Received: 4 March 2019 | Revised: 15 May 2019 | Accepted: 15 July 2019

DOI: 10.1111/mila.12296

SUBMITTED ARTICLE

WILEY

Visual indeterminacy and the puzzle of the speckled hen

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I identify three aspects to the puzzle of the speckled hen: A general puzzle, an epistemic puzzle, and a puzzle for the representationalist. These puzzles rely on an underlying "pictorialist" assumption, that we visually perceive general, determinable properties only in virtue of determinate properties or more specific, local features of our visual experience. This assumption is mistaken: Visual perception frequently starts from a position of uncertainty, and is routinely able to acquire information about general properties in the absence of more specific information. Acknowledging that visual indeterminacy is structured this way resolves all three puzzles of the speckled hen.

KEYWORDS

perceptual epistemology, pictorialism, representationalism, speckled hen, visual indeterminacy

1 | INTRODUCTION

Suppose you get a good look at a speckled hen, under optimal viewing conditions. You see the hen as speckled. Do you see the hen as having some more particular number of speckles? If quizzed, you could not say how many speckles it has. And yet, since you see the hen *as speckled*, you presumably have a visual experience of the speckles that made it so. This is the puzzle of the speckled hen: How is it that we can see the hen as speckled without seeing it as having some more determinate number of speckles? After all, the hen itself only comes to have the determinable property of being speckled in virtue of having the more determinate property of some particular number of speckles.

The puzzle of the speckled hen raises a series of broader questions about the nature of indeterminacy in visual perception: What constrains visual indeterminacy? What properties can we visually experience in the absence of other properties? Can we have a visual experience as of global, or general properties of a scene except via an experience as of the relevant local features?

I argue that the puzzle of the speckled hen arises from an implicit pictorialism in our thinking about visual perception. That grounds a supposed set of constraints on visual indeterminacy, namely, that we can have a visual experience as of higher-level, more general properties only in virtue of also having an experience as of lower-level, or local properties of a scene, just as a picture represents higher-level properties in virtue of the value of local areas of the image. On this model, visual perception is by default highly determinate, and our perception of more general features is an abstraction from that.

This paper argues that we should give up that implicit model in favor of its inverse: Visual perception frequently *starts from* uncertainty, and works toward increasing levels of determinacy in its representations, with fully determinate visual representations requiring substantial additional attentional resources. As a result, we routinely have a visual experience as of more general properties, such as the gist of a scene, or a rough impression of numerosity or size, without a corresponding experience as of the more determinate aspects from which they arise. Accepting this dissolves the puzzle of the speckled hen. It also has broader implications for the nature of visual perception.

The paper proceeds as follows. In Sections 2 and 3, I distinguish three related puzzles of the speckled hen: A general puzzle, an epistemological puzzle, and a puzzle for the representationalist. I show how the puzzle generalizes to encompass many features of our visual experience, and amounts to a broader question about the nature of indeterminacy in visual perception. In Sections 4 and 5, I show that the puzzle of the speckled hen presupposes pictorialist constraints on visual indeterminacy, and argue that we should reject them, in favor of a model on which we can visually perceive general properties directly, while specific elements remain indeterminate. This raises a further question: *How* can we experience general information in the absence of the specific? In Section 6, I draw on empirical work on how we perceive numerosity in particular, and the gist of a set or scene more generally, to answer that question and to bring out the ways in which these phenomena are inconsistent with the pictorialism that sustains the speckled hen. In Section 7, I consider the relationship between this puzzle and the debate over whether perception overflows consciousness. I conclude by showing how the approach I advocate dissolves the various problems of the speckled hen.

2 | THE PUZZLE OF THE SPECKLED HEN

The puzzle of the speckled hen first emerges in the philosophical literature in 1940, in Ayer's *Foundations of empirical knowledge* (Ayer, 1940).[1] Two years later, Roderick Chisholm offers a succinct description of the difficulty the case raises for sense data theorists. The problem, as Chisholm presents it, is for the theorist to explain how the sense datum with which a viewer is acquainted can have many speckles, without having some more specific number of speckles:

> The speckles are many in number, but it is not true that they are forty-eight in number, or forty-nine, or any other particular number. But this is very much like saying that victory will come in 1943, but not in January or February or any other particular month up to and including December. (Chisholm, 1942, p. 369)

[1]The problem was apparently suggested to him by Gilbert Ryle (Tye, 2009).

Just as Chisholm's presentation of the problem reflects the political context of the second world war within which he wrote, so the initial problem itself arises out of metaphysical commitments peculiar to perceptual epistemology in the earlier part of the 20th Century. Sense data theorists propose that the direct objects of perception are mind-dependent objects, sense data, that instantiate exactly those properties we perceive objects in the external world as having. A sense datum is perceived immediately and infallibly, but it is also an *object*, and hence cannot possess determinable properties except in virtue of instantiating determinate properties.

Sense data have largely fallen out of fashion in philosophy of perception. Yet the puzzle of the speckled hen lives on despite the death of the initial host. As Tye (2009) puts it "even once we eschew sense-data, we may find ourselves in sympathy with the thought, embraced by Ayer, that the visual experience undergone in seeing the speckled hen is indeterminate speckle-wise. How can this be?" (p. 259). He expands later upon the supposed mystery "... you see *all* the speckles on the facing side of the hen. If you see all the speckles, you see each particular speckle. How, then, can your visual experience be *indeterminate* with respect to the number of speckles?" (p. 259). Nanay (2009), in a recent response to Tye (2009) and Dretske (1993) describes the puzzle similarly, as "we can see a number of entities without seeing a determinate number of entities" (p. 499). This is what I shall call the *general* puzzle: The puzzle of how we can see an object as possessing an indeterminate number of speckles (or spots, or stripes, or windows, etc.) while not seeing it as having any particular number.

Pinning down the puzzle more precisely is part of the challenge the hen poses to philosophers. On one interpretation, the puzzle is rooted in our ability to *identify* the number of speckles on the hen, to see *that* it is speckled without seeing that it has 39 or 46 or 52 speckles. This grounds the puzzle in limitations on our ability to enumerate the speckles. On another substantive interpretation, the puzzle arises because our experience itself is equivocal as to the number of speckles on the hen. On this view, the puzzle could arise as readily for a child who cannot yet count at all and has limited number concepts as for a mathematician.[2] In what follows, my focus will be on the latter interpretation of the puzzle.

While originally and most obviously perplexing for the sense data theorist, the phenomenon of the speckled hen raises equal difficulties for the two dominant paradigms that have succeeded sense data: Direct realism and representationalism.[3] According to the former, visual experiences are constituted by the objects (and properties and relations) which feature in them (Campbell, 2002; Fish, 2009). This avoids the intermediaries that trouble the sense-data theorist, but it only displaces the puzzle of the speckled hen onto the nature of that constitution. If my experience of the speckled hen is constituted by the hen itself and the speckles upon it, what explains the indeterminacy of my experience of them? How are we to reconcile the supposed directness of our experience of the world with this limitation on its determinacy?

[2]Controversially, it might be somewhat different in the case of an individual who spent their days visually estimating quantities of speckles and so developed an expertise at doing so.

[3]A version of the puzzle also arises for adverbialist approaches which understand perceptual experience as a monadic property (such as being-appeared-to) that is modified depending on the nature of the subject's experience at a time (e.g., being-appeared-to redly) (Chisholm, 1957; Tye, 1984). The puzzle becomes that of understanding the limits on the adverbial modification of the perceptual property, and the relationship between more and less determinate modifications of it. How can a subject be appeared to in a speckled way, without that involving their being appeared to in some way that involves a precise number of speckles?

The representationalist might initially seem to be better placed to avoid these worries, since she treats our visual experience as a contentful mental representation of the external world, generated on the basis of incoming sensory signal.[4] But the puzzle remains as a puzzle about the *nature* of perceptual representation. *How* can I represent something as speckled without representing it as having some particular number of speckles? And behind that is a puzzle about the perceptual process: How can I come by this information about speckles in general without also possessing information about those individual speckles? If I do possess the latter, why is it not reflected in my experience of the hen? The puzzle is important in part because it forces us to consider the ways in which perceptual representation may be quite distinct from other kinds of pictorial or intentional representation. While endeavoring where possible to remain metaphysically neutral, I will adopt a broadly representationalist approach in what follows, in part because that meshes with the language of representation adopted by the empirical work described in the second half of the paper.

We should note two further forms the puzzle takes, one of which arises specifically in relation to representationalism. The representationalist is committed to the claim that the character of a visual experience, that is, the phenomenal feel of an experience, supervenes on, or is grounded in, its content.[5] Assuming that there is a difference in the phenomenal character of a visual experience of a hen with 48 speckles and the experience of a hen with 52 speckles, the question then arises: What is the difference in perceptual content to which that difference in character corresponds (Pautz, 2016; Schellenberg, 2016)?

Secondly, the puzzle of the speckled hen has been a particular topic of debate in perceptual epistemology, where it has been mobilized against internalist theories of immediate justification. The power of the puzzle against such theories flows from the way in which the viewer, while having a clear visual experience of the hen, does not intuitively have immediate justification for a belief that the hen has any particular number of speckles. Her visual experience takes in each of the speckles, since *ex hypothesi* she sees it under optimal conditions. The experience meets, therefore, many of the criteria proposed as standards for immediate justification by visual experience. Nonetheless, it seems intuitively wrong to say that the viewer has such justification.[6]

This kind of epistemic mobilization frequently relies on the assumption that the viewer has a visual experience that represents a determinate number of speckles, but which, for some reason or other, she cannot *access* adequately. That assumption lies behind the claim that there is some visual experience that apparently meets the desiderata for the capacity to immediately justify belief. The tension between that, and the subject's uncertainty over which belief about the speckles' numerosity is in fact justified, gives rise to the puzzle.[7]

[4]On this view, visual states have intentional content that admits of accuracy conditions: they can be true or false, and may represent non-existent objects. Their intentional content is of a kind that may be common to hallucinations and veridical experiences alike. See Tye (2010) and Siegel (2010).

[5]Representationalists vary in the precise relationship they posit between character and content. See Chalmers (2006) for discussion.

[6]This argument is made by Sosa (2003) against Fumerton (1995). For resistance, see Fumerton (2005), Fantl and Howell (2003), and Poston (2007).

[7]Poston (2007), Fantl and Howell (2003), and Pace (2010) all take the view that the puzzle arises because of limits on our access to or acquaintance with the number of speckles our experience determinately represents. They all suggest that some further criterion must be met, in addition to the subject simply having an experience of the hen, if that experience is to justify belief. Fantl and Howell (2003) attribute the lack of justification to a failure of introspective access to a determinate visual image (and ask "what is an indeterminate image anyway?" [p. 377]). Pace (2010) claims that an additional recognitional capacity is required for justification.

The puzzle of the speckled hen, then, comprises at least three related puzzles. The *general* puzzle concerns the question of how we can see the hen as speckled without seeing it as having a determinate number of speckles. Then there is the *representationalist* puzzle: When the number of speckles changes, what is the change of content that explains the change in the character or "look" of the visual experience? And finally, there is the *epistemic* puzzle: What is required for a subject to have justification for the belief that the hen has *x* speckles, in addition to simply having a visual experience as of a speckled hen?

3 | GENERALIZING THE PUZZLE

What is really at stake in the puzzle of the speckled hen? The puzzle is not in the least confined to our perception of hens or even farmyard animals at large, but afflicts almost every aspect of visual experience. We see forests, and angry mobs, and long trains, and street scenes without having a determinate experience of the trees or individuals or carriages or cars and houses that constitute them. If the speckled hen is genuinely puzzling, then visual perception is puzzling through and through. But this very general nature of the challenge compels us to reconsider its traditional articulation in terms of determinable and determinate properties.

Those terms were first coined by Johnson (1921) to pick out a relationship that holds between properties. On Johnson's account, determinable properties are superordinate categories such as being colored, or shaped, which are incapable of being subsumed in turn under some other category. A nested set of more determinate properties fall under each such category heading, which are more specific or narrower in scope than the relevant determinable property, but may still themselves be determinable, in so far as they admit of further precisification. Being colored is a determinable property, being red more determinate, and being some specific pantone of vermillion a plausible candidate for being a determinate property.[8]

Puzzling cases of the relevant sort extend well beyond what standardly falls within the strictures of the determinable/determinate relationship, however. We may experience street scenes, crowds, and forests in the absence of a determinate experience of the specific elements which constitute them. But those categories are very different to the superordinate categories of color or shape that feature in canonical discussions of the distinction (Prior, 1949; Searle, 1959). In these cases, the relevant relation seems better captured in terms of a contrast between global and local features of a scene. Being a street scene is a global property of the environment that emerges from the various local features that constitute it, but I may have a visual experience which represents a street scene, though it does not represent precisely the more particular elements that constitute it.

Despite these differences, the cases of interest to us *are* unified by exhibiting the property, supposedly distinctive of the determinable/determinate relation, of being non-conjunctively related (Rosenberg, 1995; Searle, 1959). As Rosenberg (1995) puts it, "[b]eing red is not being something *in addition* to being colored; being red is rather a way of being colored" (p. 210).

[8]One difficulty with trying to capture the puzzle in terms of a contrast between determinable and determinate properties is that many such properties are not appearance properties and so the puzzle cannot arise for them. A similar difficulty afflicts attempts to capture the determinable/determinate relationship in terms of grounding: An object manifests a determinable property *in virtue of* instantiating one of its more determinate properties, but not vice versa. This will not circumscribe the cases of interest since non-perceptible properties frequently ground perceptible ones. For instance, an object may appear brown in virtue of certain lower level molecular properties, but it is seldom thought puzzling that we can see it as brown without seeing it as possessing those latter properties.

Similarly, being a street scene is not being something *in addition* to having cars and houses arranged thus: Having cars and houses arranged thus is a way of being a street scene.

Another important commonality is that all of the "determinable" properties are *less specific* than the "determinate" properties, in the sense that there are many ways of manifesting the more general property, of which the determinate specification in hand is just one. More general properties fix less precisely how the world must be, whereas more specific properties narrow that down to a greater degree. In what follows, I shall refer to the relevant determinable, or higher-level, or global properties as "general" and the determinate, or lower-level, or local properties as "specific".

4 | PICTORIAL INDETERMINACY

The general puzzle, of how it is that we can experience one thing in the absence of another, is in essence a puzzle about indeterminacy in visual experience. It is rooted in a deeper underlying question about the nature of visual perception: What is the relationship between our experience of the general and our experience of the specific? Can the former be determinate while the latter is indeterminate, and vice versa?

Philosophers have tended to emphasize the richness and fineness of grain of visual experience rather than its indeterminacy. Fully capturing in words all the information conveyed by a brief period of visual experience is an impossible task: Our coarse-grained concepts and verbal resources struggle to do justice to its precision, richness, and variety. Visual experience often seems far more precise and determinate than our verbal or conceptual resources.

And yet the puzzle of the speckled hen arises because visual indeterminacy is widespread. The majority of the visual field, everything that falls outside the narrow focus of our attention, provides only low-resolution information (Block, 2015). Peripheral vision is limited in its acuity and contrast sensitivity. Subjects cannot identify objects when they are close together in the periphery of the visual field, a phenomenon known as crowding (Strasburger, Rentschler & Jüttner, 2011). Color detection too declines with eccentricity (Hansen, Pracejus & Gegenfutner, 2009). More generally, subjects frequently fail to notice change or detailed information outside the focus of their attention, driving claims that the apparent richness and precision of visual experience is really an illusion (Clark, 2002; Noë, 2002).

On the one hand, then, visual experience is distinguished by its precision and richness. On the other hand, indeterminacy and uncertainty are widespread. How are we to reconcile these two features of visual experience? What is the relationship between the high precision that is sometimes possible, and those indeterminate aspects? Do my experiences of determinable and determinate properties constrain one another, or are they unrelated? Could I have a visual experience that was highly precise in its rendering of detail but agnostic as to the general properties to which those details gave rise, or vice versa?

Kulvicki (2007) offers a partial answer to this question when he argues that perceptual contents are what he calls "vertically articulate", that is, "abstractions from the most determinate properties perceptual states represent are also represented by those states" (pp. 358–359). For instance, if a visual state represents an object as vermillion, it also represents it as red, and as colored, both of which are abstractions from that determinate property.

As Kulvicki himself observes, this result falls out of certain models of perceptual content. Fred Dretske's (1981) information theoretic account of content allows that perceptual states represent what they have the function of carrying information about. Information can be *nested*, in the

sense that one piece of information carries information about another. The temperature of a thermometer, for instance, carries information about the temperature of the thermometer's environment. As a result, a single signal may have the function of routinely carrying multiple pieces of nested information, in the manner of abstractions from determinate content.

We need to supplement Kulvicki's claim by asking what transpires in the opposite direction. Does visual experience of the abstract entail representation of the specific? If you have general information, do you get the specific "for free"? Is the only way to get general visual information via the specific?

Taken at face value, phenomena like the puzzle of the speckled hen reveal to us that it is routinely possible to visually experience determinable properties in the absence of the relevant determinate properties. Speckled hen cases are puzzling only if we expect to have visual experience of determinable properties via, or in virtue of, visual experience of determinate properties. Why should that be the case? There *are* certain contexts in which the instantiation of determinable properties relies on determinate properties. When it comes to objects in the real world, this is the order of priority. Objects instantiate general or determinable properties in virtue of instantiating more specific, determinate properties. An actual hen can have the property of being speckled only in virtue of having some lower-level property such as a determinate number of speckles, or at least some more particular patterning of pigment which gives rise to the impression of speckles. A train is a long train because it has some more specific number of carriages, which constitute its length. We can generalize to the following rule:

> **Object:** Determinable properties are instantiated in virtue of determinate properties.

As observed above, this rule grounds the puzzle of the speckled hen for sense data theorists: They posit mental objects which instantiate the properties in question. When it comes to certain forms of pictorial representation, similar restrictions apply. A clear photograph of a hen represents it as speckled in virtue of representing it as having some determinate number of speckles. Similarly, a photograph represents a hand in virtue of representing lower-level features, like fingers or skin. The higher-level, more general, property arises out of those more specific, local elements. Some photographs, at least, abide by the following rule:

> **Photograph:** Higher-level features (a hand, speckles) are represented in virtue of the representation of more specific, lower-level constituent elements (fingers, a particular number of speckles).

But as Ned Block has observed, not all pictorial representation need play by the rules that apply to photographs:

> [T]he photographic fallacy supposes that pictorial representations have to represent details of anything in view in the manner of a prototypical photograph. To see the fallacy, note that an impressionist painter might represent a hand in broad brush strokes that do not explicitly represent the number of fingers or whether one of them has a ring. (Block, 2015, p. 3).[9]

[9]Not even all photographs play by these rules. Photographs can be blurred or impressionistic in just the same manner as paintings, so that fingers may fail to be distinct in an image that nonetheless clearly represents a hand.

Though Block is surely right in his diagnosis, there are nonetheless particular rules that constrain the representation of higher-level properties in pictures more generally, though they are not so strict as those that apply to photographs. An impressionist painting of the hen could well capture a likeness of the hen that represented it as speckled without representing a determinate number of speckles. Nonetheless, it would be true of each point of the canvas that it was some determinate shade, and the representational properties of the picture as a whole would arise in virtue of its color at those constituent points. More generally, pictures represent in virtue of the local value of their surface. We could capture this constraint thus:

> **Picture:** Representation of general properties (including determinable properties) arises in virtue of the "pixelation" of constituent areas of the image.

Our conviction that there is something puzzling about our capacity to see an object as having a general property (that it is speckled, or largeish, or red), without seeing it as having an appropriate specific property (that it has 42 speckles, or is exactly *yay* high, or a particular shade of red) makes good sense if we think that visual perception must abide by *picture* (or *object*, or *photograph*). But what grounds that assumption? Only the further implicit assumption that perception involves an object or image that is presented to the mind, in the manner of a photograph or a painted picture.

In this way, the puzzle of the speckled hen reveals a latent pictorialism in our theorizing about visual experience. We can find this commitment articulated at points in the literature on the speckled hen, albeit inadvertently. It is contained in the common view that our visual experience in these cases must be more determinate, and contain more information than we are capable of accessing. Poston (2007), for instance, writes that if the subject "could print off (so to speak) her mental image, it would contain exactly 48 speckles" (p. 340). Talk of a visual image, an image that we could imagine *printing* no less, is both surprising and revealing. Why think that there is any such image before the mind? A similar commitment is implicit in the idea that justification by visual experience requires some ingredient in addition to the precise visual experience we are taken to have had but are unable to *access*, or the claim that the problem is to be explained by a mismatch between a fine-grained experience and coarse-grained cognitive or recognitional capacities. The view that there is a failure of access or recognition frequently implies an image to be accessed.

To free ourselves of the puzzle of the speckled hen, we need to give up the idea that visual experience always has a form we could print, "so-to-speak" or otherwise. That notion is what ensures the survival of the puzzle, because if an experience is fit for printing then it must abide by the rules that apply to pictorial representation. The puzzle of how it is that we see the hen as speckled without seeing it as having a determinate number of speckles dissolves if we give up any implicit pictorialist assumptions, because with them goes any reason to think that we can only visually perceive general, or determinable properties in virtue of more specific local or determinate properties.[10]

[10]See Stazicker (2018) for an argument against a related thesis which he terms "Determinacy", according to which "[i]f a determinable property *P* is visually present in good viewing conditions, a determination of *P* is visually present" (p. 109).

5 | IMPERFECT VISION

If we reject *picture*, what positive model of the relationship between the perception of general and specific properties should we put in its place? Many intentional states have a quite different representational structure to *picture*. When we believe, or imagine, or guess, or hope, we very often endorse general content without the relevant specific content: I can guess or suspect that it is raining without having a view on whether it is drizzling or pouring. Many of these intentional states are the result of a process of learning about the world. Thought of from that perspective, it is unsurprising that we can have more general information in the absence of more specific: More specific information frequently entails more general information but not vice versa.

An object in the world cannot have a determinable property except in virtue of having a determinate one. But when we *learn* about the world the priority tends to be reversed: Our estimates about determinate properties are constrained by our information about the determinable. If we are rational, our confidence that an object has a determinate property (a particular number of speckles) is capped by our confidence that it has the relevant determinable property (that it has speckles at all).

Perception is for the fallen. Omniscience renders it redundant: When you already know it all, you do not need to see it. For the rest of us, perception is a way of learning about the world. Perception *starts from* uncertainty. From that starting point, information about general properties is easier to acquire than information about more specific, determinate possibilities. We should expect, then, that we may frequently have a visual experience of general properties in the absence of the specific. On this approach, phenomenal features of our experience such as blur or indeterminacy are not the result of a *block* on access to a fully determinate visual image. Determinacy is an occasional achievement, not the norm against which perceptual indeterminacy must be explained.

This approach is further supported by a consideration of the ecological constraints under which the perceptual system is working. The visual system is overwhelmed with input: There is far more retinal stimulation available at any one moment than it could process at high resolution (Summerfield & Egner, 2009). High-precision visual processing requires focused attention: It is a costly activity. We only need such high precision in a small area of the visual field. We can operate successfully with a rough sketch of the rest of our environment. For the visual system to perceive everything at high resolution and then discard some information to leave behind a general impression of the environment would be the highest extravagance—far more efficient to generate a rough impression of the majority of the environment, and to invest further resources only on perceiving those areas of greatest interest.

We can build, then, on Kulvicki's notion of vertical articulation to a fuller picture of the structure of visual indeterminacy which does justice to the way in which visual experience starts from uncertainty and works toward increasingly determinate information about the environment. Vertical articulation tells us something important about very successful cases of visual experience, when we perceive highly determinate properties. It is *because* visual perception starts from uncertainty that when such highly specific information is won, it comes "stacked" on top of more general, easier to access information. If a visual experience of the hen represents it as having 89 speckles, then it represents it as speckled.

But most visual experiences are not so successful. They never make it to high levels of determinacy. In those cases, we can experience the general in the absence of the specific. The structure of visual indeterminacy is built around the fact that a visual perceptual state may present general or global features of a scene in the absence of more specific or local elements, those

elements in virtue of which an object or picture would possess the global or general properties in question. The hen may seem speckled without appearing to have some particular number of speckles; a person can appear to have a hand, without the determinate appearance of the fingers that constitute that hand.

Taken together, these features are incompatible with *picture*, or with pictorialism about visual perception. In particular, it is possible that we can have a visual experience of global features of a scene that need not be in virtue of a determinate visual experience of local parts of it. Our experience itself may be indeterminate when it comes to the local elements that give rise to those global properties.

6 | STATISTICAL SUMMARY REPRESENTATION: PERCEPTION OF THE GENERAL WITHOUT PERCEPTION OF THE SPECIFIC

It is one thing to observe that it is a routine feature of visual perception that we can see the general in the absence of the specific, and that this is to be expected given the nature of the task faced by the visual system. It is another to understand *how* we can perceive this general information without going via more specific elements of a scene. The puzzle of the speckled hen challenges us not just to diagnose a mistake in our thinking but ideally to explain what gave rise to that error in the first place, and to offer a way of unknotting the thinking that brought us there. We need to explain where this general information comes from, if not from abstracting from more specific information.

Suppose I read a book fairly rapidly, and afterwards find that I can recall only a general outline of the plot and characters, but have forgotten many of the details. In this case, I have that general information because I have first encountered, and then forgotten, more specific information. Visual perception can intuitively seem constrained to operate similarly, accessing and representing general information by abstracting from more specific. Attending to the mechanism of the eye can strengthen that intuition. It seems as though the retina must at least *register* information about the speckles in order for the visual system to arrive at a more general representation of speckledness. It is tempting to think of the retina as a kind of *canvas*, a fully determinate sensory intermediary akin to an image from which we abstract the relevant general information.

To unknot this line of reasoning, we need a positive account of *how* visual perception can generate an experience of a rough estimate of the number of speckles on the hen without going via some more determinate low-level representation. We can flesh out that positive account by drawing on recent empirical work on perception of numerosity and then gist more generally.

At its narrowest, the puzzle of the speckled hen concerns our perception of number: We see numerous speckles but we fail to see *how many* speckles the hen has. It is natural to think that we perceive numerosity in virtue of experiencing each of a collection of objects, and then extracting information from that about how many objects there are: By, in effect, counting representations of individual objects, or at least estimating their quantity. This fits with a broader model of perception on which we perceive non-specific properties in virtue of first perceiving specific features of a scene and inferring from or abstracting away from those details.

There is ample empirical evidence, however, that this is not how we go about perceiving number. Instead, we are capable of perceiving number *directly*, in the sense that numerosity is a primary visual property. We can visually experience the numerosity of a set independently of its

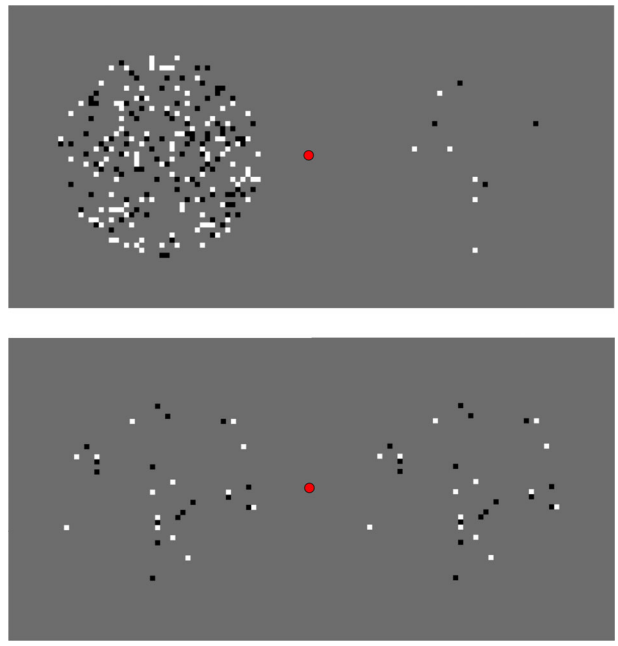

FIGURE 1 A demonstration of adaptation, reproduced from Burr and Ross (2008) by permission of Elsevier. After fixating on the red dot in the center of the upper image for 30 s or so, on fixating on the red dot in the center of the lower image, the group of dots on the right appears more numerous and that on the left less numerous (though they are in fact both the same size), demonstrating adaptation to the previous stimuli

other features. In particular, the visual system does not need to represent or count the individual members of the set to arrive at an impression of its numerosity.[11]

This is one upshot of empirical work by Burr and Ross (2008). Burr and Ross asked participants to judge how numerous a sample of dots appeared to be, after 30-s exposure to another set which was either more or less numerous than the target (Figure 1). How numerous the target set appears to be is altered by that previous exposure: The same sample seems more numerous after exposure to a less numerous set and vice versa. This effect was independent of texture or spatial frequency. This is an adaptation effect: previous exposure to a stimulus changes the sensitivity of the visual system, as when, after adapting to the downward movement of a waterfall, the unmoving environment around you appears to be moving upward. Adaptation to a visual property is often taken as an indicator that the property in question is a *primary* visual property, that is, perceived directly, and not in virtue of, or on the basis of inference from, other perceptual properties.[12]

[11]We are particularly concerned here with perception of sets of six or more, when we cannot immediately perceive (or "subitize") the number in question.

[12]Burr and Ross's result has been criticized by Durgin (2008) on the grounds that the adaptation effect is not to number per se, but rather just to texture density which, they claim, covaries with number in the relevant stimuli. That deflationary interpretation is hard to square with recent work by Cicchini, Anobile and Burr (2016). Cicchini asked participants to identify the odd one out amongst three sample sets of dots, which differed along the axis of either density, numerosity, or total area covered, without offering instructions along which axis to assess them. Participants displayed greater sensitivity to numerosity than to density or area when selecting the odd one out. When explicitly asked to discriminate stimuli on the basis of density or area in a subsequent task, they spontaneously responded based on numerosity. Cicchini et al. conclude that humans appear to be *more* sensitive to changes in numerosity than changes in density, suggesting that the first is independent of the second, and that we may extract visual information about number via dedicated mechanisms. But note that even if Durgin were right that this effect relies not on the direct perception of numerosity itself but on texture or density, that interpretation remains at odds with *picture*. The representation of number is arrived at via certain lower-level features, but not via the visual representation of individual circles, nor the pixellation of local areas of the image. For further evidence that numerosity and texture density are governed by separate mechanisms, see Anobile, Marco, Guido and David (2015).

Burr and Ross note the oddity that it feels as though the total number of dots is greatly reduced after exposure to a more numerous prime, without it feeling that any particular dot is missing. Nor does it seem accurate to say that there are extra circles that have been added to one's experience of the image after adaptation to the less numerous initial stimulus, and yet the set of circles appears more numerous. In effect, Burr and Ross's findings illustrate that we can "hack" our visual experience of numerosity *without changing anything* about the lower-level stimulus, and without altering the details of whatever lower-level representation of the dots we are enjoying. This is incompatible with *picture*: There needs to be no change in the lower-level "image" for the perception of number to change. One does not perceive numerosity by counting determinate aspects of a lower-level image. Instead, the visual system begins from a more general representation of the numerosity of the set, without first filling in the details of the circles that constitute it.

This feature of visual perception is not confined to number, but extends to almost every aspect of our experience. Empirical work attests that we can visually perceive properties of a set or scene (that it is a forested scene, for instance, or that a group of individuals are angry) independent of a precise experience of the elements in virtue of which the set or scene has the relevant properties (such as individual trees or angry faces). This phenomenon, sometimes termed "statistical summary representation" or "ensemble perception", extends to a surprisingly wide range of visual properties, including hue (Webster, Kay & Webster, 2014), size (Chong & Treisman, 2005), orientation (Dakin & Watt, 1997), motion direction and speed (Watamaniuk & Duchon, 1992), and even higher-level perception of social information from crowds, including facial expression (Haberman & Whitney, 2007) and gaze direction (Sweeny & Whitney, 2014). As Emily Ward and colleagues put it, "[t]he typical result from such experiments is that observers are impressively accurate at reporting the summary statistic, while also being generally terrible at reporting properties of any of the individual elements in the array" (Ward, Bear & Scholl, 2016, p. 79).

To better understand the relevant experimental paradigm, it is helpful to consider some of the seminal work in this area, on the perception of circle size among a set of circles. Daniel Ariely examined visual perception of sets of variously sized circles by asking participants to identify whether a single circle had been a member of a previously viewed set, and in addition asking them questions about properties of the set as a whole. Surprisingly, he found that participants were more accurate at identifying the mean size of the members of a set than they were at identifying whether particular individual circles had been a member of the relevant set; they seemed to have extracted information about the set as a whole *in the absence* of information about its individual members. Ariely (2001) poses a question not unlike the general puzzle of the speckled hen: "If the ... observers did not have accurate information about the individual items in the set, how is it that they had accurate information about the set?" (p. 160). The answer he suggests lies in "the way the visual system represents sets of items", that is, not as a composite of discrete constitutive parts, but as a set of so-called "summary statistics". By encoding the mean and range of the set, the visual system can generate a rough representation of it as a whole, but one that is too imprecise to determine whether an individual element was a member of it. Ariely (2001) concludes that "[t]he reduction of a set of similar items to a mean (or prototypical value), a range, and a few other important statistical properties may preserve just the information needed to navigate the real world, to form a stable global percept, and to identify candidate locations of interest" (p. 161).

This finding not only extends to a wide range of perceived properties, but is surprisingly stable across changes in the duration of exposure (from 50 to 2,000 ms), further suggesting that it

does not rely on the visual system collecting pieces of information in serial before arriving at the relevant summary, an activity which one would expect to be performed less successfully at shorter durations. It is also minimally affected by the nature of the distribution: Observers are able to identify the mean of the set regardless of whether the distribution was bivalent, homogeneous, or asymmetric, suggesting that the effect cannot be explained by the subject just encoding a few individuals at the extremes of the distribution (Haberman & Whitney, 2009).

Moreover, a very similar process seems to allow for the perception of the gist of a scene, even when there is no relevant *set* as such. The visual system can capitalize on structural regularities in the reflectance properties of the natural environment to produce a rough representation of the background of a scene. Whether a scene is a beach scene, or a street scene or a mountain scene can be reliably estimated using coarsely localized information about certain perceptual dimensions such as openness or ruggedness (Alvarez & Oliva, 2009; Torralba & Oliva, 2003). This gives us a handle on *how* the visual system can derive representations of higher-level properties directly, without going via more specific representations of the constituent elements that make up the scenes in question: It can do so just on the basis of low-frequency information about the patterning of light, for instance.

There is good ecological reason for our wide reliance on statistical summary representation: It draws only minimally on the limited resource of visual attention, making it a highly efficient way of gathering information. Such representations can be extracted from multiple sets simultaneously, which would not be possible if they required high levels of focused attention (Chong & Treisman, 2005). While we can only attend to and perceive with precision a few objects at a time, we can rely on this process to provide coarse-grained information about the scene as a whole (Alvarez & Oliva, 2009; Haberman & Whitney, 2009).[13]

This body of work supplies a sketch of the mechanism by which we can have a visual experience of general properties in the absence of more specific ones: The visual system can extract summary information from retinal light signals without having to transduce every piece of information to the level of visual experience. The retina is functioning more like a sampling net than a canvas in these cases. The summary statistics that are the result of this process narrow down the possible range of distal stimuli, but they fail to deliver a fully determinate representation of the environment. Hence, environmental changes that are consistent with that same summary statistic are less likely to be noticed than changes which are inconsistent with it (Alvarez & Oliva, 2009): They require no change to the content of the experience in question.

One question this gives rise to is: What is it *like* to have a visual experience whose content is constituted by a statistical summary? The most obvious answer is: Like much of your present visual experience outside of the focus of your attention. But for our current purposes, we can say something else too: *It is not like anything you can paint*. That is because, in contrast with *picture*, the experience of properties is arrived at directly, not on the basis of lower-level representations, or the pixilation of constituent areas of an image. Recall that the observer may be insensitive to changes in the scene that are consistent with the same summary statistic. At some level, their percept is indeterminate: It is consistent with the world being a number of different ways, each of which would give rise to the same summary statistic. The possibility that the underlying scene can change without any change in the subject's visual experience of it, is incompatible with the claim that visual experience has the localized determinacy of a canvas. Statistical summary representation points us away from understanding visual perception as a

[13]That said, the process is less efficient when performed in parallel, suggesting it makes at least some demands on attention (Jackson-Nielsen, Cohen & Pitts, 2017).

process of generating an image of the world from which we then read off information, and toward an understanding of it as the process of extracting low-resolution information directly from the environment.

7 | INDETERMINACY OR A LIMIT ON ACCESS?

I have argued that the literature on ensemble perception supports the claim that we can frequently have a visual experience as of determinable properties of a scene or set or object, in the absence of a visual experience as of more determinate, local features, and that this is at odds with *picture*. One natural line of resistance to this claim is that in many of these cases of apparent ensemble perception, and in the case of the speckled hen itself, we are inclined to describe a feeling that we see more than we can report: That we did see all of the speckles, we just cannot say how many there are (perhaps because we simply have not had time to count them). We can build from that aspect of visual phenomenology to an alternative interpretation of the literature on statistical summary representation, and the account of visual indeterminacy I seek to rest upon it: Our experience goes beyond what we can access; we cannot therefore map its determinacy by subjective report, or performance on the kinds of tasks that empirical work on ensemble perception relies on. We should not confuse our limited access with the underlying structure of visual uncertainty. This response can be honed to answer the epistemic puzzle too: Simple seeing is not on its own sufficient for justification. One needs to not just see the speckles, in the sense of having a visual experience of them, but to see *that* the hen is speckled to some or other degree. Seeing *that* may require additional access or recognitional capacities in addition to simply *having* a visual experience.

The literature concerning the question of whether visual perception "overflows" access is already very extensive. Block (2007, 2011) argues that conscious visual states can exceed the cognitive capacity we have to access or report them. He does so on the basis of a range of experimental evidence, including Sperling's (1960) influential paradigm in which subjects, unable to report a four by three grid of letters in its entirety, can nonetheless report much of any single postcued row from the grid (Figure 2). Block argues that a subject sees all of the letters, but faces a bottleneck when it comes to accessing and reporting the experience, rendering them capable of only recalling a more limited portion of the grid. In response, Phillips (2011) has argued that this style of experimental result could be due not to the perceiver *seeing more* than they can access, but rather to a postdictive change *in the perceptual experience* occasioned by the cue.

The prospect that perceptual experience might routinely overflow cognitive access would undercut the argument that visual experience starts from uncertainty, instead implying that it

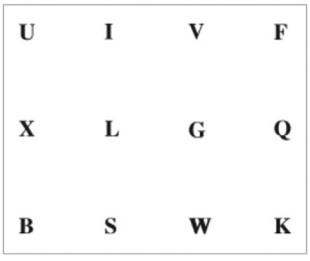

FIGURE 2 A grid similar to those used in Sperling (1960), reproduced from Phillips (2011), by permission of Wiley. Subjects see the grid for between 15 and 500 ms, and are consequently unable to recall more than four or five letters in the grid, while reporting that they did not see any of them. But when prompted to recall one or other row by a particular tone (high, middle or low), subjects are able to recall about three letters from any given row

is merely cognitive access to that experience which does so, while the basic currency of visual perception could be highly determinate iconic representations.

Should we think that ensemble perception, too, relies on intermediate iconic perceptual representations from which the statistical information is extracted (Quilty-Dunn, forthcoming)? What do we gain by positing such intermediaries? One possible gain is that it could explain how the task can be completed on the basis of very brief exposure: An iconic representation could persist in working memory, extending the period of time during which the statistical computation could take place. But we can allow that information about the various items in the set is transduced *to some degree* and briefly retained while resisting the claim that the process relies on an intermediate iconic visual *representation*. And there is good reason to doubt that the process of extracting ensemble information must rely on such intermediaries: In some cases, "ensemble representations can even be formed for stimuli that observers cannot see in the first place—as when simultanagnosic observers can accurately report average values despite only seeing one object at a time (Demeyere, Rzeskiewicz, Humphreys & Humphreys, 2008), or when neglect patients include elements from the neglected visual field in their computations of statistical properties (Pavlovskaya, Soroker, Bonneh & Hochstein, 2015)" (Ward et al., 2016, p. 80).

Of course, it is open to the overflow theorist to deploy their strategy again at this level, and claim that in these unusual cases too the subject *is* phenomenally conscious of the missing stimuli but cannot access that experience. So it is important to note that the possibility that speckled hen cases could be construed as just another frontier in the debate around overflow itself threatens to undermine the motivation for positing inaccessible visual experience more generally. Several authors have made the point that some of the evidence that Block and others construe as support for the claim that perception overflows access could equally well be interpreted as evidence of a generic, indeterminate aspect to much of perception outside of the visual field (Cohen & Dennett, 2011; Fink, 2015; Grush, 2007; Stazicker, 2011). For instance, the literature on gist allows us to validate subjects' reported sense that they "saw" all of the letters: They saw a statistical summary of those unattended features, less precise than they might imagine but precise enough to account for that phenomenology.

Similar points have been made in the debate between empirical researchers on this topic. Bronfman, Noam, Hilla, and Marius (2014) showed subjects Sperling-style grids of colored letters for 300 ms., and investigated whether they could accurately report "color diversity", that is, how wide a portion of the color wheel the colors of the letters fell within. They found that subjects could accurately report the color diversity of a group of letters outside the focus of their attention, and took this to support the claim that we can see more than we can report, their reasoning being that subjects could only report that diversity if they were consciously seeing the individual elements that composed it (an interpretation endorsed by Block, 2014).

Ward et al. (2016) push back on that interpretation. They argue that reports of color diversity in the absence of reports of individual colors could be supported just by the perception of a summary statistic for that feature. Moreover, they offer further evidence for that interpretation: Subjects continued to be able to accurately report the color diversity of unattended stimuli *even as they failed to notice that every element in the relevant display changed color*, when that change was consistent with the same summary statistic, that is, the color diversity fell within the same region of the color wheel (Figure 3). They conclude that "it may be possible to experience ensemble properties without necessarily experiencing the individual elements and features that make up those ensembles" (Ward et al., 2016, p. 84).

I have no intention of attempting to adjudicate the extensive overflow debate within the scope of this paper. Moreover, while that debate certainly bears on the nature of perceptual

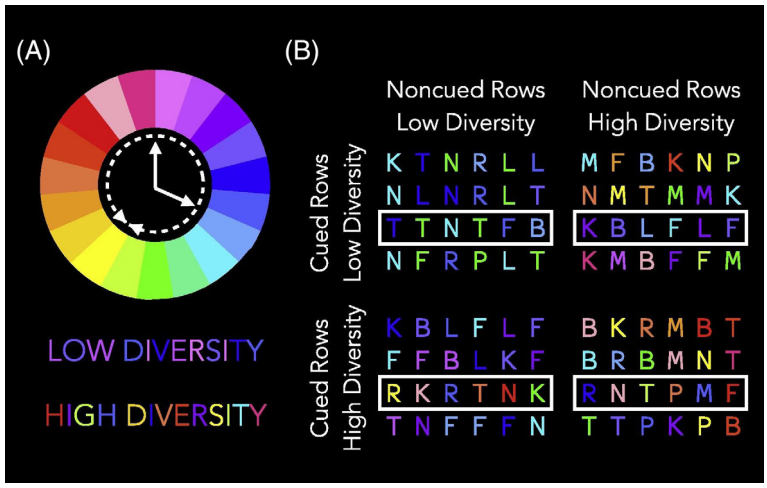

FIGURE 3 Ward et al. (2016), following Bronfman et al. (2014), showed subjects grids of letters whose colors spanned either the whole color wheel of 19 possible colors, or a subset of six colors. Subjects were able to accurately judge color diversity whilst being unable to report the colors of individual elements in the array. Subjects also failed to notice when the color of every element in the display changed, despite their ability to accurately report the color diversity of the array as a whole. Reproduced from Ward et al. (2016) by permission of Elsevier [Color figure can be viewed at wileyonlinelibrary.com]

indeterminacy, the aims of this paper do not map on to its resolution. Denying *picture* is consistent with their being occasions on which perceptual consciousness overflows access. What the literature on statistical summary perception does is to at least undermine our motivation for thinking that it *must* do so, that we can *always* locate a fully determinate experience. Much of what we see outside the focus of attention can be accounted for in terms of lower-resolution, statistical summary representations. Equally, while there may be cases when perceptual representation draws on iconic intermediaries, we should not assume that that *must* be the case, and we should be circumspect of the assumption that positing such intermediaries buys us substantial theoretical gain.

Can we say more in response to assuage the phenomenological argument that it *feels* as though one sees more? We can at least acknowledge that whenever you direct your visual attention at something, you *do* see it in high definition. This supports the feeling that the entire of one's visual field is presented in high definition: whenever one attends to it, it is! It is hard to "catch" the indeterminacy of our visual experience, just like it is hard to see that the refrigerator light is off when the door is closed. Whenever we are looking, the phenomenon in question changes (Noë, 2002).

The phenomenological argument for determinacy sometimes appeals to our perception of pictures to further support the claim that our visual experience is highly determinate. A detailed picture of a forest, for instance, seems to replicate my visual experience of the forest. It is natural to think that, since the picture is highly determinate throughout, my visual field must be too, though I may not always be "oriented toward" that high definition, just as I may not always be turned toward an area of a painting.[14]

[14]Fred Dretske's "Goldilock Test" is an instance of this methodology, proposed as a way of determining what contents are genuinely *perceptual*, part of the sensory core, and what are the accretions of further cognitive processes on top of

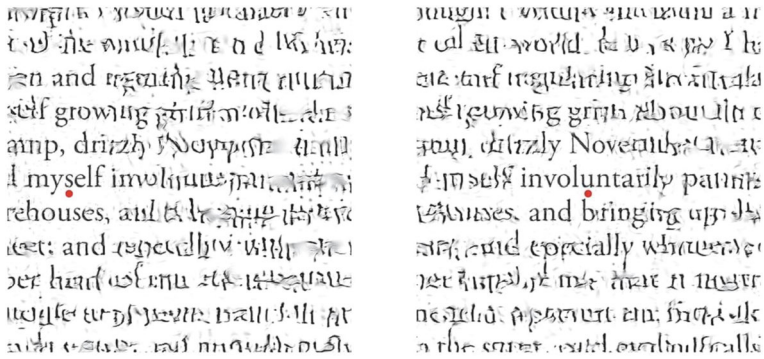

FIGURE 4 A sample pair of "metamers", images which are physically different but which a subject cannot distinguish when their gaze is held fixed on the small red dot in each. Reproduced from Freeman and Simoncelli (2011) by permission of Springer Nature [Color figure can be viewed at wileyonlinelibrary.com]

There are two difficulties with this picture-based argument. The first problem is that despite the superficial impression that a uniformly high definition picture matches our experience, we know that if subjects hold their gaze fixed, they cannot distinguish a regular picture of text or an everyday object or scene from one that is distorted at the periphery of their visual field, (Figure 4; Freeman & Simoncelli, 2011).[15] Only when we focus our gaze on the edge of the image can we detect the difference between them. Our inability to distinguish between these pictures when we hold our gaze fixed, despite their variation at the periphery, undermines the claim that our peripheral experience is highly determinate: We cannot discriminate on its basis between multiple ways the world may be.

This gives rise to the more serious, second problem with the argument. Can we learn about the nature of our visual experience by comparing it with pictures in the world? Only to a very limited degree, because we when we do so we are not in a position to compare the visual experience with the image directly, but only with *our visual experience* of the image. And our visual experience of the picture will inherit whatever limits on determinacy afflict our experience at large, as the case above shows.

8 | (DIS)SOLVING PUZZLES

Let us return to the three puzzles as described at the start of the paper. The first puzzle was the general one of how it is that we see the hen as speckled without seeing it as having a determinate number of speckles. We have not solved this puzzle so much as dissolved it, by drawing attention to, and undermining, the assumption on which it rests, namely, that visual perception has a particular structure of indeterminacy, that we perceive the determinable in virtue of the determinate, in the manner of *picture*. If we give up *picture*, and allow that visual perception is in the business of *gathering information* from the world, then there is nothing puzzling about the hen: It is to be expected that we can see the hen as having some rough number of speckles but no particular number. We can visually experience the former without the latter.

that. According to Dretske (2015), the genuinely *perceptual* content of a subject's visual experience of a tree should "become apparent in their pictorial representations of the tree", in the sense that there should be a difference in which painted representation of their experience they judge accurately captures its content (p. 165).

[15]For fuller explication and discussion of these cases see Block (2013).

What about the epistemic puzzle? Why does one's experience of the speckled hen fail to provide justification for the belief that it has some particular number of speckles? What is required for it to do so (in addition to good viewing conditions, reasonable visual hardware, etc.)? Previous approaches to the problem have tried to specify some condition of access or recognition to the supposedly determinate experience. If we allow that visual experience builds from indeterminacy toward determinacy, then we can allow that our visual justification is directly circumscribed by the specificity of the experience itself. A quick glance at a speckled hen justifies a belief that it is speckled to some rough degree, but fails to justify a belief that it has any particular number of speckles, because that is the content of the experience. This approach can mesh with other solutions to this puzzle. Tye (2009), for instance, argues that we need to *attend* to the property in question to have justification for beliefs concerning it. The account here agrees that attending in that way may have the effect in question. Attending boosts the determinacy of the ensuing visual experience. Equally, determinacy may be a precondition on seeing *that* the hen has a given number of speckles. Nonetheless, the true limiting factor on justification is not lack of attention but the resulting impact of that on the determinacy of the visual representation of the hen.

This leaves us with the representationalist puzzle: When the number of speckles changes, what is the change in content which corresponds to the change in the phenomenal character of one's experience? How are we to capture the change in the feel of the experience, if its content does not include some determinate number of speckles?

Summary scene statistics give us novel resources for understanding the relationship between our perception of general and specific elements of a scene: Our perception of general properties is akin to a mean or mode. The mean or mode of a set is determined by its members, but we cannot read off anything about those elements individually just from these composite statistics. Similarly, our experience of general properties is determined by the specific elements which make up the scene, but we cannot read off information about those individual elements from our experience of the general. Take circle size as an example. A statistical summary representation of a set of circles contains information about the mean circle size and variance, and possibly the shape of the distribution (Gaussian or otherwise), but it does not retain information about the individual members of the set.

One way in which the general and the particular relate, then, is that from the general information the visual experience encodes, we could arrive at the likelihood that a circle of a given, determinate size is a member of the set. Probable information about the particular simply *falls out* of the generic representation, just as one can plot a distribution over individual points in a hypothesis space on the basis of information about mean, variance, and distribution. Visual experience of gist or determinable properties contains some residual uncertainty: It fails to narrow down the space of possibilities to just one. There are many sets of circles that are compatible with a given summary statistic, and many ways the world could be that are consistent with a visual experience of gist. And yet, the particular items in the set still constrain the summary representation.

With this in hand, we can return to the question of how the content of the experience changes when the underlying number of speckles on the hen changes. There are a variety of ways in which the number of underlying dots will alter the summary statistic without requiring that the resulting representation be fully determinate. We can think of the perception of numerosity in the hen case as capturing a distribution over possible numbers of speckles. Adding or subtracting dots might shift the distribution right or left, or could change the shape of the distribution. Such a shift can equally be achieved without a change to the low-level

stimulus, as a result of features of the visual system itself. This is what happens in the work by Burr and Ross described above: Adaptation to the more numerous stimulus shifts the summary statistic within the hypothesis space, to rest over less numerous hypotheses, even though nothing has changed in the underlying stimulus. The vulnerability of the visual system to that sort of hacking reveals how perception of higher-level, determinable properties can come apart from the perception of lower-level, determinate, or local properties, in a manner inconsistent with *picture*.

9 | CONCLUSION

The puzzle of the speckled hen unwittingly reveals our tendency to think of visual experience in pictorialist terms. Features of our experience that betray the absence of any internal image are consequently puzzling. Giving up an implicit commitment to *picture* frees us from the puzzles of the speckled hen. It also positions us to appreciate the ways in which visual indeterminacy is at odds with pictorial representation: We can see determinable properties without seeing the determinate or local properties they would seem to depend upon. Visual perception is more like a smash-and-grab than a picture gallery: You take what information you can get, and the more determinate the information the harder it is to acquire. Work on statistical summary representation both reinforces the case that visual perception routinely has this structure, and shows us *how* it can be the case that we can see the general in the absence of the specific: The visual system can extract statistical information from the specific without transducing information about individual elements to a stage at which they determinately feature in the resulting experience.

The puzzle of the speckled hen returns us to a perennial theme in the philosophy of perception: Despite the frequent emphasis on the immediacy of visual perception, we struggle to theorize about it in a way that successfully allows that we can directly *see* the external world, rather than an intermediate representation of it. On the one hand, the approach I propose to the puzzle of the speckled hen and phenomena of its ilk can seem to demote perception, by insisting that there is less to the perceptual experience of a speckled hen, or one's environment at large, than it is sometimes natural to posit—you do not see all the speckles, but just summary properties of the set they comprise. And yet this approach also reintroduces a greater directness to our visual experience: It is the world from which we read information, not some internal canvas which perfectly reproduces it, while remaining only imperfectly accessible to us.

ACKNOWLEDGEMENTS

For feedback on earlier versions of this paper I am indebted to an anonymous referee, as well as to Daniel Greco, Jason Stanley, Bernhard Salow, Rob Hopkins and audiences at NYU, Cambridge, Glasgow, Yale and a workshop on probability and perception at Berkeley, organised by Susanna Siegel.

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How to cite this article: Munton J. Visual indeterminacy and the puzzle of the speckled hen. *Mind & Language*. 2020;1–21. https://doi.org/10.1111/mila.12296