Multisensory Evidence

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It is tempting to think that one's perceptual evidence comprises just what issues from perceiving with each of the respective sensory modalities. However, empirical, rational, and phenomenological considerations show that one's perceptual evidence can outstrip what one possesses due to perceiving with each separate sense. Some novel perceptual evidence stems from the coordinated use of multiple senses. This paper argues that some perceptual evidence in this respect is distinctively multisensory.

1. Perceptual evidence

Sense perception is a source of evidence. By using one's senses, one comes to possess evidence about oneself and one's surroundings. Thus, by seeing, hearing, touching, tasting, and smelling, one can add to one's body of evidence. Suppose perceptual evidence is evidence a subject possesses just thanks to an episode of sense perception. This paper addresses an underexplored question about perceptual evidence. The question concerns which evidence typical human perceivers possess thanks to sense perception. This turns on a question about the sources of perceptual evidence. It aims to be neutral among competing accounts of the ontology and the possession of evidence.

The simple starting point is that specific senses, such as vision and touch, are sources of evidence. But, most times, a subject perceives with more than one sense. Does all of a subject's perceptual evidence stem from perceiving with one specific sense or another, or does some perceptual evidence require using multiple senses? Put another way, is one's perceptual evidence exhausted by the evidence one possesses due to perceiving with each sense, respectively, or does perceiving jointly with several senses provide distinctive perceptual evidence?

According to one answer, a subject's perceptual evidence comprises just what stems from perceiving with each of the individual senses. All perceptual evidence is evidence one comes to possess by seeing, hearing, touching, tasting, or smelling. This is a unisensory view of perceptual evidence.

According to another answer, a subject's perceptual evidence instead outstrips what stems from perceiving with each of the individual senses. Some perceptual evidence is evidence one comes to possess by means of the coordinated use of several senses. For instance, some of one's perceptual evidence may rely on jointly seeing and touching, hearing and seeing, or tasting and smelling. This is a multisensory view of perceptual evidence. This paper argues that some of one's perceptual evidence is distinctively multisensory, in that having it relies on the joint use of multiple senses. Thus, it embraces a multisensory view of perceptual evidence.

2. Unisensory evidence

Concerning the sources of one's perceptual evidence, it is natural to look to the senses. Perception occurs in several sensory modalities. Typical human subjects see, hear, touch, taste, and smell their surroundings. Here, set aside questions about which and how many senses we possess. Plausibly, all human perception occurs using one or another sensory modality. Thus, whatever perceptual evidence a subject possesses plausibly stems from perception in one or another sensory modality.

Each sense is a distinct source of perceptual evidence. First, each way of perceiving offers evidence. Seeing the stain, I get evidence coffee spilt. Hearing sounds of voices, I have evidence people are talking. Touching a hot stove provides evidence it is on. Tasting milk gives evidence it is fresh. Smelling smoke, I gain evidence the toast is burnt.

The main reason to treat senses as numerically distinct sources of evidence is that each sense can provide evidence in absence of another. One could put on a blindfold, wear ear plugs, get local anesthesia, shut one's mouth, or pinch one's nose. And one could do all but one (or two or three) of these. For some subjects, lacking the capacity to perceive with one or more senses is original or permanent. So, the senses decouple. Their use doubly dissociates. It is possible in principle to perceive with one sense at a time.

In addition, each sense conveys evidence in a distinctive manner, both causally and subjectively. Perceiving visually relies on information transmitted through light, transduced by photoreceptors. By contrast, perceiving tactually requires contact and relies on transduction by mechanoreceptors and thermoreceptors in the skin. Subjectively, seeing presents one with extended objects at a distance bound up with shapes, colors, and movement. Touching reveals surfaces of objects contacting one's body bound

up with shape, size, texture, and temperature. While both vision and touch provide perceptual evidence concerning figure, size, and motion, each conveys that evidence in distinct ways.

Moreover, the senses are qualitatively distinct sources of perceptual evidence. For one thing, each human sense offers differing evidence. A respect in which senses offer differing evidence is that each reveals a distinctive range of features. Seeing reveals individual objects, surfaces, colors, light, shapes, and motion. Hearing presents one with sounds, pitches, timbres, loudness, locations, and durations. Touch conveys surfaces, textures, and temperature. Smell and gustation offer evidence about the attractive, repellent, nutritive, and harmful features of things in the form of their odors and tastes.

As a result, the value of evidence from two senses can differ. Consider Austin's passage about the pig.

> The situation in which I would properly be said to have *evidence* for the statement that some animal is a pig is that, for example, in which the beast itself is not actually on view, but I can see plenty of pig-like marks on the ground outside its retreat. If I find a few buckets of pig-food, that's a bit more evidence, and the noises and the smell may provide better evidence still. But if the animal then emerges and stands there plainly in view, there is no longer any question of collecting *evidence*; its coming into view doesn't provide me with more evidence that it's a pig, I can now just *see* that it is, the question is settled. (Austin 1962, 115)

It is not necessary to deny that seeing a pig provides evidence of a pig—visible shapes, colors, and movements (Byrne 2014, 102–3). The point is that seeing and hearing differ in the extent to which they offer support for the claim that the animal is a pig. Thus, senses can differ in evidential value.

One reason is that two senses can provide different quantities of evidence. Vision may offer more bits of relevant evidence than hearing. Seeing the shape, size, coloration, and movement of an animal yields more evidence that it is a pig than just hearing snuffling.

A second reason is that the quality of evidence from two senses can differ. One piece of evidence can be better evidence for a claim than another. A piggish appearance may bear more weight than snuffling sounds in supporting the hypothesis that some animal is a pig. For instance, it may make that more likely.

Even the same sort of evidence in another respect can be better evidence when it comes from one sense than when it comes from another. Suppose you hear a sound to your left and see snout movements on your left. Audible and visible direction each support the claim that the pig on the left snuffled, rather than the pig on the right. However, audition is less reliable than vision concerning direction. It is a lower quality source of evidence. In this respect, it provides lower quality evidence.

So, one's perceptual evidence stems from the senses, and each sense is a distinct source of perceptual evidence.

This suggests two plausible theses about the evidence of our senses. The first is that our senses provide independent perceptual evidence. By this I mean that which perceptual evidence a subject has by perceiving with one sense does not rely on what that subject perceives by means of another sense. Thus, perceiving with one sense does not affect which evidence perceiving with another provides. Austin's seeing the pig leaves intact which evidence hearing provides.

The second is that our senses provide complete perceptual evidence. By this I mean that which perceptual evidence a subject has by perceiving with multiple senses is just the sum of the evidence that subject has by perceiving with each of the distinct senses. Thus, perceiving at once with two senses provides no more perceptual evidence than perceiving respectively with each of those two senses. When Austin sees and hears the pig, he has only the evidence he has from seeing the pig and from hearing the pig.

Embracing independence and completeness yields a unisensory view of perceptual evidence. Denying that perceptual evidence is both independent and complete entails that having some perceptual evidence relies on the joint use of several senses. This is a multisensory view of perceptual evidence.

Put this way, a unisensory view of perceptual evidence may seem easy to refute. In a unisensory view, one's perceptual evidence is the sum of the evidence each sense conveys, where the evidence each sense conveys does not depend on another sense. So, if Austin adjusts his belief that some animal is a pig to fit the sights and to fit the sounds, he has done what his perceptual evidence calls for. But, this might not sound right. Austin's pig beliefs also must answer to joint evidence from sights and sounds.

What is the problem? Suppose one sees a collision then hears a sound. In that case, one has evidence that the collision causes the sound. If one sees moving lips while hearing a sound, one has evidence a single utterance occurs. In each case, the evidence stems from perception. But, it appears to outstrip what each sense provides on its own. If so, independence or completeness fails.

It is not so easy to establish that there is distinctively multisensory perceptual evidence. Each of these scenarios is compatible with a unisensory view of perceptual evidence.

First, according to a unisensory view, a subject's perceptual evidence comprises just that which stems in the first instance from perceiving with each individual sense. This body of evidence is not limited to what stems from any single sense, such as vision alone. It includes whatever stems from perceiving with several senses, at once or during an interval. Fixing the evidence of each individual sense thus suffices to fix a subject's perceptual evidence. One's perceptual evidence is a fusion of evidence from each distinct sense.

Next, distinguish one's perceptual evidence from what it is evidence for. The former is evidence one has due to sense perception, and the latter is that on which one's evidence bears, such as a claim or hypothesis. Evidence from seeing and hearing together can be evidence for a causal claim. But, having perceptual evidence for a causal claim does not require more than what seeing and hearing each provide. In particular, it does not require having causality as part of one's perceptual evidence. That is something more. According to a unisensory view of perceptual evidence, having causality among one's evidence may rely on inference, association, abstraction, extrapolation, conceptualization, or another extra-perceptual maneuver.

If our senses provide independent and complete perceptual evidence, one's perceptual evidence is exhausted by that which stems from each of the several distinct senses. This describes a unisensory account in which all of one's perceptual evidence stems from one or another specific sense. The unisensory view is a default model of the structure of perceptual evidence.[1]

3. Interaction

One argument against a unisensory view of perceptual evidence is that causal interactions between senses challenge independence. Sensory interactions demonstrate that which evidence a subject has due to

perceiving with one sense can depend causally on another sense. However, this argument has an important limitation. While patterns of crossmodal dependence have epistemic significance, mere causal influence does not compel one to abandon a unisensory view of perceptual evidence.

A crossmodal perceptual illusion occurs when stimulation to one sense generates a perceptual illusion associated with another sense. For example, effective ventriloquism involves an auditory spatial illusion triggered by seeing an event that is not the true source of the sound one hears. A second example, the McGurk effect, occurs when visible mouth movements reshape the auditory appearance of spoken language, yielding a phonological illusion. A third example, the sound-induced flash, is an illusory appearance as of two flashes that occurs when two audible beeps are presented with a single flash. It is a visual numerosity illusion caused by sounds.

Crossmodal illusions show that one sensory system can alter perceptual experiences associated with another sense. They stem from interactions between sensory systems, rather than just extraperceptual cognition. For instance, in the sound-induced flash, auditory processes impact visual processes as early as V1, the primary visual cortex (Watkins et al. 2006). Moreover, using transcranial magnetic stimulation to disrupt brain areas that mediate interactions between senses can disrupt crossmodal illusions while preserving perception in each sense (Beauchamp et al. 2010). Meyerhoff and Scholl (2018) show through a series of psychophysical studies that illusory visual causal crescents induced by coinciding sounds reflect a perceptual process rather than decisions or task effects.

It is reasonable to conclude that one sense can impact which perceptual evidence another sense provides. For instance, vision alters which evidence hearing provides. In particular, perceiving visually can affect one's auditory evidence concerning location and phonology, as compared to listening without looking. So, one's auditory evidence need not be wholly independent from one's visual evidence. Therefore, which perceptual evidence each sense provides need not be wholly independent from the other senses.

What is the epistemic significance of a crossmodal interaction? Altering perceptual evidence can change which beliefs one's evidence supports. Beyond that, however, it is not clear crossmodal interactions matter much. One more occasional illusion does not exactly reconfigure the epistemic landscape. A first

reason is that, apart from the isolated bad cases, a crossmodal causal influence need not affect the quantity or the quality of evidence a sense generally provides. Thus, in general, crossmodal interactions need not impact the evidential value of a given sense. A further reason is that a case of causal dependence does not show that having perceptual evidence from one sense depends constitutively on another sense. Thus, it does not guarantee distinctively multisensory perceptual evidence. Crossmodal illusions therefore do not require abandoning a unisensory view of perceptual evidence.

In what follows, I want to counter the first of these reasons. Crossmodal interactions do impact the evidential value of our senses. However, the second reason holds up, and it conveys a genuine limitation. Thus, crossmodal illusions are compatible with a unisensory view of perceptual evidence.

Start with the first. The interactions between senses that generate crossmodal illusions are not accidental or merely causal. Instead, they are part of perceptual functioning. Just as visual illusions offer insight into how vision works, crossmodal illusions reveal principles of multisensory organization for perception involving several senses. In particular, they disclose perceptual strategies for dealing with noisy, fallible information from several sensory systems.

Two principles are especially relevant. The first concerns conflict resolution. Crossmodal illusions stem from processes that tend to reduce conflicts between senses. When two senses otherwise would disagree about a common item or feature, crossmodal interactions tend to minimize or to eliminate the conflict.

Sometimes conflict resolution causes an illusion. For instance, clever performers and perceptual psychologists use the intersensory discrepancy paradigm to introduce apparently conflicting information. The ventriloquist effect misleadingly resolves a difference in visible and audible location information. The McGurk effect smoothes out divergent visual and auditory information about phonemes. The sound-induced flash settles what otherwise would seem to be a numerosity conflict. In each case, the conflict is only apparent.

Typically, however, conflict resolution does not lead to illusion. For example, since light is faster than sound, visual and auditory information about the same distal event is temporally misaligned. When a feather visibly touches your foot, the tactual signal reaches your brain after the visual signal. Or, noisiness

in one signal might lead to mismatch. One sense might lack the resolving power of another. Crossmodal interactions help iron out these differences to present a more coherent perceptual take on the environment.

Resolving conflicts between senses thus alters a subject's perceptual evidence. In particular, one's perceptual evidence from distinct senses agrees more when interactions between senses reduce conflict. That means perceptual beliefs founded on distinct senses—about the locations of events, the phonological features of utterances, and the numbers of events that have taken place—tend to disagree less when perceptual processes resolve such conflicts. Thus, they are more coherent.

The second principle concerns reliability weighting. According to leading models, recalibrations weight each sense in proportion to its reliability, or the share of variance explained by signal rather than noise, with respect to a given feature (see Bennett et al. 2014). For instance, concerning spatial location, vision is more accurate and more precise than audition. When vision and audition bear conflicting information about the spatial location of an event, the conflict is resolved in vision's favor. However, for temporal features, audition's resolution is far better than vision's, so audition tends to win. Recalibration thus defers to the more reliable sense.

Still, complete deference is not the rule. Sometimes, recalibration involves a compromise. For instance, in the McGurk effect, the /ba/ sound dubbed over video of a speaker uttering /ga/ leads subjects to experience */da/*. This may seem puzzling. However, the alveolar /da/ requires vocal gestures part way between the velar /ga/ and the bilabial /ba/. Perceptually apparent /da/ splits the difference between visual and auditory cues.

Adjusting relative reliability also can change dominance patterns. With ventriloquism, decreasing visual reliability by dimming the lights or blurring an image makes vision less dominant. The sound then auditorily appears only part way between the visual stimulus and the actual sound source. (In temporal ventriloquism, adding white noise decreases auditory dominance of vision.)

Deferring to the more reliable sense when resolving intersensory conflicts is a good strategy. When each sense is equally reliable, it makes sense to compromise by weighting each sense equally. More generally, weighting each sense in proportion to its reliability enhances the overall reliability of perception.

Weighting each sense according to its relative reliability thus affects the quality of perceptual evidence each sense provides. In particular, one sense more reliably can track a feature by taking advantage of information from another sense. Spatial audition typically is more accurate when it listens to vision. Speech perception is better when it incorporates both auditory and visual information (lip reading improves speech comprehension as much as a good hearing aid). Visual impressions of numerosity that respect audition are right more often in typical human environments than those that do not.[2]

So, intersensory recalibrations conform to principles that weight each sense in proportion to its reliability. In general, this makes sense perception more reliable, though it leads to an occasional illusion. As a consequence, beliefs based on one's perceptual evidence are more likely to be true. They are more reliable.

Crossmodal illusions thus are not mere accidents. They stem from principled perceptual strategies. In particular, they result from processes that serve to resolve conflicts between senses and to weight in favor of the more reliable sense modality. Such processes alter a subject's perceptual evidence by affecting which determinate features each sense reveals.

However, multisensory processes do not just affect which evidence perceiving with each sense provides. Crossmodal recalibrations in general affect the quality of one's perceptual evidence. For example, conflict resolution can make one's evidence more coherent, and weighting can improve its reliability. Thus, crossmodal recalibration impacts the evidential value of our senses.

Multisensory perception that conforms to principles of conflict resolution and reliability weighting encourages more coherent perceptual beliefs, with less disagreement about common features. And it more reliably yields true perceptual beliefs about a given feature, when compared with multisensory perception that does not. If either coherence or reliability is epistemically significant, multisensory effects matter epistemically. Perceiving with several senses at once thus can have evidential and epistemic advantages beyond what perceiving with each sense individually provides.

Suppose perceptual evidence provided by one sense can depend causally on another sense, and that it can do so in a way that matters epistemically, according to some accounts. Nevertheless, in another respect, the evidence each sense provides may remain independent from each other sense. Evidence a subject has

by perceiving with one sense need not depend constitutively on perceiving with another sense. If so, crossmodal illusions are compatible with a unisensory view of perceptual evidence.

Crossmodal illusions are surprising. Interactions between senses typically go unnoticed. They change only which determinate feature one seems consciously to perceive with the affected sense. Ventriloquism alters a sound's apparent location, but vision's influence on hearing is not evident as such. A subject may be none the wiser. After all, for each crossmodal illusion, there is a corresponding subjectively indiscriminable episode of perceiving with each of two senses that involves no recalibration or illusion. One can just hear a sound and see lip movements in the same place; or see and hear matching phonemes; or hear and see equinumerous beeps and flashes.

So, typically, it is not apparent to a perceiving subject that having specific evidence from one sense depends on another sense. And, for each case described, the affected sense could provide equivalent evidence on its own. Therefore, despite crossmodal recalibrations, it is plausible that having perceptual evidence from one sense does not constitutively require perceiving with another sense. In this respect, one's perceptual evidence from each sense may be independent from each other sense.

This has a noteworthy upshot. Suppose that which evidence one can have by perceiving with a given sense does not depend constitutively on any other sense. If so, then completeness also is unthreatened. Which evidence one has by perceiving with multiple senses may be just the sum of the evidence one has by perceiving with each respective sense. Perceiving at once with two senses need not provide perceptual evidence beyond what each individual sense provides.

And that seems like the right verdict. Crossmodal interactions of the sort I have described can alter which determinate feature one seems to perceive with a given sense on an occasion. But they do not affect which features one can perceive with one's senses. Crossmodal recalibrations can improve perceptual capacities a subject already possesses by making them more reliable and more coherent. But they do not add to the stock of features a subject has the capacity to perceive.

Multisensory processes of the type responsible for crossmodal illusions therefore supply no new sort of material on which a perceiving subject could base beliefs. Crossmodal recalibrations generate no novel evidence beyond what stems from each distinct sense. They yield no distinctive multisensory perceptual evidence.

4. Availability

Results from experimental psychology support the claim that typical human subjects are differentially sensitive to novel features that could not be perceived with any single sense nor with several senses working independently in parallel. Furthermore, perceptual beliefs, perception-guided actions, appearances, and dissociations indicate that such novel features sometimes are available to perceiving subjects for use in thinking, reasoning, and acting rationally. As a consequence, some evidence is possessed by perceiving subjects thanks in part to distinctive multisensory forms of perception. This evidence could not stem from any individual sense on its own nor from a simple combination of separate senses. Instead, possessing it requires the joint use of multiple senses. So, one's perceptual evidence outstrips what is associated with each of the respective senses. Thus, some perceptual evidence is constitutively multisensory. This section develops the argument.

The first step is that some features have instances that could not be perceived with one sense at a time. Using one sense, it is not possible to perceive the simultaneity or temporal order of a flash and a sound. Nor is it possible unisensorily to perceive the spatial relationship between a flash and a sound. The same holds for a distinctive pattern of motion comprising visible movements and audible movements, a causal relationship between a visible collision and its sound, or the identity of an event that is seen with an event that is heard.

Just perceiving with multiple senses at the same time also does not suffice to perceive such a relational feature. One could independently see a flash and hear a bang without perceiving the spatial, temporal, or causal relation between them. That could be something one needs to infer or work out. Being perceptually sensitive to any such novel intermodal feature instance requires the joint, coordinated use of multiple senses. Distinct senses operating independently in parallel do not suffice.

Results from perception science support the claim that typical human subjects are differentially sensitive to such novel features. In particular, experiments from perceptual psychophysics provide behavioral evidence that we detect and differentiate novel intermodal feature instances.

Multisensory rhythm and meter perception offers one clear example. Huang et al. (2012) show first that subjects auditorily and tactually can discern metrical features of rhythmic sequences. For instance, subjects quickly and accurately can resolve a series of sounds or a series of touches as either duples or triples. What is noteworthy is that Huang et al. show next that subjects also can discern audiotactually a novel intermodal metrical feature that cannot be discerned unisensorily by hearing or by touch.

The key experiment uses a sound stimulus that subjects generally cannot resolve with audition alone as either a duple or triple, along with a distinct touch stimulus that subjects cannot tactually resolve as a duple or triple. In each unisensory case, the stimulus lacks cues needed to discern duples or triples. But, together, those cues are present. In the bimodal condition, subjects quickly and accurately discern whether the joint audiotactual stimulus is a duple, a triple, or neither. This is not just hearing the audible pattern while feeling the tactual pattern. And it does not look like working things out. Performance is on par with the unisensory tasks, each of which is taken to reveal a perceptual capacity. If that is right, this study offers strong evidence that subjects perceptually are sensitive to a novel instance of a metrical feature—a duple or a triple—that comprises both sounds and touches.

This is experimental evidence that typical human subjects detect and differentiate at least one novel intermodal feature. Doing so requires perceiving in a way that relies on the coordinated use of multiple senses. Other studies converge on similar results for novel intermodal instances of temporal, spatial, and causal features, including simultaneity, order, relative location, motion, and launching.[3]

One wrinkle is that each of these novel feature instances belongs to a familiar feature type. It would be odd to say that one can perceive spatial, temporal, or causal features multisensorily but not unisensorily. Each is a relational, structural feature with instances that can be perceived using one sense at a time. Intermodal features thus are not wholly novel types of perceptible features revealed only multisensorily.

This is no real obstacle. Nothing in principle bars novel feature types that are perceptible only thanks to the joint use of several senses. Flavor is one example. Typical humans are sensitive to flavors by means of gustation, retronasal olfaction, and somatosensation working in concert. The complex but unified flavor of fresh mint leaves—menthol, grassy, cooling, and slightly bitter—is accessible only

through the coordinated use of several senses. Another example is balance. Sensitivity to being in balance implicates vestibular, visual, and proprioceptive information. Perceiving one's body, or a pen balanced on one's index finger, to be balanced relies on several sensory systems in collaboration.[4] Being balanced is an example of a novel type of feature that is accessible in the first instance only multisensorily.

Nevertheless, even so, novel intermodal feature types are not necessary for multisensory evidence. A unisensory view of perceptual evidence concerns which evidence a subject has on each occasion. The version now being considered entails that a subject's perceptual evidence includes just whatever constitutively independent evidence stems from the use of each individual sense. Accordingly, a novel intermodal instance of a familiar feature type suffices for a counterexample. A subject who is sensitive to a novel instance of a spatial, temporal, or causal feature could have perceptual evidence that a subject who is not sensitive to that feature instance lacks. To undermine a unisensory view, that evidence need not belong to a wholly novel feature type.

The upshot is that some perceptual evidence could stem from the joint use of multiple senses. Being sensitive to a novel feature instance or a novel feature type could provide a subject with perceptual evidence that outstrips what stems from each of the individual senses. If the question is whether the pig you see is making the sounds you hear, perceptually discerning intermodal causality puts new evidence in play. In that case, the evidence a subject has in perceiving with several senses is not just what perceiving with each individual sense respectively provides. If so, a unisensory view of perceptual evidence is inadequate.

This step does not go far enough. Differential sensitivity does not entail possessing evidence. One reason is that differential sensitivity does not guarantee awareness. Perceptual processes could detect and differentiate a feature in a way that affects performance in a psychophysics experiment without awareness of that feature. To complete a task that requires responding selectively to the presence of a feature, one need not be able to recognize or appreciate it, and one need not realize that it drives one's behavior. Possessing evidence, however, could require awareness. This trades on the natural idea that one does not have or possess evidence one cannot access. So, performance that evinces differential sensitivity to a novel intermodal feature does not by itself establish that a subject's perceptual evidence outstrips what

stems from one sense or another. Therefore, it does not show that any perceptual evidence is distinctively multisensory. Accordingly, the next step is to show that subjects have access to such constitutively multisensory perceptual evidence.

Awareness is being apprised. It has targets, including objects, features, facts, or states of affairs. One aspect of awareness is availability. Being aware of a feature typically means that it is presently available to a subject for use in thinking, reasoning, and acting. Availability thus is akin to access consciousness. Since awareness is an occurrent condition, rather than a mere disposition, it requires that a feature occurrently is available to a subject—as things stand, it is poised for use by a subject in an episode of thinking, reasoning, or acting rationally; it requires no further act to become so poised.

Possessing perceptual evidence need not require present awareness or occurrent availability. However, acquiring such evidence plausibly does require awareness or occurrent availability enabled by perception. If so, one cannot come to possess perceptual evidence that perception does not make available to one for use in thought, reasoning, and rational action.

Experimental evidence indicates that perceivers are differentially sensitive to novel intermodal features. My claim now is that this sensitivity plays the right role in a subject's psychology to meet an awareness condition on perceptual evidence. In particular, it serves to make novel intermodal features available for use by a subject in thinking, reasoning, and acting. So, thanks to the joint use of multiple senses, novel intermodal features sometimes are available to subjects in the respect that matters. Multisensory perception thus enables awareness of novel intermodal features.

The key premise is that perceiving makes novel intermodal features available to subjects for use in thinking, reasoning, and acting rationally. Being accessed and put to use is enough to show occurrent availability.

Perceiving subjects typically form perceptual beliefs that implicate novel intermodal features to which they are differentially sensitive. I readily come to believe the pig is making the sounds I hear; the violin's notes come from the left of the conductor; the click precedes the flash; a continuous movement is occurring between visible and felt touches to my arm; the flavor profile of the mint leaf is unified; the visible tray I am holding is in balance; and so on. The strength of this pattern (its reach, its consistency,

and its resilience) suggests that such beliefs concern features made available by multisensory perception rather than by extraperceptual acts of association, inference, or cognition.

Perception-guided actions also typically exhibit fluent sensitivity to novel intermodal features. Without needing to work it out, perceiving subjects respond quickly and competently to intermodal features, even in novel situations. I turn to visually identify the source of a sound; reach up to grab the ball I spot approaching; tell if a baserunner is safe or out by watching the runner's foot touch the base while listening for the sound of the ball striking the mitt; slow down my chewing to savor textural and olfactory contributions to flavor; look at my mirror image to keep balanced on one foot; and so on. Moreover, subjects organize further actions to take such intermodal features into account. An engineer deliberately calibrates video and its soundtrack to seem synchronous. One focuses intently on a speaker's lips better to discern spoken utterances. These actions are planned and rationalized in terms of intermodal features revealed perceptually.

Nonetheless, a reasonable skeptic could say these perceptual beliefs and perception-guided actions are not conclusive. It is possible that perception itself does not fix the target of one's beliefs or actions in the cases described. Recognition, judgment, or inference instead might make the difference.

Three further considerations support the claim that perception fixes which feature is available to a subject. The first is that a subject who is differentially sensitive to a novel intermodal feature instance sometimes can form a demonstrative thought with that feature as its target. Confronted perceptually with an explosion one sees and hears, one can think, "*That* was loud and bright!" If one discerns the causal relation between the flash and the sound it makes, one may think, "*That* was not a coincidence." Or one may demonstrate the particular spatial or temporal relationship between something seen and something felt—proximity, simultaneity—and compare it to another spatial or temporal relation. Notably, this holds even for subjects who lack further concepts for such features. One could pick out an intermodal triple, then reidentify it, lacking the concept *triple* and knowing no more about musical meter. In such cases, sensitivity to the novel feature instance enables the demonstrative thought, and perception fixes its target.

The next is that multisensory appearances can be misleading, even if a subject is not misled. During a videochat using headphones, no single event in one's surroundings has both the visible and the audible features that seem to belong to the image on screen. The appearance of binding is illusory or

misleading.[5] Or, consider a perfectly synchronized sound–flash stimulus in the psychophysics lab. Without its typical arrival delay, a sound misleadingly can seem to precede the flash. Still, someone in the know can resist forming the mistaken belief, while leaving appearances intact. This is one mark of perceptual illusion or misleading perception.

The last is that such appearances selectively can break down while cognition is unimpeded. One might just see a collision and hear a sound while failing to perceive the collision's being the source of the sound. One could work out the relation, but that need not restore the appearance. Researchers also report that it is possible, using transcranial magnetic stimulation to brain areas associated with perceptual processes rather than cognition (such as superior temporal sulcus), selectively to disrupt the coordinated use of multiple senses while perception in each individual sense is unimpaired (for instance, Beauchamp et al. 2010). In each case, how things appear may differ when one fails to discern an intermodal relation, even without changing how things appear using each distinct sense, and even without disturbing cognition.[6]

That completes the second step. Using several senses at once but merely in parallel does not suffice to make a novel intermodal feature available to a subject for use in thinking, reasoning, and acting rationally. However, the joint use of multiple senses sometimes does enable subjects to think, reason, and act using novel intermodal features. Furthermore, the evidence supports the claim that perception rather than extraperceptual cognition can make such a feature occurrently available—by fixing it as a target of thought and action. In that case, one is perceptually aware of a novel intermodal feature.

If one's perceptual evidence requires awareness, and awareness requires availability for use in thinking, reasoning, and acting, then one's perceptual evidence can include novel intermodal features. Since novel intermodal features are available perceptually only by means the joint use of multiple senses, it follows that some perceptual evidence relies for its possession on the coordinated use of several senses. Thus, some perceptual evidence does not stem wholly from any individual sense, and it is not a simple combination of constitutively independent evidence from distinct senses. In this respect, one's perceptual evidence is not exhausted by what the senses severally convey. Given this, our senses do not provide both

independent and complete perceptual evidence. A unisensory view of perceptual evidence therefore is not adequate. Some perceptual evidence is distinctively multisensory.

There is another respect in which each item of perceptual evidence might be specific to one or another sense. Some philosophers maintain that phenomenology has a distinctive evidential role. For instance, having phenomenology may be required for a perceptual episode to provide perceptual evidence. Alternatively, a distinctive evidential status may stem from phenomenality. Each helps capture the idea that differences in one's evidence require subjective, experiential differences.[7]

Suppose the joint use of multiple senses makes available novel intermodal features. Availability nevertheless need not guarantee phenomenality. In principle, a perceiver could be differentially sensitive to a feature, think about it, and rely on it in reasoning and acting, but nevertheless lack phenomenal character associated with awareness of that feature. Arguments for differential sensitivity and availability do not suffice to establish phenomenality. Accordingly, nothing so far demonstrates that perceiving novel intermodal features contributes any perceptual evidence whose possession depends on corresponding phenomenality.[8]

Multisensory perception therefore could fail to contribute to a subject's phenomenal evidence. Thus, two important prospects remain. First, phenomenal evidence associated with each sense might be constitutively independent from phenomenal evidence associated with each other sense. And, phenomenal evidence might be exhausted by what is associated with each of the respective senses. If so, that secures a unisensory view of phenomenal perceptual evidence.

5. Phenomenality

This section argues against a unisensory view of phenomenal perceptual evidence. Suppose perceptual evidence of which one is phenomenally conscious confers distinctive epistemic warrant. Not all such phenomenal evidence must stem from a specific sense. That is because novel intermodal features sometimes are reflected in phenomenal consciousness. Being perceptually sensitive to a feature by means of the joint use of multiple senses can make a distinctive difference to the phenomenal character of a

conscious perceptual episode, even by the standards of quite demanding accounts of perceptual phenomenology. Thus, even phenomenal evidence can be constitutively multisensory.

Consider a case in which one is presented with a novel intermodal feature instance, such as intermodal synchrony, motion, rhythm, meter, or causality. Suppose multisensory perceptual processes are differentially sensitive to the intermodal feature instance, enabling one measurably to respond selectively to its presence. Moreover, suppose that by means of perception the feature occurrently is available for use in thinking, reasoning, and acting.

The claim to be defended is that such an episode can differ phenomenally from an otherwise equivalent episode in which one does not perceive an intermodal feature. For instance, perceiving a causal relation can make a phenomenological difference (Nudds 2001; Siegel 2010). In particular, being sensitive to a visible event's generating a sound can make a difference to what it is like for a subject to undergo a conscious multisensory episode, even controlling for sense-specific phenomenal features, such as those that correspond to visible location and timing, or audible position and grouping. Perceiving causality can differ phenomenologically from perceiving the same events and features but not their causal relation. Thus, being perceptually sensitive to an intermodal feature in a way that requires coordination among the senses can make a distinctive phenomenal difference, when compared to perceiving with several senses working separately.

It follows that the phenomenal character of some conscious perceptual episode, in which a subject is sensitive to a novel intermodal feature instance, is not exhausted by phenomenal character associated with each of the respective senses, along with whatever accrues thanks to simple unity of consciousness. No corresponding unisensory experience could have the character distinctive to experiencing an intermodal feature instance, and merely being co-conscious does not suffice.[9]

Suppose now that a difference in phenomenal perceptual evidence requires a phenomenal difference. If so, perceiving multisensorily can impact one's phenomenal perceptual evidence, as compared with perceiving separately with several senses at once. In that case, one's phenomenal perceptual evidence does not just amount to what stems from each of the individual senses. Thus, a unisensory view of phenomenal perceptual evidence is inadequate.

This argument relies on the claim that perceiving a novel intermodal feature can make a distinctive phenomenological difference. That claim requires explication and defense. This can be structured in terms of two questions about perceptual phenomenology. The first is whether or not a phenomenal difference must be discriminable by a subject. The second is whether the phenomenal character of perceptual experiences is moderately rich or relatively thin.

Rich, discriminable

Start with the first. A phenomenal difference concerns what it is like for a subject to undergo a conscious episode. It is natural to think a phenomenal difference understood this way must in principle be discernible by a subject. The idea is that, if two episodes instantiate distinct phenomenal features, a subject ought to be able to discriminate one from the other, at least under some idealized conditions, which control for things like unreliable memory, wandering attention, inexperience, background beliefs, and conceptual innocence. Distinct phenomenal features in this view require that a subject using just the first-person perspective could tell apart an instance of one from an instance of the other. So, each phenomenal difference must be discriminable by a subject.[10]

Now consider the second. Many philosophers say perceptual phenomenology is moderately rich, rather than thin. If it is thin, only our sensitivity to relatively few sensible features, such as hue, direction, pitch, loudness, taste, odor, texture, and warmth, makes a constitutive or distinctive difference to the phenomenal character of a conscious perceptual episode. By contrast, if it is moderately rich, sensitivity to a wider range of perceptible features makes a constitutive or distinctive phenomenological difference. For instance, a subject may be sensitive to spatial relations, objecthood, motion, duration, grouping, temporal order, musical relations, oriented configurations, phonological features, or causality. If it is very rich, some differences in perceptual phenomenal character are explained by sensitivity to particulars, natural kinds, or semantic properties.

Suppose phenomenal differences must be discriminable. Even so, it is plausible that sensitivity to features such as spatial relations, phonology, and causality can make a distinctive phenomenal difference. For instance, controlling for other features, it is plausible that a conscious perceptual episode in which one event perceptibly causes another in principle could be discriminated by a competent, attentive subject

from an otherwise equivalent conscious perceptual episode in which the first event does not perceptibly cause the second. So, plausibly, discerning a causal relation can make an appreciable difference in what it is like to experience a scene. Such claims about subjective contrast and its sources have been supported by ampliative arguments that rely on introspection, performance in perceptual discrimination tasks, and selective disruptions, including clinical conditions like visual apperceptive agnosia and pure word deafness (Bayne 2009; Siegel 2010; O'Callaghan 2011).

The important point is that intermodal cases pose no special trouble. Suppose visual or auditory experience is moderately rich. So, visual or auditory sensitivity to features such as simultaneity, motion, objecthood, duration, phonemes, or causality shapes visual or auditory phenomenology. If one accepts the arguments from section 4, which establish that novel intermodal features are occurrently available, there is no principled obstacle to thinking sensitivity to novel intermodal instances of such features can make a distinctive, discernible difference to the phenomenal character of a conscious multisensory perceptual episode. Empirical evidence demonstrates differential sensitivity to such features; empirical and philosophical arguments show that this sensitivity plays the psychological role typical of perceptual awareness; and contrast arguments that rely on appearances, illusions, and dissociations suggest that, in phenomenological respects, the intermodal cases run parallel to the intramodal cases. Subjects do seem capable of discriminating such differences in what is like to perceive using multiple senses.

In fact, reasons to be skeptical that perceptual sensitivity to intermodal feature instances makes a distinctive difference to the phenomenal character of multisensory perceptual consciousness also spell trouble for a moderately rich view of perceptual consciousness in any sense. But, to insist that a subject's phenomenal evidence from any given sense includes only a very sparse set of qualities may be implausibly austere.

Rich, indiscriminable

Still, it is reasonable to be skeptical that controlled perceptual contrasts of the sort I have described are discriminable. For instance, a skeptic can doubt that a visible event followed by a sound ever differs discriminably from a visible event's causing a sound, once we control for other features, including spatiotemporal differences. One reason is that for each case in which a visible event causes an audible

sound, it is possible to construct an indiscriminable twin scenario in which the visible event does not cause the sound.

If phenomenal differences require discriminability, then for such indiscriminable scenarios either both experiences commit to the presence of causality, so the twin scenario without intermodal causality is illusory, or no distinctive difference in perceptual phenomenal character stems from being sensitive to intermodal causality. However, without begging the question, what warrants saying perceptual consciousness overcommits in the twin scenario without causality? The plausible alternative is that one only mistakenly takes the relation to be causal. If so, no relevant discriminable difference manifests in perceptual phenomenality.

Here, there are two options. The remainder of this subsection considers the first. The next considers the second.

According to the first option, phenomenal differences do not require discriminability. If so, two conscious perceptual episodes can differ in phenomenal properties while a subject cannot differentiate one from the other. With one key assumption, this secures a difference in phenomenal evidence. Thus, it is possible to hold that phenomenal evidence is moderately rich without accepting that distinct phenomenal features must be discriminable. This, however, has a cost. Phenomenal evidence can differ without being discriminable.

Some good reasons suggest phenomenal differences in perception do not require discriminability. One stems from phenomenal Sorites cases. Suppose one cannot tell a difference in color between any two adjacent chips in a stack of just differing color samples. But suppose the top chip looks to differ in color from the bottom chip. If identity is transitive, and if the color appearance of each chip is stable, there must be some phenomenal difference without a discriminable difference.[11]

If phenomenal differences do not require discriminability, then multisensory phenomenology is no problem. Being sensitive to a novel intermodal feature (such as audiovisual causality) can make a distinctive difference to what it is like for one to perceive multisensorily. However, one need not be capable of discriminating episodes that instantiate distinct phenomenal character.

This is especially plausible if *phenomenal character* is a theoretical notion. From this perspective, phenomenal features are attributes that figure in a systematic account of what it is like for each subject

across a range of conditions. As such, claims about phenomenal character must answer to a variety of evidence and arguments. This includes considerations drawn from experimental psychology, rational psychology, and phenomenology. First-person testimony is not the last word.

If it is doubtful whether subjects have full access to their phenomenal features, it can be reasonable to conclude that some experiences differ phenomenally in ways subjects could not even in principle notice just from the first-person perspective. Subjects' failing to find difference does not guarantee none exists. This need not completely untether phenomenal features from discriminability. Discriminability may suffice for a phenomenal difference. And phenomenal features remain answerable to the full scope of facts about what subjects can detect and differentiate.

If so, being sensitive to a novel intermodal feature can make a distinctive difference to the phenomenal character of perceptual consciousness even while it is not possible for a subject perceptually to discriminate a scene in which that feature is instantiated from an otherwise equivalent scene in which it is not.

Therefore, even if each difference in phenomenal evidence requires a phenomenal difference, and even if two scenes are not perceptually discriminable, a subject who is consciously aware of a novel intermodal feature instance and an otherwise equivalent subject who is not can possess differing phenomenal evidence. The cost is that two conscious multisensory episodes can differ in which phenomenal evidence they provide even though a subject could not from the first-person perspective tell them apart. So, even phenomenal evidence can differ without differing discernibly.

Some may object. Even if phenomenal differences do not require discriminability, one might insist that differences in phenomenal evidence do require discriminability. In fact, the latter claim is what motivates some philosophers to embrace phenomenal evidence.[12] If so, distinct phenomenal character does not suffice for a difference in phenomenal evidence. It also must be possible for a subject to discern or appreciate its differing. And, if so, it remains open that there is a variety of perceptual evidence—phenomenal perceptual evidence—that is wholly sense specific rather than ineliminably multisensory.

Thin, discriminable

The concern raised earlier is that if phenomenal differences require discriminability, but scenes with novel intermodal features are not discriminable from twin scenes without, then, if distinct phenomenal evidence requires a phenomenal difference, one's phenomenal evidence may remain sense specific; thus, a unisensory view of phenomenal evidence remains alive. The first response denied that phenomenal differences require discriminability. But this means distinct phenomenal evidence may be indiscriminable. The second option avoids this consequence. It describes a novel intermodal feature, sensitivity to which makes a discriminable difference. And it is compatible with a thin view of perceptual phenomenal character.

Suppose fixing only a small range of sensed features fixes which scenes a subject can differentiate. So, controlling for a sparse set of sensed features, no further feature makes a distinctive discriminable difference.

If phenomenal differences require discriminability, it follows that perceptual phenomenality is sparse. For instance, one does not consciously see faces or causality per se; one does not auditorily experience phonemes, voices, or collisions per se. Instead, one may consciously sense only hues, brightness, pitch, loudness, tastes, scents, texture, and warmth. This is one reason some philosophers maintain that perceptual experience is relatively thin—only a limited range of features makes a discriminable difference to phenomenal character. In that case, one's phenomenal evidence, too, is thin.

From this perspective, if none of the novel intermodal feature instances described so far makes a distinctive discriminable difference, then none impacts perceptual phenomenality in the right way. In that case, all phenomenal evidence is sense specific.

Even if phenomenal differences do not require discriminability, and perceptual phenomenality is moderately rich, differences in phenomenal evidence nevertheless may require discriminability. If so, one's phenomenal evidence may be thin and thus may be specific to each individual sense.

So, suppose differences in phenomenal evidence require differences that in principle one could notice. And suppose novel intermodal instances of perceptible relational features, such as causality, simultaneity, and motion, make no distinctive difference to what one consciously can discriminate (once we control for features one consciously perceives with each individual sense). This is a way to defend the view that one's phenomenal perceptual evidence is exhausted by that which stems from each of the

respective senses. What remains argues against such a unisensory view of phenomenal perceptual evidence.

Set aside the most pressing worry. This worry is that sparse accounts desiccate perceptual phenomenality, leaving only fleeting, momentary instantiations of inherently qualitative features. If so, sparse accounts struggle to capture what it is like for conscious subjects to perceive things and features in the environment over time. Supplementing sparse perceptual phenomenal character with extraperceptual phenomenality only invites further difficulty stating criteria for differentiating perceptual from extraperceptual phenomenal character. Suppose this all can be addressed satisfactorily.

Even so, thin perceptual phenomenality need not be exhausted by what is associated with each of the respective senses (plus whatever accrues due to mere co-consciousness). Thus, not even phenomenal perceptual evidence must be sense specific. It need not be both independent and complete.

Consider flavor and its perception. Unlike simultaneity, motion, rhythm, and causality, flavors cannot originally be perceived using any single sense on its own. Perceiving flavor fully requires taste, smell, and somatosensation working in concert. The flavor of Vegemite includes its bitter and salty aspects as well as its yeasty olfactory component and smooth, plastic texture. No unisensory experience in the first instance is an experience of Vegemite's flavor.

More to the point, flavor may involve novel qualitative components. Such a novel qualitative attribute could not be perceived using any single sense on its own, nor just by means of sense-specific qualities. Doing so requires multiple senses working together. For instance, being sensitive to the distinctive minty quality of mint ice cream relies on processes that integrate information from both taste and olfaction. The idea is that the sensed quality of mintiness is experienced only thanks to multisensory coordination (Smith 2015).

This type of case occurs within each sense. Sensitivity to color, pitch, or scent requires extensive processing that integrates information from multiple receptors and pathways. The apparent simplicity of a sensed quality disguises complex mechanisms. In principle, perceiving an apparently simple quality multisensorily is no more objectionable. Mostly, it is an empirical question whether multisensory processing reveals any novel sensible qualities.[13]

So, sensitivity to a quality that appears simple (or uniform or manifest) could stem from a process that implicates more than one sense. Such sensitivity could shape the phenomenal character of perceptual consciousness in a distinctive way. In particular, sensitivity to such a quality itself could determine that a subject consciously differentiates two otherwise equivalent scenes. If so, even a thin account of perceptual phenomenal character that requires discriminability can embrace multisensory qualities.

Accordingly, even a sparse account that requires discriminability for a difference in phenomenal evidence can embrace multisensory phenomenal perceptual evidence. If so, then not all phenomenal perceptual evidence stems from what individual senses provide. Put another way, one's phenomenal perceptual evidence is not exhausted by what independently stems from each sense plus whatever accrues due to mere co-consciousness. Not all phenomenal perceptual evidence must be sense specific.

In light of this, denying that one's phenomenal evidence is ineliminably multisensory means accepting that a difference in phenomenal evidence requires a difference in what is discriminable while also denying that one is sensitive to a novel qualitative attribute, such as an aspect of flavor, that is not revealed through any single sense. Abandoning either commitment leaves open that even phenomenal perceptual evidence is constitutively multisensory.

Therefore, whether the phenomenal character of a perceptual episode is moderately rich or relatively thin, and whether or not a difference in phenomenal evidence requires discriminability, one's phenomenal perceptual evidence can outstrip what stems from individual senses.

6. Conclusion

This paper has argued that some perceptual evidence is distinctively multisensory. This conclusion conflicts with the presumption that one's perceptual evidence comprises just what stems from perceiving with each of the individual senses. This orthodoxy has structured debates about perceptual evidence.

One upshot is that which perceptual evidence one has due to perceiving with a given sense is not wholly independent from which evidence one has due to perceiving with another sense. Perceiving with one sense sometimes alters which perceptual evidence another sense provides. Seeing a pig can change which evidence hearing provides. Thus, claims about evidence of one or another sense in isolation are suspect.

The other upshot is that the evidence one has due to perceiving jointly with multiple senses need not match the evidence one could have by perceiving severally with those same senses. Controlling for other factors, perceiving jointly with two senses can provide distinct evidence from what perceiving separately with the same two senses provides. Audiovisually perceiving a pig provides perceptual evidence that just seeing a pig and hearing a pig does not. Thus, constitutively independent perceptual evidence from distinct senses is not one's complete perceptual evidence.

This conclusion is robust. It is neutral among accounts of the ontology of evidence and of its possession. It holds for a variety of differing constraints on perceptual evidence. Notably, it is plausible even for strict phenomenal conceptions of evidence requiring that differences are discriminable.

Endnotes

[1]For instance, it has found support both from those who analyze perception fundamentally in relational terms and from those who analyze perception fundamentally in representational terms. Its representatives include those who endorse sense-data theory, intentionalism, naïve realism, and capacitism. A small respective sampling includes views expressed in Ayer (1940, esp. 113); Goodman (1951, esp. 156–9); Chalmers (2004); Martin (1992); Siegel (2010, esp. 19–21); Brewer (2011); Schellenberg (2018, esp. 120).

[2]If evidence is factive, and crossmodal recalibrations help us get things right more often, they also increase overall the quantity of evidence each sense provides.

[3]O'Callaghan (2019, chapter 3) offers a lengthy discussion and defense of the claim that typical human perceivers are differentially sensitive to a variety of novel intermodal features, with critical attention to this empirical literature.

[4]For illustration, stand on one foot. Now close your eyes and stand on one foot.

[5]Admittedly, the visual image complicates things, but the same holds for any compelling case of ventriloquism.

[6]Some conditions, such as autism and attention deficit hyperactivity disorder, impact sensory integration and disrupt a subject's capacity to discern intermodal features (de Gelder et al. 1991; Mongillo et al. 2008; Panagiotidi et al. 2017). However, further cognitive differences complicate the argument.

[7]Schellenberg (2018, esp. §7.2) and Smithies (2019, esp. §6.4) are two recent illustrative examples; cf. Lyons (2016). Kelly (2016) provides general overview.

[8]Note also, if perceptual evidence requires awareness, and awareness requires phenomenality, then the preceding arguments concerning availability, unsupplemented, do not establish that there is distinctive multisensory evidence.

[9]Elsewhere, I have argued at length for this claim, so I refer readers wishing for a more detailed defense to O'Callaghan (2015, 2019).

[10]On what discriminability requires, see
Williamson (1990); Raffman (2000); Farkas (2006); Speaks (2015).

[11]For a recent presentation, see Speaks (2015). Speaks argues further that a subject who perceives distinct particulars or distinct natural kind properties can instantiate distinct phenomenal properties without being able to discriminate those particulars or natural kind properties.

[12]For instance, Schellenberg (2018) says phenomenal evidence but not factive evidence matches between veridical perceptions and subjectively indistinguishable hallucinations.

[13]*Being balanced* is an intriguing example of a quality sensitivity to which involves integration of vestibular, visual, and proprioceptive information (Wong 2017).

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