two felt objects or two seen objects were the same could *not* tell that a felt object was the same as a seen object. The authors interpret these findings in terms of the original philosophical puzzle: "the answer to Molyneux's question is likely negative" (Held et al. 2011, 552).[1]

Beyond providing novel and unique data, this study has opened new avenues for thinking about Molyneux's question, and even reformulating it. While some philosophers accept that this result resolves (some renditions of) Molyneux's question, others argue it reveals that the original thought experiment is ill-suited for probing intermodal commensurability. For example, Schwenkler (2013) suggests that, while subjects' restored vision may have been sufficient to see the objects in blurry or degraded form (and perform intramodal matching on that basis), it may not have been sufficient to represent 3D shape so as to enable matching with tactile shape. (See also Green, 2021.) In any case, this work illustrates the ideal we explore in this review—having been run to test a longstanding philosophical question—and showcases the fruitfulness of this approach across disciplines and methodologies.

[1]Intriguingly, when three of the five original subjects were re-tested, some only five days later, they performed well above chance at Vision-Touch matching. So, while Molyneux's question may have a negative answer as literally written, Held et al.'s own results suggest that matching across senses can arise after extremely minimal learning.

2. The Perception of Causality

Consider the billiard balls in Figure 2a. Beyond seeing their colors, shapes, and sizes, you may also find yourself with another impression: one ball has *collided* with the other, causing it to move. What is the nature of this impression? Do we visually experience the causal transfer of force? Or do we only cognitively infer causality upon seeing one object stop as the other moves?

This question is a perceptual gloss on Hume's famous contention that we only ever experience the "constant conjunction" of various events—here, the position of each billiard ball at successive timepoints—but never their underlying causes. As philosophers have debated this claim on theoretical grounds, an empirical approach emerged from the Gestalt tradition in the middle of the last century, centered on judgments about visual demonstrations manipulating the spatiotemporal characteristics of billiard-ball-like interactions (Michotte, 1963). However, it has remained unclear whether these data address the key dispute over perceptual vs. cognitive interpretations of such causal impressions, leading many philosophers to favor approaches exploring the phenomenology of causal vs. non-causal events (Siegel, 2009).

Recently, however, a new kind of empirical evidence has emerged suggesting that causal perception truly is *perception*, as opposed to cognitive inference or judgment. Directly inspired by Hume's challenge, Rolfs et al. (2013) leveraged visual adaptation, the phenomenon whereby perceiving a visual feature makes other stimuli appear to have the 'opposite' feature (as when, e.g., staring at leftward-tilted lines makes vertical lines appear tilted rightward). Rolfs et al. extended this paradigm to the perception of causality, by repeatedly showing subjects causal "launches" (i.e., one disk appearing to cause another to move after touching it), followed by ambiguous events that could be seen as either launches or non-causal "passes" (i.e., overlapping disks where the first appears to pass over the second without causing it to move).

Remarkably, exposure to launches biased perception of ambiguous events towards passes (Figure 2c). Moreover, this effect was retinotopic: When subjects moved their eyes from the adaptation location to a new test location, the aftereffects followed along, remaining in the retinally-defined location of the original stimuli. No cognitive (i.e., non-perceptual) process is known to exhibit retinotopy, making this pattern particularly suggestive of visual processing (Block, 2014; Hafri and Firestone, 2021; Phillips and Firestone, 2022). Together, these results suggest that causality may be visually represented, not merely cognitively inferred—and, perhaps contrary to Hume, that perception distinguishes causality per se from mere constant conjunction.

Multiple researchers have further explored these results (e.g., Kominsky and Scholl, 2020), with the key philosophical questions remaining central. For example,

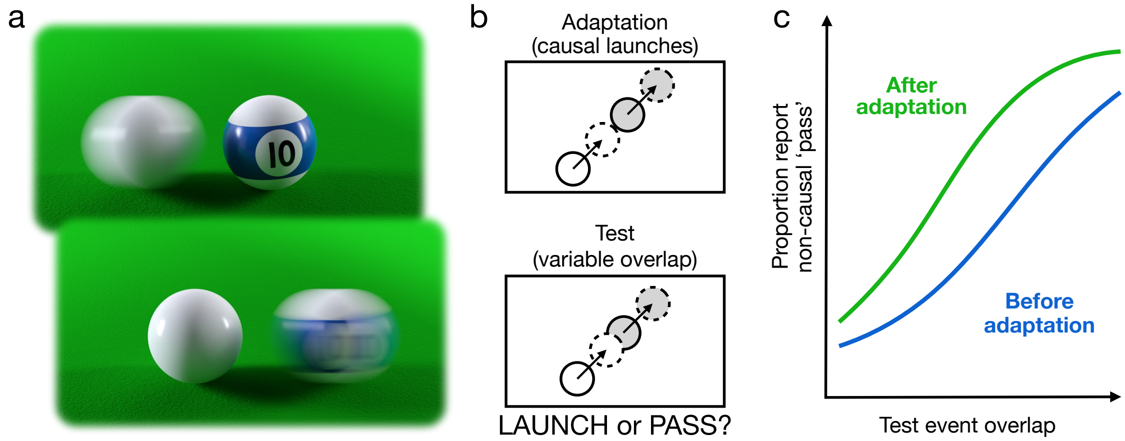

Figure 2: The perception of causality. **(a)** When looking at one event causing another (e.g., one billiard ball hitting a second billiard ball and making it move), do we truly perceive causality, or do we only represent the conjunction of one event followed by another? Is causality something we can visually experience, or something we can only judge or infer? **(b)** Rolfs et al. (2013) investigated this question using visual adaptation. Subjects saw multiple events in which one disk moved towards another and stopped just as the other disk moved (top); such events are typically seen as the first disk causally "launching" the other. Next, subjects saw an ambiguous event in which the two disks partially overlapped (bottom); these events can be seen as either a (causal) launch or a (non-causal) "pass", and they typically elicit a mix of responses from observers (launch or pass) depending on the precise degree of overlap between the disks. **(c)** After repeatedly viewing causal launches, the ambiguous events were classified as non-causal "passes" more often than before adaptation—a classic "repulsion" effect characteristic of adaptation. Crucially, this effect was specific to the retinocentric coordinates in which the events appeared, providing experimental evidence for the philosophical claim that we *see* high-level properties such as causality. Adapted from Rolfs et al. (2013).

a remaining question is whether subjects adapted to causation proper (i.e., visual representations of causation were involved) or instead only low-level features diagnostic of causation (e.g., spatiotemporal properties that produce a causation gestalt; Siegel and Byrne, 2017; for a related empirical study, see Arnold et al., 2015.) These experiments have also contributed to a broader philosophical literature on high-level properties in perception (including not only causality, but also agency, intention, emotion, and more; Block 2014; Siegel and Byrne 2017).

3. The Puzzle of Perspectival Appearance

Look at the object in Figure 3a. Though the shape it projects is that of an ellipse, we can tell that it is really a circle—a wooden "coin" rotated in depth. But which shape do we *see*? Do we see the coin as elliptical and only decide or judge that it is circular? Or is the reverse true, such that we immediately see its distal shape, and only realize on reflection that it projects an ellipse?

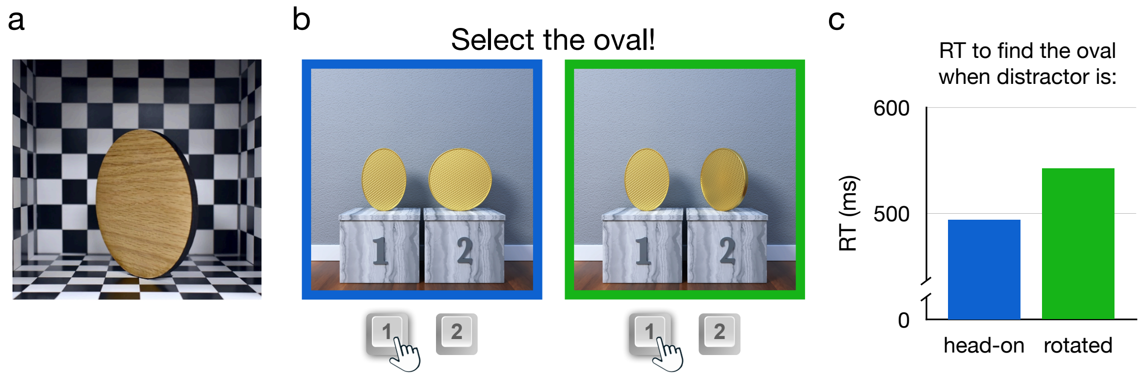

Figure 3: The puzzle of perspectival appearance. **(a)** When a circular disk is rotated in depth, do we see only its shape "out there", or are we also aware of its appearance "from here"? **(b)** Morales et al. (2020) tested this question using a visual search paradigm. On each trial, subjects saw two "coin" stimuli on numbered pedestals: One was always a (distal) ellipse and one was always a (distal) circle; subjects simply had to press a key corresponding to the number of the pedestal on which the ellipse was sitting. (In both of the images shown here, for example, the correct answer is Pedestal #1.) Crucially, on some trials, the competitor stimulus was a head-on circle (shown here with a blue border around the image), and on other trials the competitor stimulus was a rotated circle (shown here with a green border around the image). Which kind of trial is easier? In other words, which competitor stimulus is more distracting to subjects who are looking for a distal ellipse? **(c)** Subjects were faster to find the distal ellipse when its competitor was a head-on circle (blue bar) than when its competitor was a rotated circle (green bar); put another way, subjects searching for an ellipse found a rotated circle to be a stronger distractor than a head-on circle. This study provides psychophysical evidence for the philosophical view that there is "perspectival similarity" between rotated circles and head-on ellipses. Adapted from Morales et al. (2020).

A rich philosophical tradition is divided on this question. One view, tracing to the British Empiricists, holds that objects look roughly like their projections. Locke, for example, proposed that "When we set before our eyes a round globe...the idea thereby imprinted on our mind is of a flat circle" (Locke, 1975, para. II, ix, 8). A contrasting view, associated with the theoretical work of scientists as different as Helmholtz and Gibson, argues oppositely—of course the rotated coin looks circular, because perception represents distal 3D properties, not 2D patterns of stimulation. Myriad subtle views lie between, all addressing a fundamental question: To what extent is perception about *the world out there*, and to what extent is it about *ourselves* and our point-of-view?

Despite its history and centrality, much of this philosophical debate has relied more on introspection than empirical data, even with a long tradition of experimental work on shape constancy and visual perspective (Epstein and Park, 1963). For example, Schwitzgebel (2006), defending a distal-only view, writes: "[A]s I stare at the penny now, I'm inclined to say it looks just plain circular, in a three-dimensional space—not elliptical at all, in any sense" (590). Similarly, Smith (2002) writes: "the suggestion that pennies, for example, look elliptical when seen from most angles is simply not true—they look round" (172). Recently, however, Morales et al. (2020) took an empirical approach aimed more directly at this philosophical discussion, testing the specific claim that rotated coins don't look elliptical "in any sense".

Morales et al.'s approach used visual search, which probes how easily one can locate a target among distractors. Search performance is affected by the perceived similarity of targets and distractors; for example, it is easier to find a red square among blue triangles than among red triangles, because red squares and red triangles share an aspect of their appearance. Morales et al. asked a corresponding question about tilted coins: If rotated circular objects look elliptical (in some sense), might they impair search for truly (i.e., distally) elliptical objects?

The answer is *yes* (Figure 3). When subjects must quickly locate a distally elliptical object, they are slower when it is flanked by a rotated circle than a head-on circle. In other words, subjects searching for ellipses are distracted by rotated circles, consistent with the two objects sharing some aspect of their appearance. Importantly, this effect persisted even when enforcing a delay between stimulus presentation and subjects' responses (allowing extra processing time), and also when using real-world objects that sat directly in front of subjects for an entire experimental session. Together with other findings, Morales et al. take these results to support "perspectival similarity" between rotated circles and head-on ellipses: There is indeed some sense in which the rotated circle looks elliptical, even once its distal shape is known.

This finding too has fed back into philosophical discussions, with some arguing that "perspectival similarity is real and efficacious" (Green, 2021), others questioning the theoretical implications (see, e.g., Burge and Burge, 2022, and replies by Morales and Firestone, 2023 and Cheng et al., 2022), and still others suggesting follow-up experiments to explore this issue further (Cheng, 2022).

4. The Problem of the Speckled Hen

Suppose you are looking at a speckled hen—a guineafowl with spotted plumage (Figure 4). You can see that it has many speckles, and you could even discern each speckle contributing to this impression. In this scenario, are you also aware of a *determinate number* of speckles? It seems not; for example, you would be very uncertain if asked to report this number. But how can this be? How do our minds generate a percept having some particular number of speckles, while remaining ignorant of that number? This is the Problem of the Speckled Hen—specifically, its "representationalist" variant (Munton, 2021)—first posed by the philosopher Gilbert Ryle.

How might this puzzle be resolved? A promising solution has floated in the philosophical literature: Perhaps the puzzle arises from an intuitive but mistaken "pictorialist" assumption that perceiving a general property (here, number of speckles) derives from perceiving the specific properties determining it (here, each individual speckle). If impressions of the numerosity of a set of items arise wholly from impressions of the individual items themselves, then the speckled-hen scenario seems puzzling indeed; but if individuals and summaries are processed independently, then there may be no puzzle after all. However, until recently, this solution has been speculative, without empirical grounding. Could it be supported experimentally?

Burr and Ross (2008) were motivated by this philosophical discussion: "Does a single glance at a speckled hen provide us with a...percept containing a definite number of speckles?" (Ross and Burr, 2008, 363–364). In an empirical investigation of this question, they demonstrated that perception of numerosity can come apart from perception of individuals. Subjects stared at a display with many dots, and then compared the numerosity of a test display appearing in the same location against a probe display appearing in a non-adapted location. This procedure produced visual adaptation: The test display now appeared less numerous. Crucially, the authors note an odd experience that results: The perceived number of dots is altered even though no particular dot seems to have appeared or disappeared. Each individual dot seems unchanged, while the total number of dots seems changed—suggesting separate perceptual mechanisms for general and specific properties.

This finding has launched a cottage industry of work on numerosity perception, which has in turn supported new philosophical perspectives. For example, Munton (2021) suggests that this adaptation result is inconsistent with pictorialism, helping to "dissolve the puzzle of the speckled hen". (See also Block, 2022, who uses these findings in a broader account of the perception/cognition distinction.)

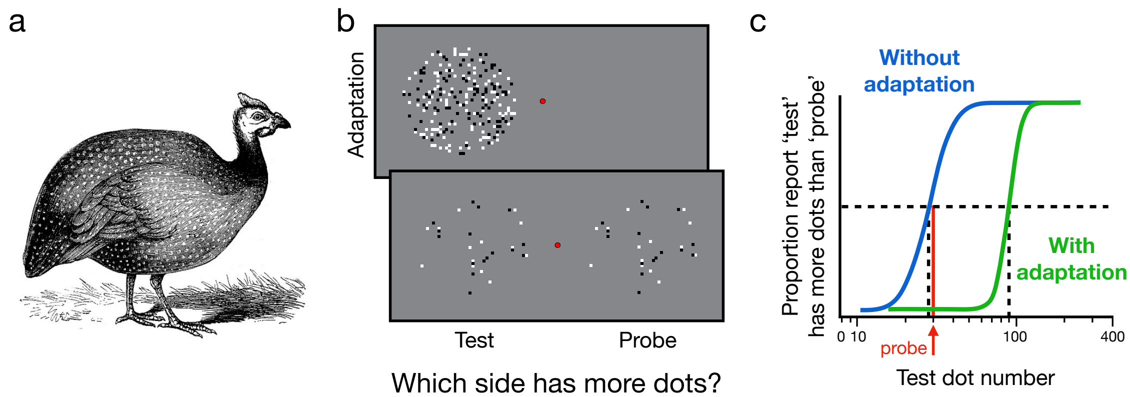

Figure 4: The problem of the speckled hen. **(a)** In seeing a speckled hen, your visual experience comprises many individual speckles. Yet, even though you can see each speckle, and you have an overall impression of the hen's speckledness, it seems you do not thereby see how many speckles there are. Why not? This puzzle is attributed to Gilbert Ryle, who suggested it to A.J. Ayer as a challenge to sense-datum theories of perception. Many variations and aspects of this puzzle exist, with different philosophical upshots; the aspect we focus on here is what Munton (2021) calls the "representationalist puzzle". **(b)** One path to resolving this puzzle lies in the insight that general properties and specific properties are processed by distinct perceptual mechanisms. Providing evidence for this solution, Burr and Ross (2008) asked whether the perceived numerosity of a set can exhibit visual adaptation, independent of the elements making up the set. Their finding is captured by this demo: After staring at the top row of this image for a prolonged time, the arrays in the bottom row do not seem to have the same number of dots, even though they are objectively equinumerous (indeed, they are just the very same image displayed twice). The left array comes to appear less numerous than the right array, due to visual adaptation. **(c)** Sample psychometric curves from an experiment where subjects adapted to different numerous stimuli (400 dots for the resulting curves in this example) and then compared the numerosity of a test display presented in the same location as the adapted stimulus against the numerosity of a probe (30 dots) present in a non-adapted location. Without adaptation (blue curve), subjects accurately compared the number of dots in the probe and test stimuli. After adaptation (green curve), subjects required about three times more dots in the test stimulus compared to the probe to perceive them as equinumerous. Curiously, these phenomena occur even when no individual dot appears to have changed; in other words, the effects are specific to numerosity perception per se. This result provides powerful evidence that perception of individuals can come apart from representations of summaries of those individuals, in line with an anti-pictorialist solution proposed in the philosophical literature. Adapted from Burr and Ross (2008).

5. The Perception of Absence

You return to your locked-up bicycle and immediately notice the front wheel missing. (Oh no! It was stolen while you were gone.) As you stare at your incomplete frame, you have a visceral sense of the wheel's *absence*; there isn't just empty space where the wheel once was—there is a missing wheel. What is the nature of this experience?

A longstanding philosophical tradition explores the metaphysics of absences, distinguishing them from mere empty space and even from holes, shadows, and occluded parts. Intriguingly, this tradition also proposes that we can *perceive* absences. A prominent example is Sartre (1944)'s case of arriving to meet his friend Pierre at the café but then seeing that Pierre is (unexpectedly) missing, which Sartre suggests is a genuine perceptual experience of absence. Contemporary philosophers argue both sides of this issue, some affirmatively (Farennikova, 2013) and others not: "while thought can range over positive and negative objects…no perceptions are of negative objects" (O'Shaughnessy, 2000, p.335). At stake is a fundamental question about what we can perceive. Indeed, if we can genuinely see absences, then Marr's field-defining characterization of visual perception—"the process of discovering from images what is present in the world, and where it is"—may need revising, since it would turn out that we can see not only what is present, but also what is absent. However, these discussions have proceeded mostly by reflecting on the phenomenology of the relevant cases. Could psychophysical evidence provide insight?

Motivated by these debates, Morales and Firestone (2021) and Goh et al. (2022) took an experimental approach, asking whether absent objects can "substitute" for present objects in certain psychophysical paradigms (Figure 5). One signature of (present) objects is that their onset captures attention: When an object suddenly appears, we spontaneously attend to it, as measured by facilitated probe detection at the object's location. Inspired by scenarios like the missing bicycle-wheel, Morales and Firestone demonstrated that this signature extends to absent object-parts. For example, if a butterfly missing a wing suddenly appears, probe detection is facilitated not only on the visible parts of the butterfly but also at the location of the missing wing. Goh et al. pursue a similar substitution approach for temporally extended absences. An intriguing illusion shows that a stimulus appearing for a single, long duration seems longer than two short appearances of the same temporal extent (Yousif and Scholl, 2019). Goh et al. replicate this finding with absences: A single, long disappearance seems longer than two short disappearances of the same temporal extent. These findings suggest that absent objects can display similar psychophysical signatures as present objects, and they have already fed back into philosophical discussions concerning the claim that we can perceive what is missing (Block, 2022).

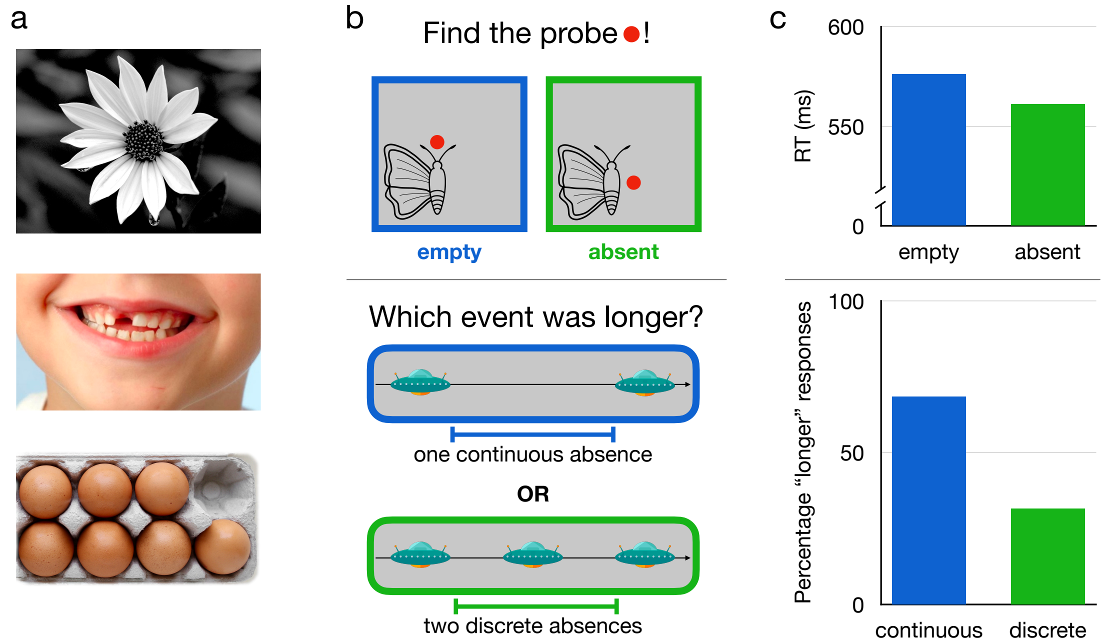

Figure 5: The perception of absence. **(a)** Something stands out in these photographs. But what stands out is not what's present, but rather what's missing: a petal, a tooth, an egg. Do these impressions of absence reflect genuinely perceptual processing? **(b)** *Top*: Morales and Firestone (2021) investigated this question by asking whether absent parts of a newly appearing stimulus capture attention in a similar way as the onset of ordinary (present) objects. Subjects saw a line drawing of an object missing a part, and then had to classify a probe which appeared either (i) on the object (not shown), (ii) pure "empty space", or (iii) in "absent space"—that is, in empty space where the missing part would have been. Absent space is, of course, physically identical to empty space (and the probe's proximity to the stimuli was equated); but,does the visual system distinguish between them? *Bottom*: Goh et al. (2022) pursue a similar approach for temporally extended absences. In the "one-is-more illusion" (Yousif and Scholl, 2019), a single stimulus lasting a certain duration is perceived as longer than two consecutively appearing stimuli. Goh et al. adapt this paradigm to study absences, by showing subjects an object that disappears for either one long period or two short periods. (c) *Top*: When presented with an object missing a part, attentional mechanisms enhance processing in the otherwise-empty region where the missing part would have been. In other words, attentional processing is facilitated in absent space more so than in empty space, suggesting that visual processing is, in some way, sensitive not only to what's there but also to what's missing. *Bottom*: Even when events with present stimuli are replaced by events with absent stimuli, the one-is-more illusion remains, with subjects judging the single, long moment of absence as longer than the two, short moments of absence, suggesting that the visual system treats events characterized by absent stimuli in similar terms as events characterized by present stimuli.

An Interdisciplinary Invitation

The philosophy and science of perception increasingly make contact with one another, as philosophers support their views using scientific research (Block, 2014;

Macpherson, 2012) or inject clarity and insight into perception science (Phillips, 2021)—sometimes even in conversation across fields (e.g., Denison et al., 2022; Knotts et al., 2019).

However, the work reviewed here goes a step further: Empirical data aren't merely fuel for philosophical discussion but are actively collected to address questions from the philosophy of perception. In some instances, philosophical thought experiments are directly fashioned into laboratory studies; in others, new methods and paradigms breathe fresh air into old debates.

Indeed, still other questions from the philosophy of perception may be amenable to empirical approaches (Figure 6). For example, questions concerning the perception of absence extend beyond vision to other sensory domains, including auditory absences: When a room is silent, do we positively perceive the absence of sound? Or do we merely infer that silence is present when we fail to hear (O'Shaughnessy, 2000)? Goh et al.'s "substitution" approach for visual absences could be illuminating here as well, if auditory illusions previously explored with sounds also arise for moments of silence (e.g., if one long period of silence is experienced as longer than two short silences of the same combined duration).

A conceptually nearby problem concerns sensory integration. When we have a perceptual experience spanning multiple senses (e.g., the sight, smell, and feel of a fresh baguette), can our experience be factored without remainder into separate, unisensory components (such that the whole is essentially the sum of its parts)? Or are there "irreducibly multisensory" experiences (O'Callaghan, 2019)? Building on experiments by Harrar et al. (2008), Green (2021) proposes that evidence for irreducibly multisensory experiences might be found in multimodal apparent motion—specifically, if conditions can be created in which subjects perceive a single individual simultaneously move through space and across sensory domains (e.g., perceiving a flash in one location transform into a tap on a finger).

Another opportunity might be the debate over the format of perception: Are all perceptual representations purely imagistic, or are some symbolic and/or language-like? A recent philosophical inroad has been through discussion of object-files—visual indexes and short-term memory stores in which object features are encoded. For example, Green and Quilty-Dunn (2021) explore findings suggesting that object-files represent not only basic visual features like color and shape, but also abstract features like category membership (e.g., FISH)—a point that may favor abstract symbols in visual perception. However, the empirical literature has proceeded without much concern for this philosophical debate, leaving interested philosophers to examine only those studies that happen to appear for other reasons. A philosophically informed

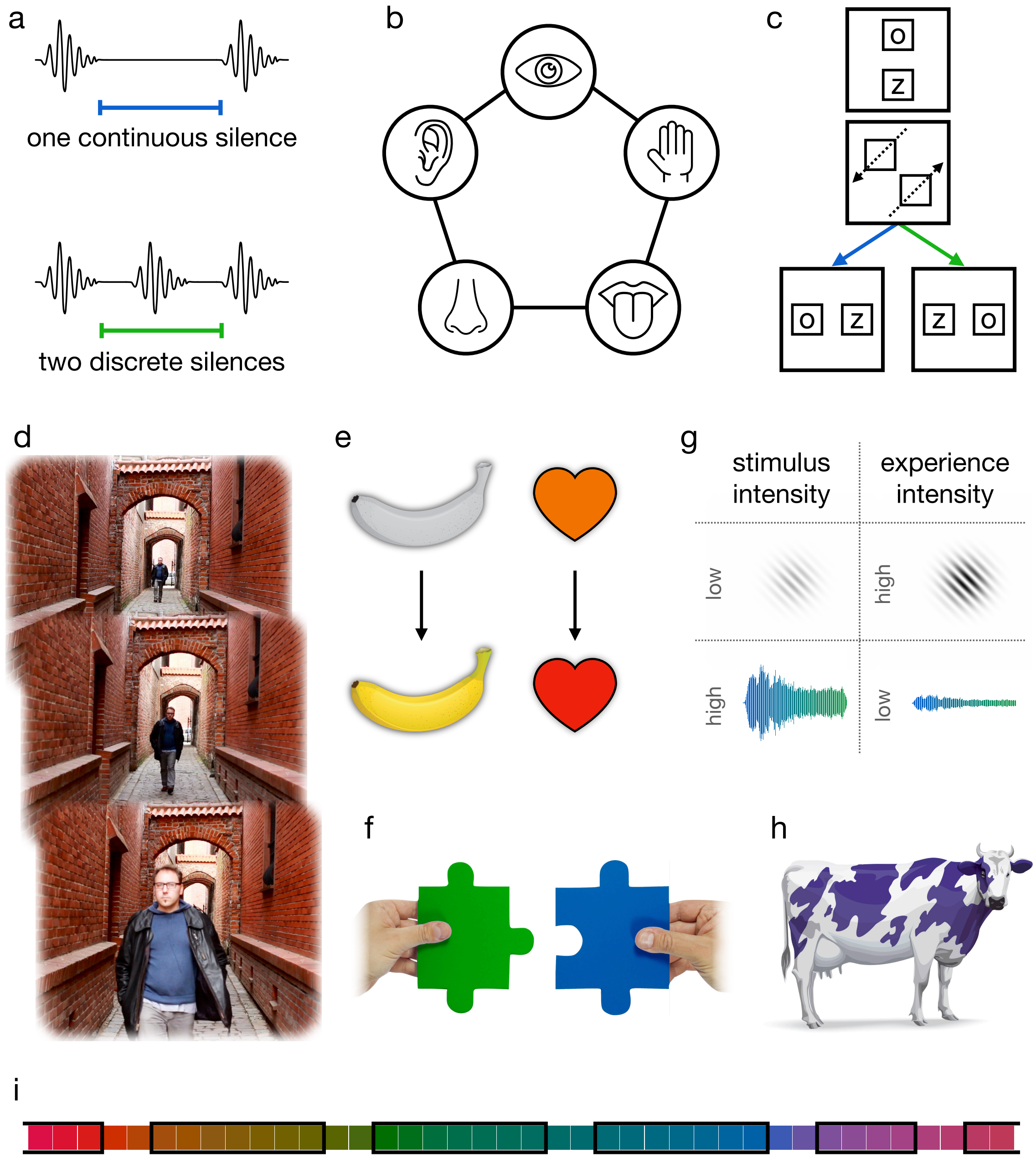

Figure 6: Caption continued on the next page

empirical research program could ask just how abstract the contents of object-file representations can be, with an eye for broader questions about perceptual formats.

Figure 6: Research opportunities at the intersection of the philosophy and psychology of perception. Several other philosophical questions about perception may be amenable to empirical approaches. **(a) The perception of silence**. When we hear the end of a piece of music, a pause in a conversation, or a break in the rain, do we perceive the absence of sound? Clearly, we can perceive the sounds that come before and after a silence, but do we also perceive silence itself? A fascinating philosophical literature asks whether we (perceptually) hear silence, or instead only (cognitively) know silence on the basis of failing to hear (O'Shaughnessy, 2000). A promising approach may be to ask whether signatures of auditory event segmentation arise for moments of silence. **(b) Multisensory perception**. Are there any perceptual experiences that are "irreducibly multisensory"? Or are multimodal perceptual experiences simply the sum of their unimodal parts? While this question has been the subject of considerable philosophical attention (O'Callaghan, 2019), it may also be open to empirical investigation through cases of multisensory object individuation (Harrar et al., 2008). **(c) The format of perceptual representations**. Does perception furnish the mind with only iconic representations of the world? Or are some perceptual representations discursive and/or language-like? Green and Quilty-Dunn (2021) propose that the empirical literature on object-files may bear on this question, if the contents of object-file representations can be shown to be sufficiently abstract and symbolic. **(d) Perceptual confidence**. According to a recent philosophical proposal, not only do beliefs assign degrees of confidence, but perceptual experiences do too (Morrison, 2016). When you see someone at a distance, you may be perceptually unsure whether they are your friend Sam; as they come closer, your perceptual confidence increases (which presumably justifies your increased credence that your friend Sam is before you). Can methods from vision science disentangle confidence in cognition from confidence assigned by perceptual experiences themselves? **(e) Cognitive penetration of perception**. One area with considerable interdisciplinary interaction is the debate over the cognitive penetration of perception. For example, inspired by Macpherson (2012)'s discussion of memory color effects (in which, e.g., a gray banana may appear tinged with yellow), Valenti and Firestone (2019) provided evidence for a non-perceptual interpretation of such effects, based on earlier work on the El Greco Fallacy. Other opportunities include: **(f) the perception of modal properties** (e.g., states or properties that are merely possible but not actual), as illustrated here by the salient impression you may have that these two puzzle pieces can fit together to create something new (Guan and Firestone, 2020); **(g) the intensity of perceptual experiences** (e.g., the modulatory role of perceptual and attentional factors in the degrees of perceptual awareness), which could be explored through dissociations between the intensity of stimulation and the intensity of experience; **(h) the (in)determinacy of mental imagery**, as illustrated by scenarios like imagining a purple cow (was it facing in a particular direction?) or a house (did it have a chimney? Schwitzgebel, 2002), which could be investigated using paradigms in which imagining certain visual features can alter conscious awareness of those features in subsequently presented stimuli (Pearson et al., 2008); **(i) conceptual vs. nonconceptual perceptual content**, a debate that might be explored through categorical color sensitivity in creatures without color concepts (as suggested by Block, 2022).

A related future direction is the recent proposal that perceptual experiences assign degrees-of-confidence (Morrison, 2016). Consider this example: At a distance, someone walking towards you looks like they could be your friend Sam; as they get closer, it looks like they probably are Sam; finally, you plainly experience Sam before you. In this case, your *beliefs* almost certainly assign degrees of confidence ("I am 50%/75%/100% sure that is Sam"). But does your perceptual experience itself also involve degrees of confidence (i.e., a perceptual confidence assignment *before* you form a belief)? This philosophical debate already blends approaches from philosophy and vision science—but it is ripe for a direct experimental approach (Denison et al., 2022).

Of course, few scientific experiments truly *resolve* the questions they address, and the present studies are no exception; indeed, several cases reviewed above generate further controversy. What is clear, however, is that work of this sort enriches each of the fields it touches—by advancing philosophical debates that were at risk of stagnation, and by introducing new questions and problems into perception science. In that case, this article may be seen not only as a review of recent progress, but also as an invitation for further interaction between these fields.

Recommended Readings

1. Munton, J. (2021). Visual indeterminacy and the puzzle of the speckled hen. *Mind & Language*, *36*(5), 643–663.

An attempt to resolve an old philosophical puzzle by appeal to new empirical data.

2. Denison, R. N. (2017). Precision, not confidence, describes the uncertainty of perceptual experience. *Analytic Philosophy*, *58*(1), 58–70.

An exemplary engagement by a vision scientist with a novel problem in the philosophy of perception.

3. Morales, J. (2021). Introspection is signal detection. *The British Journal for the Philosophy of Science.*

A theoretical approach to understanding introspection by leveraging the Signal Detection Theory framework as applied in psychophysics.

4. Lande, K. J. (2018). The perspectival character of perception. *The Journal of Philosophy, 115*(4), 187–214.

An empirically-informed philosophical discussion of visual perspective.

5. Matthen, M., & Cohen, J. (2019). Many Molyneux Questions. *Australasian Journal of Philosophy*, 98(1), 47–63.

A call to reformulate Molyneux's Question in light of the empirical data collected on it.

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