

Enhancement Through Coordination

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Current Controversies in Philosophy of Perception

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Recent work in perceptual psychology, neuroscience, and philosophy challenges the independence of our senses. Cross-modal effects, such as illusions triggered using the intersensory discrepancy paradigm, demonstrate that stimulation to one sensory system can affect another and reshape perceptual experience. Neural processes associated with one sense interact extensively with those associated with others, and integrating information across senses recruits ample cognitive resources. Matthen (this volume) describes this 21st-century boom in experimental research on multisensory perception in his introduction (see also O'Callaghan 2012).

Beyond perceptual mechanisms and processes, a current controversy among philosophers concerns whether, how, and to what extent perceptual consciousness is multisensory. On one hand, one sense might causally but not constitutively affect experience associated with another. Some maintain that experimental evidence is compatible with the claim that perceptual experience at each time is unisensory or minimally multisensory (see Spence and Bayne 2015). On the other hand, perceptual experience might reflect extensive subpersonal coordination and be richly or deeply multisensory. I defend the latter.

Section 2 distinguishes three ways in which perceptual experience may be multisensory, and it presents evidence to support the claim that mature species-typical perceptual experience in humans is richly and deeply multisensory. Section 3 explains why this matters. Section 4 raises two outstanding issues concerning psychological taxonomy for multisensory perception: how to type richly multisensory experiences by modality according to their character, and why multi-sensory effects involve perception rather than extra-perceptual cognition.

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If you could use only one sense at a time, then your perceptual consciousness at each moment would be unisensory. However, humans typically use more than one sense. You can smell beer while seeing a doorknob or watch an airplane while listening to conversation. If you can perceive with more than one sense at a time, then unless consciousness requires attention and attention is restricted to one modality at a time, in principle you could perceive consciously using more than one sense. Whenever perceptual consciousness is associated with more than one sense modality at a time, say that it is *minimally multisensory* (or *minimally multimodal*)—when restricted to exteroceptive modalities of sensory perception, here I'll treat “multimodal” as interchangeable with

“multisensory”).

Sensory processes might interact extensively while every conscious aspect of a perceptual experience remains associated with some specific modality or another. Therefore, since a subject's consciousness at a time typically is unified, human perceptual consciousness might be exhausted by features that are associated with each respective sense modality along with whatever accrues thanks to simple consciousness. I have called this claim *The Thesis of Minimal Multimodality* (O'Callaghan forthcoming; see also Matthen, this volume, sections II and III).

Is perceptual consciousness more than minimally multisensory? We may distinguish two additional ways in which perceptual experience may be constitutively multisensory. First, a perceptual experience that is associated with a given modality on a specific occasion may depend constitutively on another sense modality. For instance, an auditory episode with a certain character might be cross-modally parasitic in that it requires either prior or concurrent visual processing without which it would not be possible.

So, distinguish an auditory experience that is presently and historically exclusively auditory—a diachronically purely auditory experience—from an auditory experience that occurs within a rich mix of past and presently visual, tactile, olfactory, and gustatory experiences. For a given pattern of sensory stimulation, the auditory experience of a subject whose perceptual experience over time is purely or exclusively auditory may differ in character from the auditory experience of a subject who enjoys the typical range of visual, tactile, olfactory, and gustatory episodes. Even if the other senses are blocked or anesthetized, making an otherwise typical subject's perceptual experience at a time merely and wholly auditory, that synchronically auditory experience may differ from the auditory experience of a subject with a historically and presently (diachronically) purely auditory experience. If you only ever could hear but not see, touch, taste, or smell, then your auditory experience could differ from how it actually now is (see, e.g., Shams et al. 2011).

For example, an intermodal variety of so-called *amodal completion* may affect how you auditorily experience an event that is visible but unseen, just as seeing a region to be part of a surface that continues behind an occluder may affect how you visually experience it. Thus, hearing a spoken utterance to be the sort of thing that has visible features may impact one's auditory experience of it (see also Matthen's discussion of space and place, this volume, I.2). Or, the capacity to perceptually experience a given feature through one modality may be *cross-modally parasitic* on the capacity to perceive that feature through another modality, perhaps by perceptual learning. Matthen's discussion (this volume, I.1) of hearing a more precise or determinate spatial location thanks to vision provides one example. Seeing solidity thanks to touch may provide another. Or, vision might enable concepts or thoughts that through *cognitive penetration* affect the character of auditory experience. Or, touch might make possible *actions* that alter the structure of conscious vision.

If so, then an experience that is associated with one modality on a given occasion can depend upon past or present sensory episodes that are associated with another modality. Any such cross-modal dependence implies that a presently and historically purely unisensory visual experience, say, could differ in character from the current visual experience of a typical human subject who has a rich background of perceiving using all of the senses. Thus, if modality-specific features include only those that do not require other senses, not every aspect of a perceptual experience is modality specific. Whenever an episode inherits character from another modality, this is a noteworthy respect in which conscious perceptual experience is constitutively multisensory.

Perceptual experience at each time nevertheless might be exhausted by that which is associated with a given modality. A visual experience that depends on past or current tactal awareness is still a visual experience (even if it has features drawn from other modalities). Accordingly, it could be that each feature of a conscious perceptual episode on a given occasion is associated with some modality or another, even while some such features depend on other senses. This preserves a weaker version of The Thesis of Minimal Multimodality.

However, consider a second way in which perceptual experience may be constitutively multisensory. It may be more than a sum of modality-specific parts. Since I think atomism fails in part for the reasons Matthen describes (this volume, especially III and IV), I prefer to state the argument neutrally in terms of features, by which I mean attributes or parts, of conscious perceptual episodes. So, the conscious features of a perceptual episode may not be exhausted by those that are associated with a given modality on that occasion plus whatever accrues thanks to simple co-consciousness. For instance, one's overall perceptual experience at a time may have features that no corresponding merely visual, merely auditory, merely tactal, merely olfactory, or merely gustatory experience could have independently, even if we make an allowance for cross-modal dependence and for whatever accrues thanks to simple co-consciousness.

For example, intermodal feature binding awareness involves perceptually experiencing something common to bear features perceived using different senses (see O'Callaghan 2014). So, you may visuo-tactually experience as of something's being both red and rough, or audio-visually experience as of something's being both loud and bright. By contrast, it is possible to see something's being red while feeling something's being rough, or to hear something's being loud while seeing something's being bright, without perceptually identifying what is seen and felt, or heard and seen. Such cases differ phenomenologically from the perceptual experience of intermodal feature binding. Thus, in experiencing binding, the perceptually apparent numerical sameness of what is multisensorily perceived does not accrue thanks to simple co-consciousness. Therefore, not every phenomenal feature of a conscious perceptual episode is associated with a specific modality or accrues thanks to mere co-consciousness.

Moreover, there could be novel feature instances that are perceptible only through the coordinated use of multiple senses. For instance, there is evidence that certain relational features are perceptible multisensorily. Simple temporal and spatial relations, such as simultaneity, order, and relative direction and distance may be perceptible not only when the relata are perceived through one sense but also when they are perceived through differing senses (see, e.g., Bertelson 1999; Stone et al. 2001; Spence and Squire 2003; cf., Spence and Bayne 2015). In addition, it has been demonstrated experimentally that a novel audio-tactile musical meter is perceptible when subjects are presented with distinct audible and tactal metrical patterns (Huang et al. 2012). The same has been claimed for both intermodal rhythms and intermodal motion (Guttman et al. 2005; Harrar et al. 2008; cf., Huddleston et al. 2008). As a final example, causal relations may be perceptually apparent through a single modality, such as vision, and nothing obvious prevents a causal relation's being perceptually apparent intermodally, as in perceptually experiencing a visible event to cause a sound (Nudds 2001). This seems especially evident when combined with a case involving apparent binding. Suppose you audio-visually perceive one event as such and then audio-visually perceive another event as such. And suppose you can visually perceptually experience the first event to cause the second and auditorily perceptually experience the first to cause the second. Given that you perceptually identify the visible and audible event at each time, it also is plausible that you could perceptually experience the visible event to cause the audible event.

A case in which you multimodally perceptually experience an instance of a relational feature whose relata are accessible through different modalities differs consciously from a case in which you perceptually experience the relata but not the relation. Thus, some conscious multisensory perceptual experiences have features beyond those that could be instantiated independently by any corresponding unimodal experience under equivalent stimulation and that do not accrue thanks to mere co-consciousness. Therefore, such a multisensory perceptual experience is not a simple co-conscious sum of modality-specific components.

There also could be features of a novel type only perceptible multisensorily. Flavor is a good example because flavors are not fully perceptible thanks to any sense working on its own (see Smith 2015). Perceiving flavor involves at least taste, smell, and somatosensation working together to enable awareness of complex attributes such as the distinctive mintiness of mint, the sweet heat of a roasted chili pepper, or the buttery oak of a California Chardonnay. Flavor experiences plausibly involve unique qualitative characteristics beyond those that could be revealed by any corresponding unimodal experience. If so, the character of experiencing the distinctive mintiness of mint is not merely that of co-consciously tasting, smelling, and feeling at once. A multisensory flavor experience may have features beyond those associated on that occasion with each of the respective modalities.

If it is possible to multimodally perceptually experience intermodal feature binding, novel feature instances, or novel

feature types, then not every conscious multisensory perceptual episode is a simple co-conscious fusion of what is associated on that occasion with each of the respective modalities. A perceptual experience may be constitutively multisensory in that it cannot be factored without remainder into experiences associated with each of the individual sense modalities plus whatever accrues thanks to mere co-consciousness.

Thus, I concur with Matthen's (this volume, III) rejection of what he calls "Empiricist Atomism." Since mere co-consciousness suffices only for composite experiences, there is some constitutively multisensory experience that is not merely a composite of simple modality-specific experiences.

So, a perceptual experience may be more than minimally multisensory in at least two ways. First, an experience that is associated with one modality may not have been possible if not for the other senses. That is, it may have a character that no corresponding presently and historically unisensory perceptual experience could have. Second, a multisensory perceptual experience may have features beyond those that are associated on that occasion with each of the respective modalities and that do not accrue thanks to simple co-consciousness. Perceptual experience thus may be multisensory in more than the minimal respect.

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Suppose that conscious perceptual awareness is richly multisensory in these ways. This has two noteworthy sorts of consequences.

First, projects that aim to focus on and theorize about one or another modality in abstraction or isolation from the others face serious methodological problems. Philosophers of perception typically choose a modality—usually vision—and talk about it alone. The objects of visual awareness, the representational content and phenomenological character of visual experiences, and the epistemic status of visual episodes have dominated philosophical discussions of perception during the past five decades.

However, perception is richly multisensory. This means that there is no studying vision itself entirely or wholly in isolation from the other modalities. Seeing happens in the context of other modalities, and even a presently wholly visual episode is shaped by a history of thoroughly multisensory awareness. A visual episode may depend, causally or constitutively, historically or presently, upon other senses. Such dependence may explain, alter, or confound claims about the nature of visual processes, visual objects, visual content, visual phenomenology, and the epistemic status of apparently visual episodes.

For instance, theorists debate the nature of visual objects. Does visual awareness target material bodies as such, or does vision fail to distinguish material bodies from ephemera such as shadows, rainbows, holograms, and holes? If visually experiencing a material body as such depends constitutively on tactual awareness of solid objects, then the debate can-

not be settled by focusing on vision alone. It requires tackling vision's relationship with touch. To take another recent example, philosophers have appealed to phenomenological contrasts between pairs of visual experiences in debating whether visual experience itself represents high-level properties. Intermodal interactions and mutual dependence can affect phenomenology in ways that confound both the claim that the relevant contrast is visual and the conclusion that visual content explains an experiential difference.

Thus, no perceptual modality—not even vision itself—can be understood exhaustively without comprehending the range of its relationships and the manner of its interactions with other senses.

Moreover, perception's richly multisensory character also means that a full account of perceptual awareness requires more than collected independent treatments of the several senses. Philosophers until recently have presumed that once we have explained visual experience, auditory experience, tactual experience, olfactory experience, and gustatory experience, along with the unity of consciousness, then we will have explained perceptual experience. However, some conscious perceptual episodes have features beyond those that are associated with each of the respective modalities and that are not the result of simple co-consciousness. Thus, no complete account of perceptual awareness ends with assembling autonomous accounts of the senses. Its richly multisensory character means that current theorizing about perception just gets interesting once it has addressed each of the senses.

The second consequence is more constructive. We gain new perceptual capacities through the coordinated use of multiple senses. It could have been that the senses functioned independently, and perceptual awareness might have been structured as a simple co-conscious fusion of experiences associated with each of the modalities. In fact, however, the richly multisensory nature of perception serves to improve and to extend it.

For instance, some cross-modal processes enhance the overall reliability of perception. Suppose two senses respond to a common feature but differ in accuracy or reliability, such as when vision and audition detect the location of an event. Under such conditions, if a conflict arises, perceptual processes tend to weight the perceptual result in deference to the more reliable modality (Welch and Warren 1980; see also Wozny et al. 2010). So, vision tends to dominate hearing when they disagree about location. This yields the ventriloquist effect. When vision's reliability is poor, as with dim lighting, the effect is reversed and audition biases visual location. Concerning temporal features, vision tends to defer to audition. When audition's reliability is poor, as with white noise, the reverse holds (cf., Stokes and Biggs 2015, especially section 6).

This strategy of weighting and biasing improves the accuracy and reliability of the overall perceptual result. In fact, Shams and Kim (2010, 280) say, "This strategy is statistically optimal as it leads to minimizing the average (squared) error of perceptual estimates; however, it results in errors in some

conditions, which manifest themselves as illusions." Each of the senses does better, and collectively they yield a better product, thanks to the manner in which they coordinate (see also Matthen, this volume, I.1). The cost is predictable errors.

Furthermore, richly multisensory perception enables us to perceive new features and to undergo novel varieties of perceptual experience. In the previous section, I described perceiving the coinstantiation of features perceptible through different senses, perceiving otherwise imperceptible instances of relations that hold between things perceived using different senses, and perceiving wholly novel types of features not perceptible with any mere collection of independent senses. Each involves extending our perceptual capacities and expanding perceptual experience through the coordinated use of multiple senses. Multisensory bootstrapping thereby augments perception and awareness.

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The claim that perception is richly multisensory raises two further questions. Each concerns psychological taxonomy for richly multisensory awareness. The first deals with how to type richly multisensory experiences by modality. The second deals with why the multimodal phenomena I have discussed belong to perception and not extra-perceptual cognition.

First, do perceptual experiences come in modalities at all? The more we learn about perception's multisensory character, the more tempting it is to scrap the idea that experiences belong to modalities corresponding to something like the traditional senses. Doing so would have a big impact on theorizing about perception. For instance, many intentionalists appeal to distinct visual and tactile modes of representing content, understood by analogy with propositional attitudes such as believing and desiring. If we scrap modalities, this would have no place in theorizing about perception. Perhaps there is just perceptually representing (see Speaks 2015). This would reshape debates about the adequacy of intentionalism, especially intramodal intentionalism. So, whither the modalities?

Rejecting modalities is too quick. Experiences can be typed by modality even in the face of perception's constitutively multisensory character. However, a closely related commitment should go.

To start, perceptual experiences are conscious perceptual episodes or events. We may type such episodes in any number of ways (see Macpherson 2011; cf., Matthen 2015, this volume, II.2). We can appeal to their objects or contents, the pathways or processes they involve, or their phenomenology. In typing perceptual experiences by their phenomenology, for instance, we may appeal to the distinctive qualitative character associated with the experience as of some proper sensible, such as a hue, a pitch, a temperature, a taste, or a smell. The proper sensibles might be identified by ostension, defeasibly and subject to trial and error, or they might be identified by appealing to some other criterion for individ-

uating senses. In either case, a conscious episode involving awareness as of hue is a visual episode, and so on.

You may think this approach has important limitations. For instance, humans sometimes visually experience common sensibles such as shapes. But, it may seem according to this criterion that a shape experience as such cannot be ascribed to a modality. (Or, perhaps spatial experiences are, in Matthen's terms, "pre-modal," this volume, I.2.) So, not every experience that belongs to a modality is ascribed to that modality. In addition, it may seem according to this criterion that some apparently multisensory perceptual experiences belong to no modality at all. For instance, consciously perceiving a novel intermodal relation instance as such belongs to no modality even while it involves vision and touch.

However, recall that we are typing perceptual episodes, rather than features (properties or parts) of such episodes, by modality. Features, including phenomenal features, may be associated with a given modality on an occasion, but on this approach a feature's being associated with a modality on an occasion does not amount to that feature's belonging to a modality-specific type of experience. Since we are typing episodes rather than features by their phenomenology, a case of experiencing a common sensible may belong to a given modality if that episode also involves experiencing one of that modality's proper sensibles. In addition, every perceptual episode may belong to some modality or another even while that episode's features are not exhausted by those that are associated on that occasion with some modality or another. Thus, even richly multisensory experiences belong to the modalities they involve. So, the apparent limitations are features not bugs.

The key to this approach is that a given conscious perceptual episode's belonging to one modality does not preclude its also belonging to another modality. The modalities, understood as classes of perceptual episodes typed by phenomenology, are not exclusive. A perceptual experience that is visual also may be auditory and tactile (see also Matthen, this volume, note 7). Consider a richly multisensory experience, such as experiencing intermodal feature binding. Take a case in which a subject experiences an explosion's being both loud and bright. Loudness and brightness are proper sensibles associated with hearing and sight, so the episode is identifiable by virtue of its phenomenology as an auditory and as a visual experience (even while its features are not exhausted by those that are associated on that occasion with either audition or with vision). Being an auditory experience is compatible with being a visual experience, and being auditory does not entail being exclusively or exhaustively auditory (see also Matthen's discussion, this volume, especially III). Richly multisensory conscious episodes therefore present no trouble for this approach to classifying and investigating experiences by modality.

What does pose trouble and what I think must go is the idea that perceptual experiences can be carved, with or without remainder, into modality-specific parts. We should give up on neatly apportioning experiences by modality and theorizing about each in abstraction from the rest.

Second, why are multimodal effects perceptual rather extra-perceptual cognition? This is a fertile question, and it opens a lot of doors. I'll outline part of my approach here. I am sympathetic to the idea that no sharp or principled boundary exists between perception and cognition and that a continuum stretches between the clear cases of each. Even so, the evidence supports situating central multisensory phenomena nearer to paradigms of perception than to paradigms of cognition.

To argue for this claim requires specifying the features that tend to distinguish and to diagnose central cases of perception and cognition. And here I think it is useful to recognize that a distinction between perception and extra-perceptual cognition may play differing explanatory roles. For instance, it may figure in empirical or experimental psychological explanation, which aims to explain behavior on the basis of causally efficacious internal mental states. Or, it may figure in personal, rational, or philosophical psychological explanation, which aims to make sense of and to evaluate an agent's beliefs and actions on the basis of that subject's reasons. Or, it may figure in characterizing a subject's consciousness, which aims to capture what it is like subjectively for an individual to undergo a course of experiences. My view is that these differing explanatory projects mark the distinction between perception and cognition with criteria that yield differing diagnostic features. It is an important question how closely the verdicts line up (cf., Matthen's discussion of how scientists and philosophers distinguish the senses, this volume, II).

Rather than work through each in detail, let me sketch one piece of the argument for multisensory perception. Consider experimental psychological explanation (see Matthen, this volume, especially II.1). Being a perceptual state is a matter of occupying a certain causal functional role. In particular, it roughly involves being responsive to stimulation to the various sensory surfaces and affecting attention, recognition, learning, memory, and action. Researchers operationalize the perceptual role experimentally in a number of ways. For instance, they measure response time, accuracy, and salience, and they attempt to control for confounds such as response strategies adopted to deal with ambiguous stimuli, memory and learning effects, and quick inferences. They introduce conflicts and masks, load attention, alter contextual cues, and test for Stroopability. Lately, they investigate neural activity. The results of several decades' work leaves little doubt that paradigmatic multisensory effects indeed are perceptual and not simply a matter of higher cognition, conscious inference, or memory (see Stein 2012). Things are complicated by the fact that cognition influences perception in ways previously not recognized or not appreciated. For instance, attention, categorical perception, and perceptual learning structure perceptual processing and perceptual awareness, at a time and over time, in ways traditionally associated with cognition. And this may affect how we understand not just perception's functional role but also both perception's rational role and whether some aspect of conscious awareness is perceptual or extra-perceptual.

Resolving these issues is future work. Nevertheless, central

examples of multisensory phenomena are on par in these respects with accepted, relatively uncontroversial examples of conscious intramodal perceptual awareness, such as awareness of objects and feature binding, of events and causes, and of spatial and temporal relations (Matthen, this volume, especially I and III.3, elaborates this point). Moreover, the example of novel or emergent qualitative features, such as apparent flavors, presents a serious obstacle to skeptics about richly multisensory perceptual consciousness. Still, this question reveals plenty of opportunity for future debate.

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In summary, section 2 argued that a conscious perceptual episode may be richly or constitutively multisensory in at least two respects. First, a perceptual experience that is associated with a given modality at a time may not have been possible without past or present conscious perceptual episodes associated with another modality.

Second, perceptual experience is more than a consciously unified sum of visual, auditory, tactual, gustatory, and olfactory experiences. That is, it is not the case that perceptual experience at each time is exhausted by a mere co-conscious fusion of that which is associated on that occasion with each of the respective modalities. Thus, perceptual experience is more than minimally multimodal.

Section 3 extracted two main lessons from this. First, there are serious methodological problems with projects that claim to focus on and theorize about one modality in isolation or abstraction from the others, as philosophers of perception commonly have done. An apparently visual phenomenon might best be explained by appeal to non-visual or multisensory phenomena. Moreover, a full account of perception requires more than independently addressing each individual modality.

Second, more constructively, we gain new perceptual capacities through the coordinated use of multiple senses. Multisensory coordination enhances perception by improving accuracy and reliability. Moreover, we perceive novel features and undergo new varieties of experience thanks to multisensory bootstrapping.

Section 4 addressed two remaining questions concerning psychological taxonomy for richly multisensory perception. First, it described how to type experiences by modality according to phenomenology despite their constitutively multisensory character. The key points are that we type experiential episodes rather than features by modality and that a given episode's being of one modality does not preclude its being of another modality—the modalities of experience are not exclusive.

Second, it sketched a defense of why multisensory phenomena belong to perception rather than extra-perceptual cognition. It argued that multisensory effects fit comfortably among accepted examples of perception relative to the requirements of contemporary psychological science. Nev-

ertheless, a full defense awaits considering the differing explanatory purposes for distinguishing perception from cognition—empirical and philosophical—along with their accompanying criteria.

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